

PAL System Service Manual

Prep and Load Platform



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1 ...PAL Systems Service Manual - PAL SM

Overview - Basic Structure

The PAL SM covers the PAL and the PAL-**xt** Systems. Issues specific to the PAL-**xt** models have been emphasized as such.

1.1 PAL System Service ManualSM Introduction

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1.1.1 PAL SM Release History

Edition	Date	Author	Reason for Changes
Edition 1.0.0	August 2007	Bruno BaltenspergerCTC Analytics AG	Initial Release of the PAL SM.Edition 1 includes Basic Documents and Basic PAL Components . Other PAL Modules are not covered within Edition 1.
Edition 1.0.1	August 2010	Bruno BaltenspergerCTC Analytics AG	New PAL Logo inserted. Spare Parts for X-, X-Y-Axes updated. Minor format and content changes.
Edition 1.0.2	November 2010	Bruno BaltenspergerCTC Analytics AG	Search Routine enabled. Minor format and content changes.
Edition 1.1.0	December 2010	Bruno BaltenspergerCTC Analytics AG	Section 'PAL Power Supply' added. Section 'handheld PAL Control Terminal' added. Section 'Warranty Statement for User' added. Section 'Intended Use' added. Update for PAL- xt System. Firmware information updated to FWVersion 4.2.0. Index Topics enabled. Minor format and content changes.

1.1.2 PAL SM Release History

Edition	Date	Author	Reason for Changes
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Edition	Date	Author	Reason for Changes
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1.1.3 Introduction Notices

1.1.3.1 Warranty Statement for SM

1.1.3.2 Safety Notices

CAUTION:

A CAUTION warning refers to a potential hazard and calls for full attention to the procedure described. The task should not be continued until the information is fully understood.

Disregarding the notice can result in damage to the instrument or loss of data.

WARNING:

A WARNING notice refers to a potential hazard and calls for full attention for the procedure described. The task should not be continued until the information is fully understood.

Disregarding the notice can result in personal injury, death, damage to the instrument or loss of data.

SAFETY WARNING

A SAFETY WARNING refers to a possible safety hazard and calls for full attention to the procedure described. When working in a laboratory environment, it is important to consult the lab manager to discuss any possible exposure to chemicals, solvents or other hazardous substances.

It is the customer's responsibility to ensure the safety of the service technician during the maintenance, repair or testing of the analytical system, with respect to contact with chemicals, solvents or any other hazardous substances in the customer's facilities.

Disregarding this notice may result in personal injury, death, damage to the instrument or loss of data.

1.1.3.3 Safety Information

Detailed Safety Information is provided outlined in the special section devoted to safety.

1.2 PAL SM General Information

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1.2.1 CTC Analytics Product Warranty Statement

1.2.2 Product Warranty

1.2.2.1 Statement of Limited Product Warranty

1.2.2.1.1 What does this Warranty cover?

CTC Analytics AG warrants only that its products comply with CTC Analytics AG specifications.

This warranty covers defects in or failures of the Autosampler and major accessories, such as Agitator, Stack Coolers, or Valve Drives, occurring as a result of normal use or manufacturing defect.

1.2.2.1.2 What is NOT covered by this warranty?

This warranty does not cover defects or failures resulting from damage caused by accident, misuse or abuse, such as:

- Improper or unauthorized service or repair.
- Failure to follow the operating instructions provided by CTC Analytics AG.
- Improper or insufficient ventilation.
- 'Force Majeure': No liability for events beyond its reasonable control, including, but not limited to, fire, storm, flood, earthquake, explosions, riots, strikes, labor disputes, transportation embargoes or other contingencies beyond the control of CTC Analytics AG. (i.e. 'Act of God' or 'Force Majeure').
- Exposure to corrosive compounds.
- The warranty does not cover parts exposed directly to liquids, such as valves, valve rotors or other valve components, tubing or syringes or any other parts considered consumables and wear parts.

1.2.2.1.3 What is the Period of Coverage?

This warranty remains in effect for a period of one year from the date of installation.

1.2.2.1.4 What will CTC Analytics do to correct Problems?

CTC Analytics AG is represented by an authorized distributing or OEM partner in a respective country. These partners must be contacted to request technical assistance by phone to diagnose the nature and probable cause

of any malfunction. If we determine that the problem is due to a defect in the instrument or a module, any replacement module(s) that has (have) been determined to be necessary to correct the problem will be sent to user's location, shipping costs at previously agreed conditions.

1.2.2.1.5 What will CTC Analytics NOT Do?

A service representative will not be sent to perform service at customer's location prior to a determination by the responsible CTC Analytics representative that such is necessary.

Only after telephone support and replacement of any modules sent to user's site have failed to resolve the problem will we send a service representative on site. CTC Analytics AG will not replace 'consumable' parts, as explained above.

1.2.2.1.6 How can you get Technical Assistance?

To obtain technical assistance, call the responsible CTC Analytics representative from whom the instrument was originally purchased.

Please be prepared to provide the serial number of the instrument and discuss the problem in detail, and be willing to perform recommended tests and adjustments to help us determine the probable cause of and solution to the problem.

1.2.2.1.7 What must you do to keep the Warranty in Effect?

To keep this warranty in effect, the user must take care to avoid accidents, misuse and abuse, as described above under 'What is Not covered by this Warranty?'.

The maintenance guidelines outlined in the PAL User Manual must be followed. Preventative Maintenance (PM) or any service or repair task on the instrument must be carried out by CTC Analytics authorized personnel only.

1.2.2.1.8 Normal Responsibilities of the Buyer

The user must report any problem with the equipment to the responsible representative of CTC Analytics AG and assist the technical support representative in diagnosing and attempting to resolve the malfunction of the instrument. It is expected that the user will cooperate and will install any replacement parts (modules) that have been sent and will return any exchanges or unused replacement parts to the responsible representative of CTC Analytics AG at previously agreed conditions.

1.2.2.1.9 How does the LAW of various Countries or States relate to this Warranty?

This warranty gives you specific legal rights, and you may also have other rights which vary from country to country or from state to state.

1.2.2.1.10 How does this Warranty relate to Warranty Statements of various Distributing or OEM Partners?

This warranty statement from CTC Analytics AG gives the user specific legal rights.

If the warranty statement from your purchaser, distributor, or OEM is broader, the added value of that warranty will be valid for the user. This, however, is not the responsibility of CTC Analytics AG, but solely that of the particular distributor or OEM partner.

1.2.2.2 CTC Analytics Product Warranty Statement

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1.2.2.3.1.8 Normal Responsibilities of the Buyer

The user must report any problem with the equipment to the responsible representative of CTC Analytics AG and assist the technical support representative in diagnosing and attempting to resolve the malfunction of the instrument. It is expected that the user will cooperate and will install any replacement parts (modules) that have been sent and will return any exchanges or unused replacement parts to the responsible representative of CTC Analytics AG at previously agreed conditions.

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If the warranty statement from your purchaser, distributor, or OEM is broader, the added value of that warranty will be valid for the user. This, however, is not the responsibility of CTC Analytics AG, but solely that of the particular distributor or OEM partner.

1.2.3 Scope and Purpose

The objective of this document, provided in electronic form, is to support trained and authorized engineers in the maintenance and repair of the various PAL System models.

The first section provides general information such as warranty, safety warnings, site requirements, the returning of material to CTC Analytics for repair, etc.

The subsequent sections describe the actual maintenance/repair steps followed by listings of spare parts, technical information and the release history of hardware and software.

The section "Optimization and Troubleshooting" provides further information for understanding system function and requirements, and helps in optimizing system performance.

1.2.3.1 PAL SM Basic Documents

- [Scope and Purpose](#)
- [Responsibilities](#)
- [Warranty Statement for SM](#)
- [Copyrights](#)
- [Safety Warnings](#)
- [Return Material Authorization; RMA](#)
- [Site Requirements, Pre-Installation Guide](#)

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The section "Optimization and Troubleshooting" provides further information for understanding system function and requirements, and helps in optimizing system performance.

1.2.3.3 Responsibilities

CTC Analytics AG

It is the responsibility of CTC Analytics AG to ensure that the representative of authorized dealers are trained and knowledgeable on the equipment and procedures with respect to the PAL System only, not including other components of the total system. In the cases of IQ/OQ/PQ/PV procedures, the responsibilities are outlined in the related documents.

CTC Analytics Representatives

The company providing other equipment to complete a system, e.g. a GC, HPLC or a mass spectrometry system, usually performs the maintenance or repair of that component only. If the supplier company is authorized to install, maintain and repair the PAL System, they can be in charge for the complete system.

It is the responsibility of all authorized representatives that their employees are trained and operate using the current version of documents and technical information and will provide the needed test equipment.

Customer

The customer is responsible for supplying additional support services, which may include a dedicated electrical supply, climate control, solvents and chemicals as well as appropriate disposal facilities for solvents and chemicals.

SAFETY WARNING

Follow the Safety Instructions as outlined in the PAL User Manual, Service Manual or the corresponding manuals / instructions from the supplier(s) of the other system modules.

It is the customer's responsibility to ensure the safety of the service technician during the maintenance, repair or testing of the analytical system, with respect to contact with chemicals, solvents or any other hazardous substances in customer's facilities.

See also the Safety Warning outlined in the section "Return Material Authorization, RMA".

1.2.3.4 Intended Use for PAL and PAL-xt Systems by CTC Analytics AG

1.2.3.4.1 Introduction:

The brand name 'PAL System' represents an entire product family, the following description of intended use therefore applying to the product groups 'PAL' and

'PAL-xt', which include for example the models COMBI PAL, HTS PAL or PAL COMBI-xt and PAL HTS-xt together with other PAL/PAL-xt design-dependent subclasses.

If the PAL System is distributed through OEM partners, the product or model name can be replaced with their own trade name but the 'Intended Use' remains valid.

1.2.3.4.2 Intended Use:

The PAL System is an XYZ robotic system offering high flexibility and functionality. Its intended use can be described mainly as autosamplers or sample preparation devices for all relevant fields of application in chemical and physical analysis.

The systems are intended for use by trained operators in a professional environment.

Typical fields of application for the PAL System are:

- Environmental analysis
- Quality control in the chemical and pharmaceutical industries
- Drug discovery
- Metabolism studies on agrochemicals or pharmaceutical products

The above list of potential applications is not exhaustive.

The traditional market position of CTC Analytics AG has resulted in the PAL System being mainly used as an autosampler device for the techniques of GC (gas chromatography) and HPLC (high pressure liquid chromatography).

Sample preparation steps, such as filtration, purification or separation by means of solid phase extraction (SPE), derivatization, etc., are possible in combination with chromatographic or other techniques.

Other techniques or areas of application are also possible. XYZ robotic systems are typically used where vial (sample) transport, liquid handling or sample preparation need to be automated. Known fields of application include tablet dissolution and viscosimetry.

To a large extent, the user will determine which substances, compounds or liquids the system will come into contact with.

1.2.3.4.3 Disclaimer and Restrictions on Use:

The PAL System boundary delineates the limits of the manufacturer's responsibility. Placing samples (vials, well plates or other sample holding devices), inserting syringes, selecting reagents and wash solvents, along with all other preparative tasks, are solely the responsibility of the user. Erroneous or omitted samples cannot be detected or prevented by the PAL System. The PAL or PAL-**xt** System boundary is defined by the placement of samples in the fully prepared system.

The use of the PAL and PAL-**xt** Systems for any invasive technique on human beings or animals is strictly forbidden.

In addition, use of the PAL and PAL-**xt** Systems is prohibited in any environment requiring explosion protection.

1.2.3.5 Warranty Statement for PAL System Service Manual - PAL SM

CTC Analytics AG reserves the right to make improvements and/or changes to the product(s) described in this Addendum at any time without prior notice.

Under no circumstances shall CTC Analytics AG be held liable for any coincidental damage or damages arising as a consequence of or from the

use of this document.

CTC Analytics AG makes no warranty of any kind pertaining to this product, including but not limited to the implied warranties of merchantability and suitability for a particular purpose.

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1.2.3.6 Copyrights

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CTC Analytics AG acknowledges all trade names and trademarks used as the property of their respective owners.

1.2.3.7 Safety Warnings

Note: See also the 'Specs' chapter in the 'Safety' section for more information.

1.2.3.7.1 General Safety Information

The following general safety precautions must be observed throughout all procedures of operation, maintenance, service and repair of the PAL System and any other devices connected to complete a system. Failures to comply with these precautions or with specific warnings elsewhere in this PAL SM violates the safety standards of design, manufacture and intended use of the PAL System or the complete system. CTC Analytics assumes no liability towards authorized representatives, any other technicians, or the customer, in the event of failure to comply with these requirements.

The PAL System is a Safety Class I instrument with a power supply for protective grounding (earthing) and has been manufactured and tested according to international safety standards.

The PAL System User Manual and the corresponding 'Addendum' for a specific module must be consulted by the user under all circumstances before a unit is put in use.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The user shall be made aware that, if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

When using the PAL System, follow the generally accepted procedures for quality control and methods development.

When using the PAL System in the field of chromatographic analysis, if a change in the retention of a particular compound, in the resolution between two compounds, or in peak shape is observed, immediately determine the reason for the changes. Do not rely on the separation results until you determine the cause of a change.

1.2.3.7.2 Electrical Hazards

Note: This section is a copy of the Safety Warnings as outlined in the PAL USER MANUAL. The original Safety Warnings from the PAL USER MANUAL and Safety Warnings from any related devices of other manufacturers take first priority and are binding. These, and the warnings below, may be changed without prior notice.

Every analytical instrument has specific hazards, so be sure to read and comply with the following precautions. They will help ensure the safe, long-term use of your PAL System.

The Installation Category (over-voltage Category) for this instrument is Level II. The Level II Category pertains to equipment that receives its electrical power locally, such as an electrical wall outlet.

Use only fuses of the type and current rating specified. Do not use repaired fuses and do not short-circuit the fuse holder.

The supplied power cord must be inserted into a power outlet with a protective earth contact (ground). When using an extension cord, make sure that the cord also has an earth contact.

Do not change the external or internal grounding connections. Tampering with or disconnecting these connections could endanger you and/or damage the PAL System.

The instrument is properly grounded in accordance with these regulations when shipped. You do not need to make any changes to the electrical connections or the instrument's chassis to ensure safe operation.

The combination of a PAL System with a LC/MS System does require the safety measures as described by the LC/MS System manufacturer. Detailed instructions for the safety grounding of the LC/MS system are outlined in the corresponding operating/installation manual. CTC Analytics recommends the use of a grounding cable with

one side connected to the Injection Valve, Loop or any other suitable direct metallic contact, and the other side to an appropriate grounding point at the LC/MS System. This supplementary grounding measure will support the safety strategy of the LC/MS System manufacturer.

Do not turn the instrument on if you suspect that it has incurred any kind of electrical damage. Instead, disconnect the power cord and contact a CTC Analytics representative for a product evaluation. Do not attempt to use the instrument until it has been evaluated. Electrical damage may have occurred if the PAL System shows visible signs of damage, has been exposed to liquids or has been transported under severe stress. Damage can also result if the instrument is stored for prolonged periods under unfavorable conditions (e.g. subjected to heat, dampness, etc). In any case disconnect the power cord(s) from the power supply or from the different power supplies if optional devices are installed, before attempting any type of maintenance.

Capacitors inside the instrument may still be charged even if the instrument is turned off.

To avoid damaging electrical parts, do not disconnect an electrical assembly while the PAL system power is on. Once the power is turned off, wait approximately 30 seconds before you disconnect an assembly.

The instrument includes a number of integrated circuits. These circuits may be damaged if exposed to excessive line voltage fluctuations and/or power surges.

Never try to repair or replace any components of the instrument not described in this manual without the assistance of a CTC Analytics representative.

There are no operator-serviceable or replaceable parts inside the power suppl(ies) or in the PAL System. If a power supply is not functioning, contact a CTC Analytics representative.

The power supply for the PAL Instrument has the symbols I/O on the label for the power switch ON/OFF. Any additional power supply for other devices such as a Cooled Stack or a Valve Module shows these symbols on the label for the power switch. The symbols warn the user that in a emergency case, more than one power supply must be turned OFF or more than one power cord has to be pulled out from the power supply or from the wall outlet to shut down the complete PAL System.

If the basic PAL System is installed, then only a single power supply is installed. Turning OFF the power supply or pulling the single power cord in an emergency will stop the complete PAL System.

It is important that the power suppl(ies) are in a location where the ON and OFF power switches are accessible and easy to operate, and where it is possible to unplug the AC power cord from the power supply/wall outlet in case of emergency.

1.2.3.7.3 Other Hazards

Warnings for other hazards are described in the corresponding PAL USER MANUAL.

1.2.3.7.4 Operation

Before connecting the PAL System to the power source, comply with the installation section of the corresponding PAL USER MANUAL. In addition, the following points must be observed:

Do not remove any instrument parts or covers when operating. Before the instrument is switched on, all protective earth terminals, extension cords, power supply modules and devices connected to it (note: this listing is not complete) must have a protective earth connection via a ground socket. Special attention has to be given in cases where the PAL System is connected to a device where a high voltage is applied, for example a HPLC-MS system. Details are given in the corresponding PAL USER MANUAL.

Any interruption of the protective earth connection could cause a electrical shock hazard that could result in serious personal injury or death. Whenever it is suspected that the protective connection has been impaired, the instrument must be made inoperative and secured against any operation.

Some adjustments or tests described in the PAL SM are done with power to the system ON and with certain protective devices (such as covers) removed. Note that an active power supply at certain points may, if contacted, result in personal injury.

WARNING

Disconnect the PAL System from the power line and unplug the power cord before any maintenance or repair step is begun. Disconnect the PAL System from any other device which is part of the complete system.

Any adjustment, maintenance and repair of the opened PAL System under active voltage is forbidden.

SAFETY WARNINGS

It is important to consult the lab manager to discuss any possible exposure to chemicals, solvents or any other hazardous substance when working in a laboratory environment.

It is the customer's responsibility to ensure the safety of the service technician during the maintenance, repair or testing performing of the analytical system with respect to contact with chemicals, solvents or any other hazardous substance in the customer's facilities.

Safety Warnings as stated in the corresponding USER MANUAL(S) or any other TECHNICAL MANUAL(S)/DESCRIPTION(S) provided by CTC Analytics or any other manufacturer of component(s) which are part of the complete system, or on the SAFETY LABELS posted on devices.

Disregarding any of these notices can result in personal injury, death, damage to the instrument or loss of data.

See also the PAL [SM General Information](#).

1.2.3.8 Return Material Authorization, RMA 'Return Material Authorization Number'

1.2.3.8.1 CTC RMA-No

In cases where it is necessary to return a component of the system for repair, it is mandatory to first contact CTC Analytics. Before returning the part, a cross-check must be performed to evaluate whether all possibilities have been tested, if spare parts can be provided or if the part must be returned.

A repair case file will be opened, and a so-called 'CTC RMA No' will be provided by fax, e-mail or telephone call.

Contacts:

Tel +41 61 765 81 00

Fax: +41 61 765 81 99

e-mail: support@ctc.ch

One number will be given for each case. If a complete unit is sent back, it will receive only one number. If a related case, e.g. a heated cartridge and injection unit or CPU and MOTIO-Driver board have to be checked, we will assign one number for the case.

We ask you to clearly identify the parts with the CTC RMA-No. For all questions or correspondence concerning a repair, this number shall be used as a reference.

A detailed error description is still required. Place the description together with the parts inside the box. Any papers placed outside the box together with shipping papers are often removed by customs authorities.

1.2.3.8.2 Contamination Declaration

A form sheet 'Contamination Declaration' is provided as a download on the support web-page. It is required to fill out this form sheet to verify that the return parts are decontaminated.

SAFETY WARNING

The customer has to ensure that the system has not been contaminated by any hazardous chemical or biological compound including bacteria or viruses (list not complete).

Any part which had direct contact with the analytical sample must be removed from the system and left with the customer. Specifically dangerous are: Syringes, Valves, Loops, Tubing, Vials and Well-Plates.

If a critical part has to be returned for repair or inspection, CTC Analytics expects that an appropriate decontamination procedure is done by the customer prior to shipping.

Any critical parts received will be destroyed according to national laws for hazardous compounds.

The service engineer/technician is fully responsible for enforcing these requirements. CTC Analytics will hold the representative or customer responsible if these safety regulations are not observed.

1.2.3.8.3 Policy for Repair and Exchange

Parts:

In general, we will repair all parts required. If it is not possible to repair a part, or if repair costs are excessive, CTC Analytics reserves the right to replace the part. We will offer a so-called '-X' part. This is a repaired and tested part provided in exchange. If we have no '-X' part in stock, we will offer a new part for the price of an exchange part.

Exchange parts cannot be ordered without the return of the defective part.

Pre-Exchanged Parts:

In some cases it is necessary to react quickly to help the end user, in order to reduce the down time of the system. In these special cases, we offer a pre-exchange of parts. This will be decided from case to case. The policy is that we will send an invoice for the part supplied, and after receiving the defective part, a credit note will be issued for the difference.

A valid CTC RMA-No. is also required for a pre-exchange.

1.2.3.8.4 Packaging of Parts

We encourage users and distributors to keep the original packaging in case a part has to be returned. All instruments and sub-assemblies should be packaged in the original box.

If loose material (foam or any similar item) is used to fill up the box, it is mandatory to protect the instrument or sub-assembly in a plastic bag. Removing loose material and cleaning the unit is very time consuming.

Transport insurance covers damages caused during transport only, but not if a component is insufficiently packed. CTC Analytics will make a claim to the distributor in case of any damages caused by insufficient packaging of goods.

1.2.3.8.5 Transport of Return Parts

Return of parts is insured for the entire transport back to the factory by CTC Analytics. The individual shipment needs not be insured by the party dispatching the goods.

CTC Analytics reserves the right to select the shipping agent and the method of shipping for any parts to be returned to the factory.

If this is not respected and exaggerated costs are incurred as a result, CTC Analytics reserves the right to charge the additional costs to the distributor.

1.2.3.8.6 Waste Treatment

CTC Analytics has established procedures for all areas within the company to fulfill the European directive 2002/96/EC on 'Waste Electronic and Electrical Equipment', otherwise known as 'WEEE'.

1.2.3.9 RoHS and WEEE Compliance

CTC Analytics

CTC Analytics AG
CH-4222 Zwingen
Industriestrasse 20
Switzerland

Tel. +41 (0)61 765 81 00
Fax. +41 (0)61 765 81 99
info@ctc.ch

Zwingen, January 4th 2011

RoHS and WEEE Compliance

Supplier Certificate valid for the following product(-s) as delivered by CTC Analytics:

- PAL System including the optional modules
- PAL-**xt** System including the optional modules

Referenced Documents

Following directives of the European Union are referenced in terms of inquiries, specifications, standard(-s) or substance list(-s):

- Directive 2002/95/EC on Restriction of the use of certain Hazardous Substances, RoHS
- Directive 2002/96/EC on Waste Electrical and Electronic Equipment, WEEE

Confirmation

We herewith confirm, that the above mentioned product(-s) does/do not contain any of the reportable substances (substances being banned or to be declared) as listed in the above referenced documents in concentrations above the limits as specified therein, respectively – if there are no concentration limits specified – in concentrations being intentionally introduced.

The design and production of the electrical and electronic equipment takes into account the dismantling and recovery of WEEE and its components and materials.

WEEE Marking

The products that are subject to the WEEE Directive shipped after July 1st 2006 (date of enforcement of WEEE Directive by the European Union) are compliant with the WEEE marking requirements.

See WEEE symbol below. The meaning of the symbol is explained in the user information – indication that the product must not be disposed of with household waste.



Declaration of Compliance

All products as listed above comply with RoHS and WEEE requirements. There is no substance to be declared.

Disclaimer

All information in this declaration is given to the best of our present knowledge and belief. The information given does not imply giving a warranty within the meaning of the warranty law.

CTC Analytics AG

Beat Lüthi
CEO

1.2.3.10 Site Requirements | Pre-Installation Guide

For more details see the section "[Site Requirements](#)".

1.2.4 PAL Model Overview

PAL Model	Description	Remarks
1.2.4.1 COMBI PAL System 	The COMBI PAL System is mainly used for GC techniques. 4 different techniques are applicable: - Liquid Injection - Headspace Sample Preparation Technique - SPME (Solid Phase Micro Extraction)Fiber technique - ITEX (In Tube Extraction) Organics are trapped and thermally desorbed Standard length of X-Axis: 80 cm	SNo. for COMBI PAL System within number range of: 12xxxx. Main Electronic Boards installed: - APR CPU Board- APR MOTIO Board Injection Unit: MZ 02-00
1.2.4.2 GC PAL System 	GC PAL System mainly used for GC techniques. 2 different techniques are applicable: - Liquid Injection - SPME (Solid Phase Micro Extraction)Fiber technique. Standard length of X-Axis: 80 cm <i>Note: GC PAL can NOT be upgraded for the Head-space or ITEX Technique.</i>	SNo. for GC PAL System within number range of: 16xxxx. Main Electronic Board installed: - APR Control-GC Board Injection Unit: MZ 06-00 (Unit is shorter, equal with LC PAL) <i>Note: PAL System with certain limitations. Heating devices or Dilutor options are not compatible. Control Board has only one "Auxiliary" connector and no connector for a Wash Station (electrical driven solenoid or pump).</i>

PAL Model	Description	Remarks
1.2.4.3 HTS PAL 	HTS PAL System mainly used for HPLC Techniques. All optional devices can be operated with the HTS PAL. Examples: Dilutor, high throughput valve system, etc. Standard length of X-Axis: 80 cm	SNo. for HTS PAL System within number range of: 11xxxx. Main Electronic Boards installed: - APR CPU Board- APR MOTIO Board Injection Unit: MZ 01-00
1.2.4.4 HTC PAL 	HTC PAL System mainly used for HPLC Techniques. All optional devices can be operated with the HTC PAL. Examples: Dilutor, high throughput valve system, etc. Limitation is the length of the X-Axis, 50 cm. Routine instrument, bench space saving.	SNo. for HTC PAL System within number range of: 14xxxx. Main Electronic Board installed: - APR Control-HTC Board Injection Unit: MZ 01-00 <i>Note: Same Injection Unit as used for the HTS PAL System. Stack or a Cooled Stack can be used. Control Board has only one "Auxiliary" connector.</i>
1.2.4.5 LC PAL 	LC PAL System mainly used for HPLC Techniques or used as a standardized product for other techniques, e.g. elemental analysis. Length of X-Axis: 50 cm. <i>Note: Configuration is standardized. Other PAL Modules (Objects) cannot be loaded to firmware.</i>	SNo. for HTC PAL System within number range of: 13xxxx. Main Electronic Board installed: - APR Control-LC Board Injection Unit: MZ 06-00 (Unit is shorter, equal to that of GC PAL) <i>Note: PAL System with certain limitations. Heating devices, Dilutor option or Stacks are not compatible. Control Board has only one "Auxiliary" connector.</i>
1.2.4.6 HTX PAL Picture not available yet	HTX PAL can be used for HPLC and with limitations for the GC Technique. Main difference is the length of the X-Axis: 120	SNo. for HTX PAL System within number range of: 17xxxx.

PAL Model	Description	Remarks
	cm. Y-Axis standard length of 312 mm. Typical instrument of choice if space for the standard PAL System is limited for the various modules. Example: 3 cooled Stacks can be attached. <i>Note: Maximum Tray (Plate) number is 24. General Firmware limitation.</i>	Main Electronic Boards installed: - APR CPU Board- APR MOTIO Board Injection Unit: MZ 01-00 <i>Note:</i> <i>No Gas Flush Tube installed for the Headspace or ITEX Technique.</i>
1.2.4.7 HTXX PAL Picture not available yet	HTXX PAL can be used for HPLC and with limitations for the GC Technique. Main difference between the model HTX PAL (120 cm length of X-Axis) is the length of the Y-Axis: 402 mm. Typical instrument for special applications where reach of the Y-Axis is required. <i>Note: Maximum Tray (Plate) number is 24. General Firmware limitation.</i>	SNo. for HTX PAL System within number range of: 210xxx. Main Electronic Boards installed: - APR CPU Board - APR MOTIO Board Injection Unit: MZ 01-00 <i>Note:</i> <i>No Gas Flush Tube installed for the Headspace or ITEX Technique.</i>
1.2.4.8 LHX PAL picture not available yet.	LHX PAL can be used for the GC technique when more space for the various options is required. Gas flushing for the headspace and/or ITEX techniques is provided.	SNo. for LHX PAL System within number range of: 200xxx. Main Electronic Boards installed: - APR CPU Board- APR MOTIO Board Injection Unit: MZ 02-00 or MZ 010-00(ITEX) <i>Note:</i> <i>Gas Flush Tube for the Headspace or ITEX Technique is outside of the unit installed.</i>

PAL Model	Description	Remarks
1.2.4.9 IFC PAL Analytical Version 	The analytical IFC PAL is typically used for fraction collection with flow rates < 1.0 ml/min. Long X-axis, 120 cm. 2 Injection units independently operated, injection and collection sides are strictly separated to avoid carry-over. All available PAL Modules can be used to configure this IFC PAL to their specific needs. Trays and/or Stacks can be selected. Fraction collection can be done directly into MT-Plates up to 384-well format. Flow rates from low micro-liter (uL) range up to 1000 uL/min are used. Syringe and tubing sizes have to be adapted accordingly. Dual Injection Unit system. Length of X-Axis: 120 cm Length of Y-Axis: 40.2 cm	SNo. for the IFC PAL within number range of: 18xxxx. Main Electronic Boards installed: Injection side:- APR Control-HTC Board <i>Note: Control Board has only one "Auxiliary" connector.</i> Collector side: - APR CPU Board- APR MOTIO Board Injection Unit Injection side: MZ 01-00 Injection Unit Collector side: MZ 09-00
1.2.4.10 IFC PAL Preparative Version 	The Prep IFC PAL is typically used for fraction collection with flow rates > 1 ml/min. Typically 5 to 50 ml/min. The prep IFC PAL is delivered with a slider and drip pan on the collector side. Various Trays (racks) are available for reagent tubes with a OD range from 13 to 25 mm and holding 9 to 50 ml. Special Trays are available on request. Dual Injection Unit system. Length of X-Axis: 120 cm Length of Y-Axis: 40.2 cm	SNo. for the IFC PAL within number range of: 18xxxx. Main Electronic Boards installed: Injection side:- APR Control-HTC Board <i>Note: Control Board has only one "Auxiliary" connector.</i> Collector side: - APR CPU Board- APR MOTIO Board Injection Unit Injection side: MZ 01-00 Injection Unit Collector side: MZ 09-00

PAL Model	Description	Remarks
1.2.4.11 PAL COMBI-<i>xt</i> 	The PAL COMBI-<i>xt</i> System is mainly used for GC techniques. 4 different techniques are applicable: - Liquid Injection - Headspace Sample Preparation Technique - SPME (Solid Phase Micro Extraction) Fiber technique - ITEX (In Tube Extraction) Organics are trapped and thermally desorbed Standard length of X-Axis: 80 cm	Main Electronic Board installed: - APR Control-<i>xt</i> Board - Injection Unit: MZ 019-00 - The PAL-<i>xt</i> System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-<i>xt</i>

PAL Model	Description	Remarks
1.2.4.12 PAL GC-xt 	PAL GC-xt System mainly used for GC techniques. 2 different techniques are applicable: - Liquid Injection - SPME (Solid Phase Micro Extraction) Fiber technique. Standard length of X-Axis: 80 cm <i>Note: PAL GC-xt can NOT be upgraded for the Headspace or ITEX Technique.</i>	Main Electronic Board installed: - APR Control-xt Board Injection Unit: MZ 018-00 and MZ 015-00 (Agilent brand) (Unit is shorter, equal with LC PAL) <i>Note: PAL GC-xt System can not be equipped with a heated cartridge (Headspace technique).</i> The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt
1.2.4.13 PAL LHX-xt	PAL LHX-xt can be used for the GC technique when more space for the various options is required. Gas flushing for the headspace and/or ITEX techniques is provided.	Main Electronic Board installed: - APR Control-xt Board Injection Unit: MZ 019-00 <i>Note:</i> <i>Gas Flush Tube for the Headspace or ITEX Technique is outside of the unit installed.</i> The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt

PAL Model	Description	Remarks
		
1.2.4.14 PAL HTS-xt 	PAL HTS-xt System mainly used for HPLC Techniques. All optional devices can be operated with the PAL HTS-xt. Examples: Dilutor, high throughput valve system, etc. Standard length of X-Axis: 80 cm	Main Electronic Board installed: - APR Control-xt Board - Injection Unit: MZ 017-00 - The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt

PAL Model	Description	Remarks
1.2.4.15 PAL HTC-xt 	PAL HTC-xt System mainly used for HPLC Techniques. All optional devices can be operated with the PAL HTC-xt Examples: Dilutor, high throughput valve system, etc. Limitation is the length of the X-Axis, 50 cm. Routine instrument, bench space saving.	Main Electronic Board installed: - APR Control-xt Board Injection Unit: MZ 017-00 <i>Note: Same Injection Unit as used for the PAL HTS-xt System. Stack or a Cooled Stack can be used.</i> The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt

PAL Model	Description	Remarks
1.2.4.16 PAL HTX-xt 	PAL HTX-xt can be used for HPLC and with limitations for the GC Technique. Main difference is the length of the X-Axis: 120 cm. Y-Axis standard length of 312 mm. Typical instrument of choice if space for the standard PAL System is limited for the various modules. Example: 3 cooled Stacks can be attached. <i>Note: Maximum Tray (Plate) number is 24. General Firmware limitation.</i>	Main Electronic Board installed: - APR Control-xt Board Injection Unit: MZ 017-00 <i>Note:</i> <i>No Gas Flush Tube installed for the Headspace or ITEX Technique.</i> The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt

1.2.4.17 PAL Model Overview

PAL Model	Description	Remarks
1.2.4.17.1 COMBI PAL System 	The COMBI PAL System is mainly used for GC techniques. 4 different techniques are applicable: - Liquid Injection - Headspace Sample Preparation Technique - SPME (Solid Phase Micro Extraction) Fiber technique - ITEX (In Tube Extraction) Organics are trapped and thermally desorbed Standard length of X-Axis: 80 cm	SNo. for COMBI PAL System within number range of: 12xxxx. Main Electronic Boards installed: - APR CPU Board- APR MOTIO Board Injection Unit: MZ 02-00

PAL Model	Description	Remarks
1.2.4.17.2 GC PAL System 	GC PAL System mainly used for GC techniques. 2 different techniques are applicable: - Liquid Injection - SPME (Solid Phase Micro Extraction)Fiber technique. Standard length of X-Axis: 80 cm <i>Note: GC PAL can NOT be upgraded for the Head-space or ITEX Technique.</i>	SNo. for GC PAL System within number range of: 16xxxx. Main Electronic Board installed: - APR Control-GC Board Injection Unit: MZ 06-00(Unit is shorter, equal with LC PAL) <i>Note: PAL System with certain limitations. Heating devices or Dilutor options are not compatible. Control Board has only one "Auxiliary" connector and no connector for a WashStation (electrical driven solenoid or pump).</i>
1.2.4.17.3 HTS PAL 	HTS PAL System mainly used for HPLC Techniques. All optional devices can be operated with the HTS PAL. Examples: Dilutor, high throughput valve system, etc. Standard length of X-Axis: 80 cm	SNo. for HTS PAL System within number range of: 11xxxx. Main Electronic Boards installed: - APR CPU Board- APR MOTIO Board Injection Unit: MZ 01-00
1.2.4.17.4 HTC PAL 	HTC PAL System mainly used for HPLC Techniques. All optional devices can be operated with the HTC PAL. Examples: Dilutor, high throughput valve system, etc. Limitation is the length of the X-Axis, 50 cm. Routine instrument, bench space saving.	SNo. for HTC PAL System within number range of: 14xxxx. Main Electronic Board installed: - APR Control-HTC Board Injection Unit: MZ 01-00 <i>Note: Same Injection Unit as used for the HTS PAL System. Stack or a Cooled Stack can be used. Control Board has only one "Auxiliary" connector.</i>

PAL Model	Description	Remarks
1.2.4.17.5 LC PAL 	LC PAL System mainly used for HPLC Techniques or used as a standardized product for other techniques, e.g. elemental analysis. Length of X-Axis: 50 cm. <i>Note: Configuration is standardized. Other PAL Modules (Objects) cannot be loaded to firmware.</i>	SNo. for HTC PAL System within number range of: 13xxxx. Main Electronic Board installed: - APR Control-LC Board Injection Unit: MZ 06-00 (Unit is shorter, equal to that of GC PAL) <i>Note: PAL System with certain limitations. Heating devices, Dilutor option or Stacks are not compatible. Control Board has only one "Auxiliary" connector.</i>
1.2.4.17.6 HTX PAL Picture not available yet	HTX PAL can be used for HPLC and with limitations for the GC Technique. Main difference is the length of the X-Axis: 120 cm. Y-Axis standard length of 312 mm. Typical instrument of choice if space for the standard PAL System is limited for the various modules. Example: 3 cooled Stacks can be attached. <i>Note: Maximum Tray (Plate) number is 24. General Firmware limitation.</i>	SNo. for HTX PAL System within number range of: 17xxxx. Main Electronic Boards installed: - APR CPU Board- APR MOTIO Board Injection Unit: MZ 01-00 <i>Note:</i> <i>No Gas Flush Tube installed for the Head-space or ITEX Technique.</i>
1.2.4.17.7 HTXX PAL Picture not available yet	HTXX PAL can be used for HPLC and with limitations for the GC Technique. Main difference between the model HTX PAL (120 cm length of X-Axis) is the length of the Y-Axis: 402 mm. Typical instrument for special applications where reach of the Y-Axis is required. <i>Note: Maximum Tray (Plate) number is 24. General Firmware limitation.</i>	SNo. for HTX PAL System within number range of: 210xxx. Main Electronic Boards installed: - APR CPU Board - APR MOTIO Board Injection Unit: MZ 01-00 <i>Note:</i> <i>No Gas Flush Tube installed for the Head-space or ITEX Technique.</i>

PAL Model	Description	Remarks
1.2.4.17.8 LHX PAL picture not available yet.	LHX PAL can be used for the GC technique when more space for the various options is required. Gas flushing for the headspace and/or ITEX techniques is provided.	SNo. for LHX PAL System within number range of: 200xxx. Main Electronic Boards installed: - APR CPU Board- APR MOTIO Board Injection Unit: MZ 02-00 or MZ 010-00 (ITEX) <i>Note:</i> <i>Gas Flush Tube for the Headspace or ITEX Technique is outside of the unit installed.</i>
1.2.4.17.9 IFC PAL Analytical Version 	The analytical IFC PAL is typically used for fraction collection with flow rates < 1.0 ml/min. Long X-axis, 120 cm. 2 Injection units independently operated, injection and collection sides are strictly separated to avoid carry-over. All available PAL Modules can be used to configure this IFC PAL to their specific needs. Trays and/or Stacks can be selected. Fraction collection can be done directly into MT-Plates up to 384-well format. Flow rates from low micro-liter (uL) range up to 1000 uL/min are used. Syringe and tubing sizes have to be adapted accordingly. Dual Injection Unit system. Length of X-Axis: 120 cm Length of Y-Axis: 40.2 cm	SNo. for the IFC PAL within number range of: 18xxxx. Main Electronic Boards installed: Injection side: - APR Control-HTC Board <i>Note: Control Board has only one "Auxiliary" connector.</i> Collector side: - APR CPU Board- APR MOTIO Board Injection Unit Injection side: MZ 01-00 Injection Unit Collector side: MZ 09-00

PAL Model	Description	Remarks
1.2.4.17.10 IFC PAL Preparative Version 	The Prep IFC PAL is typically used for fraction collection with flow rates > 1 ml/min. Typically 5 to 50 ml/min. The prep IFC PAL is delivered with a slider and drip pan on the collector side. Various Trays (racks) are available for reagent tubes with a OD range from 13 to 25 mm and holding 9 to 50 ml. Special Trays are available on request. Dual Injection Unit system. Length of X-Axis: 120 cm Length of Y-Axis: 40.2 cm	SNo. for the IFC PAL within number range of: 18xxxx. Main Electronic Boards installed: Injection side:- APR Control-HTC Board <i>Note: Control Board has only one "Auxiliary" connector.</i> Collector side: - APR CPU Board- APR MOTIO Board Injection Unit Injection side: MZ 01-00 Injection Unit Collector side: MZ 09-00
1.2.4.17.11 PAL COMBI-<i>xt</i> 	The PAL COMBI-<i>xt</i> System is mainly used for GC techniques. 4 different techniques are applicable: - Liquid Injection - Headspace Sample Preparation Technique - SPME (Solid Phase Micro Extraction) Fiber technique - ITEX (In Tube Extraction) Organics are trapped and thermally desorbed Standard length of X-Axis: 80 cm	Main Electronic Board installed: - APR Control-<i>xt</i> Board Injection Unit: MZ 019-00 The PAL-<i>xt</i> System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-<i>xt</i>

PAL Model	Description	Remarks
1.2.4.17.12 PAL GC-xt 	PAL GC-xt System mainly used for GC techniques. 2 different techniques are applicable: - Liquid Injection - SPME (Solid Phase Micro Extraction) Fiber technique. Standard length of X-Axis: 80 cm <i>Note: PAL GC-xt can NOT be upgraded for the Headspace or ITEX Technique.</i>	Main Electronic Board installed: - APR Control-xt Board Injection Unit: MZ 018-00 and MZ 015-00 (Agilent brand) (Unit is shorter, equal with LC PAL) <i>Note: PAL GC-xt System can not be equipped with a heated cartridge (Headspace technique).</i> The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt
1.2.4.17.13 PAL LHX-xt	PAL LHX-xt can be used for the GC technique when more space for the various options is required. Gas flushing for the headspace and/or ITEX techniques is provided.	Main Electronic Board installed: - APR Control-xt Board Injection Unit: MZ 019-00 <i>Note:</i> <i>Gas Flush Tube for the Headspace or ITEX Technique is outside of the unit installed.</i> The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt

PAL Model	Description	Remarks
		
1.2.4.17.14 PAL HTS-xt 	PAL HTS-xt System mainly used for HPLC Techniques. All optional devices can be operated with the PAL HTS-xt. Examples: Dilutor, high throughput valve system, etc. Standard length of X-Axis: 80 cm	Main Electronic Board installed: - APR Control-xt Board - Injection Unit: MZ 017-00 - The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt

PAL Model	Description	Remarks
1.2.4.17.15 PAL HTC-xt 	PAL HTC-xt System mainly used for HPLC Techniques. All optional devices can be operated with the PAL HTC-xt Examples: Dilutor, high throughput valve system, etc. Limitation is the length of the X-Axis, 50 cm. Routine instrument, bench space saving.	Main Electronic Board installed: - APR Control-xt Board Injection Unit: MZ 017-00 <i>Note: Same Injection Unit as used for the PAL HTS-xt System. Stack or a Cooled Stack can be used.</i> The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt

PAL Model	Description	Remarks
1.2.4.17.16 PAL HTX-xt 	PAL HTX-xt can be used for HPLC and with limitations for the GC Technique. Main difference is the length of the X-Axis: 120 cm. Y-Axis standard length of 312 mm. Typical instrument of choice if space for the standard PAL System is limited for the various modules. Example: 3 cooled Stacks can be attached. <i>Note: Maximum Tray (Plate) number is 24. General Firmware limitation.</i>	Main Electronic Board installed: - APR Control-xt Board Injection Unit: MZ 017-00 <i>Note:</i> <i>No Gas Flush Tube installed for the Head-space or ITEX Technique.</i> The PAL-xt System requires - PAL Firmware Version 4.1.X or higher - PAL Object Manager Software Version 2.2.1 (or higher) - PAL Loader Software Version 2.1.1 (or higher) - Electronic Control Board: APR Control-xt

1.3 Maintaining and Repairing the PAL System

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1.3.1 Introduction to Maintaining and Repairing the PAL System

1.3.1.1 Maintaining

The PAL System is designed for easy maintenance by the user. Most of the parts are accessible from the front. Troubleshooting can be done with direct access to the components, and no covers have to be removed. CTC Analytics recommends to perform a Preventative Maintenance (PM) procedure once a year. The PM procedure is outlined in the corresponding section of this PAL SM.

The PM procedure shall be carried out only by trained and authorized representatives of CTC Analytics .

1.3.1.2 Cleaning the PAL System

Regular maintenance helps ensure the accuracy and precision of the PAL System. The suggested intervals for maintenance procedures to ensure smooth operation are given below. If you use the system heavily (for exam-

ple, on nights and weekends), or if you use aggressive solvents, you may need to perform the maintenance procedure more frequently.

Maintenance Step	Interval and Remarks
Clean the outside of the instrument	Weekly or as needed. Use only a soft lint-free paper or cloth dampened with mild soap and water.
Clean Instrument surfaces	Weekly or as needed.
Replace the syringe plunger Clean Syringe	The Syringe Plunger for a liquid syringe (Metal Plunger sealing against glass) should be cleaned on a regular base with an aqueous alcohol solution. Be aware that this plunger type should not be used for samples with a high amount of matrices, clinical or residue analysis, or for samples with a higher percentage of water as part of the analytical solution. A Polymer plunger-tip is more suitable for such applications. The Syringe Plunger for a gas-tight syringe (Polymer plunger-tip) has to be replaced on a regular base. The interval is highly dependent on the application, throughput, quality of sample solution (particles, etc.), and washing solvent. It is advisable to check the tightness of the plunger on a regular basis to adjust this to your application. Starting with PAL firmware version 2.5.2, a counter has been implemented to monitor the syringe strokes or the valve switches. This should help the user to monitor the life time of the devices.
Wash and Waste Solvent reservoirs	Weekly or as needed. If the Wash Station is equipped with vials which are sealed with a septum, also replace the Septum to avoid carry over.

1.3.1.3 Preventative Maintenance, PM

Maintaining the PAL System as described above can be considered daily or weekly PM. As a general rule, the system should be thoroughly checked and cleaned a minimum of once a year. The steps for this level of PM are described in the corresponding "Preventative Maintenance Procedure". Specific kits for the GC or the HPLC techniques are available. The kits include the parts which should be changed annually. PM Kit1 for HPLC and PM Kit2 for GC technique.

1.3.1.4 Repairing

The repair procedures go beyond the points described at the "PM level" and may require some exchange of defective parts. With the help of error description and the repair path overview of the individual PAL components, it should be possible to locate the specific error. The spare part listing indicates which parts are sold individually and which parts are combined in a kit.

It is strongly recommended that the repair of a PAL System is done only by trained and authorized CTC Analytics representatives.

WARNING:

Disconnect the PAL System from the power line and unplug the power cord before any maintenance or repair step is done. Also, disconnect the PAL System from any other device which is part of the complete system.

1.3.1.5 Updating the Firmware

The PAL System is equipped with a FLASH EPROM (CPU and Control Board). This enables a firmware upgrade using the PAL LOADER Software as described in the PAL USER MANUAL. With every PAL System, the RS232 cable and the PAL LOADER Software are provided.

For details see section 'PAL Software | [PAL Loader Software](#)'.

1.3.1.6 Overview of Maintaining and Repairing the PAL System

- [Introduction](#)
- [ESD Protection](#)
- [Overview of Basic PAL Components | PAL Modules](#)
- [Upgrade Path](#)
- [Troubleshooting](#)
- [Test Functions](#)
- [Firmware Error Messages](#)
- [Maintenance Functions](#)

1.3.1.7 Introduction to Maintaining and Repairing the PAL System

1.3.1.7.1 Maintaining

The PAL System is designed for easy maintenance by the user. Most of the parts are accessible from the front. Troubleshooting can be done with direct access to the components, and no covers have to be removed. CTC Analytics recommends to perform a Preventative Maintenance (PM) procedure once a year. The PM procedure is outlined in the corresponding section of this PAL SM.

The PM procedure shall be carried out only by trained and authorized representatives of CTC Analytics .

1.3.1.7.2 Cleaning the PAL System

Regular maintenance helps ensure the accuracy and precision of the PAL System. The suggested intervals for maintenance procedures to ensure smooth operation are given below. If you use the system heavily (for example, on nights and weekends), or if you use aggressive solvents, you may need to perform the maintenance procedure more frequently.

Maintenance Step	Interval and Remarks
Clean the outside of the instrument	Weekly or as needed. Use only a soft lint-free paper or cloth dampened with mild soap and water.
Clean Instrument surfaces	Weekly or as needed.
Replace the syringe plunger Clean Syringe	The Syringe Plunger for a liquid syringe (Metal Plunger sealing against glass) should

Maintenance Step	Interval and Remarks
	be cleaned on a regular base with an aqueous alcohol solution. Be aware that this plunger type should not be used for samples with a high amount of matrices, clinical or residue analysis, or for samples with a higher percentage of water as part of the analytical solution. A Polymer plunger-tip is more suitable for such applications. The Syringe Plunger for a gas-tight syringe (Polymer plunger-tip) has to be replaced on a regular base. The interval is highly dependent on the application, throughput, quality of sample solution (particles, etc.), and washing solvent. It is advisable to check the tightness of the plunger on a regular basis to adjust this to your application. Starting with PAL firmware version 2.5.2, a counter has been implemented to monitor the syringe strokes or the valve switches. This should help the user to monitor the life time of the devices.
Wash and Waste Solvent reservoirs	Weekly or as needed. If the Wash Station is equipped with vials which are sealed with a septum, also replace the Septum to avoid carry over.

1.3.1.7.3 Preventative Maintenance, PM

Maintaining the PAL System as described above can be considered daily or weekly PM. As a general rule, the system should be thoroughly checked and cleaned a minimum of once a year. The steps for this level of PM are described in the corresponding "Preventative Maintenance Procedure". Specific kits for the GC or the HPLC techniques are available. The kits include the parts which should be changed annually. PM Kit1 for HPLC and PM Kit2 for GC technique.

1.3.1.7.4 Repairing

The repair procedures go beyond the points described at the "PM level" and may require some exchange of defective parts. With the help of error description and the repair path overview of the individual PAL components, it should be possible to locate the specific error. The spare part listing indicates which parts are sold individually and which parts are combined in a kit.

It is strongly recommended that the repair of a PAL System is done only by trained and authorized CTC Analytics representatives.

WARNING:

Disconnect the PAL System from the power line and unplug the power cord before any maintenance or repair step is done. Also, disconnect the PAL System from any other device which is part of the complete system.

1.3.1.7.5 Updating the Firmware

The PAL System is equipped with a FLASH EPROM (CPU and Control Board). This enables a firmware upgrade using the PAL LOADER Software as described in the PAL USER MANUAL. With every PAL System, the RS232 cable and the PAL LOADER Software are provided.

For details see section 'PAL Software' | [PAL Loader Software](#)'.

1.3.1.8 Using the ESD Strap

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are touched.

Not observing this basic rule can result in erratic behavior of a component or in a damaged printed circuit board (PCB).

1.3.1.9 Overview Basic PAL Components | PAL Modules

- Basic PAL Components
 - [Injection Unit | Z-Axis](#)
 - [X-Y-Axis \(Assembly\)](#)
 - [Power Supply PAL System](#)
 - [Handhold Terminal](#)
 - Cables and Connectors (Specification)

- PAL Modules

The PAL Modules not listed under 'Basic PAL Components' will be covered in this section.

The PAL SM Edition 1 does not cover any other PAL Module. The modules will be added step-by-step. Updated editions will be announced by a Service Note and will be listed in the protected support home-page.

The distribution of the updated CD-ROM will be organized individually with each authorized representative of CTC Analytics.

The section '[PAL SM Release History](#)' shows which other modules are covered in the current edition used.

1.3.1.10 Upgrade Path | General Information

The possible upgrade path for each individual component is described in the various specific sections, e.g. for the Injection Unit, Power Supply and others.

The feasibility for each upgrade procedure is explained, including whether the upgrade can be done in the field or only at the factory, and which spare part kits are needed.

The section PAL RELEASE HISTORY will explain any differences between the previous version.

1.3.1.10.1 Upgrade Path

- [Upgrade Path Injection Unit, Z-Axis](#)
- [Upgrade Path X-Y- Axis](#)
- [Upgrade Path PAL Power Supply](#)
- [Upgrade Path handheld PAL Control Terminal](#)

[PAL Release History](#)

Spare Part Kits

...

1.3.1.11 Test Functions

The built-in test functions are described, and a link is provided to the relevant repair section.

Specific Test Functions are integrated within the PAL Firmware.

Path from the local Terminal: Menu | F3-Setup | Service

Note: The term 'Menu | F3-Setup' is described in detail below: Local Terminal. From the top level of software, press function key 'F1', Menu.Select 'Setup', put the cursor on 'Setup' but do not activate yet.Press function key 'F3'. Press 'Enter' to activate 'Setup'. ('Enter' is the central knob on the selector wheel.)

The test for the Sensors is integrated in Firmware version 2.4.0All other Tests are available from Firmware version 2.0.0.

Test	How to Run the Test	Test Criteria	Remarks
Motors	Select the Motor to be tested. Select a Start and Stop Position. Select an appropriate value for the current of the stepper-motor. X-, Y-, and Z-motors can be operated with the default value.Plunger-Motor settings have to be adjusted if a syringe is installed. (See values from Motor Plunger Drivers, MPigHigh-Med_Low, as an example.) Press 'F1' to Start and Stop.	This test can be performed to verify that a specific stepper-motor runs reliably.It can also be used for an endurance test. 'AUX' ports are also available because, for example, a valve drive or Dilutor motor can be activated directly from 'AUX-ILIARY'.	An upper limit is defined by the parameter 'MaxCycle'.The Actual Cycles shows how many cycles have been performed. This parameter can be re-set.
Check Plunger	Test 'Check Head'F1-'Check Plg' Press F1-Startrun the test 5 to 10 times Press F1-Stop	The Plunger sensor is tested. Value Tooth Counttypically 95 or higher. FW version 4.1.X (or higher):Minimum Tooth Count : 70-90Maximum Tooth Count: 80-100 Pressing 'STOP' at the end of the test, causes the Plunger Holder to move up and down quickly, enabling the detection of any mechanical and/or stepper motor problems. <i>Note: It is important that a syringe and a plunger holder are installed for the test. To run the test, do not use a syringe.For more details see the section "Testing Z-Axis".</i>	CAUTION: Important: Ensure that the syringe is removed before the test cycle is started. For details see the section 'Testing Z-Axis'.

Test	How to Run the Test	Test Criteria	Remarks
Check -Z	Test 'Check Head'F2-"Check-Z" Press F1-Startrun the test 5 to 10 times Press F1-Stop	The Penetration Sensor and Solenoid for 'Needle Guide Blocking' are tested. Pressing "STOP" at the end of the test causes the Syringe Slider Assembly to move up and down quickly, enabling the detection of any mechanical and/or stepper motor problems.	CAUTION: Important: Ensure that the syringe is removed before the test cycle is started. For details see the section " Testing Z-Axis ".
Check Switches	All Sensors from the axis can be selected. The current of the stepper motors is reduced so that one can move the Axis manually, crossing over the switch of the various sensors.	The actual status of the sensor "ON" or "OFF" is displayed. If the status does not change, this is an indication that a sensor or an electronic part is defective.	For details see the corresponding section for the Z-Sensor or X- and Y-Sensors.

1.3.1.12 PAL Firmware Error or Exemption Codes

The Firmware Error or Exemption Codes are displayed in the 'Message Line' on the display of the handheld terminal. The same codes are displayed by most of the integrated software combinations.

The PAL Firmware Error Messages are listed under 'PAL Software / Firmware'

[Firmware Error of Exemption Codes](#)

1.3.1.13 Maintenance Functions

The Maintenance Functions are mainly covered by the Firmware Class 'Utilities'.

Path: Menu | Utilities.

The Utilities class provides the most convenient access to most of the functions needed in routine work. It is the typical user level for fast access to a specific component of the PAL System.

1.3.1.13.1 Examples for the Class 'Utilities':

- Syringe: Wash the syringe, wash the injector
- Tray: Check if the correct TrayType is selected and check the corner positions of the Tray. Start the Agitator for a check.
- Injectors: Check the position of the injector and the Needle Penetration.

More detailed descriptions are given in the PAL USER MANUAL.

Note:

For a HPLC PAL System, it is important to understand the importance of regular replacement of the Needle Seal and the correct positioning of the needle penetration in the Valve-Injector. See the Section "Optimization and Troubleshooting" and specifically the hints to avoid carry-over and how to achieve good reproducibility.

1.3.2 Basic PAL Components

1.3.2.1 The following PAL components (Modules) are covered under "Basic Components":

- [Injection Unit | Z-Axis](#)
- [X- Y-Axis \(Assembly\)](#)
- [Power Supply PAL System](#)
- Handhold Terminal or Local Terminal
- Cables and Connectors (Specification)

All other PAL Modules will be covered in section 'PAL Modules'. Not included in PAL SM Revision 1.1.0.

1.3.2.2 Basic PAL Components

1.3.2.2.1 The following PAL components (Modules) are covered under "Basic Components":

- [Injection Unit | Z-Axis](#)
- [X- Y-Axis \(Assembly\)](#)
- [Power Supply PAL System](#)
- Handhold Terminal or Local Terminal
- Cables and Connectors (Specification)

All other PAL Modules will be covered in section 'PAL Modules'. Not included in PAL SM Revision 1.1.0.

1.3.2.3 Overview PAL Z-Axis

This section covers following points:

- [Z-Axis Overview](#)
- [Z-Axis Release History](#)
- [Z-Axis Troubleshooting](#)
- [Z-Axis Repair Path](#)
- [Z-Axis Upgrade Path](#)
- [Z-Axis Spare Parts](#)
- [Z-Axis Preventative Maintenance \(PM\)](#)

1.3.2.3.1 Overview Injection Units | Z-Axis

Z-AxisP/N	Used forPAL Model	Description
MZ 01-00	HTS PALHTC PALHTX PALIFC PAL Injection side	Standard Injection UnitGas flush tube, used for GC Headspace technique, not installed.Lower Neesdle Guide has no magnets installed for vial transport.Otherwise identical to MZ 02-00.
MZ 010-00	ITEX PAL	Dedicated Injection Unit for ITEX technique (In-Tube Extraction).Unit is longer to accommodate the long headspace needle combined with the trap. Gas flush tube is installed. Upper needle guide is eliminated.
MZ 011-00	AT7	Dedicated Injection Unit for Sotax Model AT7.
MZ 012-00		Dedicated Injection Unit for MicrocCal
MZ 013-00	HTS PAL	
MZ 014-00	HTS PAL	
MZ 02-00	Combi PAL	Standard Injection Unit, fully equipped with gas flush tube and vial transport magnets in lower needle guide.
MZ 03-00	Combi PAL	Injection Unit with Fine Pitch Spindle for high torque use. Equipped with gas flush tube and vial transport magnets in lower needle guide. Standard Unit for AlphaMOS electronic nose application. For headspace application if only a 5 ml syringe is used in frequent routine work. Pulling the plunger of a "dry" syringe requires a high torque level.
MZ 04-00	DS Sotax	Dedicated Injection Unit for Sotax Model DS.
MZ 05-00	VAS1	Dedicated Injection Unit for Lauda System.Application is automated for determination of the viscosity of any liquid.
MZ 06-00	LC PALGC PAL	Injection Unit is 40 mm less in height.Gas Flush Tube Z-Axis is not installed (Headspace analysis). Heating for Heated cartridge is not provided. Skirt to open the Agitator is not mounted.
MZ 07-00	HTS PAL	Early units with slit in Z-Housing (tube) for Dilutor option have been labeled with MZ 07-00.Changed to MZ 01-00 Rev. E.
MZ 08-00	FAct F	Dedicated Injection Unit for FormulAction; Revision Level F.
MZ 09-00	IFC Collector	Standard HTS PAL Injection Unit with a special lower needle guide for fraction collection. Drop at needle tip does not come in contact with needle guide.

Z-AxisP/N	Used forPAL Model	Description
MZ 014-00	PAL HTS- xt	Injection Unit branded for Agilent
MZ 015-00	PAL GC- xt	Injection Unit branded for Agilent
MZ 016-00	PAL COMBI- xt	Injection Unit branded for Agilent
MZ 017-00	PAL HTS- xt	Standard Injection Unit Gas flush tube, used for GC Headspace technique, not installed. Lower Needle Guide has no magnets installed for vial transport. Otherwise identical to MZ 019-00.
MZ 018-00	PAL GC- xt PAL LC- xt	Injection Unit is 40 mm less in height. Gas Flush Tube Z-Axis is not installed (Headspace analysis). Heating for Heated cartridge is not provided. Skirt to open the Agitator is not mounted.
MZ 019-00	PAL COMBI- xt	Standard Injection Unit, fully equipped with gas flush tube and vial transport magnets in lower needle guide.

1.3.2.3.1.1 Overview Injection Units | Z-Axis

Z-AxisP/N	Used forPAL Model	Description
MZ 01-00	HTS PALHTC PALHTX PALIFC PAL Injection side	Standard Injection UnitGas flush tube, used for GC Headspace technique, not installed.Lower Needle Guide has no magnets installed for vial transport.Otherwise identical to MZ 02-00.
MZ 010-00	ITEX PAL	Dedicated Injection Unit for ITEX technique (In-Tube Extraction).Unit is longer to accommodate the long headspace needle combined with the trap. Gas flush tube is installed. Upper needle guide is eliminated.
MZ 011-00	AT7	Dedicated Injection Unit for Sotax Model AT7.
MZ 012-00		Dedicated Injection Unit for MicrocCal
MZ 013-00	HTS PAL	
MZ 014-00	HTS PAL	
MZ 02-00	Combi PAL	Standard Injection Unit, fully equipped with gas flush tube and vial transport magnets in lower needle guide.
MZ 03-00	Combi PAL	Injection Unit with Fine Pitch Spindle for high torque use. Equipped with gas flush tube and vial transport magnets in lower needle guide. Standard Unit for AlphaMOS electronic nose application. For headspace application if only a 5 ml syringe is used in frequent routine work. Pulling the plunger of a "dry" syringe requires a high torque level.
MZ 04-00	DS Sotax	Dedicated Injection Unit for Sotax Model DS.
MZ 05-00	VAS1	Dedicated Injection Unit for Lauda System.Application is automated for determination of the viscosity of any liquid.
MZ 06-00	LC PALGCPAL	Injection Unit is 40 mm less in height.Gas Flush Tube Z-Axis is not installed (Headspace analysis). Heating for Heated cartridge is not provided. Skirt to open the Agitator is not mounted.
MZ 07-00	HTS PAL	Early units with slit in Z-Housing (tube) for Dilutor option have been labeled with MZ 07-00.Changed to MZ 01-00 Rev. E.
MZ 08-00	FAct F	Dedicated Injection Unit for FormulAction; Revision Level F.
MZ 09-00	IFC Collector	Standard HTS PAL Injection Unit with a special lower needle guide for fraction collection. Drop at needle tip does not come in contact with needle guide.

Z-AxisP/N	Used forPAL Model	Description
MZ 014-00	PAL HTS- xt	Injection Unit branded for Agilent
MZ 015-00	PAL GC- xt	Injection Unit branded for Agilent
MZ 016-00	PAL COMBI- xt	Injection Unit branded for Agilent
MZ 017-00	PAL HTS- xt	Standard Injection Unit Gas flush tube, used for GC Headspace technique, not installed. Lower Needle Guide has no magnets installed for vial transport. Otherwise identical to MZ 019-00.
MZ 018-00	PAL GC- xt PAL LC- xt	Injection Unit is 40 mm less in height. Gas Flush Tube Z-Axis is not installed (Headspace analysis). Heating for Heated cartridge is not provided. Skirt to open the Agitator is not mounted.
MZ 019-00	PAL COMBI- xt	Standard Injection Unit, fully equipped with gas flush tube and vial transport magnets in lower needle guide.

1.3.2.3.1.2 Release History Injection Unit

RevisionLevel	Modification from Previous Revision Level	Remarks
A	Basic Unit	Rev. A cannot be upgraded in the field.
B	Plunger Motor with current physical size installed.	
C	New type of sensors for Syringe ID, Plunger and Needle Penetration. Needle Guide Assembly with new Anti-Twist Device and simplified Assembly design.	Needle Guide Assembly simplified with one stopper only.
D	Stronger Solenoid for Needle Guide Blocking (15 VDC).	Solenoid is mainly used for SPME application. Requires current level of PCB for Injection Unit. Firmware version level 2.2.2 or higher.
E	Slit in Z-tube for Dilutor or Fraction Collector Option.	Slit can be machined into an existing Injection Unit in the field. Contact the support group for assistance.
F	Upper and Lower Needle Guide Assembly prepared for Gauge 19 syringe needle. (Size of hole 1.2 mm.)	Revision F only became effective for the HPLC technique. Injection units : - MZ 01-00 - MZ 09-00 Needle Guides prepared for syringe Needle Gauge 19 (Size of hole 1.2 mm). All other Z-Axis models still have the Needle Guides installed to adapt to Syringe needles with Gauge 22 or smaller. Size of hole 0.8 mm. This includes the unit MZ 06-00 (GC and LC PAL).

For further details, see also the section '[Upgrade Path for Z-Axis](#)'.

1.3.2.3.2 Troubleshooting Z-Axis

Error Symptom	Possible Cause	Recommended Actions
Syringe Needle Bending	X-Y-Z Positions misaligned Vial Septum too hard Injector septum over-tightened Syringe Needle with wrong gauge Short Tension Cord stretched Needle Length setting wrong Firmware problem Needle Guide Sensor defect (PCB) Ribbon Cable Z-Axis APR MOTIO or Control Board X-Y Sensors failed Interface to other data handling software Ribbon Cable from X-Y Axis SPME Fiber Bending (wire not sheath metal, needle)	Replace Vial Septum Check manually with syringe needle Check Needle Gauge for application Replace Tension Cord, PM Measure the distance at the Needle Guide Rod Reload complete Firmware Backup file Check Sensor, Service Mode PAL System Exchange Z-Unit to isolate source of error Replace board to isolate source of error Replace X-Y-Sensors Run PAL System without integration (standalone). Replace X-Axis Ribbon Cables Check Fiber standby Position Check the X-Y-Z Positions
Head Communication Error	Firmware PCB for Injection Unit Ribbon Cable Z-Axis APR MOTIO or Control Board Ribbon Cables from X-Y Axis	Reload complete Firmware Backup File Replace PCB Z-Axis Replace Ribbon Cable Z-Axis Replace MOTIO or Control Board Replace Ribbon Cables X-Y Axis
Plunger Sensor Error	Firmware PCB for Injection Unit	Reload complete Firmware Backup File Replace PCB Z-Axis
Needle Guide Sensor Error	Firmware Mechanical Problems in Needle Guide Assembly PCB for Injection Unit	Reload complete Firmware Backup File Check Mechanics Replace PCB Z-Axis
Syringe Not Detected	Check Firmware Syringe Detection Setting Check Syringe Holder for ID magnets Check Firmware Syringe Object Check PCB for Z-Axis Firmware problem	Turn Syringe detection ON Verify ID and check magnet positions Load the corresponding Firmware Object Replace PCB for Z-Axis Reload a complete backup file
Needle Guide Blocking Not Released	Check Firmware for "FibExp" Position Solenoid for Needle Guide Assembly PCB for Z-Axis Firmware APR Motio or Control Board Ribbon Cables from X-Y Axis SPME Parameter Settings	Path: Menu/Setup/Objects/Vials/FibExp PAL Service Mode Replace PCB for Z-Axis Reload complete Firmware Backup File Replace MOTIO or Control Board Replace Ribbon Cables X-Y-Axis Check the position of the Needle Guide

Error Symptom	Possible Cause	Recommended Actions
Object Collision	Wrong Tray Type selected X-Y-Z Axis misaligned Agitator installed in the pathway Non-PAL Device interferes in the pathway Firmware problem Needle Guide Sensor Defect (PCB) Ribbon Cable Z-Axis APR MOTIO or Control Board Ribbon Cables from X-Y Axis	Check Tray Type Check X-Y-Z positions Agitator has to be installed at the end of the X-Axis Force PAL System to control pathway Reload complete Backup file Check Sensor in PAL Service Mode Ribbon Cable Z-Axis Change the Board Change Ribbon Cables from X-Y Axis
Object Not Detected	Wrong Tray Type selected X-Y-Z Axis misaligned LC Valve Position not correct installed Firmware Needle Guide Sensor Defect (PCB) Ribbon Cable Z-Axis APR MOTIO or Control Board Ribbon Cables from X-Y Axis	Check Tray Type Check X-Y-Z positions Check Z-Position for LC-Valve Check Reload complete Backup file Check Sensor in PAL Service Mode Ribbon Cable Z-Axis Change the Board Change Ribbon Cables from X-Y Axis
Syringe Plunger Bending	Check the Various Syringe Plunger Speeds Check the Various Solvents Used for Application Check the Syringe Type Used Maintenance of Syringe and Plunger	Check speeds for sample and washing Check sample and wash solvents Replace Plunger Type Clean Syringe and Plunger regularly
Mechanical Problem with Vial Transport	Red Magnetic Ring not or wrongly installed Vial crimping deficient Vial shape deficient	Check installation Check crimping process or caps Check vial shape
Flaking-off Material from Syringe Slider or Z-Tube	Dust and dirt mixed with dried grease Corrosion from acid vapor High Tension from Guide Rollers against Guide Rods in Z-Tube Particles Flaking-off from Lower Needle Guide	Clean Guide Rollers and Rods, PM Check environment Check the adjusted distance between Rollers/Rods Check Fast Wash Station
Electronic or PCB failure	Ribbon Cable Connection to Y-Axis-Plunger Sensor failed Needle Guide Sensor failed Z-Position Sensor failed Ribbon Cable Z-Axis defective 1uF Capacitor Heating failed Electronic component burnt	Check Cable connection Perform service test for Plunger Sensor Perform service test for Needle Guide Sensor Perform service test for Z-Sensor Check Ribbon Cable See service Note #01/2002 Replace PCB for Z-Axis
Z-Position Sensor Knocked off	Inserting syringe slider into Z-housing	Check for any possible mechanical hindrance. e.g. screws of the electronic cover

Error Symptom	Possible Cause	Recommended Actions
Gas Leak within Z-Axis	Gas Flush Tube-Z defective Defective O-Ring Gasket for seal with heated cartridge Defective heated cartridge Gas Pressure setting too high	Check Gas Flush Tube-Z Check O-ring Possible leak - check the cartridge Check pressure setting, 0.5 bar for HS See also the section " X-Y-Axis Troubleshooting "

1.3.2.3.2.1 Troubleshooting Z-Axis

Error Symptom	Possible Cause	Recommended Actions
Syringe Needle Bending	X-Y-Z Positions misaligned Vial Septum too hard Injector septum over-tightened Syringe Needle with wrong gauge Short Tension Cord stretched Needle Length setting wrong Firmware problem Needle Guide Sensor defect (PCB) Ribbon Cable Z-Axis APR MOTIO or Control Board X-Y Sensors failed Interface to other data handling software Ribbon Cable from X-Y Axis SPME Fiber Bending (wire not sheath metal, needle)	Replace Vial Septum Check Needle Gauge for application Replace Tension Cord, PM Measure the distance at the Needle Guide Rod Reload complete Firmware Backup file Check Sensor, Service Mode PAL System Exchange Z-Unit to isolate source of error Replace board to isolate source of error Replace X-Y-Sensors Run PAL System without integration (standalone). Replace X-Axis Ribbon Cables Check Fiber standby Position Check the X-Y-Z Positions
Head Communication Error	Firmware PCB for Injection Unit Ribbon Cable Z-Axis APR MOTIO or Control Board Ribbon Cables from X-Y Axis	Reload complete Firmware Backup File Replace PCB Z-Axis Replace Ribbon Cable Z-Axis Replace MOTIO or Control Board Replace Ribbon Cables X-Y Axis
Plunger Sensor Error	Firmware PCB for Injection Unit	Reload complete Firmware Backup File Replace PCB Z-Axis
Needle Guide Sensor Error	Firmware Mechanical Problems in Needle Guide Assembly PCB for Injection Unit	Reload complete Firmware Backup File Check Mechanics Replace PCB Z-Axis
Syringe Not Detected	Check Firmware Syringe Detection Setting Check Syringe Holder for ID magnets Check Firmware Syringe Object Check PCB for Z-Axis Firmware problem	Turn Syringe detection ON Verify ID and check magnet positions Load the corresponding Firmware Object Replace PCB for Z-Axis Reload a complete backup file
Needle Guide Blocking Not Released	Check Firmware for "FibExp" Position Solenoid for Needle Guide Assembly PCB for Z-Axis Firmware APR Motio or Control Board Ribbon Cables from X-Y Axis SPME Parameter Settings	Path: Menu/Setup/Objects/Vials/FibExp PAL Service Mode Replace PCB for Z-Axis Reload complete Firmware Backup File Replace MOTIO or Control Board Replace Ribbon Cables X-Y-Axis Check the position of the Needle Guide

Error Symptom	Possible Cause	Recommended Actions
Object Collision	Wrong Tray Type selected X-Y-Z Axis misaligned Agitator installed in the pathway Non-PAL Device interferes in the pathway Firmware problem Needle Guide Sensor Defect (PCB) Ribbon Cable Z-Axis APR MOTIO or Control Board Ribbon Cables from X-Y Axis	Check Tray Type Check X-Y-Z positions Agitator has to be installed at the end of the X-Axis Force PAL System to control pathway Reload complete Backup file Check Sensor in PAL Service Mode Ribbon Cable Z-Axis Change the Board Change Ribbon Cables from X-Y Axis
Object Not Detected	Wrong Tray Type selected X-Y-Z Axis misaligned LC Valve Position not correct installed Firmware Needle Guide Sensor Defect (PCB) Ribbon Cable Z-Axis APR MOTIO or Control Board Ribbon Cables from X-Y Axis	Check Tray Type Check X-Y-Z positions Check Z-Position for LC-Valve Check Reload complete Backup file Check Sensor in PAL Service Mode Ribbon Cable Z-Axis Change the Board Change Ribbon Cables from X-Y Axis
Syringe Plunger Bending	Check the Various Syringe Plunger Speeds Check the Various Solvents Used for Application Check the Syringe Type Used Maintenance of Syringe and Plunger	Check speeds for sample and washing Check sample and wash solvents Replace Plunger Type Clean Syringe and Plunger regularly
Mechanical Problem with Vial Transport	Red Magnetic Ring not or wrongly installed Vial crimping deficient Vial shape deficient	Check installation Check crimping process or caps Check vial shape
Flaking-off Material from Syringe Slider or Z-Tube	Dust and dirt mixed with dried grease Corrosion from acid vapor High Tension from Guide Rollers against Guide Rods in Z-Tube Particles Flaking-off from Lower Needle Guide	Clean Guide Rollers and Rods, PM Check environment Check the adjusted distance between Rollers/Rods Check Fast Wash Station
Electronic or PCB failure	Ribbon Cable Connection to Y-Axis-Plunger Sensor failed Needle Guide Sensor failed Z-Position Sensor failed Ribbon Cable Z-Axis defective 1uF Capacitor Heating failed Electronic component burnt	Check Cable connection Perform service test for Plunger Sensor Perform service test for Needle Guide Sensor Perform service test for Z-Sensor Check Ribbon Cable See service Note #01/2002 Replace PCB for Z-Axis
Z-Position Sensor Knocked off	Inserting syringe slider into Z-housing	Check for any possible mechanical hindrance. e.g. screws of the electronic cover

Error Symptom	Possible Cause	Recommended Actions
Gas Leak within Z-Axis	Gas Flush Tube-Z defective Defective O-Ring Gasket for seal with heated cartridge Defective heated cartridge Gas Pressure setting too high	Check Gas Flush Tube-Z Check O-ring Possible leak - check the cartridge Check pressure setting, 0.5 bar for HS See also the section " X-Y-Axis Troubleshooting "

1.3.2.3.2.2 Syringe Needle Bending

Firmware Error Message Number: not applicable

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
X-Y-Z Positions misaligned	Check the X-Y-Z Positions. Path from Local Terminal: Menu/Utilities/select the various Object classes.If a deviation is found make the changes under: Menu/Setup/Objects/select the Object class.Check also the Needle Penetration value if found to be critical for an object.	This is one of the most common sources of errors. A wrong Tray Type has been selected or a hardware Object has been moved to another position.
Vial Septum too hard	The hardness of the vial septum is critical. There are several septa on the market which are too hard to penetrate. (Example PharmaFix). The effect of needle bending caused by the hardness of the septum is seen first with the SPME Fiber and secondly with Headspace vials. These septa are generally 3 mm thick. For SPME, try to use septa which are only 1.5 mm thick. Another common mistake is a high tension on the septum caused by an inadequate crimping tool. For the Headspace technique, 2 different needle gauges are available. Gauge 23 : OD = 0.63 mm Gauge 26 : OD = 0.47 mm. The Gauge 26 should only be used if the GC injector inlet does not accept a thicker needle. Older types of injectors have been built with an inlet hole diameter to accept the standard GC needle Gauge 26 only. Use the thicker needle whenever pos-	For more details see Service Note # 02/2002 "Vial-Caps-Septa for Headspace-SPME Technique". See also the vendor catalogs prepared for the PAL System. Chromacol, La-Pha-Pack and MicroLiters are the preferred suppliers, listed on our web-page. These catalogs are supplied with every new instrument.

Possible Cause	Recommended Action	Remarks
	sible. Example CTC P/N: SyrC HS2.5-23-5.	
Injector Septum over-tightened	Often, the injector nut is too tight and as a consequence places a high tension on the septum. Make it a rule whenever a septum is changed to try to feel the tension by inserting manually the syringe with the needle Gauge or type which will be used. This is almost mandatory for the SPME technique. The Fiber assembly is a delicate device. Care has to be taken that the Fiber is not destroyed at the very first penetration. The following procedure has been proven useful in practice: - Pierce the septum with a GC syringe needle first (with this first penetration one will feel the tension of the septum). - Repeat the piercing with an old SPME Fiber needle assembly. - If the tension or restriction is acceptable the next step is automation.	Over-tightening is a common mistake by the user. It is often seen with the Shimadzu split/splitless injector. The septum has a unique shape. Tightening the injector nut has to be done in 2 steps: - tighten the nut with one finger (very loose, no force applied) until the very first resistance is felt. - tighten the nut 1/4 turn only. Should the nut be tightened as for all other GC injectors, the septum would be completely compressed and one would have no chance to penetrate successfully. For this injector type it is also recommended to use a needle with Gauge 23S, and not Gauge 26S. "S" indicates small internal diameter, used for all GC syringes up to a volume of 100ul (standard applications). To avoid the possibility of needle bending because of the injector septum, one can use the Merlin Adapter. This is a septum free adapter with a spring-loaded lip. Merlin is available for almost every type of GC Injector. In some cases a dedicated adaptor is required. Ask the GC manufacturer for more details. Merlin is supplied by Supelco (amongst other suppliers).
Syringe Needle with wrong Gauge (dimensions)	The syringe needle dimensions are specified in the Gauge. Gauge 26: OD = 0.47 mm Gauge 23: OD = 0.63 mm For syringe volumes < 100 ul the needles with a small internal diameter are preferred. The needle volume is drastically less. Gauge 26S and Gauge 23S.	See also the points above.

Possible Cause	Recommended Action	Remarks
Short Tension Cord stretched (or loose)	The function of the Short Tension Cord in the injection unit is to press the vial or the well plate down with the lower needle guide at the moment the syringe is withdrawn. An indication of a stretched or loose Tension Cord is the needle bending at the lower part (L-shape). This effect is first seen typically in the headspace or SPME technique where a thick vial septum is generally used. Replace the Short Tension Cord. CTC Analytics recommends to change the Tension Cords on a regular basis once a year. This should be part of a preventative maintenance procedure. The cord is part of the PM Kit.	Length of the Short Tension Cord = 90-100 mm (measured in-between the knobs). The dedicated Short Tension Cord for the Combi PAL System has been eliminated (length 115-125 mm) See Service Note # 09/2006. The needle shape after a collision or any other incident resembles a 'Z-form'. Examining the bended needle shape can give an indication on the possible cause.
Needle Length setting wrong	The correct setting for the needle length is important to avoid any problems. If the distance is too short, the needle tip sticks out and can catch an object when crossing over. If the distance is too long the needle tip can catch on the internal funnel of the lower needle guide. In the moment of penetration, the tip is blocked and the needle does 'Z-out'. How to adjust the needle length is described in the section "Needle Guide Assembly". The standard setting is : 50.5 +0.5/-0 mm. Use a sliding caliper to measure.	It can occur that the needle length has been set correctly, all the Z-positions have been checked and accepted. Within a short time difference a Z-collision occurs. If this is observed more than once, check the Mechanical Stop for the Needle Guide (P/N: MZ 20-14). If the screw is loose or the bracket broken the Needle Guide Rod can be pushed down by the force of the Short Tension Cord.
Firmware	Reload complete FW backup file. If part of the flash memory is disrupted this may be the fastest way to recover. <i>Note: Do not use Firmware only (core software). Complete Backup has a file size of approx. 1.5 MB.</i>	Use the Firmware backup file made at the time of installation or any newer version for the particular PAL System.
Needle Guide Sensor Defect (PCB)	In case the Needle Guide Sensor would be defective an error message is reported. The PAL System would come to a stop before the needle is bent. The Needle Guide sensor can be checked with the PAL Service Mode. If any doubts remain, an exchange of the complete Injection Unit would narrow down the possible causes of the error.	The statement under "Recommended Action" holds true as long as the setting for the various Tray Types has not been changed. The default setting is always with a "Z-Tolerance" value >0. Standard exemptions: LC Valve and Tray-Cooler (surface of lid is addressed as an absolute value). This means that the system looks for an object within a certain level of tolerance. If not found, an error is reported: "Vial not Found". If an unexpected object is found a collision error is reported. In both cases the system will stop. In the case of Z-Tolerance=0, the syringe slider moves to the absolute Z-value.

Possible Cause	Recommended Action	Remarks
Ribbon Cable Z-Axis	Inspect the cable for any possible damages.	By exchanging a complete Injection Unit the possible cause of error can be narrowed down and isolated.
APR MOTIO Board APR Control Board	Change the MOTIO or Control Board.P/N:- APR MOTIO- APR Control GC- APR Control-HTC- APR Control-LC	By exchanging a MOTIO or Control Board the possible cause can be narrowed down or isolated.
X-Y Sensors Failed	Check in the PAL Service Mode if the Sensors are still active. <i>Note: Test for Switches is available with Firmware level 2.4.0 or higher.</i> If necessary replace sensor PCBs. For P/N see the section "X-Y-Axis Spare Parts".	In case a sensor is defective or erratic the position would not be found. Referencing of the axis would be impossible. The error could also be intermittent. Check also the red connector from the Ribbon Cable to the Sensor PCB. <i>Note: This failure is extremely rare.</i>
Interface in other Data Handling Software	Run the PAL System in isolation from the other Data Handling System Standalone mode.	Start/Stop/Ready control via Interface cable.
Ribbon Cable from X-Y-Axis	If all other actions did not solve the problem, change the 2 Ribbon Cables for the X-and Y-Axis.Inspect the cables for any damage. For P/N see the section "X-Y-Axis Spare Parts".	If ribbon cables are changed, it is advisable to update to the current level and also exchange the X-,Y-sensors. For more details see the section on the X-Y-Axis. <i>Note: After completion of repair work check the system completely. For more details see the "Testing Z-Axis" and "Firmware Configuration" sections.</i>
SPME Fiber Bending	The SPME Fiber did bend, not the sheath metal (Needle) but the fiber wire at the screw connection. The main reason for this is the Standby Position of the Fiber. In the original SPME User Manual (Varian) it has been described that the standby Position should be adjusted so that the Fiber is 0.1 mm inside of the needle. It has been observed that at the moment of penetration the fiber is pushed against the GC Injector septum. The fiber gets blocked at this moment. The next step is the fiber penetration movement, and at this moment the wire becomes bent. The Standby setting of the fiber is recommended with a minimum 1.0 mm inside of the needle.	<i>Note: This effect has been observed typically with very soft GC Injector septa.</i> <i>The septum for the Shimadzu split/splitless injector is a good example.</i> <i>Using a Merlin Adapter is a possible solution if the wire bending cannot be resolved.</i>

1.3.2.3.2.3 Communication Error Z-Axis

Communication Error Injection Unit (Z-Axis or Head) with PAL System.

Firmware Error Message Number:

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Firmware	Reload complete FW backup file. If part of the flash memory is disrupted it may be the fastest way to recover. <i>Note: Do not use Firmware only (core software). Complete Backup has a file size of approx. 1.5 MB.</i>	Use the Firmware backup file made at the time of installation or any newer version for the particular PAL System.
PCB for Injection Unit	Change PCB.P/N: PAL MZCtrl	By exchanging a complete Injection Unit, the possible cause of error can be narrowed down and identified.
Ribbon Cable Z-Axis	Change the ribbon cable, Z-Axis. Inspect the ribbon cable for any possible damage.P/N: MZ 50-00 or MZ 50-01 for ITEX unit.	By exchanging a complete Injection Unit, the possible cause of error can be narrowed down and identified.
APR MOTIO Board APR Control Board	Change the MOTIO or Control Board.P/N:- APR MOTIO- APR Control GC- APR Control-HTC- APR Control-LC	By exchanging a MOTIO or Control Board, the possible cause of error can be narrowed down and identified.
Ribbon Cables Y-or X-Axis	If all other actions did not solve the problem, change the 2 Ribbon Cables for the X- and Y-Axes. Inspect the cables for any damage. For P/N see the section "X-Y-Axis Spare Parts".	If ribbon cables are changed, it is advisable to update to the current level and also exchange the X- and Y-sensors. For more details, see the section on the X- and Y-Axes. <i>Note: After completion of repair work check the system completely. For more details see the "Testing Z-Axis" and "Firmware Configuration" sections.</i>

1.3.2.3.2.4 Plunger Sensor Error

Firmware Error Message Nr.:

Follow the listed points in the order given:

Possible Cause	Recommended Action	Remarks
Firmware	Reload complete FW backup file if part of the flush memory is disrupted it may be the fastest way to recover. <i>Note: Do not use Firmware only (core software). Complete Backup has a file size of approx. 1.5 MB.</i>	Use the Firmware backup file made at the time of installation or any newer version for this particular PAL System.
PCB for Injection Unit	Check the unit in the <u>PAL Service Mode</u> to see if the Z-Plunger Sensor is still intact. <u>Replace PCB Z-Axis</u>	The <u>Sensor itself is not available</u> as single spare part. <i>Note: After completion of repair work check the system completely through. For more details see "<u>Testing Z-Axis</u>" and as well confirming "<u>Firmware Configuration</u>"</i>

1.3.2.3.2.5 Needle Guide Sensor Error

Firmware Error Message Nr.:

Follow the listed points in the order given:

Possible Cause	Recommended Action	Remarks
Firmware	Reload complete FW backup file if part of the flush memory is disrupted it may be the fastest way to recover. <i>Note: Do not use Firmware only (core software). Complete Backup has a file size of approx. 1.5 MB.</i>	Use the Firmware backup file made at the time of installation or any newer version for this particular PAL System.
Mechanical Problem in Needle Guide Assy	Check the mechanical movement of the Needle Guide Assy. Verify following points: - Are the rods bended? - Are the Bearings Bushings at the bottom of the Syringe Slider intact? - Has the Assy been cleaned with a solvent and greased/oiled? Has dust been collected by this action? - Is the Guiding Bushing for the Needle Guide Spindle intact? - Is the Short Tension Cord intact? - Does the Short Tension Cord touch the Rollers or catch an electronic chip if the Assy is pushed up? - Is the Gas Flush Tube Z-Axis intact?	For more details concerning the <u>Needle Guide Assy</u> , see specific section.

Possible Cause	Recommended Action	Remarks
PCB for Injection Unit	Check the unit in the PAL Service Mode to see if the Needle Guide Sensor is still intact. Replace PCB Z-Axis	The Sensor itself is not available Sensor itself is not available as single spare part. <i>Note: After completion of repair work check the system completely through. For more details see 'Testing Z-Axis' and as well confirming 'Firmware Configuration'</i>

1.3.2.3.2.6 Syringe Not Detected

Firmware Error Message Nr.:

Follow the listed points in the order given:

Possible Cause	Recommended Action	Remarks
Check Firmware Setting "Syringe Detection"	PAL Local TerminalPath: Menu/F3-Setup/System/Syr Detection ON	
Check Syringe Holder for ID Magnets	Are the magnets installed? Does the ID correspond with the binary code?	The ID Nr. is given by a binary code. On the back side of the syringe holder plate, 5 possible positions are prepared. The active one(s) have magnets installed. Binary Code: 1,2,4,8,16. Calculate the sum to verify ID Nr.
Check Firmware Syringe Object	Is the corresponding Syringe Firmware Object loaded? Check from the PAL Local Terminal: Path: Menu/F3-Setup/Object/Syringes	If the object is not loaded, use the PAL Object Manager Software provided to load the new object.
Check PCB for Z-Axis	The sensors to identify the binary code of the syringe ID Nr. are placed on the PCB for Z-Axis. Replace the PCB if necessary.	To verify the failure it is advisable to use a second syringe holder.
Firmware	Reload the complete FW backup file. If part of the flash memory is disrupted it may be the fastest way to recover. <i>Note: Do not use Firmware only (core software). Complete Backup has a file size of approx. 1.5 MB.</i>	Use the Firmware backup file made at the time of installation or any newer version for the particular PAL System.

1.3.2.3.2.7 Needle Guide Blocking Not Released

Firmware Error Message Number: 137

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Check Firmware for "FibExp" Position	Check if the position 'FibExp' has been installed.Path: Menu/Setup/Objects/Vials/FibExp.	This position is used to block the Needle Guide. Mainly used for SPME applications. This allows the insertion of the SPME Fiber into the vial and shaking the setup in the Agitator. The needle is free standing.Details are given in the SPME Manual.
Solenoid for Needle Guide Assembly	Check the unit in the PAL Service Mode . Check Head / "F1". The Needle Guide is blocked and released. If not, error message No. 137 shows up. Audible noise of this "click-clack" is noticeable. If the error is verified, replace the Solenoid and if necessary also the PCB. For details, see the section " Solenoid ".	Replacement Solenoid requires PCB level K.L or higher.
PCB for Z-Axis	Replace PCB for Z-Axis.	The solenoid and the PCB have to match the levels. If critical, change both parts at the same time.
Firmware	Reload a complete backup file.If part of the flush memory is disrupted it may be the fastest way to recover. <i>Note: do not us Firmware only (core software). Complete backup file as a file size of approx. 1.5 MB</i>	If available, use the backup file made at the time of installation or any newer version of the backup file for the particular system.
APR MOTIO or Control Board	Change the MOTIO or Control Board.P/N:- APR MOTIO- APR Control GC- APR Control-HTC	By exchanging a MOTIO or Control Board the possible cause can be nar-

Possible Cause	Recommended Action	Remarks
		rowed down.
Ribbon Cables for X-Y-Axis	If all other actions did not solve the problem, change the 2 Ribbon Cables for the X-and Y-Axis. Inspect the cables for any damage. For P/N see section "X-Y-Axis Spare Parts"	If ribbon cables are changed, it is advisable to update to the current level and exchange also the X- and Y-sensors. For more details, see the section on the X- and Y-Axes. <i>Note: After completion of repair work, check the system completely. For more details, see the "Testing Z-Axis" and "Firmware Configuration" sections.</i>
SPME Parameter Settings	Needle Guide Blocking is mainly used for the SPME technique. After the equilibration step, the Needle Guide is released by activating the Solenoid. If the Needle Guide Sensor does not detect a movement of the gearwheel from the spindle bushing, then the error message "Could not Release Needle Guide" is displayed. The same effect can be caused by a combination of a too low Z-Position and an extreme needle penetration. If the Needle Guide does practically touch the lid of the vial during the equilibration phase, a release cannot be detected by the sensor.	<i>Note: During the SPME Cycle, the PAL Firmware takes following steps at the moment the equilibration process has been terminated:- insert the fiber into the sheath metal (needle)- move 50% of the fiber length down with the Syringe Slider. (This reduces the audible noise at the moment of the release).- Release of the Needle Guide.</i> For more details, see Service Note # 15/2001.

1.3.2.3.2.8 Object Collision

Firmware Error Message Number:

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Wrong Tray Type selected	Check Tray TypePath: Menu/Utilities/Trays. Check corners of the Tray, "F3"	If Tray Type is correct, check the Tray and Vial height in the Tray Type itself. Path: Menu/F3-Setup/Objects/TrayType. The sum of Tray- and Vial-heights is the total height for detection of an object.
X-Y-Z Axes misaligned	Check the X-Y-Z positions	Check also the needle length as described under "Needle Bending".

Possible Cause	Recommended Action	Remarks
Agitator installed in the pathway	Check position of Agitator. The Y-Z-Assembly cannot cross over the Agitator transporting a 20 ml vial. The Agitator has to be installed at the far right or left position.	
Non-PAL Device interferes in the pathway.	A Non-PAL Device can be e.g. a large detector housing from a GC. Such a device can stick out so that the Y-Z-Assembly collides (especially during vial transport). The solution is to make the PAL Y-Axis always move back to the position "0-Y" (back to the X-Axis). Path: Menu/F3-Setup/F3-Objects/Motors/Y-Motor/Strategy/select RETRACT	Note that this lowest level of Firmware shall not be made public and given away to customers. On this level many parameters can be changed and the PAL System can be destroyed. If you suspect that the customer has "played around" on this level, load a completely new backup file.
Firmware	Reload a complete backup file. If part of the flash memory is disrupted it may be the fastest way to recover. <i>Note: do not use Firmware only (core software). Complete backup file as a file size of approx. 1.5 MB</i>	If available, use the backup file made at the time of installation or any newer version of the backup file for the particular system.
Needle Guide Sensor defect	In case the Needle Guide Sensor would be defective an error message is displayed. The PAL System would come to a stop before the needle is bent. The Needle Guide sensor can be checked with the PAL Service Mode. If any doubts remain, exchanging the complete Injection Unit could narrow down the possible cause of error.	The statement under "Recommended Action" holds true as long as the setting for the various Tray Types has not been changed. The default setting is always with a "Z-Tolerance" >0. Standard exemptions: LC Valve and TrayCooler (surface of lid is addressed as an absolute value). This means that the system looks for an object within a certain tolerance. If not found, an error is reported: "Vial not found". If an unexpected object is found, a collision error is reported. In both cases, the system will stop. In the case of Z-Tolerance=0 the the syringe slider moves hard to the absolute Z-value.

Possible Cause	Recommended Action	Remarks
Ribbon Cable Z-Axis	Inspect the cable for any possible damage.	By exchanging a complete Injection Unit, the possible cause of error may be narrowed down and identified.
APR MOTIO or Control Board	Change the MOTIO or Control Board.PNo.: - APR MOTIO- APR Control GC- APR Control-HTC- APR Control-LC - APR Control- xt	By exchanging a MOTIO or Control Board, the possible cause of error may be narrowed down and identified.
Ribbon Cables from X-Y Axis	If all other actions did not solve the problem, change the 2 Ribbon Cables for the X-and Y-Axis. Inspect the cables for any damage. For P/N see section ' X-Y-Axis Spare Parts '	If ribbon cables are changed, it is advisable to update to the current level and also exchange the X- and Y-sensors. For more details, see the section on X- and Y-Axes. <i>Note: After completion of repair work check the system completely. For more details see the "Testing Z-Axis " and "Firmware Configuration" sections.</i>

1.3.2.3.2.9 Object Not Detected

Firmware Error Message Number:

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Wrong Tray Type selected	Check TrayTypePath: Menu/Utilities/Trays.Check corners of the Tray, "F3"	If Tray Type is correct, check the Tray and Vial height in the Tray Type itself.Path: Menu F3-Setup Objects Tray Type.The sum of Tray- and Vial-heights is the total height for detection of an object.
X-Y-Z Axes misaligned	Check the X-Y-Z positions	Check also the needle length as described under "Needle Bending"

Possible Cause	Recommended Action	Remarks
LC Valve Z-Position not correct	The Lower Needle Guide from the Injection Unit has to be positioned in the Z direction such that the black part does not sit directly on the needle guide from the valve inlet.	The Valve Z-position has no Z-tolerance, the absolute Z-value is used. If the position is wrongly taught it is possible that the Z- stepper motor loses steps. This will be observed in the following step of the cycle, e.g. Wash Station. See also "Optimization".
Firmware	Reload a complete backup file. If part of the flush memory is disrupted it may be the fastest way to recover. <i>Note: do not use Firmware only (core software). Complete backup file as a file size of approx. 1.5 MB</i>	If available, use the backup file made at the time of installation or any newer version of the backup file for the particular system.
Needle Guide Sensor defect	In case the Needle Guide Sensor is defective, an error message is displayed. The PAL System would come to a stop before the needle is bent. The Needle Guide sensor can be checked with the PAL Service Mode. If any doubts remain, exchanging the complete Injection Unit could narrow down the possible cause of error.	The statement under "Recommended Action" is true as long as the setting for the various Tray Types has not been changed. The default setting is always with a "Z-Tolerance" >0. Standard exemptions: LC Valve and TrayCooler (surface of lid is addressed as an absolute value). This means that the system looks for an object within a certain tolerance. If not found, an error is reported: "Vial not found". If an unexpected object is found, a collision error is reported. In both cases the system will stop. In the case of Z-Tolerance=0 the syringe slider moves hard to the absolute Z-value.
Ribbon Cable Z-Axis	Inspect the cable for any possible damage.	By exchanging a complete Injection Unit, the possible

Possible Cause	Recommended Action	Remarks
		cause of error may be narrowed down and identified.
APR MOTIO or Control Board	Change the MOTIO or Control Board.P/N:- APR MOTIO- APR Control GC- APR Control-HTC- APR Control-LC	By exchanging a MOTIO or Control Board, the possible cause of error may be narrowed down and identified.
Ribbon Cables from X- or Y Axes	If all other actions did not solve the problem, change the 2 Ribbon Cables for the X- and Y-Axes. Inspect the cables for any damage. For P/N see section "X-Y-Axis Spare Parts".	If ribbon cables are changed, it is advisable to update to the current level and also exchange the X- and Y-sensors. For more details, see the section the X- and Y-Axes. <i>Note: After completion of repair work check the system completely. For more details see "Testing Z-Axis" and "Firmware Configuration" sections.</i>

1.3.2.3.2.10 Syringe Plunger Bending

Firmware Error Message Number:

Follow the points listed in the order given:

Possible Cause	Possible Action	Remarks
Check the various Syringe Plunger speeds	There are several speeds which have to be considered. The various speed settings have to be adapted to the Syringe Volume (size) and the liquid or type of solvent. For the solvent, the boiling point is the main point to consider. The other point of importance is the quality of the sample solution. This must be pure, with no particles and should not be highly matrix loaded. Method Parameters: - Fill Speed Fill Speed has to be adjusted to the boiling point (bp) of the solvent solution. Examples : - Pentane bp 35°C Fill Speed 1 ul/sec- iso-octane bp >100°C Fill Speed 5 to 10 ul/sec- aqueous solution fill speed 5 ul/sec. - Inject Speed The Inject Speed depends highly on the application.Examples: - GC Technique: The values can vary from 50 ul/sec for "split" to 1 ul/sec for "cold on-column" injection mode. For more details see "Recommended Parameters" for GC technique in the PAL Firmware Overview. - HPLC Technique: The Injection Speed for standard HPLC application, loop size 20 ul, is approx. 5 ul/sec.for larger loop and syringes sizes can the speed be increased. Syringe Parameter: - Eject Speed: The Eject Speed is used for the Fill Strokes to elim-	It is important that a new syringe is never inserted into a dry stage. Manually fill the syringe with the solvent type used for the application. The plunger and glass surface have to be wetted first. This precaution is important for the lifetime for a syringe. The rule of thumb is, as soon as air bubbles are observed in the syringe the Fill Speed has to be reduced. If the Injection Speed is too high for the HPLC technique, the loop and the valve bore form a restriction. As a first error, the high speed can cause turbulence in the loop which results in bad reproducibility. If the speed is much too high, the restriction will cause a back-flush of the sample solution in port 1 (fill port) of the valve, and smears around the needle. The result is not only a bad reproducibility but also carry over and loss of material. The rule of thumb is to move the plunger the full way down within approximately 1 second. Examples: - 10 ul Syringe: Eject Speed approximate. 10 ul/sec.- 100 ul Syringe: Eject Speed approximate. 100 ul/sec. For larger syringes one has to ensure that the stepper motor for the plunger does not lose steps if the Eject Speed selected is too high. The limit is around 500 to 750 ul/sec.

Possible Cause	Possible Action	Remarks
	inate possible air bubbles in the syringe. Wash Station Parameter: For the wash cycle another fill speed is selectable, "Max Fill Speed". Select the speed accordingly considering the points described above. Path: Menu/F3-Setup/- Objects/Wash Stations/ Make the changes for "Wash" and also for "Wash2".	
Check the Various Solvents used for the application.	As described above, the boiling point is a critical parameter to consider for the correct filling of a syringe. Related to the boiling point, the plunger can only be bent if extreme conditions are selected. More important is the quality of the solvent. Are particles, salt or matrix, present? For more information on this, see below. Another important point to observe is the application using biofluid solutions. Proteins precipitate with a higher concentration of organic solvents, such as >5% of methanol or >10% of acetonitril. The precipitate can clog the needle. The washing procedure for biofluid samples is first aqueous, followed by an organic solvent solution for cleaning. Before the next sample is picked up, the syringe has to be cleaned with aqueous solvent again to prevent precipitation within the needle and syringe content of any remaining organic solvent.	Matrix, salt or any particles can destroy the syringe plunger tip and the HPLC valve. The rotor and stator can be scratched, and the valve will not be pressure tight anymore. Filtering the sample solution is advisable. Filtering can be time consuming and expensive. If the filtering step is not practical and is eliminated, the user must be aware that the syringe and the HPLC valve have to be replaced very frequently. Replacing the syringe plunger only does not eliminate the problem. The glass surface inside the barrel is scratched and will rapidly destroy the Polymer tip. Only replacing the rotor has the same effect. The stator is scratched and this will rapidly destroy the newly-installed rotor. Clogging the needle or burning the plunger to the glass surface may not only lead to plunger bending but could also prevent correct referencing of the plunger position. As a consequence, the plunger would be pulled by the following

Possible Cause	Possible Action	Remarks
		step, e.g Washing.
Check the Syringe type	Basically 2 syringe plunger types are available: - Metal Plunger Seal is achieved by the liquid film in between the plunger and the glass wall. - Plunger with a Polymer Tip. Also referred to "gas tight". The metal plunger is commonly used for the GC Technique. The sealing film is achieved by the organic solvent. As soon as the solvent gets more aqueous, the film is no longer formed properly. This effect leads to air bubbles, bad reproducibility and the plunger burns to the glass wall. Plunger bending is the final result. As soon as aqueous solvents or organic solvents which may contain traces of acids (like hydrochloric acid) are used, it is recommended to change from the "L" to the "G" type of plunger. For further examples, see "Remarks". The same rule is valid for sample solutions containing particles from salt or matrix. The "G" plunger is more forgiving but the tip will be destroyed sooner or later.	Examples CTC PNo.: SyrC L10-26S-AS Syringe used mainly for GC Technique. 10 ul size, Needle Gauge 26S and point style of needle "AS", conical. 'L' refers to liquid plunger. No Polymer tip installed. Metal plunger only. This plunger type is not replaceable. SyrC G10-26S_AS Same syringe as described above. difference is the Plunger type "G", gas tight or with Polymer tip installed. This plunger type is replaceable.
Maintaining the Syringe or Syringe Plunger	It is a good laboratory practice to manually check the syringe with a regular frequency (daily if necessary). Clean the syringe and plunger to avoid any blockage. Cleaning the plunger is more important for the "L" type. Use a mixture of an alcohol solution with water, applied to a lint free paper (Kleenex) and wipe the plunger clean. Ensure that the needle is open.	

1.3.2.3.2.11 Mechanical Problem with Vial Transport

Firmware Error Message Number:

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Red magnetic Ring not or wrong installed	Check if the red magnetic Ring is installed and if yes, that it is installed facing down.	The red magnetic ring is used for the transport of 10 or 20 ml vials. 2 ml vials can be transported without the ring. The lower needle guide should have the magnets installed, example in the Combi PAL version.
Vial Crimping deficiency	The crimping tool has to be checked that the crimped surface of the cap is even and not cambered. Check that the cap is attached squarely and is not angled.	The vial has to be attached square or parallel to the magnet. If not, the vial is at an angle to the Z-Axis. Moving the vial to a position can fail because of the mechanical hindrance at the moment of vial penetration in the object, example in the Tray (Rack).
Vial Shape deficiency	The vial has to have a rounded shape at the bottom. This shape is more important for larger vials, like 10 or 20 ml vials. The rounded shape is more forgiving when placing the vial into a Tray, as an example. The chance to encounter a mechanical obstruction is practically eliminated with this type of vial shape.	The recommended vials from the major suppliers like Chromacol, La-Pha-Pak or MicroLiter fulfil this requirement.

1.3.2.3.2.12 Flake-Off Particles from Syringe Slider or Z-Tube

Firmware Error Message Number: not applicable

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Dust and dirt mixed with dried grease	Clean the Guide Rollers and Guide Rods from the Z-Tube intensively. Re-grease the parts with the dedicated grease for the PAL system. P/N: PAL Lube (part of the PM Kit).	Black material has been observed flaking off from Z-Units which have not been cleaned and maintained over a longer period. CTC Analytics recommends to perform a PM once a year. The ded-

Possible Cause	Recommended Action	Remarks
		icated Grease is included in the PM Kit.
Corrosion from acid vapor	Check the environment to find the sources of the acidic vapor phase. Clean the unit intensively and grease the parts again. If the unit is highly contaminated, a check with pH-indicator paper helps to ensure the cleaning process. In case of severe corrosion, contact CTC Analytics for further assistance.	In rare cases, this effect has been observed. It is more related to accidents in the lab. Be aware that not only the common known mineral acids, such as sulfuric acid, can cause corrosion but also the organic volatile acids, such as TFA or acetic acid.
High tension from Guide Rollers against Guide Rods in Z-Tube	If the tension of the rollers against the guide rods is too high there is a possibility that the material becomes abraded. Mixed with grease, this can form black flakes. Do not change the setting. If this has been done for any reason, ensure that the tension is so low that one can almost feel a play at the side. In case of any doubt, contact CTC Analytics for further assistance.	The distance of the rollers to the Guide Rods is very critical. See also the section " Limitations for Z-Axis ".
Particles flaking off from Lower Needle Guide	Material flaking off from the lower guide has been observed mainly in the HPLC application. Wash Solvent from the Fast Wash Station could "spit" along the needle, reaching the Lower Needle Guide. Solvents containing acids, e.g. TFA, can corrode the installed magnets. The corrosion goes through to the black protection coating. Check the Fast Wash Station.	For more details see Service Note # 06/2001. See also the section 'Needle Guide Assembly' or 'Spare Part Kits for Z-Axis'. A chemically inert Needle Guide is also available.

1.3.2.3.2.13 Electronic or PCB Failure

Firmware Error Message Number: not applicable

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Ribbon Cable connection to the Y-Axis	Check the Ribbon Cable connection to the Y-Axis. Is the Y-Axis Ribbon Cable folded? Is the cable connector at the Z-Axis intact?	This is a common error. During installation of the Z-Axis, the Y-Axis Ribbon Cable is distorted. If any damage is observed, replace the Ribbon Cable (or better, both cables).
Plunger Sensor failed	Run the Service Test as described in the section " Testing Z-Axis ". If the test is negative, replace the PCB from the Z-Axis.	<i>Note: Observe the Revision Level as described in the section "Solenoid".</i>
Needle Guide Sensor failed	Run the Service Test as described in the section " Testing Z-Axis ". If the test is negative, replace the PCB from the Z-Axis. Test also the mechanical part of the Needle Guide Assembly. Any hindrance observed?	<i>Note: Observe the Revision Level as described in the section "Solenoid".</i>
Z-Position Sensor failed	Run the service Test as described in section " Testing Z-Axis ". Check if the Switching Magnet is still intact in the housing of the Z-Axis. Check if there is a direct contact from the Z-Position Sensor solder point to the cover of the electronic part. If the tests are negative, replace the PCB from the Z-Axis.	Run "Test Switches" See also section " Z-Axis Housing ". With a contact would the syringe Slider Assy move up and down, not finding a position. <i>Note: Observe the Revision Level as described in section "Solenoid".</i>
Ribbon Cable Z-Axis defective	Check Ribbon Cable and replace it if any defect is observed.	
1 uF Capacitor, heating failed	It has been observed that a specific 1 uF capacitor has failed in the past. Typically, the temperature for the headspace syringe does not reach the set temperature. For details see Service Note # 01/2002.	Corrections have been implemented in PCB for Z-Axis, Revision E.L. The failure has been observed with Rev. level E.K.
Electronic component burnt	Replace PCB for Z-Axis	<i>Note: Observe the Revision Level as described in the section "Sole-</i>

Possible Cause	Recommended Action	Remarks
		noid".

1.3.2.3.2.14 Z-Position Sensor Knocked-Off

Firmware Error Message Number: not applicable

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Inserting Syringe Slider into Z-Housing	The Z-switching magnet can be knocked off during a repair procedure. The screws from the Cover Electronic Part have to be tight. Screws standing out more than 1 mm can cause a collision with the magnet. Replace the magnet as described in the section "Z-Axis Housing".	In order to replace the magnet, one has to remove the Deco Stripe at the side. If a replacement kit is ordered, specify the type of Deco Stripe (CTC or any OEM version).

1.3.2.3.2.15 Gas Leak within Z-Axis

Firmware Error Message Number: not applicable

Follow the points listed in the order given:

Possible Cause	Recommended Action	Remarks
Gas Flush Tube-Z defective	Check Gas Flush Tube-Z. The most common errors are: - Sealing gasket of connections lost or over-tightened. - Gas Flush Tube-Z is jammed against the Cover for Electronic Part. Replace tube.	
Defective O-ring Gasket for seal with Heated Cartridge	The sealing O-ring Gasket is installed in the Syringe Slider. The O-ring is glued in. If damage is observed, check if the tube connection from the Heated Cartridge has sharp edges.	Description of O-Ring: Glue used: <i>Note: Remove carefully all remaining particles before the new gasket is glued on, to ensure a tight seal again.</i> CAUTION: Do not use any other glue or solvent, as recommended. Avoid any contamination in the gas line.

Possible Cause	Recommended Action	Remarks
Defective Heated Cartridge	Check the following points at the cartridge: - Is the tube connection (gas inlet for cartridge) intact? - Are the O-ring Gaskets inserted? 2 red O-rings inside of the Cartridge.	
Gas Pressure Setting too high	Check the gas pressure setting at the Pressure Regulator. Correct setting for Headspace technique is 0.5 Bar. ITEX Technique, less than 0.1 Bar. See ITEX user manual.	<i>Note: A higher setting does not deliver a higher gas flow. The restriction is at the needle of the syringe.</i> See also the section " X-Y-Axis Troubleshooting "

1.3.2.3.3 Overview Injection Unit Repair Path

The following overview shows the path used to reach a certain level or part for repair.

As a first step, "Disassembling the Injection Unit" is described. This step is a pre-requisite for all other repair steps. The disassembly procedure is only described once, and for all other steps it is only referred to with a link.

The same procedure is used for the final assembly step.

After the assembly, the test procedure for the injection unit is described.

- [Disassembling Injection Unit, Z-Axis](#)
- [Needle Guide Assembly](#)
- [PCB for Injection Unit, Z-Axis](#)
- [Solenoid](#)
- [Gas Flush Tube-Z](#)
- [Stepper-Motor for Z-Axis](#)
- [Stepper-Motor for Plunger](#)
- [Z-Housing | Z-Tube | Slider Housing](#)
- [Ribbon Cable-Z](#)
- [Assembling Injection Unit, Z-Axis](#)
- [Limitations](#)
- [Testing of Injection Unit, Z-Axis](#)

1.3.2.3.3.1 Overview Injection Unit Repair Path

The following overview shows the path used to reach a certain level or part for repair.

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- [Stepper-Motor for Plunger](#)
- [Z-Housing | Z-Tube | Slider Housing](#)
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- [Assembling Injection Unit, Z-Axis](#)
- [Limitations](#)
- [Testing of Injection Unit, Z-Axis](#)

1.3.2.3.3.2 Disassembling Injection Unit, Z-Axis

In this procedure, the Disassembly of the PAL Injection Unit or Z-Axis is described in detail.

All further steps are described separately, see "Repair Path Overview".

The Disassembly Steps at this level are identical with the PM (Preventative Maintenance) Procedure for the Injection Unit.

The assembly steps are described in "Assembling Z-Axis".

Note: CTC Analytics AG provides a dedicated Tool Kit which contains the necessary screwdrivers, especially the Torx drivers.

P/N: PAL ToolKit

WARNING:

Disconnect the PAL System from the power line and unplug the power cord before any maintenance or repair step is done.

Also, disconnect the PAL System from any other device which is part of the complete system.

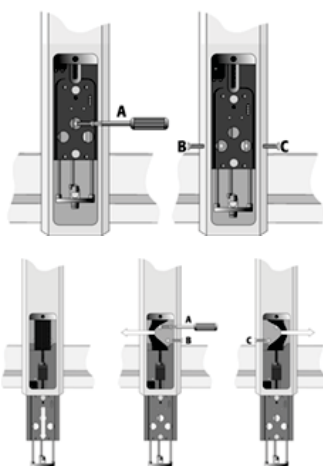
CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case, if electronic parts will be handled.

Not observing this basic rule can result in erratic behavior of a component or even in a damaged printed circuit board (PCB).

Indication for Disassembling Injection Unit (Z-Axis)

The procedure "Disassembling Injection Unit" is needed for all maintenance and repair steps for the PAL Injection Unit.



Step 1: Remove the Injection Unit from the Y-Axis.

This schematic shows the situation for the standard size injection unit, e.g. MZ 01-00 or MZ 02-00.

For detailed descriptions, see the corresponding PAL USER MANUAL.

Note: Do not pull the ribbon cable too far out of the Y-Axis.

This schematic shows the situation for the shorter injection unit, MZ 06-00, used for the PAL models LC and GC PAL.

Note that the syringe slider has to be completely pulled down.

Required Tools: Torx T20

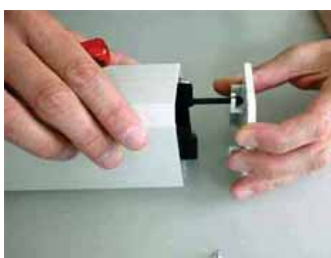
Material Description: Screw M3x4 mm



Step 1: Loosen the top cover screw.

Required Tools: Torx T10

Material Description: - Top Cover Z-Axis ; P/N: PAL MZCovTop includes: cover and Screw;
P/N: BN4851 M3x6 mm- Tension Cord 280 mm;
P/N: MZ 30-21



Step 3: Pull away top cover.

Required Tools:

Material Description: - Top Cover Z-Axis ; P/N: PAL MZCovTop includes: cover and Screw;
P/N: BN4851 M3x6 mm- Tension Cord 280 mm;
P/N: MZ 30-21



Step 4: Unhook the long Tension Cord.

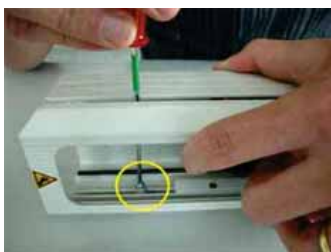
Note: The function of the long Tension Cord is to hold the syringe slider assembly in position when the power is turned off. It is recommended to replace the Tension Cord once a year. The Tension Cord is part of the PM Kit.

Required Tools:

Material Description: Tension Cord 280 mm;
P/N: MZ 30-21

Step 5: Mark the position of the Slider Stopper. Loosen the Slider Stopper.

Note: The correct position of the Slider Stopper can be checked by pulling out the slider completely. The 2 lower rolls from the slider should be visible by 50% at the bottom of the Z-Tube. The penetration path is lost if the stopper is fixed too high up, and if the stopper is fixed too low, the slider will disengage from the rails.



Required Tools:

Allen Key, round headed (included in PAL ToolKit)

Material Description: Z-Axis Slider Stopper Assy; P/N: PAL SlidStop Kit



Step 5 cont'd: Note: The Slider Stopper can be accessed easily with the Allen key in cases where the injection unit is equipped with a slit for the Dilutor option (Revision Level E or higher), see picture above. In cases for modules without a slit, it is crucial to use a round-headed Allen key to prevent distortion of the screw head. The round-headed Allen key is provided with the PAL Tool Kit.



Step 6: Move the Slider Stopper out of the Z-Tube.

Required Tools: Allen Key, round-headed

Material Description: Z-Axis Slider Stopper Assy; P/N: PAL SlidStop Kit

Step 6: Carefully pull out the syringe slider assembly from the Z-tube.

CAUTION:

The syringe slider is still connected to the ribbon cable and in the case of a Combi PAL module, also to the gas flush tube. Pay attention that the gas flush tube does not latch up with the corner of the sheet metal or ribbon cable inside the Z-Tube. Use a tool to lift up the gas flush tube as shown in the picture.

Required Tools:

Material Description: Z-Axis Ribbon Cable;
P/N: MZ 50-00

Z-Axis Gas Flush Tube; PAL TubeFlushZ

Step 6 cont'd: Place the syringe Slider and the attached Z-tube on a clean, solid workspace in front of you.

Step 7: Loosen the 5 screws on the cover of the electronic and needle guide mechanical part.

Note: Modules with lower revision levels have been equipped with screws with Phillips screw heads. If possible replace these with screws containing Torx heads.

Required Tools: Torx T8

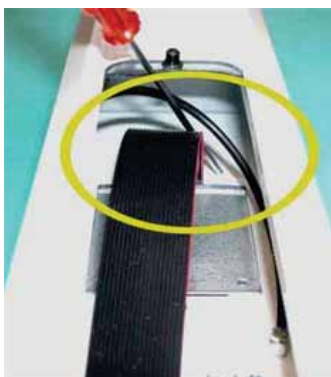
Material Description: - Cover for electronic Part;
P/N: PAL MZCovCtrl includes: Screws; P/N: BN 15857 M2.5x6 mm and Serrated Lock Washers; P/N BN 782 M2.3

Step 8: Remove the cover to gain access to the electronic and needle guide mechanical parts.

Required Tools:

Material Description: See Point 7.

This concludes the disassembly of the PAL Injection Unit or Z-Axis. All further steps are described separately, see "Repair Path Overview". The disassembly steps at this level are identical with the PM (Preventative Maintenance) Procedure for the Injection Unit. The assembly steps are described in "Assembling Z-Axis".



1.3.2.3.3 Needle Guide Assembly

This procedure for the Needle Guide Assembly describes the maintenance and replacement of the mechanical parts of the needle guide.

Indications for Maintaining or Replacing of the Needle Guide Assembly are:

- Loose short tension cord. Should be part of the PM procedure. Vials are not retrieved (picked-up) causing needle bending at the lower part (approx. 10 to 15 mm from the bottom). Seen first with Headspace and SPME applications. - Mechanically sticking or distorted needle guide rods. - Lower Needle Guide corrosion of magnets. (Can be caused by HPLC washing solvents using high or low pH's, see Service Note # 06/2001). - Needle Guide stopper does not hold the needle length in position. - Guide Bushing for needle guide spindle broken apart. - General overhaul of Injection Unit with cleaning, maintaining and upgrading to a current level. - Stack Drawer Magnet has to be replaced. Example: protection foil damaged.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case, as soon as electronic parts are handled.

Not observing this basic rule can result in erratic behavior of a component or even in a damaged printed circuit board (PCB).

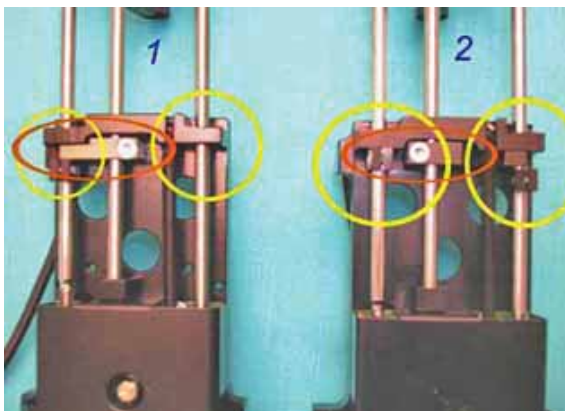
1.4 Introduction



Introduction Needle Guide Assembly Point 1:

The Needle Guide Assembly has been redesigned with the change from Z-Axis Revision B to C.

The current level is shown on the left side, marked with Nr. 1. The Anti-Twist Device points to the left side and there is only 1 mechanical stopper for the needle guides.



Introduction Needle Guide Assembly Point 2:

New type of "Anti-Twist Device" (single mechanical stop).

Old type of "Anti-Twist Device" (two mechanical stops mounted on outer rods for needle guide):

With the stop on the left hand side one adjusts the distance for the needle length.

Standard Setting: Length of blank metal rod $50.5 + 0 + 0.5$ mm. Measured within inner edges of black colored metal parts.



Introduction Needle Guide Assembly Point 3: Spare Part Kit: The procedure below describes in detail how to change the single parts. The lower Needle Guide is not provided as a single piece. The picture shows the parts which are provided with the Spare Part Kit.

Needle Guide without Magnets installed (HPLC) P/N: MZ 23-01; Needle Guide with Magnets installed (GC) P/N: MZ 23-02

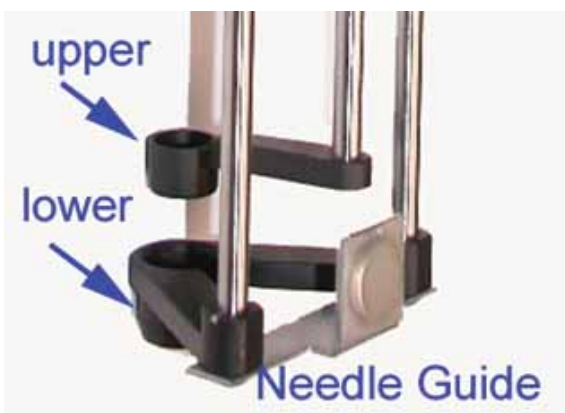
Needle Guide Assembly for ITEX version: MZ 23-03



Introduction Needle Guide Assembly Point 4: Early manufactured injection units had a bushing with black colored material and a black plunger nut installed.

Starting with Revision C of the Z-Axis, a new needle guide bushing containing a whitish/gray colored material has been installed. This material is a Teflon based Polymer mix which is a "self-smearing" compound.

CTC Analytics recommends to replace the old type of bearing whenever possible.



Introduction Needle Guide Assembly Point 5:

The standard coating for the lower and upper needle guide is a mixture of Elox with Teflon.

It has been observed that certain acids, such as tri-fluoroacetic acid (TFA) can partially dissolve the protection coating.

For dedicated applications, needle guides with a special chemical resistant coating are available. This coating can withstand TFA contact for a long time.

Material:

Lower Needle Guide, Gauge 19, chemical resistant coating; P/(N: MZ 20-45

Upper Needle Guide, Gauge 19, chemical resistant coating; P/(N: MZ 20-46

Note: These are guide parts only. No assembly with rods.

1.5 Needle Guide Assembly Repair and Maintenance Procedure

It is assumed that the Injection Unit has been already disassembled as described in "Disassembling the Injection Unit".

All further steps are separately described, see "Repair Path Overview".

The assembly steps are described in "Assembling Z-Axis".



Step 1: The steps to disassemble the Injection Unit or Z-Axis are described in "Disassembling the Injection Unit".

Note: It is advisable to replace the long Tension Cord once a year. The tension cord is part of the PM Kit.

Required Tools:

Material Description: PM Kit for PAL HPLC Technique; P/N: PAL PM Kit1
PM Kit for PAL GC Technique; P/N: PAL PM Kit2
Tension Cord 280 mm; P/N: MZ 30-21

Step 2: Disconnect the short Tension Cord from the top of the needle guide rod.

Required Tools:

Material Description: Holder for short tension Cord; P/N: MZ 20-15
Tension Cord for all PAL Systems; P/N: MZ 30-23

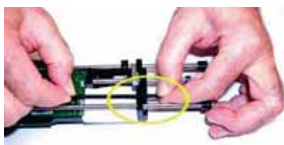
Note: The dedicated Tension Cord for the Combi PAL, P/N: MZ 30-22 is obsolete.

Note: The function of the short Tension Cord is to press the vial or well plate down with the lower needle guide, at the moment the syringe is withdrawn. An indication of a loose Tension Cord is needle bending. First seen with Headspace vials or SPME application.

Typical form of the bent needle is an "L-form". Compare to picture.

It is advisable to replace the short Tension Cord once a year. The tension cord is part of the PM Kit.



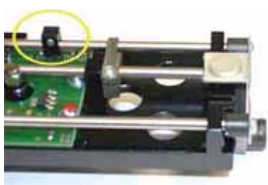


Step 3: Disconnect the short Tension Cord from the Syringe Slider base plate by stretching the cord.

Required Tools:

Material Description: PM Kit for PAL HPLC Technique;
P/N: PAL PM Kit1PM Kit for PAL GC Technique; P/N:
PAL PM Kit2

Tension Cord for all PAL Modules, 90-100 mm; P/N: MZ 30-23



Step 4: Loosen the screw from the Mechanical Stop for the Needle Guide.

CAUTION:

The screw is firmly tightened. Apply from the back a counter pressure to the screw driver to avoid damaging the screw head or bending the rod.

Note: This Mechanical Stop holds the Needle Guide Assembly in position with the defined needle length. Standard setting: 50.5 -0+0.5 mm.

Required Tools: Torx T10

Material Description: Mechanical Stop for Needle Guide;
P/N: MZ 20-14.

The Stopper is part of the Needle Guide Assembly, and can also be ordered individually. See Spare Part Kits for Z-Axis.

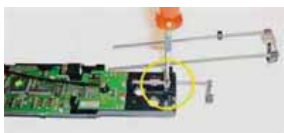


Step 5: Loosen the screw from the Anti-Twist Device holding the Upper Needle Guide.

Required Tools: Torx T10

Material Description: Upper Needle Guide Assy, Gauge 19; P/N: PAL UpNdlGdeAnti-Twist Device is part of the kit. Details see "Spare Part Kits for Z-Axis".

Note: There is only one Upper Needle Guide Assembly for all PAL Modules available.



Step 6: After loosening the screw from the Anti-Twist Device (step 5), remove the Lower and Upper Needle Guides.

Required Tools: Torx T10

Material Description: Lower Needle Guide Assembly;
P/N:

Needle Guide without Magnets installed (HPLC) P/N: MZ 23-01; Needle Guide with Magnets installed (GC)

P/N: MZ 23-02

Needle Guide Assembly for ITEX version: MZ 23-03



Step 7:

Note: If the Needle Guide Assembly has to be changed, it is necessary to change the Assembly Guide Bushing at the same time. The Bushing is hand selected for the specific spindle (needle guide). Any mechanical play can damage the bearing within a short time.

See also the note above in Introduction Point 5.

The picture shows bushing with installed spindle from needle guide.

Step 8:

CAUTION:

As described above in the Introduction Point 4, 2 different types of Assembly Guide Bushing are in use.

It is important to understand that for cleaning and maintaining (PM) one has to differentiate the cleaning procedure: Old type (black material): Silicon spray can be used to wipe off any material with a lint free wipe or cloth, and very lightly lubricate the bearing (not the spindle) with a Silicon Spray. Clean the plunger spindle using a wipe and grease very lightly with "PAL-Grease".

New Type (whitish/gray material, Teflon-Mix Polymer): Teflon material is self-smearing and leaves a thin film on the metal surface. Clean the needle spindle with a dry lint-free wipe or cloth. DO NOT USE ANY SILICON SPRAY; OIL OR GREASE.

Step 9: Turn the slider (Injection Unit) upside down. Loosen the 2 screws as indicated in the picture.

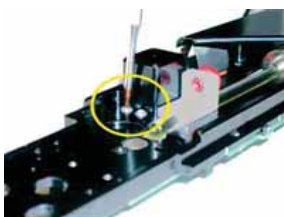
Note: As described above (Introduction Point 4) single parts of the Lower Needle Guide assembly are not available.

Required Tools: Torx T10

Material Description: Needle Guide without Magnets installed (HPLC) P/N: MZ 23-01; Needle Guide with Magnets installed (GC) P/N: MZ 23-02

For Details see "Spare Part Kits for Z-Axis".

See also Introduction Point 6 for special chemical resist-



ant needle guides.

Screws for Assembly Guide Bushing; P/N: BN4851
M3x6 mm

Step 10: The Assembly Guide Bushing can be replaced as shown in the picture.

Note: The spindle of the Needle Guide is shown in the picture only for the purposes of orientation.



Step 11: As indicated above, the Lower Needle Guide is available as a Spare Part Kit. It is not recommended to change single parts, such as the black needle guide, the rods, etc. directly on-site.

If for example a chemical-resistant Upper or/and Lower Needle Guide has to be installed, then observe following points (see Introduction Point 5): Push the Lower Needle Guide all the way into the Syringe Slider as shown in the picture. This helps to avoid the bending of the rods. Be careful opening the screws. The screws are secured with LocTide 243.

Required Tools: Torx T10

Material Description: Stack Drawer Magnet; P/N: PAL
StkDrwMagScrews holding magnet with lower needle
guide; P/N: 6404 3x6 mm (included in Magnet kit).



Step 11: A splint secures the twisting of the needle guide rods. This splint is pressed into the black lower needle guide. It is best practice to knock the black needle guide out of position by hammering very gently from the top, as shown in the picture.



Step 12: This picture shows the splinted ends of the needle guide rods, with the splints inserted.

This concludes the procedure for the section on "Needle Guide Assembly". The Assembly of the unit follows in the logical order, backwards. In the section "Assembling of the Injection Unit " some specific important points are described. All further steps are described separately, see "Repair Path Overview".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section, Test Procedure.

1.5.0.0.1 PCB for Injection Unit

This procedure for the PCB for Injection Unit or Z-Axis describes the replacement of the PCB (Printed Circuit Board).

Indications for a replacement of the PCB are:

- Plunger Sensor, specific error message. Test: Service Mode Injection Unit.- Needle Guide Penetration Sensor, specific error message. Test: Service Mode Injection Unit.- Z-Sensor, specific error message. Error shows up only if switching magnet in Z-Tube is defective or broken away.- Wrong temperature read as described in Service Note # 01/2002

- Head Communication Error. This error can also be related to:--- Firmware (corrupt firmware in Flash Memory, re-load a complete new back-up file)--- Defective MOTIO or Controll Board--- Defective Z-Axis ribbon cable or X-Z-Axis ribbon cables.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case, when electronic parts are handled.

Not observing this basic rule can result in erratic behavior of a component or even in a damaged printed circuit board (PCB).

1.6 Introduction

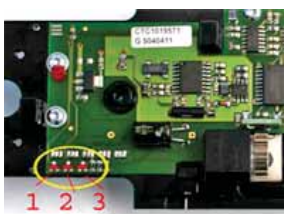
A replacement PCB for the Injection Unit is provided as a kit which includes the corresponding screws, washer and the protection foil. P/N: PAL MZCtrl. The provided PCB is the current level, corresponding to Injection Unit Revision Level D or higher. If a PCB is replaced on a unit with a lower level, the solenoid also has to be changed.



Introduction PCB for Injection Unit Point 1:

Indicators for:- Needle Penetration Sensor (left on picture)- Plunger Sensor; P/N (right on picture).

Note: The sensors are not available for field replacement.



Introduction PCB for Injection Unit Point 2:

Indicator for the sensor LED's. The Function of the LEDs are:

1: Needle Penetration Sensor

2: not active

3: Plunger Sensor



Introduction PCB for Injection Unit Point 3:

Indicator for the 1 uF Capacitor part of the temperature readout circuit as described in the Service Note # 01/2002

P/N: Service Note Kit01/2002



Introduction PCB for Injection Unit Point 4:

Indicator for the connector of the Gas Flush Tube. P/N: PAL TubeFlushZ

Note: The Gas Flush Tube is installed in the Combi PAL and ITEX Model, P/N MZ 02-00/MZ 010-00.



Introduction PCB for Injection Unit Point 5:

Indicator for: - Z-Axis Position Sensor (Hall sensor)

Note: The sensor is not available for field replacement.

Switching Magnet for Hall Sensor is mounted inside of the housing. Access through the hole, hidden under the decoration strip.

Note: To obtain better photographic contrast, a piece of white paper has been placed in between the sensor and the black frame of the slider.



Introduction PCB for Injection Unit Point 6:

Indicator for the CTC Serial Number label. Example: CTC 1019571. The second number is a factory-specific number and has no meaning related to service. The Revision Level is marked as common parameter directly on the print. Example of current level: Rev. E.L.

1.7 Replacing the PCB for PAL Injection Unit, Procedure

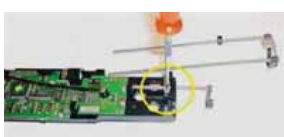
It is assumed that the Injection Unit has been disassembled as described in "Disassembling the Injection Unit" and that the Needle Guide Assembly has been removed already. In addition, the connectors for the "Solenoid" and for the Plunger- and Z-Motor have to be disconnected as described in the section "Ribbon Cable".

All further steps are described separately, see "[Repair Path Overview](#)".

The assembly steps are described in "Assembling Z-Axis".

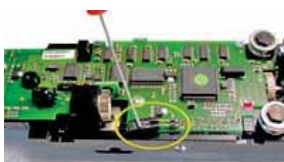


Step 1: The steps to disassemble the Injection Unit or Z-Axis are described in "Disassembling the Injection Unit".



Step 2:

The steps to remove the "Needle Guide Assembly" are described in the specific section.



Step 3: Disconnect the solenoid connector. Details are described in the section "Solenoid".



Step 4: Open the cover for the motors and disconnect the ribbon cable as described in the section "Ribbon Cable".



Step 5:

Disconnect the connectors for the Plunger- and Z-Motor as described in the section "Plunger Motor" or "Z-Motor".

**Step 6:**

Loosen and remove the 6 screws holding the PCB to the Syringe Slider Assembly frame.

Required Tools: Torx T10

Material Description:

PCB for Injection Unit; P/N: PAL MZCtrlIncludes: APR HeadScrew for PCB; P/N:BN6404 M3x6 mmWasher; P/N: BN715 M3Protection Foil for PCB; P/N: MZ 30-20

**Step 7:**

Remove the PCB. Below the PCB is a protection foil which has to be re-installed.

Required Tools:

Material Description: See point 6.

**Step 8:**

Note: Replacement PCBs are suitable for Injection Unit revision level D or higher. See above, "Introduction".

Re-Installing the PCB:

- Position the protective foil- Place the PCB on the Syringe Slider frame. Be aware that the magnet on the PCB will constrict the positioning of the PCB.
- Tighten the PCB with the 6 screws.
- Use for the lower 2 screws only one washer each, as shown in the picture. The screws are too long for these two positions.

CAUTION:

Check that the screws in the position of the Syringe Holder are not sticking out at the back. It could cause a problem inserting the Syringe Holder.

Required Tools: Torx T10

Material Description: See Point 6.



After mounting the PCB verify that all connectors are in place. Mount the cover for the motor side.

CAUTION:

Ensure that the sheet metal corner of the cover is tightly pressed down to avoid the plunger holder catching on the sheet metal cover.

Ensure that the Ribbon Cable Z-Axis is correctly positioned in the cut-out of the sheet metal cover.

CAUTION:

All assembly steps are described in detail under:-
[Plunger- or Z- Motor- Ribbon Cable for Z-Axis- Solenoid- Needle Guide Assembly- Assembling the Z-Axis](#)

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section, Test Procedure.

1.7.0.0.0.1 Solenoid Injection Unit

This procedure describes the replacement of the Solenoid for the Injection Unit (or Z-Axis, Head).

Indications for a replacement of the Solenoid are:

- Needle Guide Blocking not successful- Release of Needle Guide Blocking not successful Needle Guide Blocking is mostly used for the fiber technique, SPME (Solid Phase Micro Extraction).

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.8 Replacing Solenoid for PAL Injection Unit: Procedure

It is assumed that the Injection Unit has been disassembled as described in "Disassembling the Injection Unit" and that the Needle Guide Assembly has been removed already.

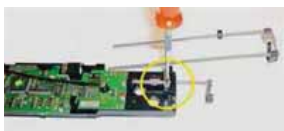
The Assembly Guide Bushing and the PCB for the Injection Unit have to be removed to gain access to the Solenoid.

All further steps are described separately, see "[Repair Path Overview](#)".

The assembly steps are described in "[Assembling Z-Axis](#)".



Step 1: The steps to disassemble the Injection Unit or Z-Axis are described in "Disassembling the Injection Unit".



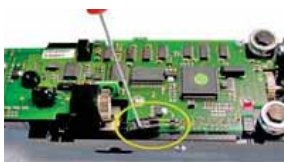
Step 2:

The steps to remove the "Needle Guide Assembly" are described in the specific section.



Step 3:

Remove the Assembly Guide Bushing as described in the section "Needle Guide Assembly".

**Step 4:**

Disconnect the Solenoid cable from the connector mounted on the PCB.

**Step 5:**

Remove the PCB for the Injection Unit as described in the specific section.

**Step 6:**

As described under Step 3, first remove the Assembly Guide Bushing to gain access to the Solenoid.

This close-up picture illustrates the situation in detail.

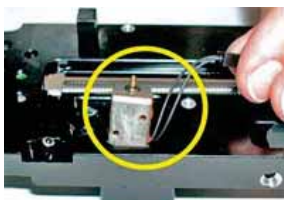
**Step 7:**

Loosen and remove the 2 screws.

Remove the Solenoid.

Required Tools: Torx T02 or Allen Key

Material Description: Solenoid for Needle Guide Blocking; P/N: NdIBlkMagIncludes: Solenoid (Injection Unit Rev. D or higher), Screw for Solenoid; P/N:BN21 M2x4 mm and Allen key.

**Step 8:**

Insert the new Solenoid as shown in the picture. The cable has to be twisted by a half turn.

Insert the 2 screws.

Install the PCB (APR Head).

Connect the solenoid to the PCB connector.

Note: Revision Level "C" of the Injection Unit requires a later version of the PCB for the Injection Unit (Version E.L. or higher). Injection Unit Revision Levels D or higher already contain the later version of the Injection Unit PCB. The current type of Solenoid and the PCB (15VDC) are compatible.

Required Tools: Torx T02 or Allen Key

Material Description: See Point 7.



Step 9:

All assembly steps are described in detail under:-

[Plunger- or Z- Motor- Ribbon Cable for Z-Axis- Needle Guide Assembly- Assembling the Z-Axis](#)

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section, "Test Procedure".

1.8.0.0.1 Gas Flush Tube Z-Axis

This section describes the replacement of the Tube for the Gas Flush Tube for the Injection Unit (or Z-Axis) .

Indications for a replacement of the Gas Flush Tube Z-Axis are:

- Seal no longer tight- Kinked Gas Flush Tube- Tube aged or worn-out from normal wear and tear

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.9 Introduction:



Introduction Gas Flush Tube Z-Axis: Point1

The Gas Flush Tube-Z is used in general for the GC-Headspace Application. Therefore, the Flush Tube is installed in the Injection Unit for the Combi PAL, P/N MZ 02-00 and ITEX version, MZ 010-00.

Note: To complete the listing, the tube is also installed in the MZ 03-00 and MZ 07-00 models.



Introduction Gas Flush Tube Z-Axis: Point 2

The O-Ring in the Syringe Slider that seals against the heated cartridge is pressed into a socket. The sealing socket is glued into the slider. Removing the sealing socket requires a special tool. It is advisable to return a damaged Injection Unit back to the factory.

How to test the gas tightness is described in the section "[XY-Axis Test](#)".

Required Tool to test for a possible gas leak: Tool Flush; see section "[Z-Axis Spare Part List](#)".

Note: In case a replacement O-Ring is glued in place, be aware that volatile compounds may contaminate the gas line. This would result in the presence of so-called "ghost peaks" in the chromatogram.

1.10 Replacing the Gas Flush Tube-Z for the PAL Injection Unit: Procedure

It is assumed that the Injection Unit has been disassembled as described in "Disassembling the Injection Unit".

All further steps are described separately, see "Repair Path Overview".

The assembly steps are described in "Assembling Z-Axis".



Step 1:

The steps to disassemble the Injection Unit or Z-Axis are described in "Disassembling the Injection Unit".

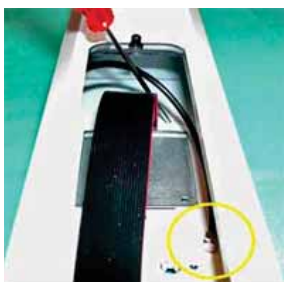
Step 2:

Hold the Gas Flush Tube-Z and loosen the screw.

Note: A thin, transparent Sealing Gasket is installed in between the slider connector and the gas flush tube adapter.

Required Tool: Slotted Screwdriver, 0.6 x 4 mm

Required Parts: Gas Flush Tube-Z: P/N : PAL Tube-



FlushZ

Step 3:

Loosen the screw and remove the tube from the Z-housing (Z-Tube).

Note: A thin, transparent Sealing Gasket is installed in between the housing connector and the gas flush tube adapter.

Required Tool: Slotted Screwdriver, 0.6 x 4 mm

Required Parts: Gas Flush Tube-Z: P/N : FlushTube-Z

Step 4:

Install a new Gas Flush Tube-Z (Kit including Sealing Gasket and connecting adapters).

Bend the tube slightly against the housing wall and tighten the screw carefully.

CAUTION:

Do not stress the Sealing Gasket by over-tightening the screw.

The connections have to be free of solvents, detergents or any other cleaning material. Do not apply any oil or grease to this area. Any impurity in the system could reach the syringe and can cause ghost peaks.

Step 5:

The Gas Flush Tube Z-Axis is placed in the housing.

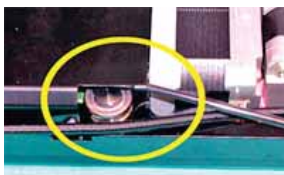
Form a natural bow above the ribbon cable to allow a easy slider movement.

Step 6:

When connecting the Gas Flush Tube Z-Axis to the connector, ensure that:- the tube is not twisted- the tube is placed in the middle of the slider- the sealing gasket is not stressed- there are no mechanical hindrances from the tube against the Needle Guide Assembly

CAUTION:

The connections have to be free of solvents, detergents and any other cleaning material. Do not apply any oil or grease to this area. Any impurities in the system could reach the syringe and can cause ghost peaks.



Step 7:

CAUTION:

When installing the black metal cover for the electronic side, pay attention that the flush tube is not placed towards the side to the roll. The cover has a pin-guiding at the front end for the tube. Compare the position with that shown in the picture.

All assembling steps are described in detail under: - Needle Guide Assembly- Assembling the Z-Axis

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section, "Test Procedure".

1.10.0.0.0.1 Stepper Motor for Z-Axis

This section describes the replacement of the Motor for the Stepper Motor Z-Axis (Motor for slider of Injection Unit or Z-Axis).

Indications for a replacement of the Z-Motor are:

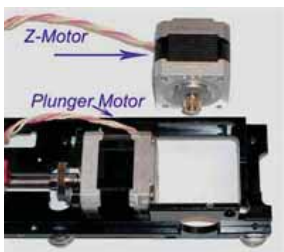
- Pinion fallen off or has a loose connection to the Stepper Motor axis. (Corrections with Rev. D, Pinion pinned.)- Partially or completely shorted wires of the motor (This error is extremely rare; also search for other potential sources of failure.)- Z-Motor movement error can also be caused by:— Firmware (corrupt firmware in Flash Memory, re-load a completely new back-up file)— Defective MOTIO or Control Board— Defective Z-Axis ribbon cable(s) — Z-Sensor failure or magnet for Hall sensor in Z-Tube broken

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.11 Introduction



Introduction Stepper Motor Z-Axis Point 1:

Looking at the slider in the picture, the Z-Motor is the upper of the two stepper motors.

Note: The physical size of the stepper motor for plunger has changed from Injection Revision A to B. The unit used for Rev. A was smaller in size than the stepper motor used starting with Rev. B. The cut-out for the motor in the slider is matched for the motor used. This is the reason that a Rev. A motor cannot be upgraded in the field to a higher revision level. The Injection unit has to be sent to the factory for any upgrade in the area of the



Plunger motor. See Upgrade Path for Injection Unit. The physical size of the Z-Motor has not been changed since the introduction of the PAL System.

Introduction Stepper Motor Z-Axis Point 2:

As described above under "Indications", it has been observed that the pinion could get loosened from the motor-axis.

Test: Apply a slotted screwdriver in between the pinion and the motor. Apply gentle force to see if the connection is loose.

Beginning from Injection Unit Revision D, the pinion has not only been glued to the motor-axis but also mechanically fixed (pinned). All units received at the factory for an upgrade or overhaul have been reworked and the Z-Motor/Pinion has been replaced.

1.12 Replacing the Z-Motor for the PAL Injection Unit: Procedure

It is assumed that the Injection Unit has been disassembled as described in "Disassembling the Injection Unit" and that the Needle Guide Assembly has already been removed. Furthermore, the connectors for the "Solenoid" and for the Plunger- and Z-Motor as described the section "Ribbon Cable" have to be disconnected.

All further steps are separately described, see "[Repair Path Overview](#)".

The assembly steps are described in "[Assembling Z-Axis](#)".

For further information, see also "[Limitations for Repair Z-Axis](#)".

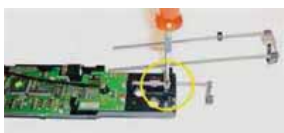


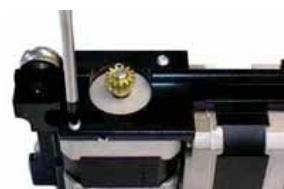
Step 1: The steps to disassemble the Injection Unit or Z-Axis are described in "Disassembling the Injection Unit".

Step 2:

The steps to remove the "Needle Guide Assembly" are described in the specific section.

Note: This step is not absolutely necessary, only if the Z-Motor has to be replaced.





Step 3:

The steps to remove the cover for the motor side is described in the section "Ribbon Cable for Z-Axis".

Step 4:

This picture gives an overview of the two stepper motors and the wiring harness connected to the PCB.

Note: The arrangement or order of motors is identical with the order of the connectors (left-right; left right). - Remember the exact position and direction of the connectors before they are removed. (Examples for reversed connection: Plunger Motor Rev.A or Plunger Motor combined with fine pitch spindle.)

Step 5:

Disconnect the motor cable.

Keep the connector orientation in mind.

CAUTION:

The pictures shows the situation for Injection Unit Revision E and the Print level E:L: (See Note under Point 4, above).

Step 6:

Manually check the movement of the pinion. If it turns smoothly, there is no need to replace it.

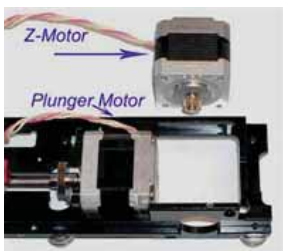
Open the 2 screws holding the Stepper Motor Z-Axis. The screws are tightened with LocTide 243.

If necessary, replace the Stepper Motor Z-Axis.

Note: At this stage, the device is also ready for exchange of the Plunger Stepper Motor.

Required Tools: - Torx T20- LocTide 243

Required Parts: - Stepper Motor Z-Axis, complete; P/N: PAL MotZincludes Z-Motor and Screws; P/N: BN 6404 M3x6 mm.



Step 7:

Installing the Stepper Motor Z-Axis:- Place the Motor in position- Fix the 2 screws lightly- Bend the wiring harness of the 2 motors to a clean shape and connect the corresponding parts. Observe the orientation and position of the connectors.

Step 8:

Insert the slider into the housing. Move the slider in both directions to feel if there is a mechanical play from the pinion on the toothed rack.

It is important to check at several positions, e.g. at the lower and upper part of the Z-travel direction.

To feel a mechanical play, it is best practice to move the slider only a very short distance. At the moment of reversing the direction, a possible play can be felt.

If there is a play, take the slider out and readjust the position of the Stepper Motor Z-Axis by a fraction of a mm. The holes are so-called "slotted-holes" and allow a certain tolerance.

Note: Except for early sliders, starting with Injection Unit Rev. B slotted holes are the standard.

Repeat this until no mechanical play is observed. If the slider moves too hard, it has to be re-adjusted as well. Both situations, too loose (too much play) and too hard, can impact the long-term stability and reliability of the Injection Unit.

Finally, fix the 2 screws from Z-Motor with LocTide 243. (It is important to fix the screws one after the other - to keep the position of the motor tight).

See also the section "Limitations".

Step 9:

Mount the cover for the motor side.

CAUTION:

Ensure that the sheet metal corner of the cover is tightly pressed down to avoid that the plunger holder catches on the sheet metal cover.

CAUTION:

Tightening the screws for the cover when the Ribbon Cable is not positioned correctly in the cut-out of the



cover may destroy the cable.

All assembly steps are described in detail under: - [Ribbon Cable Z-Axis](#)- [Solenoid](#)- [Needle Guide Assembly](#)- [Assembling the Z-Axis](#)

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section Test Procedure.

1.12.0.0.0.1 Stepper Motor for Plunger

This section describes the replacement of the Motor for the Stepper Motor for Plunger (Motor for syringe plunger).

Indications for a replacement of the Stepper Motor for Plunger Driver:

- Plunger Bushing fails or shows mechanical play.- Partially or completely shorted wires of the motor. Test: Service Test PAL (This error is extremely rare; also search for other possible sources of failure.)- Plunger Stepper Motor movement error can be caused also by:— Blocked syringe — Wrong Motor Driver for the syringe type, MPiG-Setting "low", "medium" or "high"(Syringe Parameter)— Firmware (corrupt firmware in Flash Memory, reload a completely new back-up file)— Defective MOTIO or Control Board— Defective Z-Axis ribbon cable(s)— Plunger-Sensor failure. Test: Service Test PAL

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.13 Introduction



Introduction Plunger Stepper Motor Point 1:

Plunger Stepper Motor complete; P/N: PAL MotPiGKit with stepper motor/Standard spindle/bushing

The pictures shows the 3 possible Spindle/Motor/Bushing combinations:

#1: Stepper motor and spindle bushing (nut) as first version, Injection Unit Revision A. Motor physically smaller (compare to # 3) and black bushing used (old type of bushing).

#2: Stepper motor with so-called "fine pitch spindle". For details, see below. Stepper motor old style (size) but spindle equipped with the new bushing (gray color).

#3: Current type of stepper motor (physical size larger, installed since Revision B). Standard pitch spindle with new type of bushing.

Note: The "plunger motor" is provided as a spare part only in the "triple kit": Motor/Spindle/Bushing. The bushing is hand-selected for the spindle. The Polymer mix (Teflon mix Polymer) is soft and has a certain tolerance. Important: Do not remove the bushing from a spindle kit and use it with any other spindle!

CAUTION:

Cleaning instructions are given below. DO NOT USE solvents, oil or grease for cleaning the spindle!

Introduction Plunger Stepper Motor Point 2:

Close-up of the two types of plunger motor spindle:

#1: Fine Pitch Spindle (also referred to as "flat spindle") Used if a high torque is required. Example: Headspace Syringe 5 ml. To move the 5 ml plunger of a dry syringe requires a high torque. NOT required for rare uses of a 5 ml Headspace Syringe, 2.5 and 1 ml Headspace Syringes or HPLC syringes where a liquid film contributes to smooth movement.

#2: Standard Pitch Spindle.



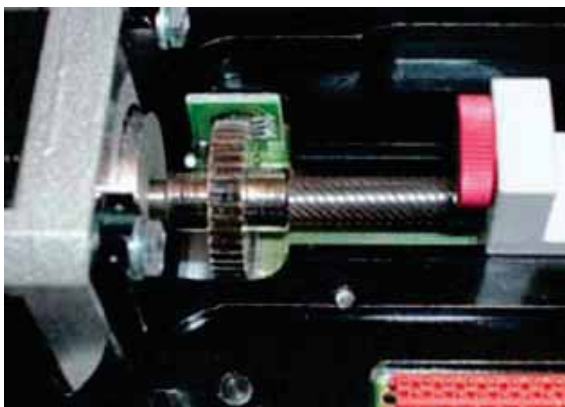
Note: The type of Plunger motor has changed from Injection Revision A to B. The unit used for Rev. A was physically smaller in size than the currently-used stepper motor. The cut-out for the motor in the slider is matched for the motor used. This is the reason that a Rev. A motor cannot be upgraded to a higher revision level in the field. The Injection unit has to be sent to the factory for any upgrade in the area of the Plunger motor.

To use syringes (and the SPME fiber) with the fine thread spindle, change the Syringe parameter steps/uUnit.Menu/F3-Setup/F3-Objects/MotorDrives/select the corresponding Driver for the Syringe in question.

PAL System:- Standard setting: 2.5 uU (2500 nU)- Fine Pitch Spindle: 625 nU (0.625 uU)

PAL-xt System:- Standard setting: 3.125 uU (3125 nU)- Fine Pitch Spindle: 781 nU (0.781 uU)(Thread Factor = 4).

See Upgrade Path for Injection Unit. The Stepper Motor Z-Axis has not been changed since the introduction of the PAL System.



Introduction Plunger Stepper Motor Point 3:

Plunger Motor Sensor:

Note: The Plunger sensor detects the movement of the syringe plunger. Test: PAL Service Mode. Path: Menu/F3-Setup/Service/Test Head/F1 Plunger The test controls the movement of the tooth wheel. Result on message line: Tooth count: >90. For details, see the section "Test Procedure".

Replacing the Plunger Sensor: It is advisable to replace the PCB for the Injection Unit as such. Soldering the sensor in and out under field conditions is usually not ideal. A defective PCB (P/N: APR Head) should be marked with the error and returned to CTC Analytics for inspection and repair. (CTC RMA Nr. is required.)

1.14 Replacing the Stepper Motor for the Plunger Drive of the PAL Injection Unit: Procedure

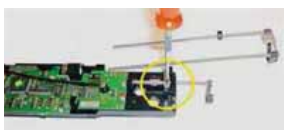
It is assumed that the Injection Unit has been disassembled as described in "Disassembling the Injection Unit" and that the Needle Guide Assembly has been already removed. The connectors for the "Solenoid" and for the Plunger- and Z-Motor as described the section "Ribbon Cable for Z-Axis" are disconnected. Furthermore, the Stepper Motor Z-has to be removed, as described in the section "Stepper Motor Z-Axis".

All further steps are described separately, see "[Repair Path Overview](#)".

The assembly steps are described in "Assembling Z-Axis".



Step 1: The steps to disassemble the Injection Unit or Z-Axis are described in "Disassembling the Injection Unit".



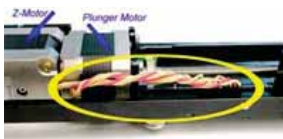
Step 2:

The steps to remove the "Needle Guide Assembly" are described in the specific section.



Step 3:

The steps to remove the cover for the motor side are described in the section "Ribbon Cable Z-Axis".



Step 4:

The picture gives an overview of the two stepper motors and the wiring harness connected to the PCB.

Note: The arrangement, or order, of motors is identical with the order of the connectors. Remember the exact position and direction of the connectors before they are removed.



Step 5:

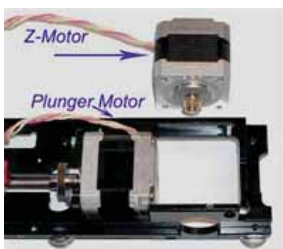
Disconnect the motor cable.

Keep the connector orientation in mind.

CAUTION:

The pictures show the situation for Injection Unit Revision E and the Print level E:L.

Note: The arrangement, or order, of motors is identical with the order of the connectors (left-right; left right). - Remember the exact position and direction of the connectors before they are removed. (Examples for reversed connection: Plunger Motor Rev. A or Plunger Motor combined with fine pitch spindle.)



Step 6:

Remove the Stepper Motor Z-Axis as described in the specific section.



Step 7:

Do not loosen the screws which are visible on the face after removing the Z-Motor. These screws hold the stepper motor brackets together.



Step 8:

Removing the Stepper Motor for Plunger:

- Move the bushing towards the Plunger Motor.
- First loosen the nut from the screw which is not hidden by the roll, using a socket wrench as shown in the picture.



Step 9:

Removing Stepper Motor for Plunger Drive cont'd:

- Loosen the nut of the screw which is hidden by the roll, using a flat wrench (key) to gain access.
- Move the motor assembly out of the slider cut-out.

Required Tools:- Socket Wrench: 5.5. mm- Flat Wrench (key): 5.5 mm

Required Material:- Stepper Motor for Plunger complete; P/N: PAL MotPlgincludes: Plunger Motor standard pitch spindle, bushing for plunger holder, Screws; P/N: BN 56 M3x8, Washer; P/N: BN 715 M3



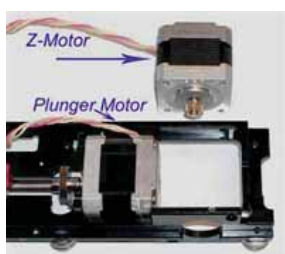
Step 10:

Installing the Stepper Motor for the Plunger Drive:

- Place the motor assembly into the slider and check the free movement of the bushing.
- Place the washer in between the slider and the motor.
- Tighten the nut of the screw which is hidden by the roll first.
- Tighten the nut of the second screw.
- Secure the nuts with LocTide 243.

CAUTION:

During tightening, always check the free movement of the bushing.



Step 11:

Install the Z-Motor and connect the wire harness as described in the section "Z-Motor".

All further assembly steps are described in detail under:- [Ribbon Cable Z-Axis- Solenoid- Needle Guide Assembly](#) Needle Guide Assembly- [Assembling the Z-Axis](#)

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

For further information, see also "[Limitations to Repair Z-Axis](#)".

1.14.0.0.0.1 Z-Housing - Z-Tube - Slider-Liner

This section describes the procedure for repair and overhaul of the Z-Tube, of the Z-Housing or Z-Tube (Syringe Slider Liner for Injection Unit).

Indications for a repair or overhaul of the Z-Housing or Z-Tube are:

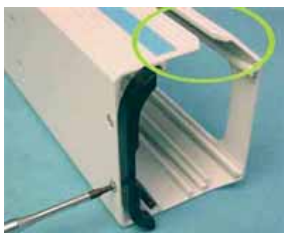
- Field-upgrade of Z-Tube with a slit for Dilutor Option- Bumper for Agitator opening replacement- Uneven movement of the slider, cleaning of Rails or Tooth-rail- Tooth-Rail out of position or damaged- Rails damaged, corroded- Z-Sensor Switching Magnet broken away, knocked off- Plexiglas Safety Shield for Injection Unit defective

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.15 Introduction



Introduction Z-Tube Point 1:

Field-Upgrade of Z-Tube with slit for Dilutor Option:

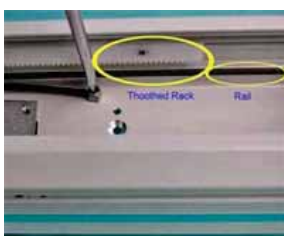
Starting with Injection Units Revision E, all units are equipped with a slit for the Dilutor Option. For an intermediate time was the MZ 07-00 supplied and this version was afterwards renamed to 'Revision E'. The difference in this version was only the slit. See "Overview Injection Units".

A field-upgrade is possible: The complete Injection Unit has to be sent back to CTC Analytics for the machining. Contact CTC Analytics in advance to make arrangements. Early sliders do not have the screw holes to hold the Dilutor syringe adapter.

Note: It is important to realize that the Z-Tube cannot simply be exchanged. The rolls of the slider are mechanically matched with the distance to the rails and the pinion of the Z-Motor is matched with the distance to the Toothed-Rack.

CAUTION:

In case the slit is milled on-site, remove the complete slider to avoid any metallic particles will coming in contact with the electronics. A complete cleaning process for the Z-Tube is mandatory.



Introduction Z-Tube Point 2:

CAUTION:

Rails: For maintenance, the rails can only be cleaned and greased. If any damage (mechanical or corrosion) is observed, the unit has to be returned for an overhaul to CTC Analytics.

Toothed Rack: Adjusting or replacing the Toothed Rack requires detailed knowledge and extensive experience to make the correct adjustment. If a service engineer is not specifically trained or not experienced with the PAL System, it is advisable to return the unit to CTC Analytics for an overhaul.

See the section "Limitations"

1.16 Repairing and Overhaul of the Z-Housing or Z-Tube for the PAL Injection Unit: Procedure

It is assumed that the Injection Unit has been disassembled as described in "Disassembling the Injection Unit" and that the Ribbon Cable Z-Axis has been removed from the Z-Tube as described in the section "Ribbon Cable Z-Axis".

All further steps are described separately, see "[Repair Path Overview](#)".

The assembly steps are described in "[Assembling Z-Axis](#)".



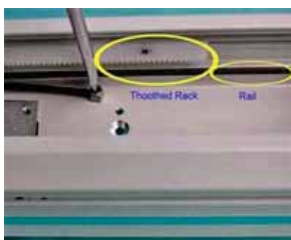
Step 1:

The steps to disassemble the Injection Unit or Z-Axis are described in "Disassembling the Injection Unit".



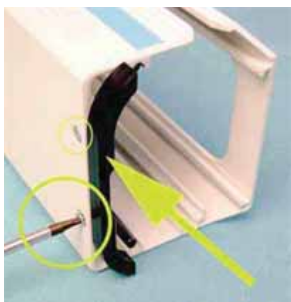
Step 2:

The steps to remove the Ribbon Cable of the injection Unit are described in the section "Ribbon Cable Z-Axis".



Step 3: Cleaning:

- Cleaning the rails is described in the PM Procedure.
- The Toothed Rack should be cleaned with a dry, lint-free towel only. Do not apply grease or oil.



Step 4:

Replacing the bumper which is used to open the Agitator lid: - Loosen the 2 screws and remove the skirt

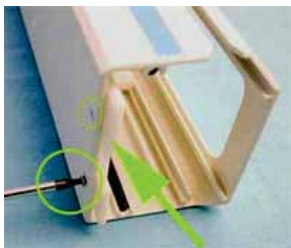
- Install the new skirt and tighten the screws

Note: The picture shows the old type of bumper, used up to Injection Unit Revision Level E. The new type is shown in the picture below.

The skirt is as a standard configuration installed at the Combi PAL Injection Unit. P/N: MZ 02-00 and ITEX version, MZ 010-00.

CAUTION:

If the Combi PAL System is used with a Stack or Cooled Stack module, which is typically used for the HPLC technique, then remove or adjust the bumper.



The bumper would interfere with the opening of the stack drawer, with the magnet mounted at the injection unit.

Step 5

This picture shows the current version of the skirt.

The steps for replacing it are described above in step 2.

Required Tools: Torx T10

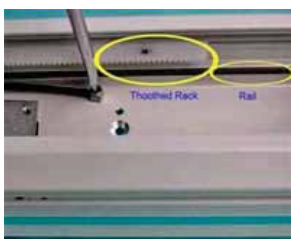
Required Materials:- Skirt for Injection Unit; P/N: tbd-
Screws; P/N: tbd

Step 6:

CAUTION:

Before starting the job, read the comments for replacing or adjusting the Rails or Toothed Rack above, under "Introduction Z-Tube Point 2".

Adjusting or replacing the Toothed Rack:- Remove the Deco-stripe on the right side to gain access to the screws holding the Tooth Rail.- Remove the Toothed Rack for inspection.



Inserting a new Toothed Rack: - Install the Toothed Rack such that the edge is flush with the Z-Tubing Aluminum edge on the top of the Z-Tube.- Tighten the screws.- Insert the slider into the Z-Tube and check the movement of the Z-Motor pinion.- If necessary, make fine adjustments and move the Tooth-Rail to the side to ensure that there is no mechanical play.- See also the description in the section "Stepper Motor for Z-Axis" for adjustment.

Required Tools: Allen Key; tbd

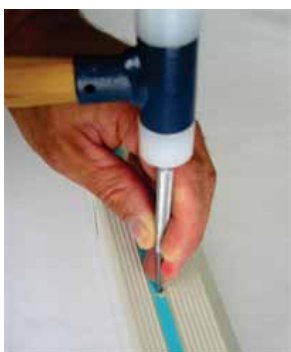
Required Material: Toothed Rack; P/N: MZ 10-
12Screws; P/N: BN 3 M3x6 mmNuts; P/N: BN 117
M3Deco Stripe Z_Axis; P/N: tbd

Note: For all models of Injection Units, the same Toothed Rack is used.

Z-Position Sensor Magnet broken away or knocked-off

Switching Magnet for Z-Axis

Note: The picture shows the magnet fixed on a screw driver. The top face is painted to indicate that the active side is at the opposite end of the magnet.

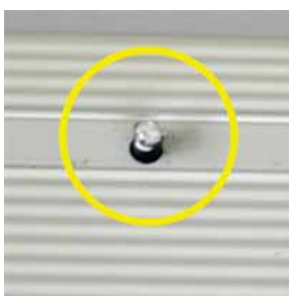


Step 7:

Note: The Z-Sensor Switching Magnet can be knocked off in the process of repairing the Injection Unit Slider.

CAUTION:

One example are the screws at the side of the metal cover for the electronic compartment. If the screws are not fully tightened and the screw head stand out by even very little, it can touch the switching magnet when



the slider is inserted in the Z-Tube. If any restriction is felt at this point, remove the slider again and check the screws or any other possible source of obstruction.

Do not use any force at this stage!

The syringe Slider Assembly has to be removed first.

To gain access to the magnet, one has to remove the Deco-Stripe at the right side.

In case the magnet is still connected to the Z-Axis Housing, knock it off using an adequate tool.

Clean the surface. Remove all remaining parts of the Deco-Stripe on the profile and in the hole.

Position the new magnet on the tip of a slotted screw driver.

Insert the magnet carefully through the hole of the Z-Axis housing to ensure that the magnet fits snugly.

In case the magnet does not fit into the hole, scrape away some remaining material to ensure a tight fit.

After this positioning test, apply a little of the LOCTIDE 638 (green) on a piece of paper.

Attach the magnet to a tool and turn the magnet to apply the glue all around its sides.

Apply the Activator around the rim of the hole (cut-out) of the Z-Profile.

Position the new magnet strictly square to the profile (perpendicular) and insert it very carefully.

Press the magnet into the hole and make sure that it is positioned slightly to the inside of the aluminum surface.

Required Tools: Screw Driver Torx T10 or any adequate tool to knock out the original magnet. Slotted screw driver.

Required Materials: Sensor Magnet Kit : P/N PAL MZZMag Includes the magnet and 2 Deco-Stripes. CTC colors

Note : If other Deco-Stripe colors are required, specify OEM label with the order.

LOCTIDE 638 (green) and Activator.

Note: LOCTIDE 480 (black) can also be used. This is a quick-setting glue and corrections are practically not possible.



Step 8:

Replacing the Z-Axis Safety Shield:

- Press down the inserted shield with 2 fingers until the bend is good enough to slide the knob under the metallic bridge of the Z-Tube.
- Insert a new shield in the same manner.

Required Tools: none

Required Materials:- Safety Shield for Z-Axis;

Combi/HTS/HTC PAL: P/N: MX 32-00

GC and LC PAL: P/N MX 3(complete shield with knob and O-ring installed.)

Note: The shield material is Polycarbonate.

Step 9:

All assembly steps are described in detail under:- [Ribbon Cable for Z-Axis- Assembling the Z-Axis](#)

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".



...LTC ANALYTICS

PAL SM Edition 01

1.16.0.0.0.1 Ribbon Cable Z-Axis

This section describes the replacement of the Ribbon Cable for the Z-Axis.

Indications for a replacement of the Ribbon Cable Z-Axis are:

- Connector Z-Tube for the cable Y-Axis is broken- Ribbon Cable partially damaged, intermittent Z-Axis errors- Z-Axis errors can also be caused by:--- Firmware (corrupt firmware in Flash Memory, re-load a complete new back-up file)--- Defective MOTIO or Control Board--- Defective X-Z-Axis ribbon cables--- Z-Sensor failure or switching magnet for Hall sensor in Z-Tube broken off

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.17 Introduction



Introduction Ribbon Cable Z-Axis Point 1:

Use only an original Ribbon Cable Z-Axis provided by CTC Analytics.

The cable has been carefully selected and tested for long-term stability.

The Ribbon Cable Z-Axis has the 2 corresponding connectors mounted and is pre-formed.

Ribbon Cable Z-Axis; P/N: MZ 50-00; length 500 mm. This cable is for all PAL Injection models with the exception of the ITEX Version (MZ 011-00). P/N : MZ 50-01; length 560 mm.

1.18 Replacing Ribbon Cable Z-Axis (PAL Injection Unit): Procedure

It is assumed that the Injection Unit has been disassembled as described in "Disassembling the Injection Unit".

All further steps are described separately, see "[Repair Path Overview](#)".

The assembly steps are described in "Assembling Z-Axis".



Step 1:

The steps to disassemble the Injection Unit or Z-Axis are described in "Disassembling the Injection Unit".



Step 2:

Loosen the 2 screws at the side of the slider holding the cover for ribbon cable and motors.

Required Tools: Torx T10. For older versions Crosstip Screwdriver 205/1.5

Required Materials: See Point 2.

**Step 3:**

Lift up the cover carefully. At the same time, the red connector from the cable is disconnected from the PCB.

Required Tools: none

Required Materials: See Point 2.

**Step 4:**

Bend up the edge of the sheet metal cover using a slotted screw driver very carefully. Open up enough to be able to remove the Ribbon Cable.

CAUTION:

Avoid forming any sharp edges at this point. Sharp edges can cut into the ribbon cable.

Required Tools: Slotted Screwdriver point, No. 4

Required Materials: Cover for Ribbon Cable/Motors; P/N: PALMZCovCbl

**Step 5:**

Remove the Ribbon Cable from the cover.

Required Tools: none

Required Materials: See Point 2.

**Step 6:**

Loosen the screw on top of the cover for ribbon cable and motors.

Required Tools: Torx T10. For older versions Crosstip Screwdriver 205/1.5

Required Materials: - Cover for Cable/Motor; P/N: PALMZCovCbl Includes: Cover, Screw; P/N: BN4851 M3x8 mm, Screw; P/N: BN 15857 M2.5x6 mm and Serrated Lock Washer; P/N: BN 782 M2.3

**Step 7:**

- Press the sheet metal holding the Ribbon Cable in position.

- Pull out the cable of the Z-Tube in the direction of the gray connector.

Required Tools: none

Required Materials: Ribbon Cable Z-Axis; P/N: MZ 50-



00 (or MZ 50-01 for ITEX)

Test 8:

Re-Installing the Ribbon Cable Z-Axis:

- Insert the new cable through the cut-out of the Z-Tube.

Note: Do not force the gray connector through the cut-out.

- Place the sheet metal in position and tighten the screws with the connector. See Step 7.

Required Tools: Torx T10

Required Materials: Screws; P/N: BN6404 M3x10 mmWasher; P/N: BN715 M3Ribbon Cable Z-Axis; P/N: MZ 50-00 (or MZ 50-01 for ITEX)

Step 9:

Insert the pre-formed fold of the Ribbon Cable Z-Axis into the sheet metal cover.

CAUTION:

It is important to press the edge of the cover completely back into position. Use a towel to protect the sheet metal cover.

If the edge is standing up, it may touch the bushing from the plunger motor spindle when moved up and down.

Required Tools: Flat Pliers

Required Materials: Cover for Cable/Motors; P/N: MZ 20-29Ribbon Cable Z-Axis; P/N: MZ 50-00 (or MZ 50-01 for ITEX)

Step 10:

- Position the cover such that one can easily connect the cable to the PCB.

CAUTION:

Ensure that the red connectors are tightly pressed into position. A bad contact could lead to erratic movements which may be observed only intermittently. In case of any abnormal behavior of the Z-Axis after working with the Ribbon Cable Z-Axis, re-check the position of the red connectors, as a first step.

- Tighten the cover with the screws (do not completely tighten at this step!). Reverse the order of steps from "opening" as described in steps 2 and 3.





Required Tools: Torx T10. For older versions Crosstip Screwdriver 205/1.5

Required Materials: See Point 2.

Step 11:

- Ensure that the Ribbon Cable Z-Axis is correctly positioned in the cut-out of the sheet metal cover.

CAUTION:

Tightening the screws for the cover when the Ribbon Cable is not positioned correctly in the cut-out of the cover could destroy the cable.

- Tighten the screws after checking the position of the Ribbon Cable Z-Axis.

Step 12:

Insert the slider into the Z-Tube as described in the section "Assembling the Z-Axis."

CAUTION:

Ensure that the Ribbon Cable Z-Axis is formed nicely in the Z-Tube. In the case of the Combi PAL Injection Unit (P/N: MZ 02-00) or the ITEX version MZ 010-00, it is important that the Gas Flush tube is placed over the Ribbon Cable.

All assembly steps are described in detail under: - [Assembling the Z-Axis](#)

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.18.0.0.0.1 Assembling the Z-Axis

This section describes the assembly of the PAL Injection Unit or Z-Axis. The procedure covers the most critical points, less attention is given to the simpler, self-explanatory steps. In general the steps are performed in reverse order from those described in the Disassembling Procedure.

All further steps are separately described, see "Repair Path Overview".

The Assembly Steps at this level are identical to those in the PM (Preventative Maintenance) Procedure for the Injection Unit.

CAUTION: ESD WARNING

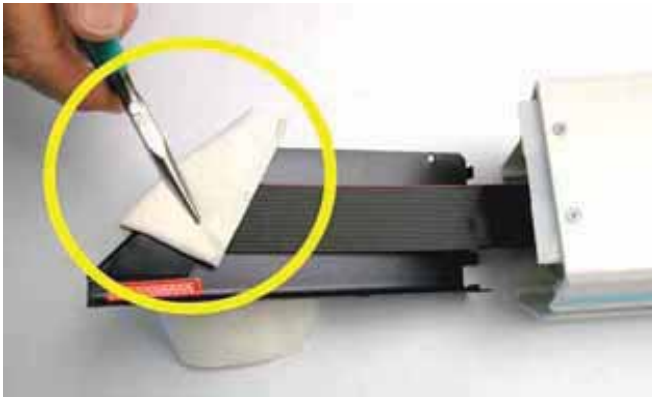
It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are handled.

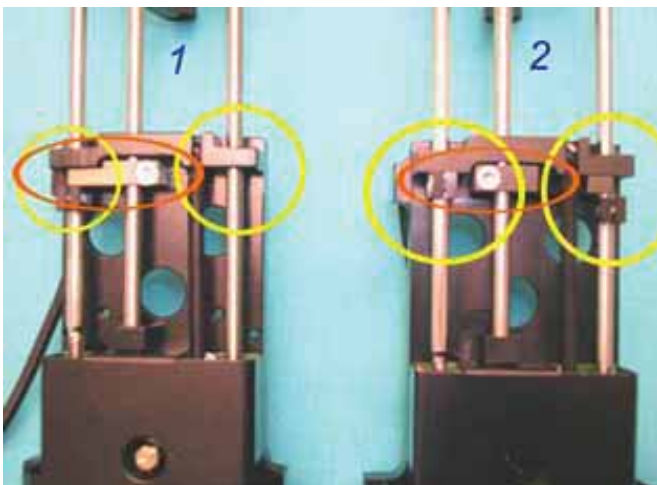
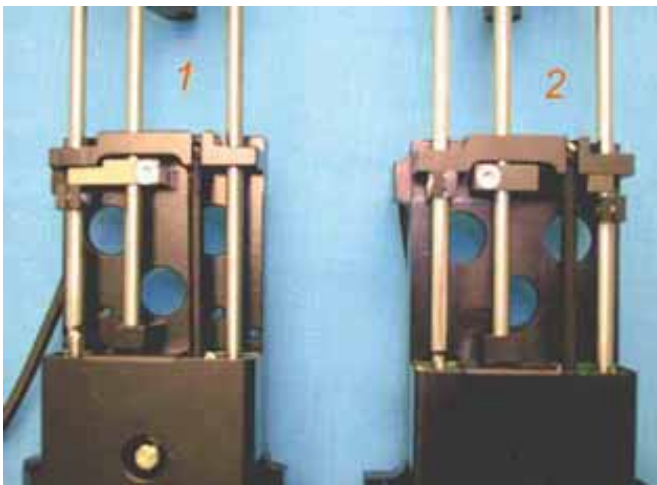
Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

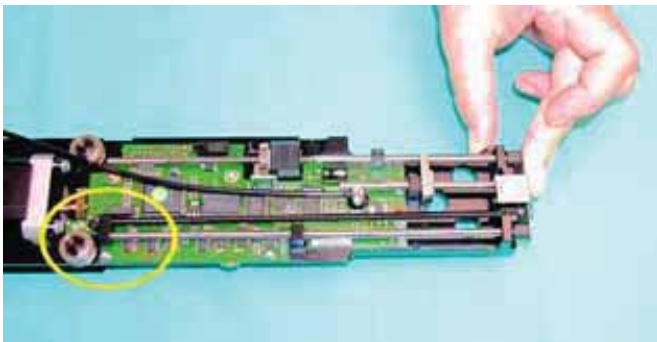
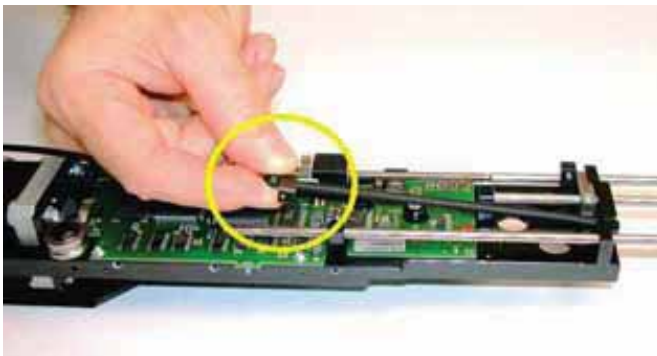
1.19 Assembling the PAL Injection Unit: Procedure

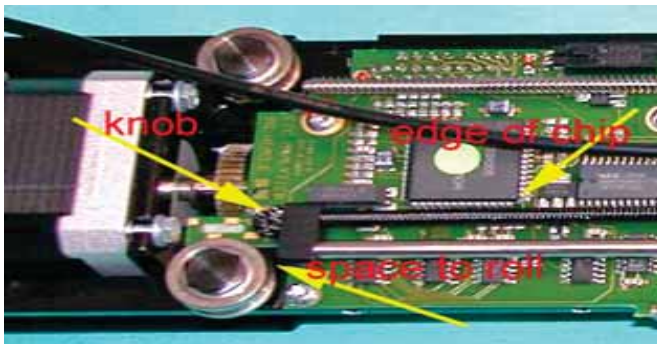
It is assumed that the Injection Unit has been assembled as described in the various sections, e.g. "Stepper Motor Z-Axis", "Stepper Motor for Plunger", "Needle Guide Assembly", "Ribbon Cable Z-Axis", etc.

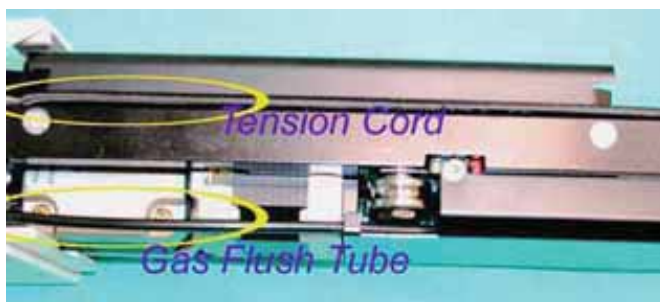
In the assembly procedure, the most critical points are listed again.



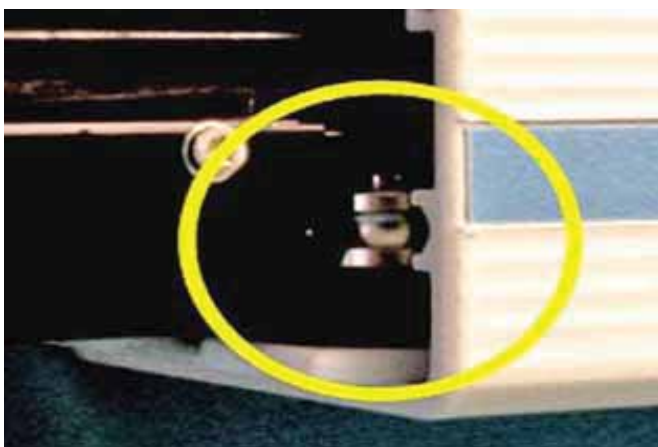












This concludes the Assembly Procedure.

It is good practice to move the syringe slider up and down to check if there is mechanical play, mechanical hindrance and how well the rolls are gliding. In addition, press the Lower Needle Guide Assembly fully up into the Z-Tube. Check if the lower and upper needle guides collapse nicely into each other. When releasing the Needle Guide Assy, it should be automatically released downwards (effect of Short Tension Cord).

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section, "Test Procedure".

1.19.0.0.0.1 Limitations for Repairing the Z-Axis

1.20 Introduction

Successful repair of the Z-Axis depends on the availability of spare parts, the skill of the service engineers and technical limitations of the situation.

If a service engineer is not specifically trained in or extensively exposed to the PAL System, it is advisable to return the Injection Unit back to CTC Analytics for an overhaul.



Z-Axis Limitations Point 1:

Most of the individual parts for the Lower Needle Guide Assembly are not provided as a single spare parts. The Bushing is hand-selected for the particular Spindle. Do not interchange any Bushing or Spindle in the field.

For more details, see section "[Needle Guide Assembly](#)".

Spare Part Kit: - MZ 23-01 for HTS/HTC/LC PAL- MZ 23-02 for Combi/GC PAL- MZ 23-03 for ITEX PAL



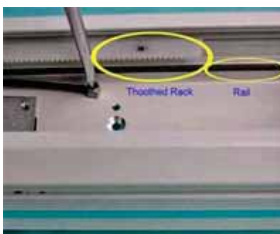
Z-Axis Limitations Point 2:

All 3 Sensors, Plunger Motor (example shown in the picture), Needle Guide (Penetration) and Z-Position Sensor are not provided as spare parts.

The PCB may be exchanged in the field. The defective board can be returned to CTC Analytics for repair. An error description and the CTC RMA Nr. are required.

For further details, see the sections "PCB for Injection Unit" and "Needle Guide Assembly".

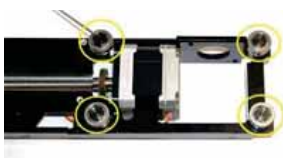
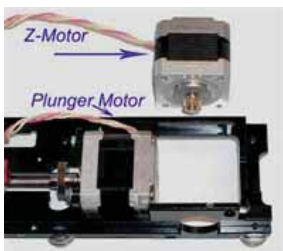
PCB for Injection Unit; P/N: PAL MZCtrlCurrent version will be supplied. See hardware release history for backwards compatibility.



Z-Axis Limitations Point 3:

Rails: To maintain the rails, they should be only cleaned and greased. If any damage (mechanical or corrosion) is observed, the unit has to be returned for an overhaul to CTC Analytics.

Toothed Rack: Adjusting or replacing the Toothed Rack requires a detailed knowledge and extensive experience to make the correct adjustments. If a service engineer is not specifically trained or is not extensively exposed to the PAL System, it is advisable to return the Injection Unit back to CTC Analytics for an overhaul.



Z-Axis Limitations Point 4:

The Stepper Motor Z-Axis has to be adjusted such that the Pinion fits perfectly with the Toothed Rack.

Any mechanical play could affect the long-term stability of the Injection Unit.

If a service engineer is not specifically trained or is not extensively exposed to the PAL System, it is advisable to return the Injection Unit back to CTC Analytics for an overhaul.

Z-Axis Limitations Point 5:

CAUTION:

When it comes down to the rollers there is a strict limitation: do NOT touch the fixation. The rollers are matched in side distance against the Rails in the Z-Tube. The Injection Unit may be damaged within a few months if the alignment is too tight.

The alignment can only be done in the factory using a dedicated setting gauge.

1.20.0.0.0.1 Testing the Z-Axis

Testing the Z-Axis (Injection Unit of PAL System) after Repair, Overhaul, or PM (Preventative Maintenance)

Note: In the case where a Repair, an Overhaul or PM has been done on a PAL System, it is advisable to also check the Firmware version level and if this is not current, upgrade it whenever possible. For more details see the section "[PAL Firmware](#)".

In the case of a Repair, it is possible that the flash memory has been stroked and the firmware is partially corrupt. This has been observed in situations where the fuse had blown on the CPU or Control Board. After a repair it is good practice to re-load the specific back-up file for the particular PAL System. If not available or not at the current level, make an upgrade with a complete backup file (including objects, not core software only). Upgrading with firmware only (core software) in an uncontrolled situation such as after a repair case, runs the risk that potentially erratic firmware is not brought back to a secure operating level.

Test Description	Test Procedure
1. Z-Axis not installed	Z-Axis after repair, not installed yet on PAL System

Test Description	Test Procedure
1.1. Syringe Slider Movement in the Z-Tube	Move the syringe slider up and down to check if there is mechanical play, mechanical hindrance and how well the rolls are gliding. If mechanical play is observed, check the position of the Stepper Motor Z-Axis and/or the Toothed Rack in the Z-Tube again.
1.2. Needle Guide Assembly Movement	Press the Lower Needle Guide Assembly fully up to the Z-Tube. Check if the lower and upper needle guides collapse nicely into each other. If not, readjust the Upper Needle Guide. When releasing the Needle Guide Assy, it should be automatically released downwards (effect of Short Tension Cord).
2. Z-Axis Installed on PAL System	WARNING: Disconnect the PAL System from the power line and unplug the power cord before any maintenance or repair work is done. Also, disconnect the PAL System from any other device which is part of the complete system. CAUTION: When installing the Injection Unit to the Y-Axis, make sure that the Ribbon Cable is not pulled too far out of the Y-Axis. A disorganized ribbon cable can cause a mechanical hindrance which will be seen with the error message "Y-sensor not detected"!
2.1. Power up the PAL System	Check if the motors are starting to move, and the position of the axis will be referenced. Check if the Solenoid of the Z-Axis is activated and released (audible noise). Check if any error message comes up during the process of powering up the system. Error messages not related to the Z-Axis can have various causes, including modules not installed, wrong Firmware level or wrong Firmware Objects loaded, etc.
2.2. PAL Service Test: 'Check Plunger'	<i>Note: This test is done with a syringe and plunger holder but without a syringe installed. (The holder is required to have a defined syringe setup for the plunger motor current. The plunger holder limits the travel path of the Spindle Guide Bushing to the same distance as if a syringe were installed. The bushing should not reach the very lowest part of the cut-out in the Syringe Slider.)</i> Path: Menu F3-Setup Service Test Head F1 - 'Check Plg' Press F1-Start: The Plunger Holder is moved up and down. Let the test run for 5 to 10 times and observe the value. On the message line of the local terminal a value 'Tooth Count = XX' is displayed. PAL Firmware Version 2.X.X. to 3.0.X: Ideal values are 95 or higher. If the value drops below 90 the error message 'Plunger Sensor Failed' will come up. PAL-xt Firmware Version 4.1.X (or higher): Minimum Value: 70-90; If value is below, Error Message 'Plunger Sensor Minimum bad Sensitivity'. Maximum Value: 80-90; If value is above, Error Message 'Plunger Sensor Maximum bad Sensitivity'. Press F1- Stop: The Plunger Holder moves up and down. This end-test is designed to detect potential problems related to the plunger motor and/or mechanic drive. The test is passed if the Plunger Holder has moved the full path without any loss of steps (typical audible noise from stepper motor can be noticed). Conclusions: If Minimum value is undercut: Mechanical and/or Hall Sensor problems detected.

Test Description	Test Procedure
	If Maximum value is exceeded: Software Problem. Load as a first step a new Firmware backup File.
2.3. PAL Service Test:'Check Z'	<i>Note: This test is done with a syringe holder but without a syringe installed. (The holder is required to have a defined syringe setup for the plunger motor current.) A 'Waste' Position has to be known by the system. If a Wash Station is not installed, the position 'Waste' on the table plate can be used as the 'Waste' reference point. Pay attention that the plate is solid, do not lean on the table during the test. The values may vary.</i> Path: Menu F3-Setup Service Test Head F2 - 'Check Z' Press F1-Start: The Injection Unit moves to the 'Waste' Position and makes the penetration movement of the syringe slider including the so-called 'Needle Guide Blocking'. The needle guide is blocked and released with the action of the Solenoid. Let the test run for 5 to 10 times and observe the value. On the message line of the local terminal two values are displayed: 'Min=XX' and 'Max=YY' The interpretation of the values are: For PAL Firmware versions 2.X.X to 3.0.X: - Minimum Value: if < than 20: ErrorMessage 'Needle Penetration Sensor Failed'. - Maximum Value: typically around 40 to 80. If close to 100 or higher, mechanically check the Needle Guide Assembly and/or the Needle Guide Sensor. - The sum of the 'Min' and 'Max' Values should be typically around 100. If the sum deviates far from 100 (for example 125), it is an indication that the Needle Guide Assembly and/or the Needle Guide Sensor is defective. For PAL-xt Firmware version 4.1.X or higher: - Minimum Value: If < 20: ErrorMessage 'Needle Guide Bad Sensitivity'. - Maximum Value: If > 100: ErrorMessage 'Needle Guide Bad Sensitivity'. For all PAL Firmware Versions: If the Needle Guide Blocking fails, Solenoid, the ErrorMessage # 137 'Needle Guide not released' is displayed. Press F1-Stop: The Syringe Slider moves at the highest possible speed with the lowest possible current to operate the Stepper Motor Z-Axis. This end-test is designed to detect potential problems related to the motor and/or mechanic drive. The test is passed if the Syringe Slider has been moved the full path without any loss of steps (typical audible noise from stepper motor can be heard). Conclusions: If Minimum value is undercut: Mechanical and/or Hall Sensor problems detected. If Maximum value is exceeded: Software Problem. Load as a first step a new Firmware backup File.
2.4. PAL Test:'-Syringe Detection'	Insert a Syringe Holder and verify if the syringe ID is correctly identified. Path: Menu/F1-'Change Syr' The Injection Unit moves the Position 'Change Syringe'. <i>Note: The Position 'Change Syringe' can be changed by: Menu Utilities F3-Set Pos.</i> Insert a Syringe Holder, accept 'Continue' on the local Terminal. On the message line, the Syringe Type will be displayed. Verify the value. If instead of 'Continue', a message with a syringe type selection is displayed, it is the indication that the syringe Detection Mode has been turned OFF. Change the settings from the local terminal. Path: Menu F3-Setup System Syringe Detection ON. <i>Note: A new Firmware Backup-File can have the Syringe Detection always turned OFF to avoid a software conflict</i>

Test Description	Test Procedure
	with a possible installed syringe. Beginning with Firmware level 2.5.2 the Syringe Detection is turned ON. The test is passed if the correct Syringe Type is displayed.
2.5. PAL Test:'Heated Syringe'	This test is described in the section, 'PAL Modules/Heated Cartridge'. <i>NOte: This section is covered in PAL SM Edition 1.1.0.</i>
2.6 PAL Test:'Gas Leak Test Z-Axis'	This test is described in the section 'XYTest'. The leak test is done with the full system from the Pressure Regulator, Flush Valve, and Gas Tubing to the Injection Unit. The leak test applies only to the PAL Modules which have a Gas Flush Tube installed, typically used for Headspace applications. PAL Systems: MZ 02-00, MZ 08-00, MZ 010-00. PAL-xt Systems: MZ 016-00, MZ 019-00.

Note: The service tests "Test Switches" and "Motors" are described in the section '[Testing XY-Axis](#)'.

1.20.0.0.1 Overview Upgrade Path | Spare Part Kit | PM for PAL Injection Unit, Z-Axis

- [Upgrade Path for Z-Axis](#)
- [Spare Part Kits for Injection Unit, Z-Axis](#)
- [Preventative Maintenance, PM](#)

1.20.0.0.1.1 Overview Upgrade Path | Spare Part Kit | PM for PAL Injection Unit, Z-Axis

- [Upgrade Path for Z-Axis](#)
- [Spare Part Kits for Injection Unit, Z-Axis](#)
- [Preventative Maintenance, PM](#)

1.20.0.0.1.2 Upgrade Path for Z-Axis (Injection Unit)

This section provides an overview of the various modifications for each revision level of the Z-Axis (Injection Unit). Also given in this section are information on whether a field upgrade is possible, and which parts may be changed.

The definition of Revision Level is identical for all PAL Injection Unit models. Those Injection Unit models added to the production line at later stages began with the current level at the time of introduction of the unit. Example: MZ 06-00 model for GC and LC PAL. First Revision Level "B". An exemption is for the current level Revision F. This level is only active for the HPLC Line, MZ 01-00 and MZ 06-00.

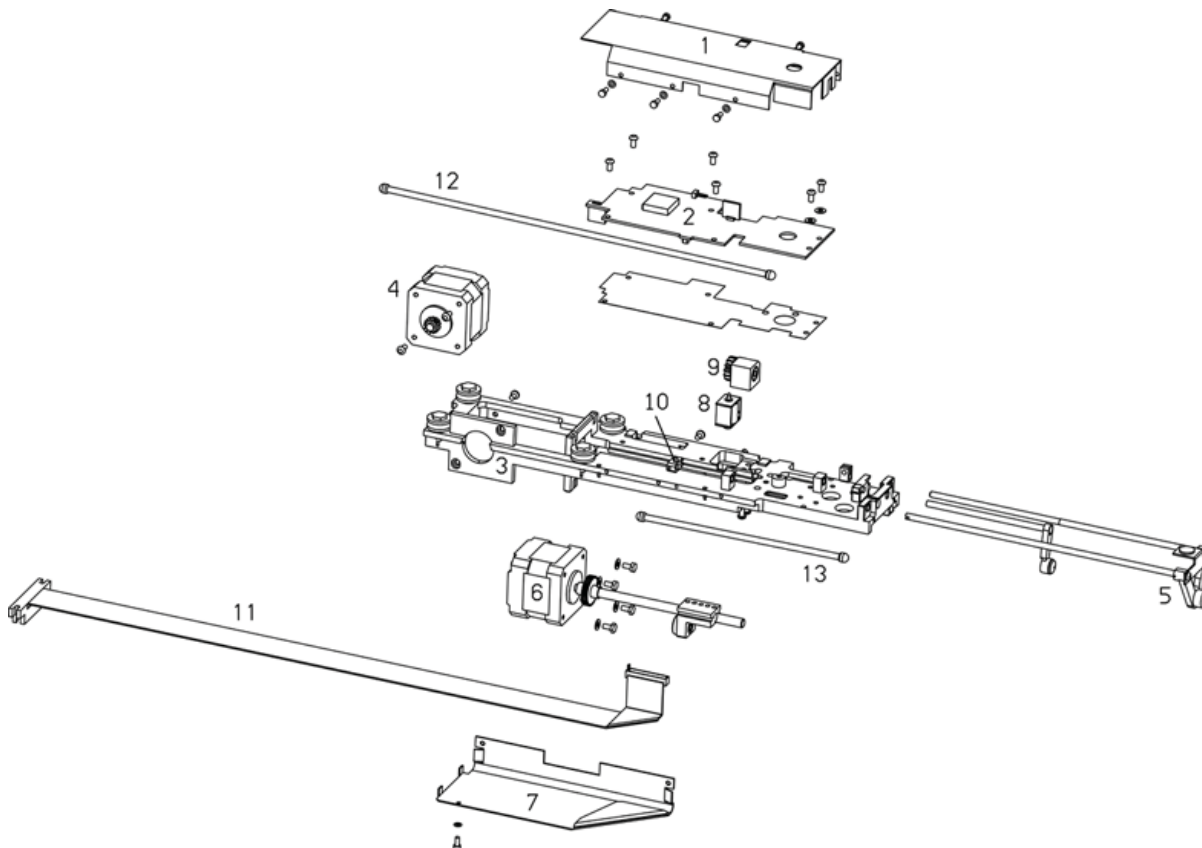
RevisionLevel	Modification from Previous Level	Required Parts and Steps for Upgrade to Current Level	Remarks
A	Basic Unit	No Field Upgrade possible. See "Remarks". Unit has to be upgraded at CTC Analytics if Plunger Motor of PCB has to be replaced.	Plunger Motor is physically smaller than the type used beginning with Rev. B. The cover for the electronic part does not fit neatly.
B	Plunger Motor with the current size installed. Upgrade to Rev. D possible. If slit for Dilutor is required (Rev. E) ensure that the screw hole for the Dilutor Syringe Holder is prepared in the syringe slider.	Solenoid PCB for Injection Unit Rev. E.L. or higher. Needle Guide Assembly Slit in Z-Tube	Solenoid is mainly used for SPME application. Requires current level of PCB for Injection Unit. Firmware level 2.2.2 or higher. Needle Guide Assembly with new type of Anti-Twist Device and simplified Assembly design. Change to Rev. E. Beginning with Rev. F. was the slit for Dilutor Option introduced.
C	New type of sensors for Syringe ID, Plunger and Needle Penetration. Needle Guide Assembly with new Anti-Twist Device and simplified Assembly design. Upgrade to Rev. D possible. If slit for Dilutor is required (Rev. E) ensure that screw hole for Dilutor Syringe Holder is prepared in syringe slider.	PCB for Injection Unit Rev. E.L. or higher. Needle Guide Replacement Kit for PAL Upper Needle Guide Assembly (Gauge 19) Slit in Z-Tube	Sensors are not individually available . Select the specific kit for the various PAL models. See section " Spare Part Kits for Z-Axis ". See section " Spare Part Kits for Z-Axis ". Change to Rev. E. Beginning with Rev. F. was the slit for Dilutor Option introduced.
D	Stronger Solenoid for Needle Guide Blocking (15 VDC). Upgrade to Rev. E possible. If slit for Dilutor is required (Rev. E) ensure that the screw hole for the Dilutor Syringe Holder is prepared in the syringe slider.	Solenoid PCB for Injection Unit Rev. E.L. or higher. Slit in Z-Tube	Solenoid is mainly used for SPME application. Requires current level of PCB for Injection Unit. Requires current level of PCB for Injection Unit. Firmware level 2.2.2 or higher. Change to Rev. E. Beginning with Rev. F. was the slit for Dilutor Option introduced.

RevisionLevel	Modification from Previous Level	Required Parts and Steps for Upgrade to Current Level	Remarks
E	Slit in Z-tube for Dilutor or Fraction Collector Option. Upgrade to Rev. F possible.	Upper and Lower Needle Guide Assembly for Gauge 19 needle. It is preferable to change the whole assembly. P/N: -MZ 23-01 - PAL UprNdIGde. See section "Spare Part Kits for Z-Axis".	The entire Injection Unit has to be returned to the factory to mill the slit into the housing. RMA Nr. is required. Revision F only became effective for HPLC technique. Injection units :- MZ 01-00 - MZ 09-00
F	Upper and Lower Needle Guide Assembly prepared for Gauge 19 syringe needle (Size of hole 1.2 mm.)	Current level at release of PAL Service Manual Edition 1.0.0.	Revision F became only effective for the HPLC technique. Injection units : - MZ 01-00 - MZ 09-00 Needle Guides prepared for syringe Needle Gauge 19 (Size of hole 1.2 mm) All other Z-Axis models still have the Needle Guides installed to adapt to syringe needles of Gauge 22 or smaller. Size of hole 0.8 mm. This includes the unit MZ 06-00 (GC and LC PAL).

1.20.0.0.1.3 Spare Part Kits for PAL Injection Unit, Z-Axis

The Spare Parts and Kits for the Z-Axis listed below are all available.

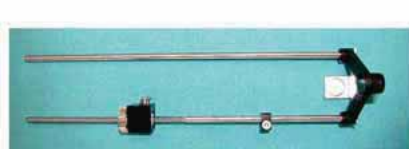
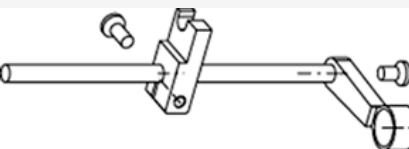
Any Single Parts which are not listed below are included in a kit.

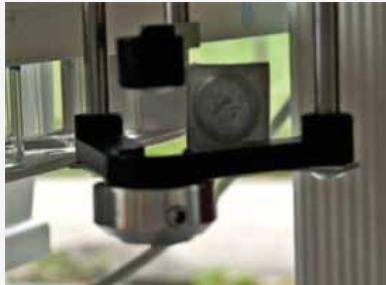
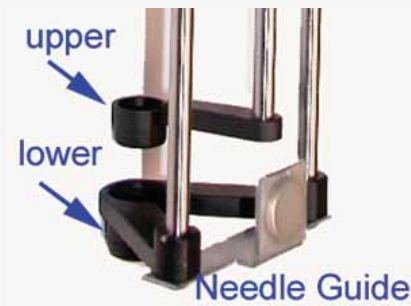


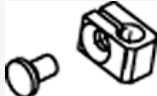
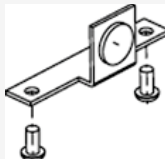
Note: The number identification of parts or kits corresponds to those given in the table below. See the numbers in the table column "P/N", or under "Remarks" for further hints.

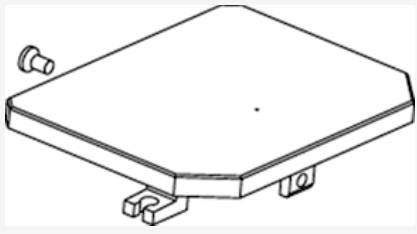
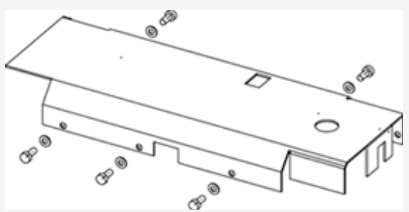
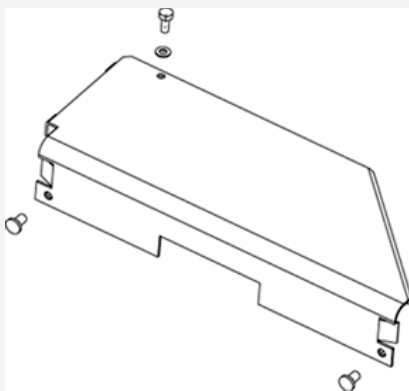
The part labeled # 3 is the syringe slider. This part is not available in isolation.

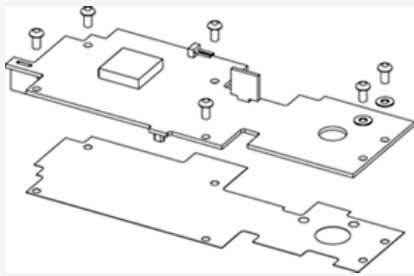
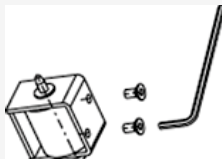
1.21 Spare Parts and Kits for PAL Injection Unit, Z-Axis:

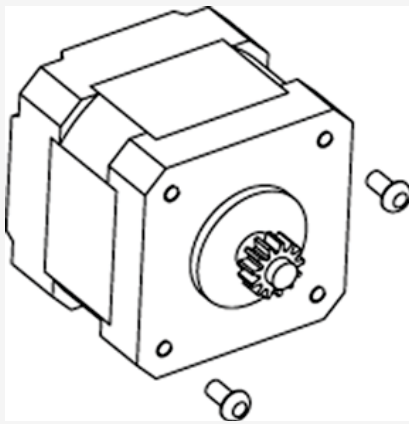
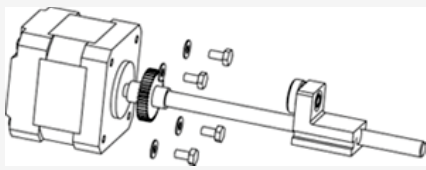
P/N	Part or Kit Description	Remarks
MZ 23-01 # 5	Needle Guide Replacement Kit for HTS/HTC/LCPAL 	Lower Needle Guide Assembly includes: - Lower Needle Guide without magnets installed- - Stack Drawer Magnet - Needle Guide rods/spindle - Bushing (selected for specific spindle) # 9 - Mechanical Stop for Needle Guide
MZ 23-02 # 5	Needle Guide Replacement Kit for Combi PAL <i>Note: Picture identical with MZ 23-01</i> 	Lower Needle Guide Assembly includes: - Lower Needle Guide with magnets installed- - Stack Drawer Magnet- - Needle Guide Rods/Spindle - Needle Guide Bushing (selected for specific spindle) # 9 - Mechanical Stop for Needle Guide
MZ 23-03 # 5	Needle Guide Replacement Kit for ITEX PAL <i>Note: Picture identical with MZ 23-01 or MZ 23-02, Rods are longer.</i>	Lower Needle Guide Assembly includes: - Lower Needle Guide with magnets installed - Stack Drawer Magnet - Needle Guide rods/spindle (extended length for ITEX) - Needle Guide Bushing (selected for specific spindle) # 9 - 2 pcs. Mechanical Stop for Needle Guide
PAL UprNdlgde	Upper Needle Guide Assembly (Gauge 19)  <i>Note: In the expanded drawing, the Lower Needle Guide is shown as part of the Lower Needle Guide, labeled with #05</i>	Upper Needle Guide Assembly includes: - Upper Needle Guide mounted on rod. Hole fits for Needle Gauge 19. - Screw BN4851 M3x6 - Anti-Twist Device incl. screw BN4851 M3x8
MSZ 01-00	Magnetic Adapter Ring for 20 ml vials	Allen Set Screw: P/N: BN 29M 3x3 Description: Allen Set Screw with point, zinc coated.

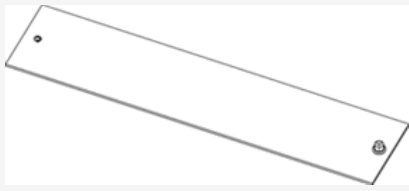
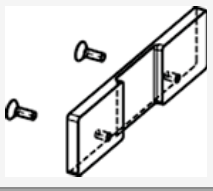
P/N	Part or Kit Description	Remarks
		
MSZ 02-01	Microtiter Plate Foil Cutter, for needles Gauge 22 max. 	See section Optimization "Piercing Adapter"  Allen Set Screw: P/N: BN 29M 3x3 Description: Allen Set Screw with point, zinc coated.
MZ 20-11 MZ 20-38 MZ 20-39 MZ 20-35 MZ 20-45 MZ 20-46	Lower Needle Guide, transport magnets installed, hole for needle diameter up to Gauge 22, hole diameter 0.8 mm. Mainly used for GC technique. Part of Kit MZ 23-02. Lower Needle Guide, without transport magnets installed, hole for needle Gauge 19, diameter 1.2 mm. Mainly used for HPLC technique. Part of Kit MZ 23-01. Lower Needle Guide for Fraction collector unit, Injection Unit MZ 09-00. Lower part is wide open so that liquid from the needle tip cannot touch the Needle Guide. Special Lower Needle Guide dedicated for SOTAX system DS2. Adapter MZ 20-36 is associated with this device. Lower Needle Guide with chemically-resistant coating. Without transport magnets installed; hole size for Gauge 19 needles. Upper Needle Guide with chemically-resistant coating. Hole size for Gauge 19 needles.	As described under Z-Axis, Needle Guide Assembly both the Lower and Upper Needle Guide are not individually available. The Needle Guide Kits are supplied; see above. This listing gives an overview and orientation for special cases. The chemically-resistant parts are individually available. For more details see the section "Needle Guide Assembly", Introduction Point 5. 

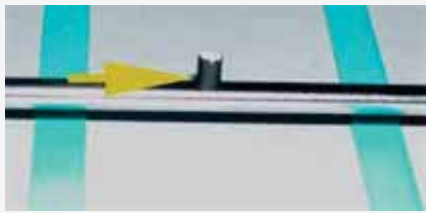
P/N	Part or Kit Description	Remarks
MZ 20-14	Mechanical Stop for Needle Guide 	Stopper to adjust the syringe needle length. This stopper is also part of the Lower Needle Guide Assembly, P/N MZ 23-xx.
PAL SlidStopKit	Slider Stopper Assembly (Z-Axis) 	Stopper for Syringe Slider Assembly to limit travel path in Z-Tube.
PAL StkDrwMag	Stack Drawer Magnet Assembly, Kit 	Stack Drawer Magnet incl. screws BN6404 M3x6
PAL TCord280 MZ 30-21 #12	Tension Cord 280 mm (5 pcs.) 	Long Tension Cord, identical for all PAL Injection Unit modules. This Tension Cord is also part of the PM Kit. Note: The PNo. MZ 30-21 is for a single Tension Cord. Use the PNo. PAL TCord280 for reorder.
PAL TCord90 MZ 30-23 # 13	Tension Cord 90-95 mm (5pcs) 	Short Tension Cord, identical for all PAL Injection Unit modules. This Tension Cord is also part of the PM Kit. Note: The PNo. MZ 30-31 is for a single Tension Cord. Use the PNo. PAL TCord90 for reorder.
MZ 20-22	Tension Cord 115-125 mm	Short tension Cord specific for Combi PAL Part is obsolete. See Service Note #09/2006
MZ 20-15 #10	Adapter for Short Tension Cord (Z-Axis) 	Adapter to attach short tension cord to needle guide rod
PAL MZCovTop	Top Cover for Z-Axis, Kit	Kit includes:- Top cover for Z-Axis - Screw BN4851 M3x6

P/N	Part or Kit Description	Remarks
		
PAL MZCovCtrl # 1	Cover for Control Module Z-Axis, Kit. 	Kit includes: - Cover for electronic Part (black sheet metal) - Screws BN6404 M2, 5x6 - Serrated Locking Washers BN782 M2.3
PAL MZCovCbl # 7	Cover for Motors and Ribbon Cable Z-Axis, Kit. (Rev. B or higher) 	Kit includes: - Cover for Motors and Ribbon Cable (black sheet metal) - Single Screw and Washer for face side of Cover: -- Screws BN15857 M2.5x6 -- Serrated Locking Washers BN 782 M2.3 - 2 Screws and Washers for cover side: -- Screws BN 6404 M2.5x6 -- Serrated Locking Washers BN 782 M2.3
MZ 50-00 # 11	Ribbon Cable Z-Axis, 500 mm 	Ribbon Cable for Z-Axis, length 500 mm. complete with connectors and pre-formed cable. Ribbon Cable for Standard size Injection Unit, e.g. MZ 01-00 or MZ 02-00. For details see " Overview Injection Unit ".

P/N	Part or Kit Description	Remarks
MZ 51-00	Ribbon Cable Z-Axis, 450 mm <i>Note: Picture is identical as for MZ 50-00, but the length of cable is different.</i>	Ribbon Cable for Z-Axis, length 450 mm. Complete with connectors and preformed cable. Ribbon Cable for Injection Unit, e.g. MZ 06-00. Shorter Version of Injection Unit. For details see "Overview Injection Unit" .
MZ 50-01	Ribbon Cable for ITEX Z-Axis, 560 mm <i>Note: Picture is identical as for MZ 50-00, but the length of cable is different.</i>	Ribbon Cable for ITEX Z-Axis, length 560 mm. complete with connectors and preformed cable. For details see "Overview Injection Unit" .
PAL MZCtrl # 02	PCB Assembly for PAL Injection Unit, Kit.(Rev. D or higher) 	PCB Assembly includes: - APR Head, current revision level - Protection Foil for PCB - Screws BN6404 M3x6 - Washers BN715 M3 <i>Note:</i> <i>If the PCB from a revision lower than "D" is replaced, is it mandatory to replace the solenoid as well.</i> <i>See the section "Solenoid".</i>
PAL NdIBlkMag # 8	Solenoid for Needle Guide Blocking Assembly, Kit 	Solenoid Assembly includes: - Solenoid 15 VDC (requires PAL Injection Unit PCB Rev. E.L.) - Screws BN 21 M2x4 - Allen Key 1.3 <i>Note: If the solenoid from a revision lower than "D" is replaced is it mandatory to replace the PCB as well. See the section "Solenoid".</i>

P/N	Part or Kit Description	Remarks
PAL TubeFlushZ	Gas Flush Tube for Z-Axis Replacement Kit 	Gas Flush Tube Kit includes: - Gas Flush Tube cut to length - Gas Tube Adapters installed - Sealing Gaskets mounted <i>Note: The Gas Flush Tube Z is installed in MZ 02-00 and MZ 03-00 only.</i>
PAL MotZ # 4	PAL Stepper Motor Z-Axis, Kit 	The Z- Motor Assembly includes: - Z-Motor with Pinion, cables and connectors mounted - Screws BN6404 M3x6
PAL MotPlg # 6	PAL Stepper Motor Plunger, Kit (For Injection Rev. B or higher only) 	The Plunger Motor Assembly includes:- Plunger Motor with standard spindle, bushing for plunger holder, cables and connectors mounted. - Screws BN56 M3x8 - Washers BN 715 M3 <i>Note:</i> - The Plunger Assembly with fine spindle thread (flat spindle) is available on request. Contact CTC Analytics directly for details. - The Plunger Assembly for Injection Unit Revision A is not provided for field upgrades. The Injection Unit has to be sent to the factory for repair/upgrade.

P/N	Part or Kit Description	Remarks
MZ 32-00	Safety Shield for PAL Injection Unit 	Safety Shield complete. 226 mm. Knob and O-ring installed. Material: Polycarbonate.
MZ 32-01	Safety Shield for ITEX Unit <i>Note: Picture is identical with MZ 32-00, but the length is different.</i>	Safety Shield for ITEX PAL Injection Unit, complete. 284 mm. Knob and O-ring installed. Material: Polycarbonate
PAL MZAgiOpen	Bumper for PAL Injection Unit, Kit 	Bumper to open the Agitator Lid. Kit includes: - 1 Bumper - 2 Screws BN11308K25x6
PAL MZTRack350	Toothed Rack, 350 mm, Kit 	Kit Toothed Rack, length 350 mm. Includes - Toothed Rack, - Screws; P/N: BN 3 M3x6 mm-Nuts; P/N: BN 117 M3-2 Deco Stripes Z-Axis; For the lengths for all Z-Axis units with the exception of MZ 06-00, see below. <i>Note: If other Deco Stripe colors are required, specify the OEM label with the order.</i>
PAL MZTRack300	Toothed Rack, 300 mm, Kit <i>Note: The picture of the kit is identical to the picture above.</i>	Kit Toothed Rack, length 300 mm. Includes: - Toothed Rack, - Screws; P/N: BN 3 M3x6 mm-Nuts; P/N: BN 117 M3-2 Deco Stripes Z-Axis; Length for Injection Unit P/N MZ 06-00. For all other Z-Axes, the PAL MZTRack350 is required (see above). <i>Note: If other Deco Stripe colors are required, specify the OEM label with the order.</i>
PAL MZZMag	Switching Magnet for Z-Sensor, Kit <i>Note: The picture shows the magnet fixed on a screwdriver. The top face is painted to indicate that the active side is at the opposite of the magnet.</i>	Kit Z-Axis Magnet, includes: - Switching Magnet, active side original surface, back side painted (to aid in orienting the magnet during installation) - 2 Deco Stripes Z-Axis <i>Note: If other Deco Stripe colors are required, specify the OEM label with the order.</i>

P/N	Part or Kit Description	Remarks
		
PAL PMKit1	Preventative Maintenance (PM) Kit for PAL HPLC Technique	Preventative Maintenance Kit for all PAL Systems, dedicated for HPLC and similar or related techniques. For details, see the section " PM ".
PAL PMKit2	Preventative Maintenance (PM) Kit for PAL GC Technique	Preventative Maintenance Kit for all PAL Systems, dedicated for GC and similar or related techniques. For details, see the section " PM ".
PAL LubKit	PAL Lubrication Kit 	PAL Lubrication Kit includes: - PAL Lub (dedicated grease for PAL System, approx. 5g) - Brush for greasing This lubrication kit is part of the PM Kit
Tool Flush	Leak Test Meter for Gas Flush Line in PAL System	Tool to check for gas leaks throughout the entire PAL System, X-Y-Z Axis. For details, see the section " XY-Test ".

P/N	Part or Kit Description	Remarks
		
PAL ToolKit	Tool Kit for PAL System 	Includes the necessary Tools, like Torx drivers, Allen key, etc.
	LOCTIDE 243	Color: Blue Used to fix screws. <i>Note: Not provided by CTC Analytics, for information only</i>
	LOCTIDE 638	Color: Green Used to glue parts like Switching Magnet for Sensors. (In combination with AM Activator). <i>Note: Not provided by CTC Analytics, for information only.</i>
	LOCTIDE 480	Color: Black Used to glue parts, such as Switching Magnets in the Syringe Holder. LOCTIDE 480 is a quick-setting glue. No corrections are possible. <i>Note: Not provided by CTC Analytics, for information only</i>

Note: Detailed information on Syringes, Plungers, Syringe- and Plunger-Holders is provided in the section 'Spare Parts | Syringes | Plungers | Holders'.

1.21.0.0.0.1 Preventative Maintenance- (PM) Z-Axis

Preventative Maintenance (PM) for the PAL Injection Unit, the Z-Axis, is covered in the PM Document for GC and HPLC Technique.

The following 'PM Kits' are available:

- PAL PM Kit1: PM Kit for HPLC Technique, HTS, HTC, LC PAL Systems (including PAL DLW-2 Option).
- PAL PMKitDLW for HPLC Technique. PAL systems including PAL DLW Option (not for PAL Dlw-2 Option).
- PAL PM Kit2: PM Kit for GC Technique, COMBI and GC PAL Systems.

Note: The PM Kits are identical for PAL and PAL-xt Systems.

The PM Kits contain the PM Procedure Document, the Spare Parts recommended to be changed annually as well as the PAL-specific Grease and a brush.

CTC Analytics recommends performing a PM procedure for the PAL System once a year.

For more details, see the section '[Preventative Maintenance](#)'.

1.21.0.0.1 Overview PAL Z-Axis

This section covers following points:

- [Z-Axis Overview](#)
- [Z-Axis Release History](#)
- [Z-Axis Troubleshooting](#)
- [Z-Axis Repair Path](#)
- [Z-Axis Upgrade Path](#)
- [Z-Axis Spare Parts](#)
- [Z-Axis Preventative Maintenance \(PM\)](#)

1.21.0.1 X,-Y- Axes Overview

This section covers following points:

- [X-, Y-Axes Release History](#)
- [Troubleshooting](#)
- [X-, Y--Axes Repair Path](#)
- [X-, Y-Axes Upgrade Path](#)
- [X-, Y-Axes Spare Parts](#)
- [X-, Y-Axes Preventative Maintenance \(PM\)](#)

1.21.0.1.1 Overview X-Y Axes

X-Y-Axis PNo.	Used for PAL Model	Description
MXY 01-01	HTS PAL	Standard Axis : X-Axis 798 mm Y-Axis 312 mm. Electronic Boards, PCBs:- APR CPU- APR Motio <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>
MXY 02-01	Combi PAL	Standard Axis: X-Axis 798 mm Y-Axis 312 mm. Electronic Boards, PCBs:- APR CPU- APR Motio Gas Flush Tube is installed. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration.
MXY 03-01	LC PAL	Standard Axis: X-Axis 504 mm Y-Axis 312 mm. Electronic Board: APR Control-LC; Code 1 with limited Firmware access
MXY 04-01	HTC PAL	Standard Axis: X-Axis 504 mm Y-Axis 312 mm. Electronic Board, PCB: APR Control-HTC; Code O without Firmware limitations.
MXY 05-01	HSC2 OEM version for Alpha MOS	Standard Axis: X-Axis 504 mm Y-Axis 312 mm. Electronic Board, PCB: APR Control-LC; Code 1 with limited Firmware access
MXY 06-01	GC PAL	Standard Axis: X-Axis 798 mm Y-Axis 312 mm. Electronic Board, PCB: APR Control-GC; Code 0 without Firmware limitations
MXY 07-01	HTX PAL	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Boards, PCBs:- APR CPU- APR Motio <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>
MXY 08-01	IFC PAL	Special length for X- and Y- Axes: X-Axis 1176 mm Y-Axis 402 mmSystem with two Injection Units installed (Dual). Electronic Boards, PCBs:- APR CPU- APR Motio- APR Control-HTS; Code O without Firmware limitations.
MXY 09-01	HS PAL OEM version	Standard Axis: X-Axis 798 mm Y-Axis 312 mm. Electronic Board, PCB: APR Control-HTC; Code O without Firmware limitations. Gas Flush Tube is installed. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration.

X-Y-Axis PNo.	Used for PAL Model	Description
MXY 010-01	LHX PAL	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Boards, PCBs:- APR CPU- APR Motio Gas Flush Tube is not inside the profile installed. Tube is provided in a kit with external connections. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration. Special Blind Cover has a hole to provide access to the external Gas Flush Tube.
MXY 010-02	MPS OEM version for Gerstel	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Boards, PCBs:- APR CPU- APR Motio Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration. Special Blind Cover has a hole to provide access to the external Gas Flush Tube. Without Gas Flush Tube.
MXY 011-01	HTXX PAL	Special Length X- and Y-Axis: X-Axis 1176 mm Y-Axis 402 mm System with single Injection Unit. Electronic Boards, PCBs:- APR CPU- APR Motio
MXY 012-01	PAL HTS- xt	Standard Axis : X-Axis 798 mm Y-Axis 312 mm. Electronic Board, PCB:- APR Control-xt <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>
MXY 013-01	PAL HTC- xt	Standard Axis: X-Axis 504 mm Y-Axis 312 mm. Electronic Board, PCB:- APR Control-xt
MXY 014-01	PAL COMBI- xt	Standard Axis: X-Axis 798 mm Y-Axis 312 mm. Electronic Board, PCB:- APR Control-xt Gas Flush Tube is installed. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration.
MXY 015-01	PAL GC- xt	Standard Axis: X-Axis 798 mm Y-Axis 312 mm.
MXY 016-01	PAL LHX- xt	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Board, PCB:- APR Control-xt Gas Flush Tube is not inside the profile installed. Tube is provided in a kit with external connections. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pres-

X-Y-Axis PNo.	Used for PAL Model	Description
		sure Regulator are part of the standard configuration. Special Blind Cover has a hole to provide access to the external Gas Flush Tube.
MXV 017-01	PAL HTX2H- xt	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with two Injection Units. Electronic Board, PCB: - APR Control-xt <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>
MXV 018-01	PAL HTX- xt	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Board, PCB:- APR Control-xt <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>

1.21.0.1.1.1 Overview X-Y Axes

X-Y-Axis PNo.	Used for PAL Model	Description
MXY 01-01	HTS PAL	Standard Axis : X-Axis 798 mm Y-Axis 312 mm. Electronic Boards, PCBs:- APR CPU- APR Motio <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>
MXY 02-01	Combi PAL	Standard Axis: X-Axis 798 mm Y-Axis 312 mm. Electronic Boards, PCBs:- APR CPU- APR Motio Gas Flush Tube is installed. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration.
MXY 03-01	LC PAL	Standard Axis: X-Axis 504 mm Y-Axis 312 mm. Electronic Board: APR Control-LC; Code 1 with limited Firmware access
MXY 04-01	HTC PAL	Standard Axis: X-Axis 504 mm Y-Axis 312 mm. Electronic Board, PCB: APR Control-HTC; Code O without Firmware limitations.
MXY 05-01	HSC2 OEM version for Alpha MOS	Standard Axis: X-Axis 504 mm Y-Axis 312 mm. Electronic Board, PCB: APR Control-LC; Code 1 with limited Firmware access
MXY 06-01	GC PAL	Standard Axis: X-Axis 798 mm Y-Axis 312 mm. Electronic Board, PCB: APR Control-GC; Code 0 without Firmware limitations
MXY 07-01	HTX PAL	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Boards, PCBs:- APR CPU- APR Motio <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>
MXY 08-01	IFC PAL	Special length for X- and Y- Axes: X-Axis 1176 mm Y-Axis 402 mmSystem with two Injection Units installed (Dual). Electronic Boards, PCBs:- APR CPU- APR Motio- APR Control-HTS; Code O without Firmware limitations.
MXY 09-01	HS PAL OEM version	Standard Axis: X-Axis 798 mm Y-Axis 312 mm. Electronic Board, PCB: APR Control-HTC; Code O without Firmware limitations. Gas Flush Tube is installed. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration.

X-Y-Axis PNo.	Used for PAL Model	Description
MXY 010-01	LHX PAL	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Boards, PCBs:- APR CPU- APR Motio Gas Flush Tube is not inside the profile installed. Tube is provided in a kit with external connections. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration. Special Blind Cover has a hole to provide access to the external Gas Flush Tube.
MXY 010-02	MPS OEM version for Gerstel	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Boards, PCBs:- APR CPU- APR Motio Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration. Special Blind Cover has a hole to provide access to the external Gas Flush Tube. Without Gas Flush Tube.
MXY 011-01	HTXX PAL	Special Length X- and Y-Axis: X-Axis 1176 mm Y-Axis 402 mm System with single Injection Unit. Electronic Boards, PCBs:- APR CPU- APR Motio
MXY 012-01	PAL HTS- xt	Standard Axis : X-Axis 798 mm Y-Axis 312 mm. Electronic Board, PCB:- APR Control-xt <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>
MXY 013-01	PAL HTC- xt	Standard Axis: X-Axis 504 mm Y-Axis 312 mm. Electronic Board, PCB:- APR Control-xt
MXY 014-01	PAL COMBI- xt	Standard Axis: X-Axis 798 mm Y-Axis 312 mm. Electronic Board, PCB:- APR Control-xt Gas Flush Tube is installed. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pressure Regulator are part of the standard configuration.
MXY 015-01	PAL GC- xt	Standard Axis: X-Axis 798 mm Y-Axis 312 mm.
MXY 016-01	PAL LHX- xt	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Board, PCB:- APR Control-xt Gas Flush Tube is not inside the profile installed. Tube is provided in a kit with external connections. Right Side Cover equipped with Gas Distribution Block. Gas Flush Valve and Pres-

X-Y-Axis PNo.	Used for PAL Model	Description
		sure Regulator are part of the standard configuration. Special Blind Cover has a hole to provide access to the external Gas Flush Tube.
MXY 017-01	PAL HTX2H- xt	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with two Injection Units. Electronic Board, PCB: - APR Control-xt <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>
MXY 018-01	PAL HTX- xt	Special length X-Axis: X-Axis 1176 mm Y-Axis 312 mm System with single Injection Unit. Electronic Board, PCB:- APR Control-xt <i>Note: Gas Flush Tube is not installed. Standard side covers without gas connections are installed.</i>

1.21.0.1.1.2 Release History X-Y-Axes

Revision Level	Modifications from Previous Revision Level	Remarks
A	Basic Unit of MXY	Part Number 'MXY' reflects the X-Y-Axes Assembly with the electronics built-in.
B	Minor mechanical modifications. Major changes in the various PCBs, such as X-Y-Sensors, Motio and CPU Boards. The changes were made during the early stages of the PAL system.	See also section ' XY-Upgrade Path '

1.21.0.1.2 Troubleshooting the X-Y-Axes

Error Symptom	Possible Cause	Recommended Actions
X- or Y-Axis Position Error	X-Y-Z misaligned Firmware Interface to any other data handling software Gas Flush Tube in X-Y-Axis kinked APR MOTIO or Control Board X-Y- Sensors failed X-Y- Ribbon Cables	Check X-Y-Z Positions Reload complete Firmware backup file Run PAL System without integration (in standalone mode) Check tube and if necessary replace it Replace the board to isolate the source of error Replace X-Y- Sensors Replace Ribbon Cables
Gas Flush Tube in X-Axis collapsed	Aging of Gas Flush Tube X-Y Motor settings too fast Gas Flush Tube replaced and shortly after installing became kinked again. FlexBand broken	Replace Gas Flush Tube Check settings, Firmware Backup Check procedure in Service Manual. Replace FlexBand
Gas Leak at Pressure Regulator	Tube Connector broken O-ring Gaskets destroyed Manometer leaky	Replace connectors Replace O-ring Gaskets Replace Manometer
Gas Leak within X-Y Assembly	Gas Pressure set too high Pressure Regulator Connection X-Axis Side Cover Gas Flush Valve Gas Flush Tube X-Y-Axis Connection Y-Axis to Z-Axis Z-Axis Heated Cartridge for HS-syringe	Check gas pressure (0.5 Bar). Replace regulator. Replace side cover Check Firmware settings, replace valve Check Gas Flush Tubing X-Y for leaks Replace Y-Axis Front Cover Check Z-Axis for leaks Check heated cartridge for leaks
Flexband broken	X-Y-Motor settings too fast- Flexband aged (old style black material)	Check setting Replace Flexband
Ribbon Cables defective	Installation of Z-Axis Sheet Metal Cover Y-Axis Mechanical destruction within X-Y-Axis Not original cable used for replacement	Remove Z-Axis and check cable Check for any destruction Check for any possible reason for destruction Replace cable with original cable
Loose Guide Rod/Rail	Environment in lab Aging of glue/cement	Check lab environment Glue in rod

Error Symptom	Possible Cause	Recommended Actions
Flaking-Off Material from X-Y-Axis	Dust and dirt mixed with dried grease Corrosion from acid vapor- High Tension from Guide Rollers against Guide Rods in X-Y-Tube	Clean Guide Rollers and Rods, PM Check environment Check the adjusted distance Rollers/Rods
Electronic or PCB failures (CPU/MOTIO/Control Boards)	Cable disconnected and re-connected Short circuit on connectors 1uF Capacitor on MOTIO/Control Board	Check Fuse on CPU/Control Board Check cables and connectors Check level and replace board
X- Position Sensor	Firmware PCB X-Sensor defective APR MOTIO/Control Board Connector Ribbon Cable Ribbon Cables Switching Magnet for X-Sensor	Load Firmware Backup File Run service test "Test Switches" Replace MOTIO/Control Board- Check Ribbon Cable connectors Check Ribbon Cables Check the Switching Magnet
Y-Position Sensor	Firmware PCB Y-Sensor defective APR MOTIO/Control Board Connector Ribbon Cable Ribbon Cables Switching Magnet for X-Sensor	Load Firmware Backup File Run service test 'Test Switches' Replace MOTIO/Control Board Check Ribbon Cable connectors Check Ribbon Cables Check the Switching Magnet

1.21.0.1.2.1 Troubleshooting the X-Y-Axes

Error Symptom	Possible Cause	Recommended Actions
X- or Y-Axis Position Error	X-Y-Z misaligned Firmware Interface to any other data handling software Gas Flush Tube in X-Y-Axis kinked APR MOTIO or Control Board X-Y- Sensors failed X-Y- Ribbon Cables	Check X-Y-Z Positions Reload complete Firmware backup file Run PAL System without integration (in standalone mode) Check tube and if necessary replace it Replace the board to isolate the source of error- Replace X-Y- Sensors Replace Ribbon Cables
Gas Flush Tube in X-Axis collapsed	Aging of Gas Flush Tube X-Y Motor settings too fast Gas Flush Tube replaced and shortly after installing became kinked again. FlexBand broken	Replace Gas Flush Tube Check settings, Firmware Backup Check procedure in Service Manual. Replace FlexBand
Gas Leak at Pressure Regulator	Tube Connector broken O-ring Gaskets destroyed Manometer leaky	Replace connectors Replace O-ring Gaskets Replace Manometer
Gas Leak within X-Y Assembly	Gas Pressure set too high Pressure Regulator Connection X-Axis Side Cover Gas Flush Valve Gas Flush Tube X-Y-Axis Connection Y-Axis to Z-Axis Z-Axis Heated Cartridge for HS-syringe	Check gas pressure (0.5 Bar). Replace regulator. Replace side cover Check Firmware settings, replace valve Check Gas Flush Tubing X-Y for leaks Replace Y-Axis Front Cover Check Z-Axis for leaks Check heated cartridge for leaks
Flexband broken	X-Y-Motor settings too fast- Flexband aged (old style black material)	Check setting Replace Flexband
Ribbon Cables defective	Installation of Z-Axis Sheet Metal Cover Y-Axis Mechanical destruction within X-Y-Axis Not original cable used for replacement	Remove Z-Axis and check cable Check for any destruction Check for any possible reason for destruction Replace cable with original cable
Loose Guide Rod/Rail	Environment in lab Aging of glue/cement	Check lab environment Glue in rod

Error Symptom	Possible Cause	Recommended Actions
Flaking-Off Material from X-Y-Axis	Dust and dirt mixed with dried grease Corrosion from acid vapor- High Tension from Guide Rollers against Guide Rods in X-Y-Tube	Clean Guide Rollers and Rods, PM Check environment Check the adjusted distance Rollers/Rods
Electronic or PCB failures (CPU/MOTIO/Control Boards)	Cable disconnected and re-connected Short circuit on connectors 1uF Capacitor on MOTIO/Control Board	Check Fuse on CPU/Control Board Check cables and connectors Check level and replace board
X-Position Sensor	Firmware PCB X-Sensor defective APR MOTIO/Control Board Connector Ribbon Cable Ribbon Cables Switching Magnet for X-Sensor	Load Firmware Backup File Run service test "Test Switches" Replace MOTIO/Control Board- Check Ribbon Cable connectors Check Ribbon Cables Check the Switching Magnet
Y-Position Sensor	Firmware PCB Y-Sensor defective APR MOTIO/Control Board Connector Ribbon Cable Ribbon Cables Switching Magnet for X-Sensor	Load Firmware Backup File Run service test 'Test Switches' Replace MOTIO/Control Board Check Ribbon Cable connectors Check Ribbon Cables Check the Switching Magnet

1.21.0.1.2.2 X- or Y-Axes Position Error

Firmware Error Message Number:

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
X-Y-Z Axis misaligned	Check the X-Y-Z Positions. Path from Local Terminal: Menu/Utilities/select the various Object classes.If a deviation is found make the changes under: Menu/Setup/Objects/select the Object class.Check also the Needle Penetration value if found critical for an object.	This is one of the most common sources of errors. A wrong Tray-Type has been selected or a hardware Object has been moved to another position.
Firmware	Reload the complete Firmware backup file.If part of the flush memory is disrupted, this may be the	Use the Firmware backup file made at the time of installation or the latest available version for the particular PAL System.

Possible Cause	Recommended Action	Remarks
	fastest way to recover. <i>Note: Do not use Firmware only (core software). Complete Backup has a file size of approx. 1.5 MB.</i>	
Interface to any other data handling software	Run PAL System without integration (in standalone mode)	If the error still occurs, continue with the steps described below.
Gas Flush Tube in X-Y-Axis kinked	Check for any mechanical hindrance by moving the X-Y-Axis manually (power off).	
APR MOTIO or Control Board	Change the MOTIO or Control Board. P/N: - APR MOTIO - APR Control GC - APR Control-HTC - APR Control-LC	By exchanging the MOTIO or Control Board, the possible cause of error can be narrowed down.
X- or Y-Sensor PCB failed	Run the service Test as described in the section " Testing X-Y-Axis ". If the test is negative, replace the Sensor PCB, or even better both PCBs at the same time.	<i>Note: Use the service test "Test switches".</i>
X-Y-Ribbon Cables	If all points described above did not lead to a solution, then the replacement of the Ribbon Cables is strongly recommended. It is also recommended to replace the X-Y-Sensor PCBs at the same time.	<i>Note: If the error is seen with older PAL Systems, which do not have the new type of Y-Axis Cover with the Polymer shield installed, it is necessary to replace the Ribbon Cables to eliminate the error. This is typically an erratic error, occurring from time to time.</i>

1.21.0.1.2.3 Gas Flush Tube in X-Axis collapsed

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Note: This section covers the Gas Flush Tube in the X-Axis. It is rare that the tube in the Y-Axis is damaged. If this occurs, see the section "Gas Flush Tube X-Y (complete tube)" for detailed instructions.

Possible Cause	Recommended Action	Remarks
Aging of Gas Flush Tube	Replace Gas Flush Tube as described in section "Gas Flush Tube X-Y (complete Tube)"	<i>Note: It is normal that the tube wears out</i>

Possible Cause	Recommended Action	Remarks
		<i>over time and after several years has to be replaced.</i>
X-Y Motor settings too fast	Load a completely new Firmware Backup File.	<i>Note: The Firmware settings for the COMBIPAL system have been optimized to avoid any kinking of the Gas Flush Tube. In case a user changes the settings, he/she could unknowingly create tube kinking. The default values for Motor X are: - Max Speed 400 mU/s - Acceleration 6. See also Service Note # 03/99.</i>
Gas Flush Tube Replaced, but kinked again a short time later	Check the detailed procedure as described in the PAL Service Manual in sections ' Gas Flush Tube X, Replacement ' or ' Gas Flush Tube X-Y (complete Tube) '.	<i>Note: The original description provided with the kit "PAL Tube Flush-X" was not optimized. Instructions were given only in text without diagrams. The procedures given in the Service Manual better illustrate these points.</i>
FlexBand broken	Replace the Flexband as described in the section " Flexband Replacement ".	

1.21.0.1.2.4 Gas Leak at Pressure Regulator

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
Tube Connector broken	Replace Tube Connector. Replacement kit is available, see section "X-Y Spare Part Kits".	<i>Note: New type of tube connectors with O-ring Gaskets have been available since June 2007.</i>
O-Ring Gasket destroyed	Replace O-Ring Gaskets. Replacement kit is available, see section " X-Y Spare Part Kits ". CAUTION: It is important that any tightening is	<i>Note: New type of tube connectors with O-ring Gaskets have been available since June 2007.</i>

Possible Cause	Recommended Action	Remarks
	done using two flat wrenches. The O-ring Gasket can be destroyed easily if too much force is applied!	
Manometer leaky	Replace the manometer Replacement is available, see the section " X-Y Spare Part Kits ".	

The required tool to test for a possible gas leak is the Tool Flush. See the section "[XY-Spare Parts](#)".

CAUTION:

Do not use any soap solution (or other similar methods) to test for gas leaks. There is a risk of contaminating the Gas Flush Line.

1.21.0.1.2.5 Gas Leak within X-Y Assembly

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Note: The Gas Leak test is described in the section "X-Y-Axis Testing".

Possible Cause	Recommended Action	Remarks
Gas Pressure set too high	Check gas pressure. Recommended pressure for:- Head-space Technique: 0.5 bar- ITEX Technique: < 0.1 Bar (see ITEX User Manual for gas flow adjustment).	<i>Note: A higher gas pressure does not provide a higher flow rate. The limiting factor is the syringe needle.</i>
Pressure Regulator	Replace the Pressure Regulator	<i>Note: See also the section "Troubleshooting Gas Leak at Pressure regulator".</i>
Connection X-Axis Side Cover	Replace X-Axis Side Cover	<i>Note: Do not contaminate the gas flow path by cementing the Gas Distribution Block back in position.</i>

Possible Cause	Recommended Action	Remarks
Gas Flush Valve	Check Firmware settings: Path to check default setting: Menu/F3-Setup/Ob- jects/Events/flush Vlv/Active State ON - Actual State OFF. Check also the connection from the Gas Flush Valve to the Elbow connector and to the tubing. If necessary, replace the parts.	<i>Note:</i> <i>A reversal of the power out setting does not occur by itself. The typ- ical observation is that the gas flow is tuned on at the moment the PAL System is powered up.</i>
Gas Flush Tube X-Y-Axis	Leak check Gas Flush Tubing X-Y Check the Sealing Gasket, is it installed and tight?	
Connection Y-Axis to Z-Axis	Replace Y-Axis Front Cover	<i>Note:</i> <i>The Y-connection inside the cover is made with the Gas Tube Adapter (sealing Gasket) and out- side with the O-ring. Both sides should be inspected.</i>
Z-Axis	Check Z-Axis for leaks	For details, see the section Troubleshooting " Gas Leak within Z-Axis ".
Heated Cartridge for HS-syringe	Check heated cartridge for leaks	For details, see the section Troubleshooting " Gas Leak within Z-Axis ".

The required tool to test for a possible gas leak is the Tool Flush. See the section '[XY-Spare Parts](#)'.

CAUTION:

Do not use any soap solution (or other similar methods) to test for gas leaks. There is a risk of contaminating the Gas Flush Line.

1.21.0.1.2.6 FlexBand Replacement

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
X-Y- Motor Settings too fast	Check settings	<i>Note:</i> <i>The standard Firmware backup set- tings are optimized. If a user has altered these values, load a com- plete, fresh Firmware Backup File.</i>

Possible Cause	Recommended Action	Remarks
Flexband aged (old style black material)	Replace FlexBand See the section " X-Y-Spare Part Kits " and/or the section " Flexband ".	Note: The old style FlexBand was a black metallic band. The new model is a whitish Polymer type band.

1.21.0.1.2.7 Ribbon Cables defective

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
Installation of Z-Axis	Remove Z-Axis and check cable	See the section ' X-Y Ribbon Cables ' for details
Sheet Metal Cover Y-Axis	Check for any destruction	See the section ' X-Y Ribbon Cables ' for details
Mechanical destruction within X-Y-Axis	Check for any possible reason for destruction	<i>Note: If the error is seen with older PAL Systems, which do not have the new type of Y-Axis Cover with the Polymer shield installed, it is probably necessary to replace the Ribbon Cables to eliminate the error. This is typically an erratic error, occurring only from time to time.</i>
Not the original cable used for replacement	Replace cable with original recommended cable.	<i>Note: We sometimes observed that any cable found in an electronic shop is used as a replacement. The endurance of the cable is not guaranteed under these circumstances.</i>

1.21.0.1.2.8 Loose Guide Rod/Rails

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
Environment in lab	Check the lab environment for organic and acidic vapor phases. Is an unexpectedly high degree of corrosion visible?	
Aging of glue/cement	Glue in Rods If the rods are only partially loose at the ends, use an appropriate glue to cement the rods in again. If the rods are completely loose, the unit has to be returned to the factory. This is because the Guide Rods must be replaced, and the channel in the profile has to be cleaned to be able to glue them in. Finally, the distance of the Rollers has to be matched.	Note An appropriate glue/cement could be: LOCTIDE 638 (Green color). May be used in conjunction with an activator. See also the section 'X-Y Profile'.

1.21.0.1.2.9 Flaking-off Material from X-Y- Axis

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
Dust and dirt mixed with dried grease	Clean the Guide Rollers and Guide Rods from the X-Y-Axes very intensively. Re-grease the parts with the dedicated grease for the PAL system. PNo: PAL Lub (part of the PM Kit).	It has been observed that black material flakes off from X-Y-Axes which have not been cleaned and maintained over a long period. CTC Analytics recommends performing a PM once a year. The dedicated Grease is included in the PM Kit.
Corrosion from acid vapor	Check the environment to find possible sources of acidic vapor. Clean the unit intensively and grease the parts again. If the unit is highly contaminated, checking with pH-indicator paper helps to ensure that the cleaning was effective. In case of severe corrosion, contact CTC Analytics for further assistance.	In rare cases, this effect has been observed. This is usually related to accidents in the lab. Be aware that not only the commonly-used mineral acids such as sulfuric acid can cause corrosion, but also the organic volatile acids, such as TFA or acetic acid.

Possible Cause	Recommended Action	Remarks
High Tension from Guide Rollers against Guide Rods in X-Y-Tube	If the tension of the rollers against the guide rods is too high, there is a possibility that material becomes abraded. Mixed with grease, can this form black flakes. Do not change the setting. If this has been done for any reason, ensure that the tension is so low that one can 'almost feel a play' at the side. In case of any doubt, contact CTC Analytics for further assistance.	The distance from the rollers to the Guide Rods is critical. See also the section ' Limitations for X-Y-Axes '.

1.21.0.1.2.10 Electronic or PCB failure

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
Cable disconnected and re-connected	Check Fuse on CPU/Control Board. In the past, the fuse on the CPU/Control Board was rated with 4 Amp. Reconnection of the DC cable with the power supply running will blow the fuse. The new type of fuse is rated with 6 Amp., and is more forgiving. For details see service Note # 06/2002.	<i>Note:</i> <i>Blowing a fuse could cause partial damage to the Flash memory. It is recommended to re-install a new Firmware Backup file after such an incident.</i>
Short circuit on connectors	Check cables and connectors. Reconnecting a cable with the power on can cause welding spots at the pins. This could lead to short circuits and secondary damage.	<i>Note:</i> <i>A warning label at the back of the PAL System notifies the user of the potential danger.</i>

Possible Cause	Recommended Action	Remarks
1uF Capacitor on MOTIO/Control Board	Check level and replace board. It has been observed that a 1 uF Capacitor from the MOTIO or Control Board can blow out (current leak). This could lead to the blowing of the fuse on the CPU or Control Board. If the fuse level is not at the current level, replace the MOTIO or Control Board as a first step. Do not replace the fuse only.	<i>Note: Details are described in Service Note # 12/2002.</i>
Electronic component burnt	Replace the affected board.	<i>Note: Return defective board to the factory for repair/replacement. A CTC MA Number is required.</i>
Firmware	Re-load a complete Firmware Backup file (either a safety backup file for the specific PAL System or a complete new version). Before loading a new file, it is advisable to perform a backup of the system files first.	See also the section 'PAL Software', ' PAL Firmware '.

1.21.0.1.2.11 X-Position Sensor Switching Magnet

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
Firmware	Re-load a complete Firmware Backup file (either a safety backup file for the specific PAL System or a completely new version). Before loading a new file, it is advisable to perform a backup of the system files first.	See also the section "PAL Software", "PAL Firmware".
PCB X-Sensor defective	Check the sensor by running the PAL Service Test.Path: Menu/F3-Setup/Service/Test Switches/ X-Sensor Check if the sensor component is intact and well soldered to the	Move the Y-Axis across the sensor switch in the middle of the X-Axis.Observe the status change on the display. For details see the section "Testing X-Y".

Possible Cause	Recommended Action	Remarks
	PCB.	
APR MOTIO/Control Board	Replace to the board to isolate the problem.	It is rare that the MOTIO/Control boards are the reason for the X-Sensor Problem. Replacing the board is easily done, and is a quick test before the system has to be dismantled to check the X-Sensor PCB or the Ribbon Cables.
Connector Ribbon Cable	Check the little red connector from the Ribbon Cable to the PCB first.	Is the connector properly attached? Are the pins intact?
Ribbon Cables	Check for any possible damage at one of the ribbon cables.	In case of any doubt, replace the Ribbon Cables including the PCP for the X-Sensor.
Switching Magnet for X-Sensor	The switching Magnet is mounted in the X-Y-Carriage. The magnet cannot get knocked off nor has it been observed that the magnet has fallen out of position.	For details see the section " X-Sensor ".

1.21.0.1.2.12 Y-Position Sensor Switching Magnet

Firmware Error Message Number: not applicable

Follow the points listed in the order given.

Possible Cause	Recommended Action	Remarks
Firmware	Re-load a complete Firmware Backup file (either a safety backup file for the specific PAL System or a completely new version). Before loading a new file, it is advisable to perform a backup of the system files first.	See also the section "PAL Software", "PAL Firmware".
PCB X-Sensor defective	Check the sensor by running the PAL Service Test.Path: Menu/F3-Setup/Service/Test Switches/ Y-Sensor Check if the sensor component is intact and well soldered to the PCB.	Move the Y-Axis across the sensor switch which is approx. 2 mm away from the X-Axis. Observe the status change on the display. For details see the section " Testing X-Y ".

Possible Cause	Recommended Action	Remarks
APR MOTIO/Control Board	Replace to the board to isolate the problem.	It is rare that the MOTIO/Control boards is the reason for the Y-Sensor Problem. Replacing the board is easily done, and is a quick test before the system has to be dismantled to check the X-Sensor PCB or the Ribbon Cables.
Connector Ribbon Cable	Check the little red connector from the Ribbon Cable to the PCB first.	Is the connector properly attached? Are the pins intact?
Ribbon Cables	Check for any possible damage at one of the ribbon cables.	In case of any doubt, replace the Ribbon Cables including the PCP for the Y-Sensor.
Switching Magnet for Y-Sensor	The switching Magnet is mounted into the Toothed Rack of the Y-Axis. The magnet cannot get knocked off, nor has it been observed that the magnet has fallen out of position.	For details see the section " Y-Sensor ".

1.21.0.1.3 Overview X-Y-Axes Repair Path

The following section describes the steps on how to gain access to a certain level or part for repair.

As a first step, "Disassembling X-Y Axis" is described. This step has to be done prior to all other repair steps. The disassembly procedure is only described once, and for all remaining steps it is only referred to with a link.

The same procedure is used for the final assembly step.

After the assembly, the test procedure for the X-Y-Axis is described.

- [Disassembling X-Y-Axes](#)
- [Pressure Regulator](#)
- [Gas Flush Valve](#)
- [Gas Flush Tube-X Replacement](#)
- [Gas Flush Tube-X-Y \(complete Tube Replacement\)](#)
- [Flexband](#)
- [Ribbon Cables X-Y-Axes](#)
- [Stepper Motor X-Axes](#)
- [Stepper Motor Y-Axes](#)

- [X-Y-Axes Housing, Alum Profile, X-Y-Side Covers](#)
- [PCB Position Sensor-X](#)
- [PCB Position Sensor-](#)
- [PCBs | CPU Board | MOTIO Board | Control Boards | PCB Injection Unit](#)
- [Assembling X-Y-Axes](#)
- [Limitations for Repair X-Y-Axes](#)
- [Testing X-Y-Axes](#)

1.21.0.1.3.1 Overview X-Y-Axes Repair Path

The following section describes the steps on how to gain access to a certain level or part for repair.

As a first step, "Disassembling X-Y Axis" is described. This step has to be done prior to all other repair steps. The disassembly procedure is only described once, and for all remaining steps it is only referred to with a link.

The same procedure is used for the final assembly step.

After the assembly, the test procedure for the X-Y-Axis is described.

- [Disassembling X-Y-Axes](#)
- [Pressure Regulator](#)
- [Gas Flush Valve](#)
- [Gas Flush Tube-X Replacement](#)
- [Gas Flush Tube-X-Y \(complete Tube Replacement\)](#)
- [Flexband](#)
- [Ribbon Cables X-Y-Axes](#)
- [Stepper Motor X-Axes](#)
- [Stepper Motor Y-Axes](#)
- [X-Y-Axes Housing, Alum Profile, X-Y-Side Covers](#)
- [PCB Position Sensor-X](#)
- [PCB Position Sensor-](#)
- [PCBs | CPU Board | MOTIO Board | Control Boards | PCB Injection Unit](#)
- [Assembling X-Y-Axes](#)
- [Limitations for Repair X-Y-Axes](#)
- [Testing X-Y-Axes](#)

1.21.0.1.3.2 Disassembling the X-Y-Axes

1.22 In this section, the Disassembly of the PAL X-Y-Axis is described in detail.

All further steps are separately described, see ['Repair Path Overview'](#).

The Disassembly Steps are identical to those described in the PM (Preventative Maintenance) Procedure for the X-Y-Axis.

The assembly steps are described in ['Assembling X-Y-Axis'](#).

Note: CTC Analytics AG provides a dedicated Tool Kit which contains the necessary screwdrivers, especially the Torx drivers.

P/N: PAL ToolKit; see the section ['Spare Part Kits'](#).

WARNING:

Disconnect the PAL System from the power line and unplug the power cord before performing any maintenance or repair.

Also, disconnect the PAL System from any other device which may be connected to the complete system.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in every case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

Indication for Disassembling the Injection Unit (Z-Axis)

The procedure "Disassembling X-Y-Axis" is needed for all maintenance and repair steps for the PAL X-Y-Axis.

It is assumed that the Injection Unit has been removed from the X-Y-Axis. For detailed instructions see ['Disassembling Injection Unit, Z-Axis'](#).

CAUTION: GENERAL REMARKS

Disconnect any cable, gas line, HPLC tubing, etc. Ensure that a schematic drawing is made to re-establish the original configuration, especially in the case of specific, dedicated applications. Remove the X-Y-assembly from all devices, to gain access to the unit conveniently on all sides. Place the unit whenever possible on the standard legs for a PAL System, as used for HPLC devices. PNo.: PAL MR-Std.

Remove any hardware Objects, such as Tray Holders, Stacks, Valve Drives, Agitator, etc. Remember the original setup and positions of the Objects.

CAUTION: FIRMWARE BACKUP

Before starting any work on a PAL System, perform a Firmware backup by using the PAL Loader software. The software is provided with every PAL Instrument (PAL USER MANUAL, CD-ROM).



Step1:

Remove the blind cover on the left side first.

Note: Units with 50 cm X-Axis do not have a blind cover installed.

Required Tools: Torx T10

Material Description:

- Screws BN 6404 M3x6**
- Blind Cover PAL 80: MX 30-12**
- Blind Cover for PAL80, Model GC PAL: MX 30-34**
- Blind Cover PAL120, Model HTX PAL: MX 30-39**
- Blind Cover PAL 120, Model LHX PAL: MX 30-42**



Step 2:

Disengage the MOTIO Board from the connector of the CPU Board, if applicable.



Step1:

Remove the blind cover on the left side first.

Note: Units with 50 cm X-Axis do not have a blind cover installed.

Required Tools: Torx T10

Material Description:

- Screws BN 6404 M3x6
- Blind Cover PAL 80: MX 30-12
- Blind Cover for PAL80, Model GC PAL: MX 30-34
- Blind Cover PAL120, Model HTX PAL: MX 30-39
- Blind Cover PAL 120, Model LHX PAL: MX 30-42



Step 3:

Disconnect the Ribbon Cables from the MOTIO or Control Board.



Step1:

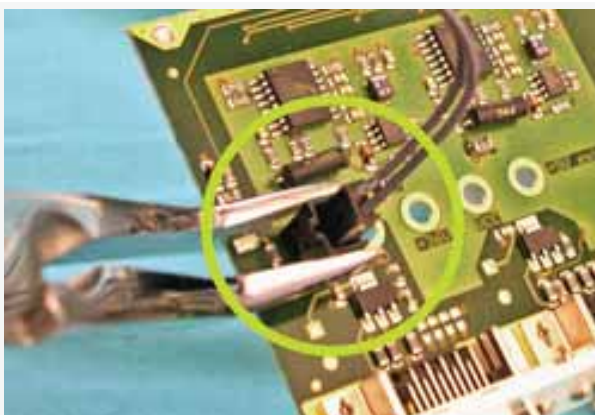
Remove the blind cover on the left side first.

Note: Units with 50 cm X-Axis do not have a blind cover installed.

Required Tools: Torx T10

Material Description:

- Screws BN 6404 M3x6
- Blind Cover PAL 80: MX 30-12
- Blind Cover for PAL80, Model GC PAL: MX 30-34
- Blind Cover PAL120, Model HTX PAL: MX 30-39
- Blind Cover PAL 120, Model LHX PAL: MX 30-42



Step 4:

If applicable, disconnect the cable connector from the Gas Flush Valve to the board.

CAUTION:

Use Gripping Pliers to open the connector nozzle as shown in the picture. The cable connector sits tight in the connector.



Step1:

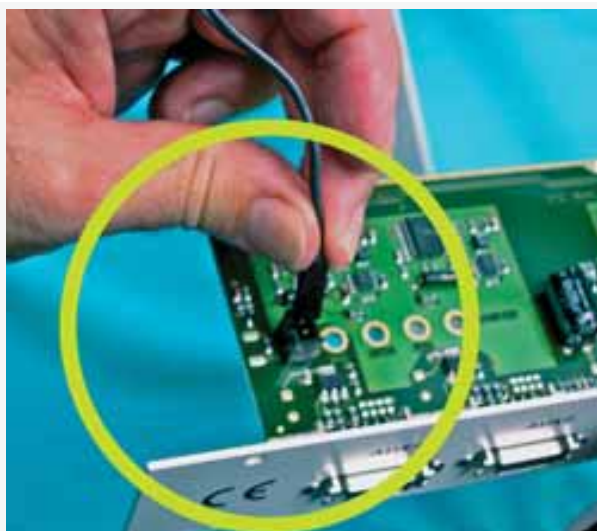
Remove the blind cover on the left side first.

Note: Units with 50 cm X-Axis do not have a blind cover installed.

Required Tools: Torx T10

Material Description:

- Screws BN 6404 M3x6
- Blind Cover PAL 80: MX 30-12
- Blind Cover for PAL80, Model GC PAL: MX 30-34
- Blind Cover PAL120, Model HTX PAL: MX 30-39
- Blind Cover PAL 120, Model LHX PAL: MX 30-42



Step 5:

Disconnect the cable connector.

For further details on the Gas Flush Valve, see either "[Spare Parts for X-Y-Axis](#)" or "[Gas Flush Valve](#)".

Step 5:

Remove the CPU or Control Board.



Step1:

Remove the blind cover on the left side first.

Note: Units with 50 cm X-Axis do not have a blind cover installed.

Required Tools: Torx T10

Material Description:

- Screws BN 6404 M3x6

- Blind Cover PAL 80: MX 30-12

- Blind Cover for PAL80, Model GC PAL: MX 30-34

- Blind Cover PAL120, Model HTX PAL: MX 30-39

- Blind Cover PAL 120, Model LHX PAL: MX 30-42

Step 6:

Remove both Side Covers from the X-Axis.

Pay attention to the connection of the Gas Flush Tube and the cable of the Gas Flush Valve, as shown below.

Required Tools: Torx 20 (Earlier units had screws with a Phillips head installed.)

Material Description:

Side Cover Right Side: MX 30-27

Side Cover Left Side: MX 30-10

Side Cover Right Side incl. Gas Distribution Block (for CombiPAL): MX 30-11

Screws: BN 4851 M4x25

Note: This part does not include the Elbow Adapter.

1.22.0.0.0.1 Pressure Regulator

This section describes the maintenance and replacement of the Pressure Regulator.

Indications for Maintenance or Replacement of the Needle Guide Assembly are:

- Damaged thread to gas line connections
- Leaks at connections to Pressure Regulator body

CAUTION:

Ensure that the gas supply is shut down before opening any connection to the Pressure Regulator.

SAFETY WARNING:

The main application where gas is required in combination with the PAL System is headspace analysis. For this and other applications, an inert gas is required. Helium or Nitrogen are the most commonly-used gases.

FOR SAFETY REASONS, DO NOT USE A REACTIVE GAS, SUCH AS HYDROGEN!

Note: In the section on Optimization "GC Headspace Technique, Gas" further details are given on which type of gas and which quality should be used. Safety aspects are also covered.

1.23 Introduction

Pressure Setting with Pressure Regulator:

As described above under Safety warnings, the main application requiring a gas supply is the headspace technique. The setting for the Pressure Regulator should be 0.5 Bar as described in the PAL USER MANUAL.

Using a higher pressure causes undue stress on all the connections within the system. Furthermore, a higher flow rate cannot be achieved simply by increasing the pressure. The limiting factor is the syringe needle which is the restriction in the flow path.

The primary pressure from the gas supply pressure regulator should not exceed 5 Bar or 70 psi, (inlet pressure for PAL Pressure Regulator).

1.24 Pressure Regulator Repair and Maintenance Procedure

The Pressure Regulator is installed on the back side of the X-Axis, easily accessible without any Disassembly Steps (as described in the corresponding section of the X-Y-Axis).

**Step 1:**

Working at the connections for the Pressure Regulator it is ...

CAUTION:

... mandatory to always use two flat wrenches ...

... as shown in the picture.

Using only one wrench increases the chances of damaging or destroying the sealing gaskets.

Step 2:

The connecting gas tube to the Pressure Regulator is often made of metal, either stainless steel or copper.

Due to the stiffness of the metal tubing, handling it can loosen the SwageLok connection at the Pressure Regulator. An example is when changing the gas supply tank.

It is recommended to wind up the tube with two or three coils, and secure the coils at a stable point using a cable strap. An example is fixing it at the vertical pole of the PAL mounting kit for the GC.

**Step 3:**

CAUTION:

Never use grease, oil or any glue (cement) in combination with the Pressure Regulator, Gas Flush Tube or any connecting part to the gas system. Volatile fractions of the oil, grease or glue can migrate into the system and can cause "ghost peaks" with sensitive detection systems such as GC-MSD.

It is known that grease migrates at room temperature at a rate of approximately 40 cm in the tubing per month. Grease has also been seen to migrate against the flow current within tubing.

1.24.0.0.0.1 Gas Flush Valve

This section describes the maintenance and replacement of the Gas Flush Valve.

Indications for Maintenance or Replacement of the Gas Flush Valve are:

- Gas Flush Valve cannot be activated.
- Leaks at connections to Gas Flush Tubing.
- Connector to the PCB is damaged.
- PAL Firmware setting of Power-Out Signal is reversed. Path to check default setting: Menu/F3-Setup/Objects/Events/Flush Vlv/Active State ON - Actual State OFF.
- **Gas Flush Valve error can also be caused by:**
 - Firmware (corrupt firmware, re-load a complete new backup file. This would also eliminate a reversed power-out signal).— Defective MOTIO or Control Board.

CAUTION:

Ensure that the gas supply is shut down first before opening any connection to the Gas Flush Valve.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handles.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.25 Introduction

The gas supply is mainly used for the GC headspace application. For more details, see the Introduction in the section "[Pressure Regulator](#)" and the section Optimization "[GC Headspace Technique, Gas](#)".

The Gas Flush Valve is built into the Combi PAL System only as a standard configuration. All other PAL modules, as described in the section "[PAL Model Overview](#)", are equipped either with none or only a partially built-in gas supply device. Some points to check are the Gas Flush Tube in the X-Y-Axis, the Gas Flush Valve, the corresponding Gas Distribution Block in the Side Cover X-Axis, Electronic Board (PCB) and Gas Flush Tube availability in the Z-Axis.

1.26 Gas Flush Valve Repair and Maintenance Procedure

It is assumed that the X/Y-Assembly has been disassembled as described in the section "[Disassembling X-Y-Axis](#)".

All other steps are separately described, see "[Overview X-Y- Repair Path](#)".

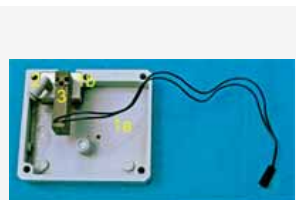
The assembly steps are described in the section "Assembling X-Y-Axis".



Step 1: The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 2: The Gas Flush Valve is built into the X-Axis, with the right hand side looking from the front of the PAL system.



Step 3:

This picture shows the Gas Flush Valve assembly in the side cover. Note that the Gas Distribution Block (1b) is built into the special side cover.

1a: Side Cover incl. Gas Distribution Block; P/N MZ 30-111b: Gas distribution Block, part of MZ 30-11.2: Elbow Adapter for Gas Flush Tube; P/N: KJL 23-M33: Gas Flush Valve including electrical cable/connector. P/N for Combi PAL: MX 90-00 P/N for LHX and HS PAL: MX 90-01

Note: The Distribution Block is not individually available. Do not use any glue (cement) to fix a loose part. Volatile organic compounds can contaminate the gas system. Risk of ghost peak detection.



Step 4:

In order to replace the Gas Flush Valve, disconnect the electrical cable first at the PCB. The electrical connection from the Gas Flush Valve to the PCB (either MOTIO or Control-HTC Board) is fragile.

CAUTION:

Use Gripping Pliers to open the connector nozzle as shown in the picture. The cable connector sits tight in the connector.



Step 5:

Mount the new Gas Flush Valve, tighten the 2 screws carefully.

If applicable, reconnect the Gas Flush Tube to the Elbow Connector. Press in the spring-loaded fitting of the Elbow Connector to open the fit. Ensure that the tube grips and stays in the correct position.

Required Tools:

Material Description: Elbow Adapter for Gas Flush Tube; P/N: KJL 23-M3

Gas Flush Valve including electrical cable/connector. P/N for Combi PAL: MX 90-00 P/N for LHX and HS PAL: MX 90-01



Step 6:

When re-installing the side cover, ensure that the electrical cable is securely out of the way. Do not damage the cable in this step.

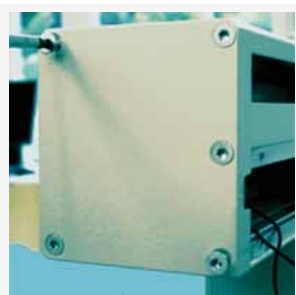
Reconnect the cable to the PCB.

Do not kink the Gas Flush Tube during the positioning of the side cover.

Note: Do not apply any mechanical stress to the Elbow Connector or to any other part, this risks causing a gas leak.



Step 1: The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 7:

Re-install the Side Cover. Note the position of the electrical cable.

Connect the cable to the PCB.

Required Tools: Torx T20

Material Description: - Screws: BN 4851 M4x25

This concludes the procedure for the section of "Gas Flush Valve".

The assembly of the unit goes in the logical order backwards. In the section "Assembling of the X-Y-Axis " several important points are described.

All further steps are separately described, see "[Overview X-Y-Axis Repair](#)".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.26.0.0.0.1 Gas Flush Tube-X Replacement

This section describes the replacement of a kinked Gas Flush Tube in the X-Axis .

The Gas Flush Tube is a single piece for both the X- and Y-Axes. The replacement of the whole tube is described in the section "[Gas Flush Tube X-Y \(complete tube\)](#)".

Indications for Maintenance or Replacement of the Gas Flush Tube-X are:

- Gas Flush Tube kinked in the X-Axis.
- If the Gas Flush Tube is worn out or aged, is it advisable to replace the entire tube. See the section "Gas Flush Tube X-Y, complete Tube".
- Gas leak detected.
- Refurbishing a PAL System. For example, when replacing Ribbon Cables or Sensor PCBs. In this case replace the whole tube as described in the section "Gas Flush Tube X-Y, complete Tube".
- If a gas leak is suspected, check also the connections from the Y- to the Z-Axis, the Gas Flush Tube-Z, the connection to the syringe cartridge and the cartridge itself.

CAUTION:

Ensure that the gas supply is shut down before opening any connection to the Gas Flush Valve.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

CAUTION:

It is highly recommended to match the original tubing quality as provided by CTC Analytics. Any other tube material or quality is not tested for endurance and purity. Traces of impurities due to the presence of any volatile compounds can contaminate the analytical system and can lead to so-called "ghost peaks".

1.27 Introduction

The replacement of the Gas Flush Tube-X may be necessary after several years of operation because of normal wear and aging of the tube.

It is important to understand that the Gas Flush Tube-X is only the part running in the X-Axis. The tube itself is inserted in the X/Y-Carriage leading in both directions, towards the X- and Y-Axes. The replacement of the whole tube is described in the section "Gas Flush Tube X-Y (complete tube)".

The replacement of the Gas Flush Tube-X has been described in Service Note # 15/2000. Over the years we have observed that the replacement has not always been done successfully. Soon after the repair, the tube collapsed and kinked again. The main reasons for these unsuccessful replacements have been:

- Cutting the original installed tube at the wrong position.
- Alignment of the tube around the gear wheel of the X/Y-Carriage.
- Length of the tube not adjusted, too much play in the X-Axis.
- The adapters provided to hold the tube in the channel of X-profile were not used or positioned wrongly.

With the description below, we consider these important points to provide better information to service engineers.

Note: The Gas Flush Tube for the PAL Model "LHX PAL" is guided outside along the X-Axis. Details are described in the section "[Gas Flush Tube X-Y, complete Tube](#)", at the end of the section.

1.28 History

The Combi PAL had originally the same speed and acceleration settings for the Stepper Motor X-Axis as used for the HTS PAL (HPLC technique). In the year 1999 it was recommended that the speed and acceleration be slowed down; see Service Note #03/1999. The reason for the slowing down was the observation that the Gas Flush Tube could be kicked out of the fixation in the channel of X-Axis profile. CTC Analytics took the following actions:

- Firmware settings: The lower values for the speed and acceleration for the Stepper Motor X-Axis became a standard setting with Firmware level 2.1.7. and has been maintained for all the subsequent Firmware releases.
- In the profile of the X-Axis, a steel tube was inserted on the left side (looking from the front to the unit). The Gas Flush Tube is inserted in this tube and can not jump out of its fixation, as before. This change occurred with the CombiPAL S/N 1210968.

These two measures improved the situation dramatically. In the GC technique, speed in most cases is not so important, because the chromatographic run lasts over several minutes. Today, normal wear and aging are the main reasons to change the Gas Flush Tube-X.

1.29 Gas Flush Tube-X Replacement, Repair and Maintenance Procedure

It is assumed that the X/Y-Assembly has been disassembled as described in the section "[Disassembling X-Y-Axis](#)".

All other steps are separately described, see "[Overview X-Y- Repair Path](#)".

The assembly steps are described in the section "[Assembling X-Y-Axis](#)".

Note: All orientations are described from the back side of the Combi PAL.



Step 1:
The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 2:
Disconnect the gas flush tube from the Elbow connector on the left hand cover.
Press firmly on the spring seal against the body of the Elbow connector, to open up the seal.

**Step 3:**

For earlier versions of the Combi PAL Systems, S/N <120968, where the steel tube has not yet been installed (for details see "History" above):

Mark the positions of the tube clamps (or fixation adapters) with a pen at the profile of the X-Axis.

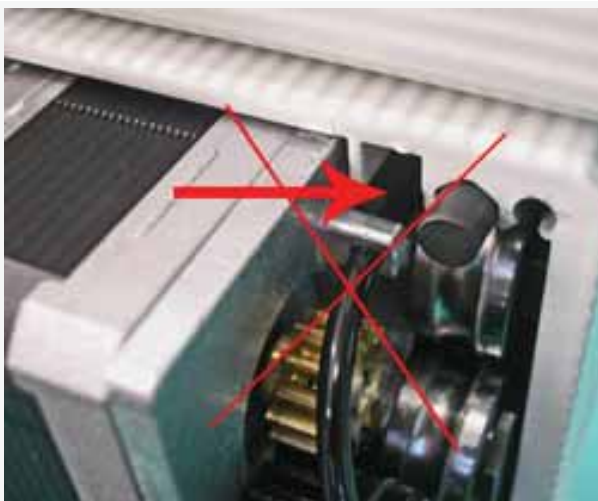
Pull the tube upwards to force the three adapters to jump out of the fixation.

Note: The picture shows only the Adapter which will fix the tube at the end of the X-Axis. The other two adapters are located inside of the X-profile.

**Step 4:**

Move the X/Y-Carriage (Y-Z-Assembly) to the right side until the wheels are visible as shown in the picture.

Cut the tube using a sharp knife to avoid squeezing of the tube. The correct distance of the cut is **6 mm** to the right side of the fixation with the hole (open end of the cut gas tube) pointing away from the X-Axis. See picture, the arrow indicates the correct position to cut the tube.



Step 5:

CAUTION:

This picture shows the wrong position for cutting the tube.

The reason why this cut position is so important is the outer diameter of the metallic adapter used for the replacement Gas Flush Tube-X.

The adapter does not fit in the tube guiding hole. If the tube connection is done on the inside, as indicated with the arrow in the picture, the Gas Flush Tube is too stiff and does not form a nice bow with the movement of the X/Y-Carriage.

In case the tube is cut on the wrong side (as shown in the picture) the entire Gas Flush Tube needs to be replaced, on both X- and Y-Axes. Details are described in the section "[Gas Flush Tube X-Y \(complete tube\)](#)".



Step 6:

Connect the replacement Gas Flush Tube-X by using Gripping Pliers.

Note: The picture does not show the actual situation with the connection of the metallic adapter to the Gas Flush Tube.

The metallic adapter is shown in the close-up picture of the tube end.

The tube has to be inserted into the X-Axis. It is important that the tube forms a natural bow and falls more or less in position.

Move the X/Y-Carriage approximately 10 to 15 mm inside the X-Axis.

Required Tools: Gripping Pliers

Required Material: P/N: PAL TubeFlushX; PAL Tube Flush for X-Axis, Replacement Tube.

Note: In the kit two replacement Gas Flush Tubes are provided. In case the tube gets kinked or damaged during the replacement process, a second attempt is possible.

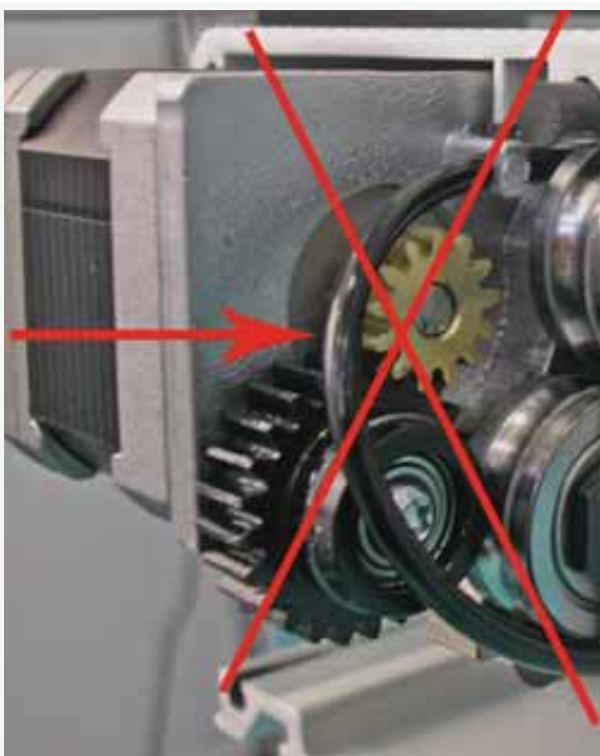


Step 7:

Place the tube tightly around the gear wheel as shown in the picture.

Insert the Gas Flush Tube into the steel tube and push it all the way to the other side of the X-Axis.

Pull at the end of the Gas Flush Tube to adjust the length in the X-Axis.



Step 8:

CAUTION:

Note that the Gas Flush Tube is not tight around the gear wheel.

This position can cause a problem in routine runs. The tube has too much play around the gear wheels and can be caught either by the gear wheels or the rollers from the X/Y-Carriage.

Tighten the length of tube as described below.

For the earlier Combi PAL systems, where the steel tube was not yet installed, the two adapters provided in the repair kit must also be installed.

In step 3, removing the defective Gas Flush Tube, the positions have been marked. Install the 3 adapters in the approximate positions. Details for positioning the adapters (cut face down) are described below in Step 11.

As a general rule, the tube on the left side of the X-Axis is fixed and the right side has to be able to follow the movements.

The X/Y-Carriage has to be moved from the right side to the left side, crossing over the adapters. It is advisable to press the adapter using a slotted screwdriver into the channel of the X-Axis profile. Press the adapters carefully into position.

Step 9:

Procedure for Combi PAL with S/N < 120968, as described above in "History".



Step 10:

If a steel tube is mounted in the X-Axis profile, insert the Gas Flush Tube and push it all the way to the front.

To fix the Gas Flush Tube at this point, one of the Adapters will be used. See below.

Step 11:

Apply one of the adapters provided over the Gas Flush Tube.

CAUTION:

The adapter is a piece of tube, cut in center-line. It is mandatory that the cut is facing downwards. In this way, the adapter can be pressed into the channel of the X-Axis profile.

A slight twist in the angle of the cut would cause the tube fixation to be pressed out of the channel.

If the cut would face upwards, the rollers of the X/Y-Carriage could be mechanically hindered.

Note: In the provided field upgrade or repair kit with P/N PAL Tube-FlushX, 3 adapters are provided to fix the Gas Flush Tube in the side channel of the X-Axis profile.

The instructions given with this kit, Service Note #15/2000, does not mention that in case a steel tube is mounted in the channel of the X-Axis profile only one adapter is needed to fix the tube at the end of the X-Axis (see steps below).

Because of this missing point, the other two adapters have often been used on the side where the tube has to be able to follow the movement of the Y-Z Assembly. The result of this error is that the tube catches in the X/Y-Carriage rollers.

**Step 12:**

Move the adapter as close as possible to the steel tube. Press it with your finger gently into the channel. It has to be fixed but not yet tightened.

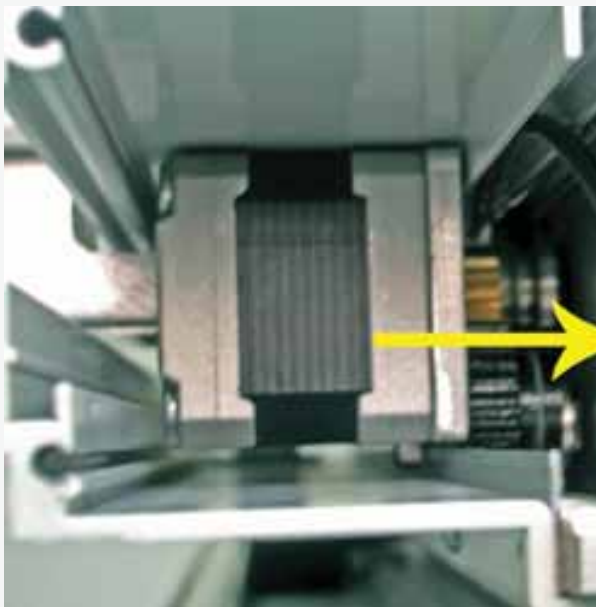
Ensure that the cut is facing downwards.



Step 13:

To check the correct length, hold the right side cover in position and move the X/Y-Carriage to the right side to the mechanical stop.

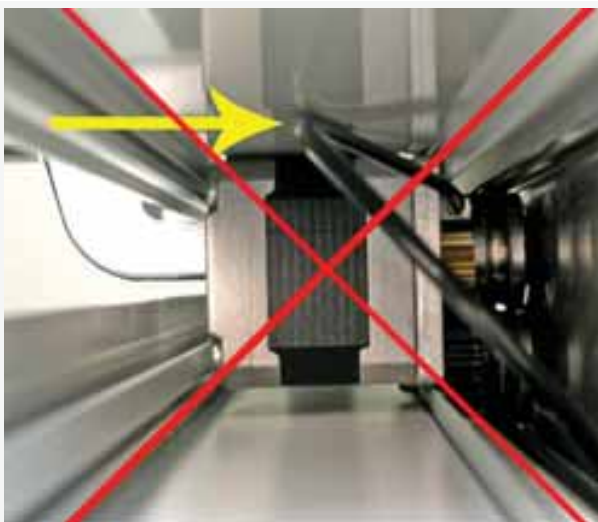
Pull the tube at the other side if necessary. See the example of the correct length for forming the bow around the gear wheels in Steps 7 and 8.



Step 14:

Remove the side cover and check the alignment of the Gas Flush Tube around the gear wheels as shown in Steps 7 and 8.

It is important that the tube forms a natural bow inside the X-Profile.



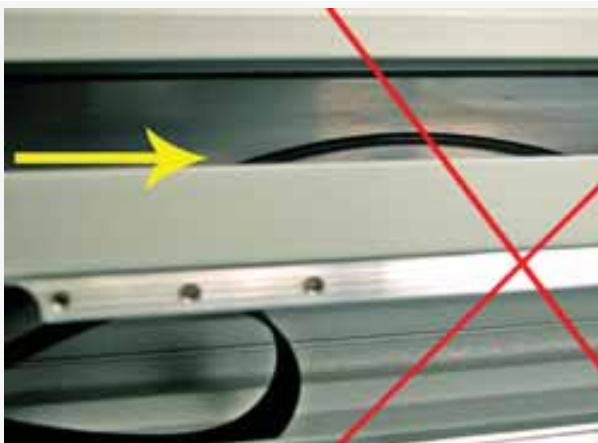
Step 15:

CAUTION:

This picture (slightly exaggerated) shows that the Gas Flush Tube is leaning to the inside of the X-Profile.

If the tube is fixed in such a position, there is a high chance that the tube catches around the rollers of the X/Y-Carriage.

Ensure that the Tube is always "leaning" against the side wall of the profile. If necessary, give a little twist to the tube to force this position.



Step 16:

CAUTION:

Move the X/Y-Carriage in both directions and check if the Gas Flush Tube forms a nice bow and does not collapse in the middle section.

CAUTION:

Move the carriage slowly back and forth. The Gas Flush Tube has to be formed first. Moving too fast can result in kinking of the tube.

If one or the other effect is seen, take the time to re-adjust the length of the tube again.

This is a crucial step. If the proper attention is not provided at this step, there is a high probability that the unit has to be repaired again within a very short time.



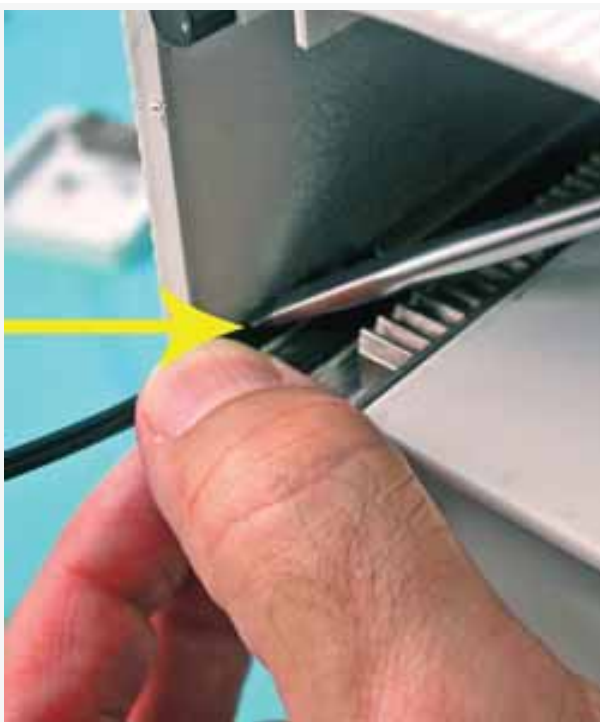
Step 17:

After moving the X/Y-Carriage several times in both directions, check the correct length and position of the Gas Flush Tube again.

Place manually the side cover to the profile of the X-Axis. Move the carriage all the way to the mechanical stop.

Remove the cover and check if the Gas Flush Tube is aligned around the gear wheel as shown in Step 7.

If this is not the case, repeat the steps to properly position the Gas Flush Tube.



Step 18:

Move the X/Y-Carriage to the left side and check how the Gas Flush Tube follows the movement, how the bow is formed, etc.

CAUTION:

Move the carriage slowly at this stage. If moved too fast, the Gas Flush Tube could be caught by the rollers.

If all the checks are positive, move the X/Y-Carriage over the Adapter to press the Adapter firmly into the channel of the X-Axis profile.

Ensure the seat of the Adapter using a slotted screwdriver.



Step 19:

Measure a tube length of 75 mm from the edge of the X-Axis profile.

Cut the tube using a scissor or a sharp knife.

The length is critical and should be observed.



Step 20:

Reconnect the Gas Flush Tube to the Elbow connector in the side cover.

Press the spring seal towards the body of the Elbow connector and insert the tube.



Step 21:

CAUTION:

When mounting the side cover which includes the Gas Flush Valve, it is important to pay attention to the Gas Flush Tube.

Bend the tube with care when the side cover is attached to the X-Axis profile. The tube can be kinked easily at this stage.

This concludes the procedure for the section on "Gas Flush Tube-X Replacement".

The replacement of the entire Gas flush Tube X-Y-axes is described in the section "[Gas Flush Tube X-Y Axis \(complete tube\)](#)".

The Assembly of the unit follows the logical order backwards. In the section "Assembling of the X-Y-Axis " several important points are described.

All further steps are separately described, see "Overview X-Y-Axis Repair".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.29.0.0.0.1 Gas Flush Tube X-Y, complete Tube

This section describes the replacement of the entire Gas Flush Tube in the complete X-Y System.

The Gas Flush Tube is a single piece for both the X- and Y-Axes. The replacement of the tube only in the X-Axis is described in the section "[Gas Flush Tube-X Replacement](#)".

Note: Installing or replacing the Gas Flush Tube for the PAL LHX Model is described at the end of this section.

Indications for Maintenance or Replacement of the Gas Flush Tube X-Y, complete Tube are:

- Gas Flush Tube worn out or aged.
- Gas leak detected.
- Refurbishing a PAL System. An example is when replacing Ribbon Cables or Sensor PCBs.
- If a gas leak is suspected, check also the connections from the Y- to the Z-Axis, the Gas Flush Tube-Z, the connection to the syringe cartridge and the cartridge itself.

CAUTION:

Ensure that the gas supply is shut down before opening any connection to the Gas Flush Valve.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.30 Introduction

The replacement of the entire Gas Flush Tube X-Y may be necessary after several years of operation because of normal wear and aging of the tube.

It is important to understand that the Gas Flush Tube-X is only the part running in the X-Axis. The tube itself is inserted in the X/Y-Carriage leading in both directions, towards the X- and Y-Axes. The replacement of the tube in the X-Axis only is described in the section ["Gas Flush Tube-X Replacement"](#).

The replacement of the Gas Flush Tube-X has been described in Service Note # 15/2000. Over the years we have observed that the replacement has not always been done successfully. Soon after the repair, the tube collapsed and kink again. The main reasons for these unsuccessful replacements have been:

- Cutting the original installed tube at the wrong position. This will require a replacement of the entire tube as described in this section.
- Alignment of the tube around the gear wheel of the X/Y-Carriage.
- Length of the tube not adjusted, too much play in the X-Axis.
- The adapters provided to hold the tube in the channel of X-profile were not used or positioned wrongly.

The description below considers all these important points to provide better information to service engineers.

The changes made to the mounting of the Gas Flush Tube over time is described in detail in the section ["Gas Flush Tube-X, Replacement"](#) under the point ["History"](#).

CAUTION:

It is highly recommended to match the original tubing quality as provided by CTC Analytics. Any other tube material or quality is not tested for endurance and purity. Traces of impurities of any volatile compounds can contaminate the analytical system and can lead to so-called "ghost peaks".

1.31 Gas Flush Tube X-Y: Complete Tube Repair and Maintenance Procedure

It is assumed that the X/Y-Assembly has been disassembled, as described in the section ["Disassembling X-Y-Axis"](#).

Replacing the Gas Flush Tube in the X-Axis only is described in the section ["Gas Flush Tube-X, Replacement"](#).

All other steps are separately described, see ["Overview X-Y- Repair Path"](#).

The assembly steps are described in the section ["Assembling X-Y-Axis"](#).

Note: All orientations are described from the back side of the Combi PAL.



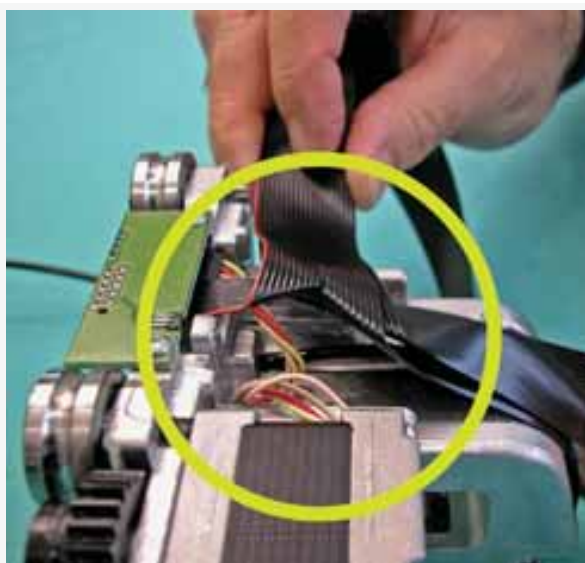
Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 2:

The step to disconnect the Gas Flush Tube from the Elbow connector is described in the section "[Gas Flush Tube-X, Replacement](#)".



Step 3:

The steps to remove the Ribbon Cables from X-Y Assembly and the X/Y-Carriage are described in section "[Ribbon Cables X-Y Axis](#)".



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 4:

In order to replace the complete Gas Flush Tube, it is necessary to remove everything from the X/Y-Carriage, including Ribbon Cable, Flexband, etc.

If one is already down to this level, it is recommended to change the X-Y-Sensor PCBs at the same time.

Our experience has shown that a PAL System with a worn-out Gas Flush Tube has already been several years in use. The X-Y-Sensor PCBs have also altered during this time. An upgrade or refurbishing to the current level does not require much more time. The reliability of the entire system can be greatly improved.

Details on the sensors are described in the section "[PCB Position Sensor X](#)" and "[PCB Position Sensor Y](#)".

The picture shows an example of an X-Sensor PCB.



Step 5:

Insert the Gas Flush Tube through the whole of the fixation adapter from the X/Y-Carriage.

Push the tube towards the cut-out, as shown in the picture.

Required Tools: none

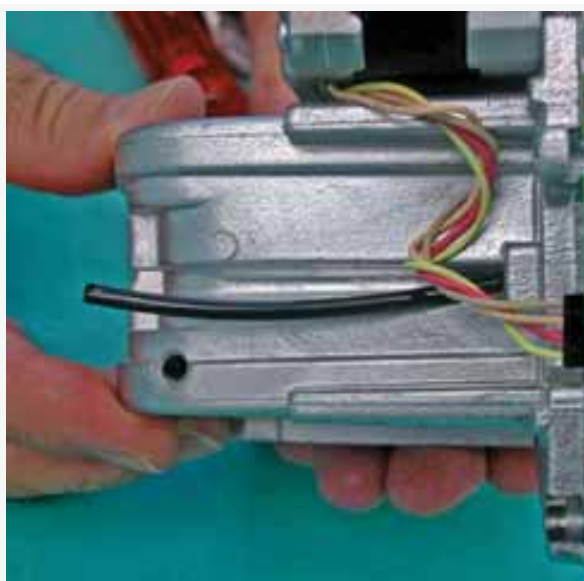
Required Material: P/N: PAL FlushTubeXY



Step 1:
The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 6:
Guide the tip of the tube carefully into the whole of the cut-out. Use an appropriate tool to support.



Step 7:
Push the tube carefully until it reaches the other side of the X/Y-Carriage.



Step 1:

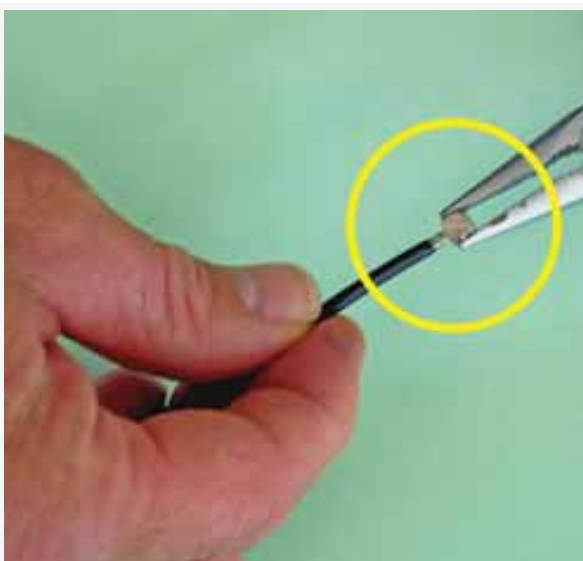
The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 8:

Guide the tip of the Gas Flush Tube through the whole of the X/Y-carriage at the position of the Y-sensor PCB.

Continue to push the tube until a length of approximately 380 mm is reached on the left side of the X/Y-Carriage frame (see picture).



Step 9:

Insert the provided Gas Tube Adapter carefully.

Ideally, the connector should be inserted in a bench vise. If not available on-site, use Flat Pliers.

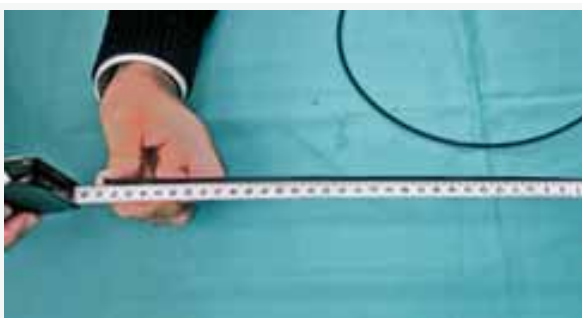
CAUTION:

The Gas Tube Adapter has a transparent Sealing Gasket installed. Do not loosen or destroy it.



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 10:

Adjust the Gas Flush Tube to the Y-Axis to a length of exactly **380 mm**.



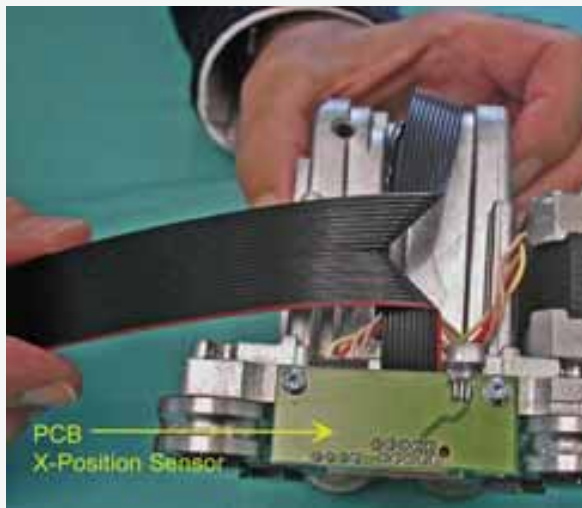
This is measured from the X/Y-Carriage frame to the center of the Gas Tube Adapter.

Note: Exactly 380 mm, NOT as shown in the picture.



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 11:

The X/Y-Carriage is at this stage prepared with respect to the Gas Flush Tube.

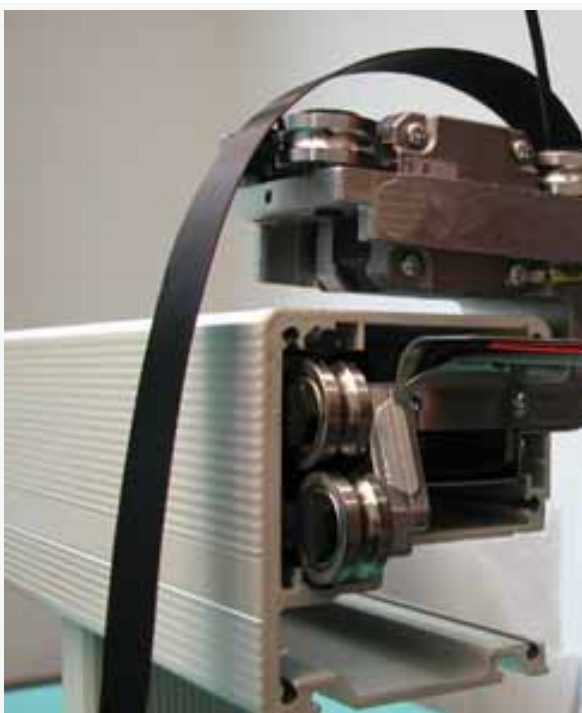
At this point, the Ribbon Cables, the FlexBand and if necessary the X-Y-Sensor PCBs must be installed.

For details see the section "[Ribbon Cables X-Y-Axis](#)", "[Flexband](#)" and the corresponding section for the "[X-Sensor](#)" and "[Y-Sensor PCB's](#)".



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 12:

It is assumed that at this point the Sensor PCBs, the grounding cable, the Ribbon Cables and the FlexBand have been installed.

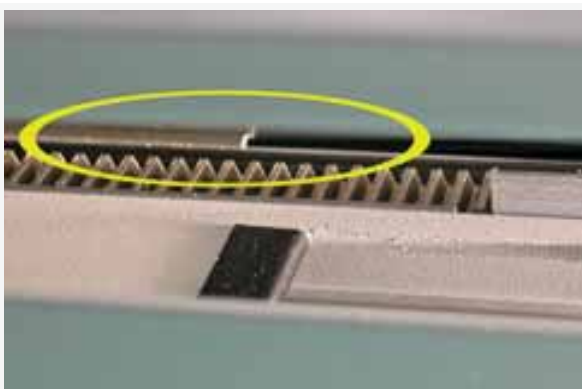
Engage the X/Y-Carriage into the X-Axis Profile.

The next steps at the X-Axis are :

- Re-install the Ribbon Cable and FlexBand
- Install the Gas Flush Tube-X

The details are described in the corresponding sections and will not be covered in this section "Gas Flush Tube X-Y".

It is recommended to leave the unit at this stage and continue with the Y-Axis as described below.



Step 13:

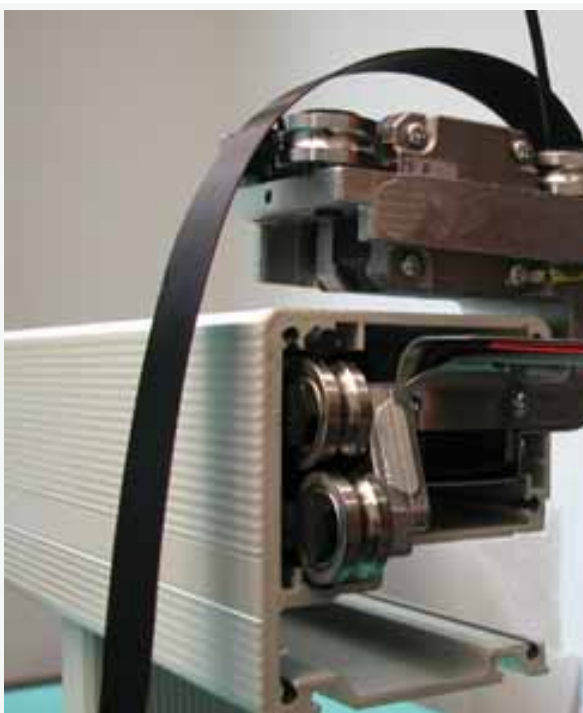
Feed the Gas Flush Tube with the longer branch, X-Axis, into the steel tube in the channel of the X-Axis profile.

Note: Early units of Combi PAL Systems had no steel tube installed. For details see the section "[Gas Flush Tube-X, Replacement](#)".



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 13:

The X/Y-Carriage has been engaged into the X-Axis.

The next steps at the X-Axis are:

- Re-install the Ribbon Cable and FlexBand
- Install the Gas Flush Tube-X

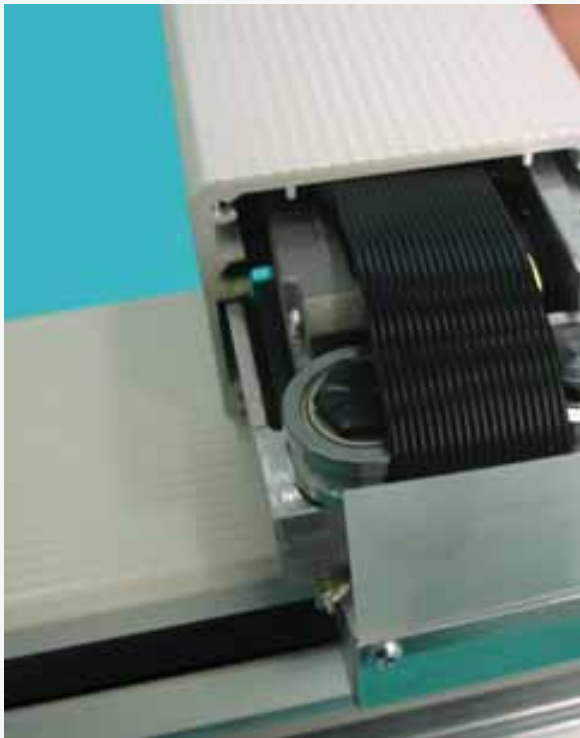
The details are described in the corresponding sections and will not be covered in this section "Gas Flush Tube X-Y".

It is recommended to leave the unit at this stage and continue with the Y-Axis as described below.



Step 1:

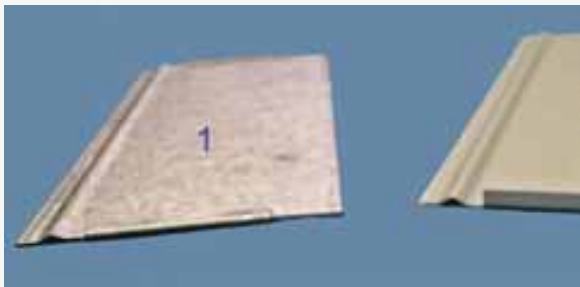
The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 14:

Engage the Y-Axis profile with the rollers from the X/Y-Carriage.

Guide the Ribbon Cable and the Gas Flush Tube carefully that no damage is done at this stage.



Step 15: The Sheet Metal Cover has been changed during the time:

1: Original Version

2: Current Version

**Step 1:**

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".

**Step 16:**

Insert the Sheet Metal Cover into the Y-Axis profile.

Note the special channels in the Y-Axis profile to keep the Ribbon Cable and the Gas Flush Tube separate and in position.

In the Sheet Metal Cover is a groove formed for the Gas Flush Tube. This groove also helps with orientation.

CAUTION:

Carefully insert the Sheet Metal Cover. Ensure that the Ribbon cable and the Gas Flush Tube do not get damaged at this point.

If the Ribbon Cable and the Gas Flush Tube are pulled to the front, it is possible that the Sheet Metal Cover touches them. Using force, one could damage the cable and the tube when pushing the cover into the profile.

Required Tools: none

Required Material:

Y-Axis length 312 mm (standard) P/N: MY 30-12

Y-Axis length 402 mm (IFC and Dual PAL systems) P/N: MY 30-14

Note: Normally the original cover can be used again. In case an older version is installed, consider replacing the cover in the process of refurbishing a PAL System. See Step 15 for comparison of the two versions.



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 17:

The Sheet Metal Cover is pushed into the Y-Axis profile all the way until the stop point is reached.

Note: Earlier units had no designated stop point in the Y-Axis Profile.

Ensure that the connector from The Ribbon Cable fits into position without restriction, as shown in the picture.

If this is not the case, form the sheet metal to allow a free movement of the cable including the adapter.



Step 18:

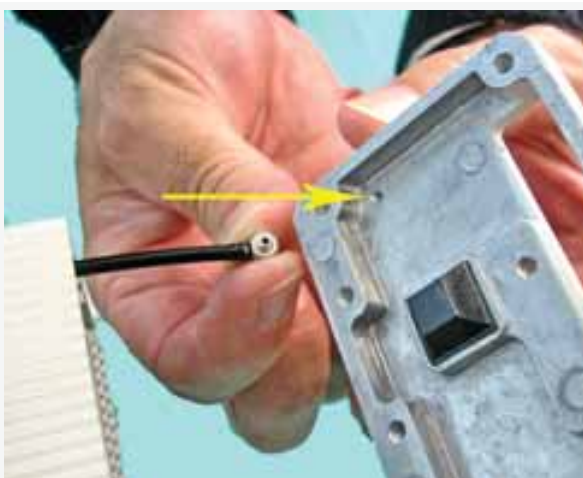
Check the arrangement of the Ribbon Cable and the Gas Flush Tube in the Y-Axis from underneath in the cut-out of the profile.

Both parts have to be able to move freely without hindrance or restriction.



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 19:

Connect the Gas Flush Tube to the Front Cover Y-Axis.

The tube should be positioned along the side wall of the cover, NOT pointing to the center of the cover.

CAUTION:

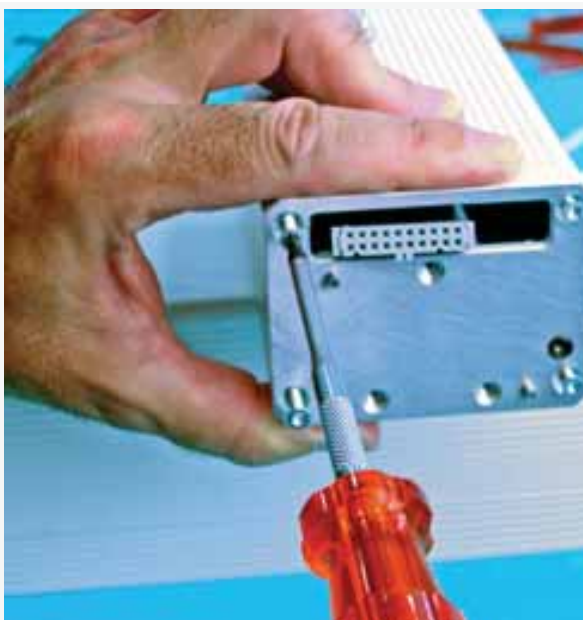
The Gas Tube Adapter has a transparent Sealing Gasket installed.

Do not over tighten the connection, it would destroy the gasket.

Required Tools: Slotted Screwdriver

Required Material: Front Cover Y-Axis:P/N: MY 30-10

Gas Tube Adapter:P/N : M-3ALU-3.



Step 20:

Tighten the Y-Axis Front Cover.

Pay attention at this point that the Ribbon Cable and the Gas Flush Tube are not kinked or jammed.

Required Tools: Torx 10

Required Material:

Front Cover Y-Axis: P/N MY 30-10

Screws: P/N BN 4851 M3x20

**Step 1:**

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".

**Step 21:**

Check again if the Ribbon Cable is not jammed and that the connector fits nicely into position.

This concludes the procedure for the section on "Gas Flush Tube-X-Y, complete Tube".

As described in Step 13 of this section, the final steps to complete the X-Axis are covered in the sections "[Ribbon Cables](#)", "[FlexBand](#)" and "[Gas Flush Tube-X, Replacement](#)".

The Assembly of the unit follows the logical order backwards. In the section "Assembling of the X-Y-Axis " several important points are described.

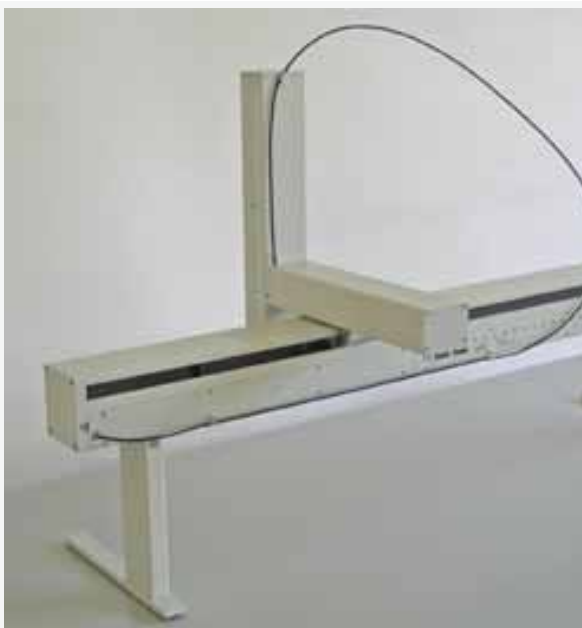
All further steps are described separately, see "Overview X-Y-Axis Repair".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.32 Installing or Replacing the Gas Flush Tube for PAL LHX

The Gas Flush Tube for the model PAL LHX is guided outside along the X-Axis. Earlier versions of the model LHX have been supplied without the Gas Flush Tube option (actually the model HTX PAL was converted for GC application). Today the "Kit Flush LHX" is part of the basic LHX PAL configuration.

For a field upgrade, the kit can be ordered. Another kit contains the replacement tubing for the LHX PAL. For details see the section "[XY Spare Parts](#)".



GAS Flush Tube PAL LHX: Step 1

The Gas Flush Tube is guided along the X-Axis, at the backside of the PAL unit, as shown in the picture.

Required Material:

This kit is part of the standard configuration for a LHX PAL.

For details see the section "XY Spare Parts".

The Gas Flush Tube is available individually as a replacement kit: PNo PAL Tube-FlushLHX;Replacement Kit for Gas Flush Tube LHX PAL. (Length 200 cm.)



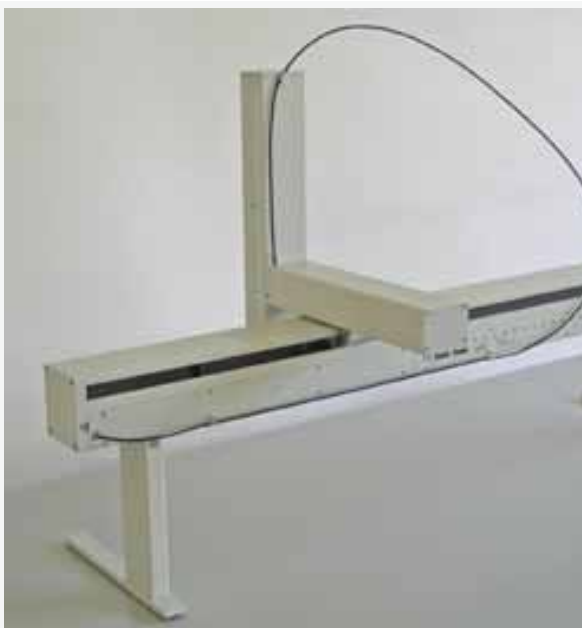
GAS Flush Tube PAL LHX: Step 2

A blind cover with a cut-out for the tube connection is installed.

Blind Cover P/N: MX 30-42.

The Elbow Adapter for the Gas Flush Tube is the standard adapter, P/N: KJL23-M3. The adapter is turned facing the back side of the system to fit into the hole of the Blind Cover MX 30-42.

The Gas Flush Tube (P/N PAL TubeFlush LHX) is connected with the quick-fit.



GAS Flush Tube PAL LHX: Step 1

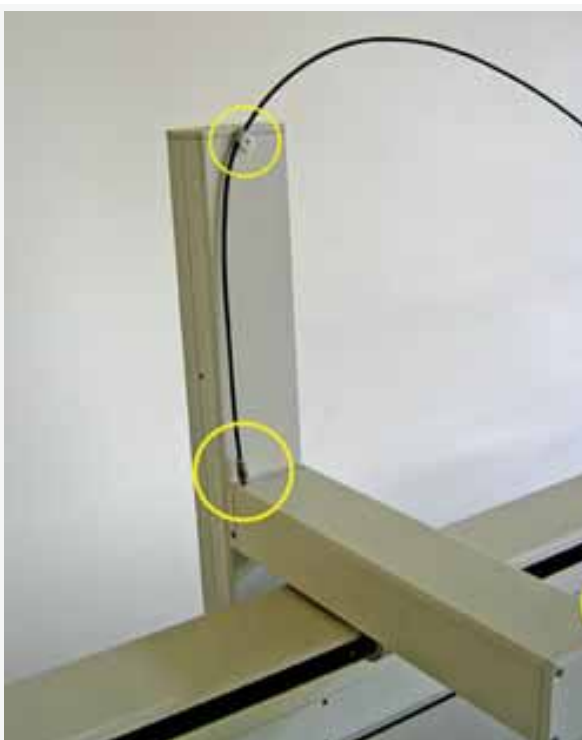
The Gas Flush Tube is guided along the X-Axis, at the backside of the PAL unit, as shown in the picture.

Required Material:

This kit is part of the standard configuration for a LHX PAL.

For details see the section "XY Spare Parts".

The Gas Flush Tube is available individually as a replacement kit: PNo PAL Tube-FlushLHX;Replacement Kit for Gas Flush Tube LHX PAL. (Length 200 cm.)



GAS Flush Tube PAL LHX: Step 3:

The Gas Flush Tube is fixed with the cable clips provided (Nylon).

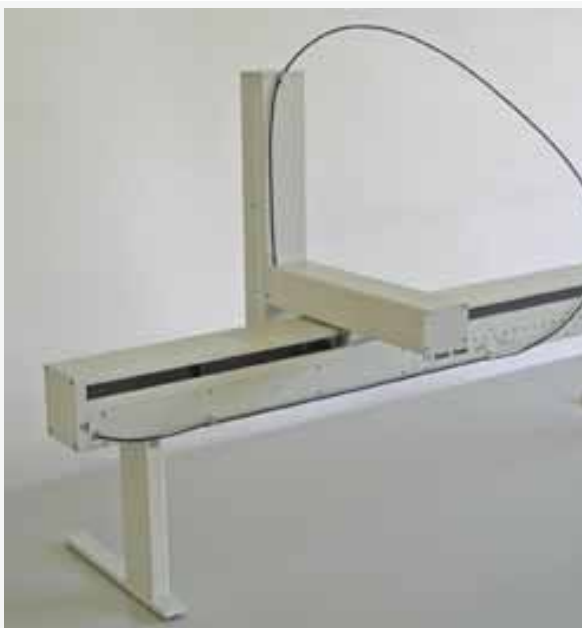
The Gas Flush tube is connected at the cut-out of the dedicated Y-Axis Front Cover.

Cable Clips, Screws and Washers:

P/N Cable Clips: 900 101

P/N Screws: BN 6404 M3x8

P/N Washers: BN 715 M3



GAS Flush Tube PAL LHX: Step 1

The Gas Flush Tube is guided along the X-Axis, at the backside of the PAL unit, as shown in the picture.

Required Material:

This kit is part of the standard configuration for a LHX PAL.

For details see the section "XY Spare Parts".

The Gas Flush Tube is available individually as a replacement kit: PNo PAL Tube-FlushLHX;Replacement Kit for Gas Flush Tube LHX PAL. (Length 200 cm.)



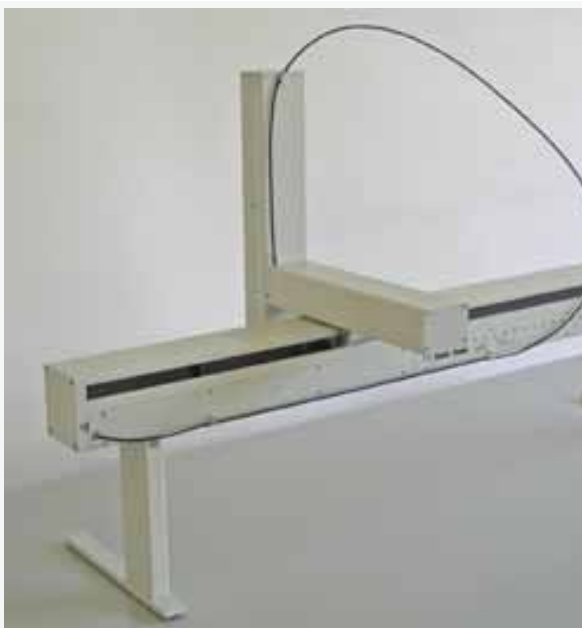
GAS Flush Tube PAL LHX: Step 4:

Tube connection at the cut-out of the Y-Axis Front Cover.

Required Parts:

MY 31-01; PAL Y-Axis Front Cover for LHX PAL including Gas Flush Tubing connections.

Note: The part MY-31-01 is part of the standard LHX PAL configuration. Use this P/N only in cases of replacement or repair.



GAS Flush Tube PAL LHX: Step 1

The Gas Flush Tube is guided along the X-Axis, at the backside of the PAL unit, as shown in the picture.

Required Material:

This kit is part of the standard configuration for a LHX PAL.

For details see the section "XY Spare Parts".

The Gas Flush Tube is available individually as a replacement kit: PNo PAL Tube-FlushLHX;Replacement Kit for Gas Flush Tube LHX PAL. (Length 200 cm.)



GAS Flush Tube PAL LHX: Step 5:

Y-Axis Front Cover with cut-out for Gas Flush Tube Connection.

The Y-Axis Front Cover for LHX PAL has a cut-out for the gas connection.

The cover and the Gas Tube with both connectors installed are not individually available.

P/N: MY 31-01; PAL Y-Axis Front Cover for LHX PAL including Gas Flush Tubing connections.

See also the section "[XY Spare Parts](#)".

1.32.0.0.0.1 FlexBand to Support Ribbon Cables

This section describes the replacement of the FlexBand support bands.

Indications for Maintenance or Replacement of the FlexBand are:

- FlexBand broken
- Replacement of the older type of FlexBand during a PM procedure
- Refurbishing a PAL System. An example is during the replacement of Ribbon Cables or Sensor PCBs.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

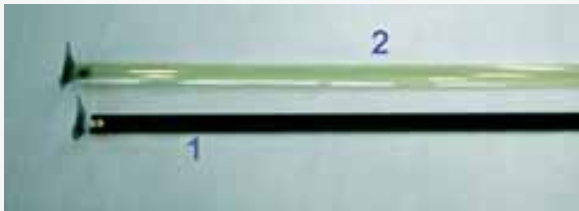
1.33 Introduction



Introduction Point 1:

The function of the FlexBand is to support the Ribbon Cables in the X-Axis during their movements.

Without the FlexBand, the Ribbon Cables would collapse. They could be caught by the X/Y-Carriage rollers which would jam the mechanics.



Introduction Point 2:

Picture #1. Early versions of the PAL System had a black colored Flex-Band installed.

This black FlexBand was a metal band. In cases of wear, sharp metallic edges could cut into the Ribbon Cables.

Picture #2. The black metallic FlexBand has been replaced by a Polymer type.

This new type of FlexBand has been in use for several years. We have not observed any breakage or wear. If it would break, there is no danger that the line of breakage could cause secondary damage.

The Polymer type of FlexBand has been provided in PM Kits since. It is likely that most of the older black, metallic FlexBands have been replaced over the years.



Introduction Point 3:

This picture shows a comparison of the two types of FlexBands for installing in the X/Y-Carriage.

1.34 FlexBand Replacement Procedure

It is assumed that the X/Y-Assembly has been disassembled as described in the section "[Disassembling X-Y-Axis](#)".

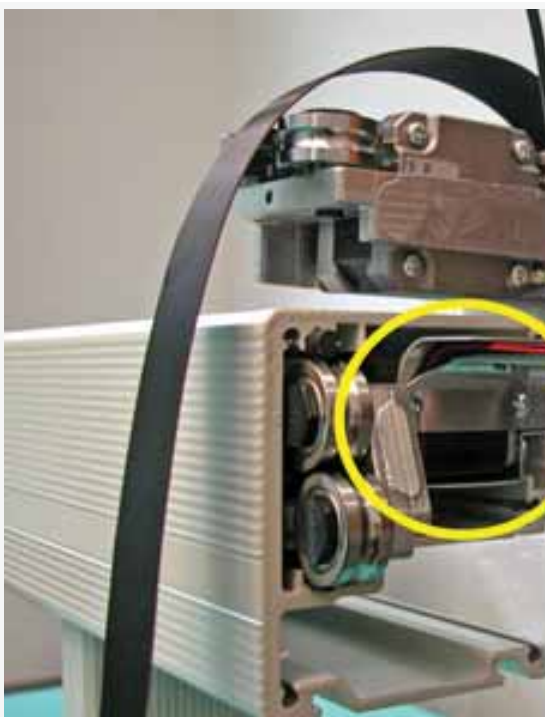
All other steps are described separately, see "[Overview X-Y- Repair Path](#)".

The assembly steps are described in the section "[Assembling X-Y-Axis](#)".



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 2:

When replacing the FlexBand on a Combi PAL System where a Gas Flush Tube is installed, it is advisable to move the X/Y-Carriage to the end of the X-Axis, but do not disengage the carriage from the X-Axis. The Gas Flush Tube is still connected, therefore removing the X/Y-Carriage from the X-Axis would apply unnecessary stress to the Gas Flush Tube connections.

In cases where a Combi PAL requires other repair steps or refurbishing, for example replacing the Ribbon Cables or Sensor PCBs, then it would be logical to disconnect the Gas Flush Tube from the Elbow Connector (side cover) and disengage the X/Y-Carriage completely from the X-Axis profile.

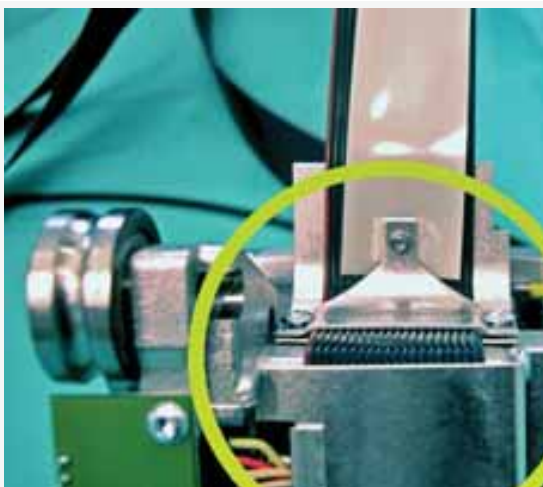
All other PAL Systems have no Gas Flush Tube installed. Remove the X/Y-Carriage to be able to work more comfortably on the carriage.

Note: It is not required to remove the Y-Axis Profile from the X/Y-Carriage as shown in the picture.



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 3:

Open the 2 screws and remove the original FlexBand.

Earlier versions of the PAL Systems had the screws fixed with LockTide. In such cases, pay attention when opening the screws. Do not destroy the screw head.

Required Tools: Torx 10

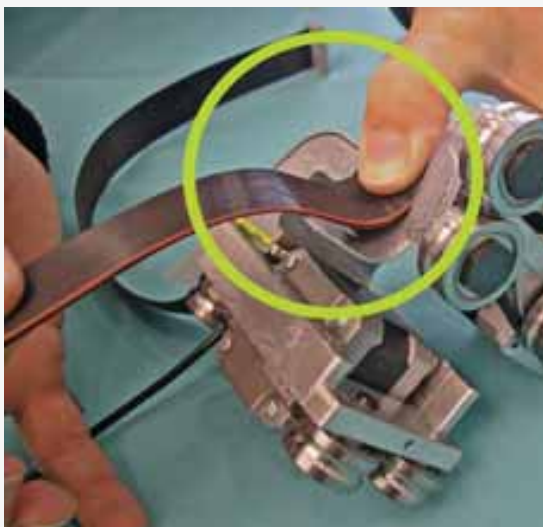
Required Material:

P/N: PAL FlexBand Kit 1 or FlexBand Kit 2

Kit 1: Pal 80 and 50 cm X-Axis Kit 2: PAL 120 cm and Dual Head PAL.

Screws: P/N: BN 6404 M3x6 (part of the kit)

For details, see the section "[Spare Part X-Y-Axis](#)".



Step 4:

Re-install the new FlexBand, keeping the Ribbon Cable tight in position as shown in the picture.

Re-use the Metal Angle Bracket which is positioned underneath the Ribbon Cables.



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 5:

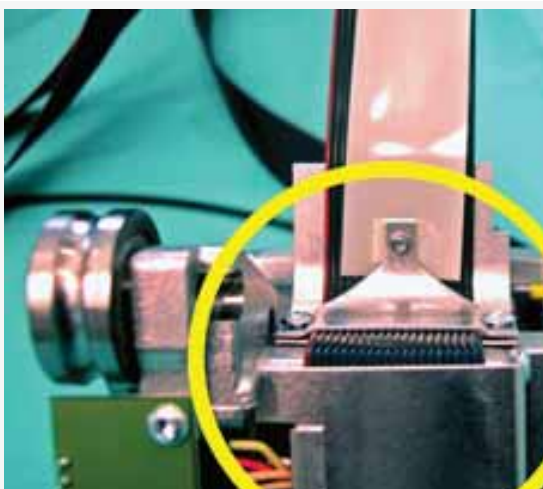
Position the new FlexBand and tighten the screws. LokTide fixation is not required.

Required Tools: Torx 10

Required Material:

P/N: PAL FlexBand Kit 1 or PAL Flexband Kit 2.

Screws: P/N: BN 6404 M3x6 (part of the kit)



Step 6:

Check the assembly with the set-up shown in the picture.

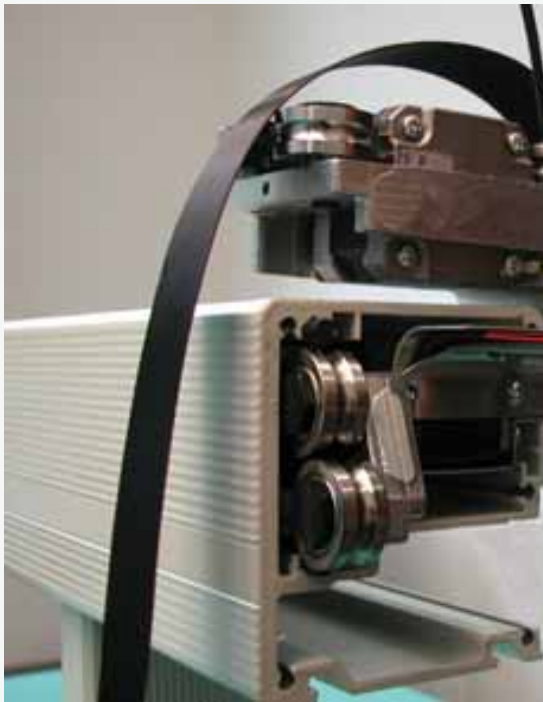
The Angle Bracket underneath the Ribbon Cables, the cables and the bracket from the FlexBand should be aligned as a unit.

CAUTION:

The Ribbon Cable has to be positioned within the cut-out of the bracket from the FlexBand.

**Step 1:**

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".

**Step 7:**

Engage the X/Y-carriage into the profile of the X-axis.

All other steps, such as positioning the Ribbon Cables, the Gas Flush Tube, etc. are described in their specific sections.

This concludes the procedure for the section on "FlexBand".

As described in Step 6 of this section, the final steps to complete the X-Axis are covered in the sections "[Ribbon Cables](#)" and "[Gas Flush Tube-X, Replacement](#)".

The Assembling of the unit follows the logical order backwards. In the section "Assembling of the X-Y-Axis " several important points are described.

All further steps are described separately, see "Overview X-Y-Axis Repair".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.34.0.0.0.1 Ribbon Cables X-Y

This section describes the replacement of the Ribbon Cables in the X-Y System.

Indications for Maintenance or Replacement of the Ribbon Cables are:

- Ribbon Cable at the connector Y-Axis to the Z-Unit kinked and damaged
- Erratic behavior of the PAL System, such as "Position Error", "Vial not found", "Z-Communication Error", etc.
- Refurbishing of a PAL System. An example is during replacement of Sensor PCBs or the Gas Flush Tube.

- Typical errors which could be related to Ribbon Cables should be checked first before Ribbon Cables are exchanged:

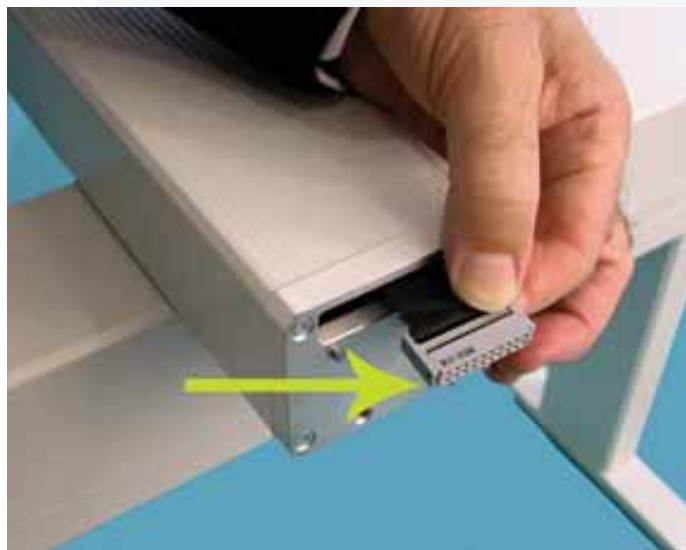
- Firmware (corrupt firmware in Flash Memory, re-load a complete new back-up file).
- Combi PAL Gas Flush Tube kinked and caught by the X/Y-Carriage Rollers.
- Z- Position error caused by a loose adapter to fix the syringe needle length. Check Troubleshooting for Injection Unit, Z-Axis.
- Z-Communication Error, faulty Z-Ribbon Cable or Z-PCB. Check Troubleshooting for Injection Unit, Z-Axis.
- Defective MOTIO or Control Board.
- X- or Y-Sensor PCB.
- Toothed Rack loose or misaligned.
- Stepper motors X- or Y-Axis are moving in the opposite direction.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.35 Introduction



Introduction Point 1:

The most common error during an installation is that the Ribbon Cable Y-Axis is pulled too far out at the moment the Injection Unit is connected.

If the cable is not pulled back and reorganized in the Y- Axis, the Ribbon Cable could become kinked. If one of the wires does break, this could cause irreproducible, erratic behavior of the PAL System after a certain time.

For more details, see the section "[Troubleshooting X-Y-Axis](#)".



Introduction Point 2:

The second common error seen in the field is the destruction of the Ribbon Cables at the moment the Electronic Board, MOTIO or Control Board, is re-installed.

The cable can catch on the connector or on an electronic component of the PCB. If the cable is not reorganized at this moment, this could cause a potential destruction of these components over time.



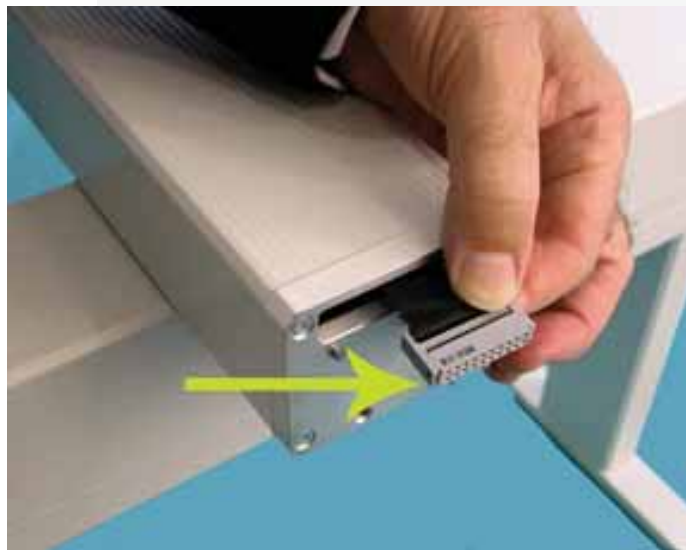
Introduction Point 3:

If one of the cables has to be changed, is it advisable to change both cables at the same time.

- Ribbon Cable X/Y

- Ribbon Cable X/Z

Be aware that the two cables have different lengths. Install the cables as described below. If the wrong cable is on top of the other one, it will not be possible make the connection to the MOTIO or Control Board. The unit has to be disassembled again and the procedure restarted from the scratch.

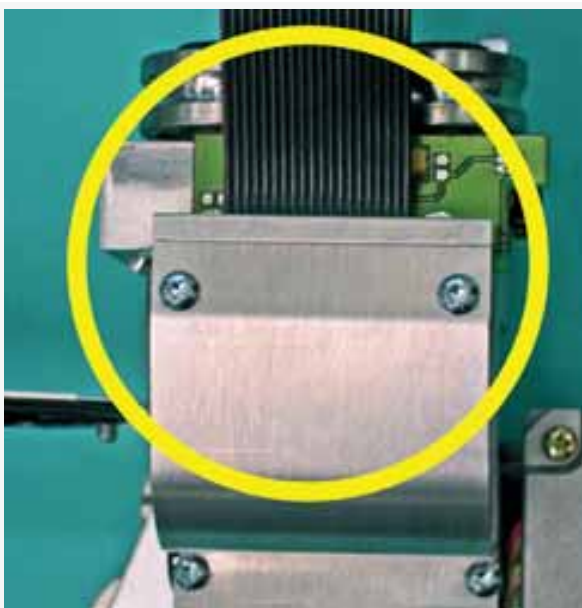


Introduction Point 1:

The most common error during an installation is that the Ribbon Cable Y-Axis is pulled too far out at the moment the Injection Unit is connected.

If the cable is not pulled back and reorganized in the Y- Axis, the Ribbon Cable could become kinked. If one of the wires does break, this could cause irreproducible, erratic behavior of the PAL System after a certain time.

For more details, see the section "[Troubleshooting X-Y-Axis](#)".



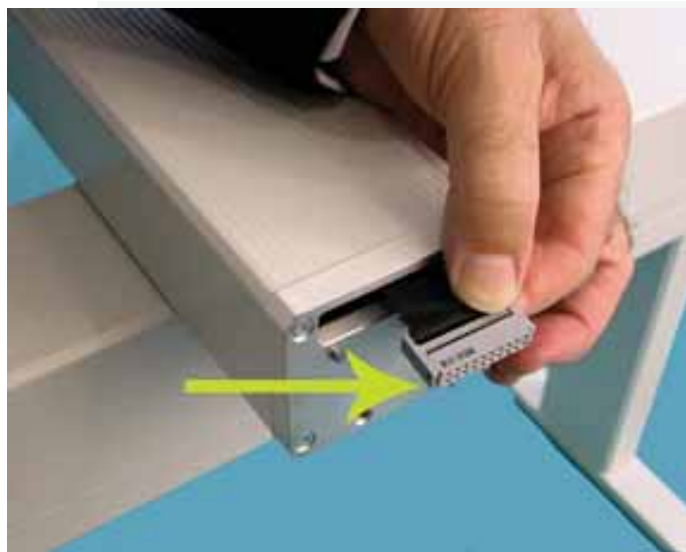
Introduction Point 4:

A common source of damage to the Ribbon Cable has been noticed at the back of the X/Y-Carriage.

The lower edge of the metallic cover for the Ribbon Cable could be pressed against the cables when the Y-Axis moves the full distance.

Moving the full distance range is often necessary in combination with a Cooled Stack. Therefore this kind of damage has been more frequently observed in combination with HPLC techniques. HTS and HTC PALs have been more commonly affected by this error.

The picture shows the old design of the cover for the Ribbon Cable.

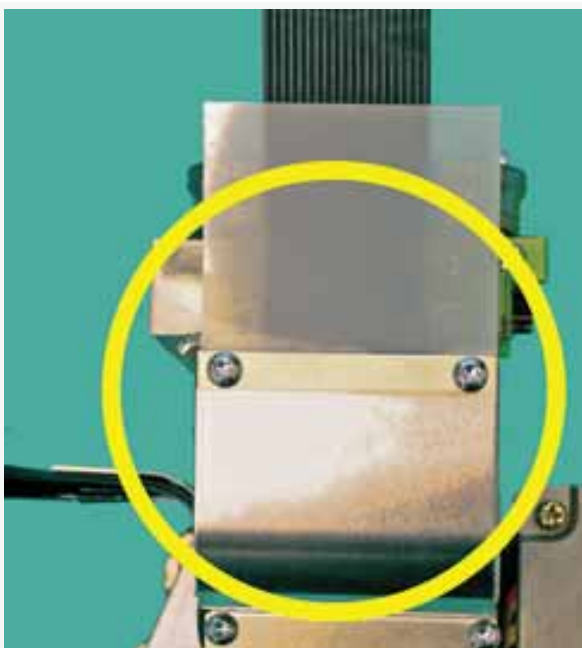


Introduction Point 1:

The most common error during an installation is that the Ribbon Cable Y-Axis is pulled too far out at the moment the Injection Unit is connected.

If the cable is not pulled back and reorganized in the Y- Axis, the Ribbon Cable could become kinked. If one of the wires does break, this could cause irreproducible, erratic behavior of the PAL System after a certain time.

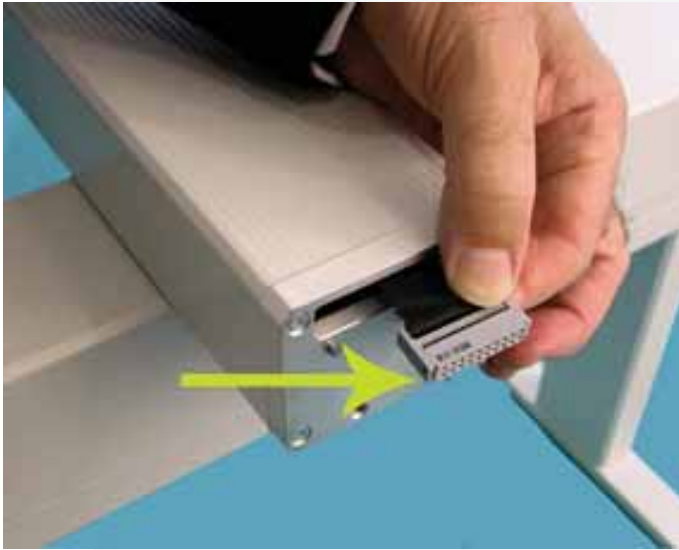
For more details, see the section "[Troubleshooting X-Y-Axis](#)".



Introduction Point 5:

CTC Analytics has responded to this and changed the cover design. A Polymer Guiding Shield was installed to force the Ribbon Cable back into the Y-Axis Profile.

The picture shows the new design of the cover for the Ribbon Cable with the Polymer Guiding Shield installed.



Introduction Point 1:

The most common error during an installation is that the Ribbon Cable Y-Axis is pulled too far out at the moment the Injection Unit is connected.

If the cable is not pulled back and reorganized in the Y- Axis, the Ribbon Cable could become kinked. If one of the wires does break, this could cause irreproducible, erratic behavior of the PAL System after a certain time.

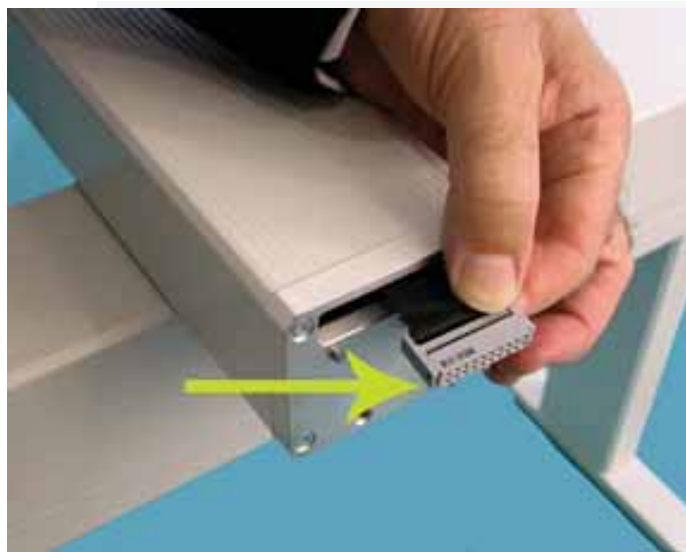
For more details, see the section "[Troubleshooting X-Y-Axis](#)".



Introduction Point 6:

Comparison of the 3 covers for the Ribbon Cable:

- # 1: First design, installed in very early PAL Systems
- # 2: Second design, installed in PAL Systems up to production date 2001
- # 3: Current design including the Polymer Guiding Shield.

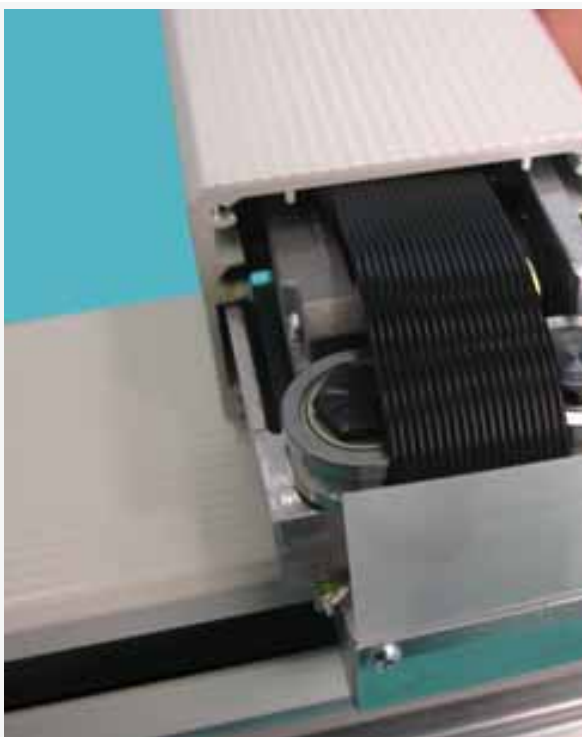


Introduction Point 1:

The most common error during an installation is that the Ribbon Cable Y-Axis is pulled too far out at the moment the Injection Unit is connected.

If the cable is not pulled back and reorganized in the Y- Axis, the Ribbon Cable could become kinked. If one of the wires does break, this could cause irreproducible, erratic behavior of the PAL System after a certain time.

For more details, see the section "[Troubleshooting X-Y-Axis](#)".



Introduction Point 7:

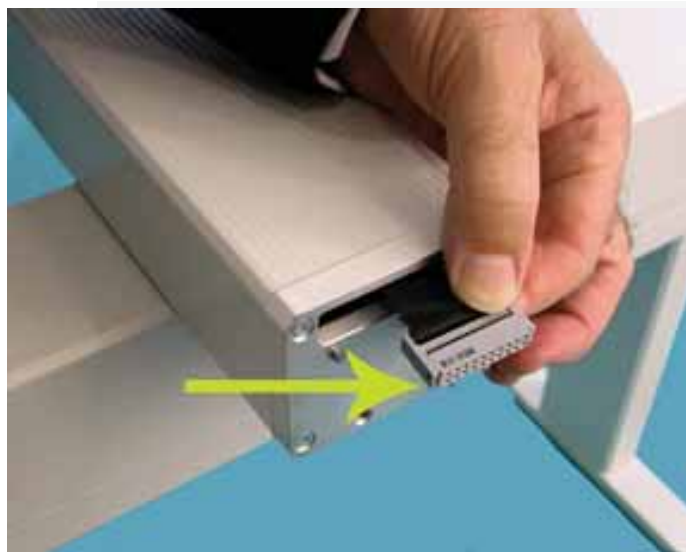
This picture shows the installed cover with the Polymer Guiding Shield installed.

The situation illustrates how the Ribbon Cable is kept in position in the Y-Axis.

It does not make sense to change the Ribbon Cables and re-install the old type of cover, as within a few years this unit could show similar problems.

Consequently, the Ribbon Cable kits include the newest type of cover including the Polymer Guiding Shield.

Single Ribbon Cables are no longer provided.

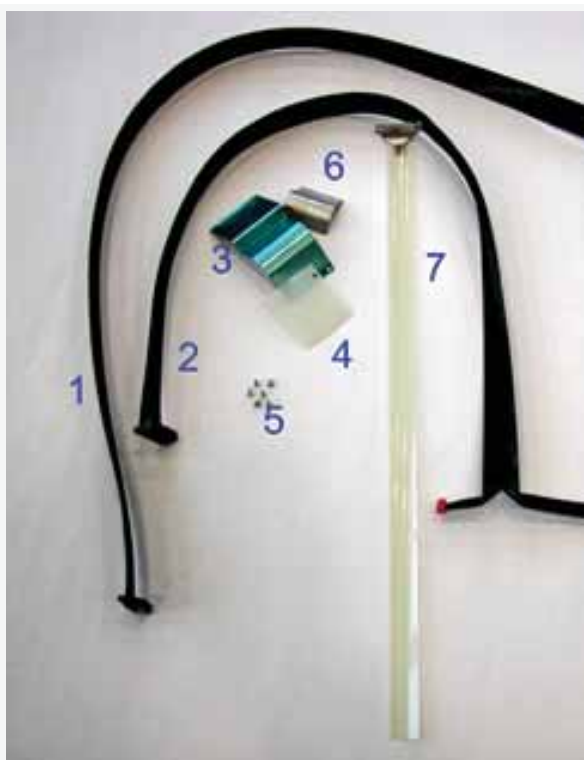


Introduction Point 1:

The most common error during an installation is that the Ribbon Cable Y-Axis is pulled too far out at the moment the Injection Unit is connected.

If the cable is not pulled back and reorganized in the Y- Axis, the Ribbon Cable could become kinked. If one of the wires does break, this could cause irreproducible, erratic behavior of the PAL System after a certain time.

For more details, see the section "[Troubleshooting X-Y-Axis](#)".



Introduction Point 8:

Ribbon Cable Kits:

Ribbon Cable Kit for 50 cm, 80 cm or 120 cm length of X-Axis:
P/N: PAL RCbl50, PAL RCbl80 or PAL RC120

Each Kit contains 2 Ribbon Cables and:

#1: Cable X/Z:- X-Axis 50 cm: length 1115mm- X-Axis 80 cm: length 1305 mm- X-Axis 120 cm: length 1690 mm

2: Cable X/Y:- X-Axis 50 cm: length 760 mm
- X-Axis 80 cm: length 870 mm
- X-Axis 120 cm: length 1105 mm

3: Cover for Ribbon Cable Y-Axis

4: Polymer Guiding Shield for Cover Y-Axis

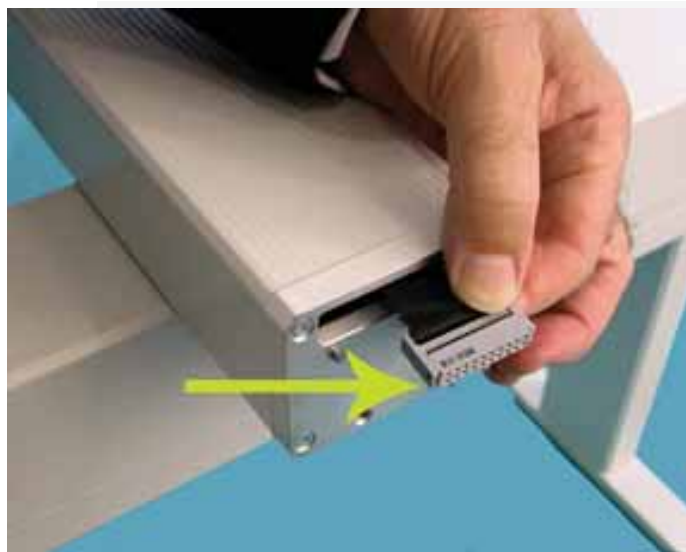
5: Screw BN 6404 M3x6

6: Metal Angle Bracket for Ribbon Cable. This Adapter is not part of the Ribbon Cable Kit. The form has not been changed. It can be reused from the original system.

7: FlexBand The FlexBand is also not part of the Ribbon Cable Kit. For details see the section "[Flexband](#)".

Note: Parts # 6 and # 7 are shown in the picture only to illustrate in detail all the parts around the Ribbon Cable installation.

The Ribbon Cable Kit for the Fraction Collector, PAL IFC, or other modules with 120 cm X-Axis length and 2 Injection units are shown below (Introduction Point 9).

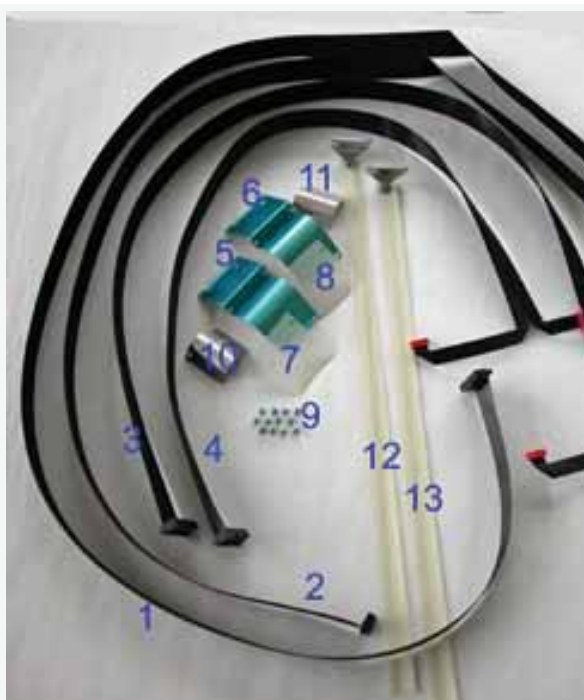


Introduction Point 1:

The most common error during an installation is that the Ribbon Cable Y-Axis is pulled too far out at the moment the Injection Unit is connected.

If the cable is not pulled back and reorganized in the Y- Axis, the Ribbon Cable could become kinked. If one of the wires does break, this could cause irreproducible, erratic behavior of the PAL System after a certain time.

For more details, see the section "[Troubleshooting X-Y-Axis](#)".



Introduction Point 9:

Ribbon Cable Kit for the Fraction Collector, PAL IFC or any other PAL model with X-Axis length of 120 cm and 2 Injection units installed. Because 2 Injection units are independently operated, all parts are duplicated. Compare the pictures from Introduction Points 8 and 9.

P/N: PAL RCbDual

- #1: Cable X/Z, Injection Unit right side, length 1785 mm
- #2: Cable X/Z, Injection Unit left side, length 1510 mm
- #3: Cable X/Y, Injection Unit left side, length 1220 mm
- #4: Cable X/Y, Injection Unit right side, length 1105 mm
- #5 and #6: Covers for Ribbon Cable Y-Axis
- #7 and #8: Polymer Guiding Shields for Cover Y-Axis
- #9: screws BN 6404 M3x6
- #10 and #11: Metal Angle Bracket for Ribbon Cable. Not part of the kit.
- #12 and #13: FlexBands. Not part of the kit.

Note: Parts #6 to #13 are shown in the picture only to illustrate in detail all the parts around the Ribbon Cable installation.

CAUTION:

Use only original Ribbon Cables provided by CTC Analytics. The cable type has been carefully selected and tested for endurance.

1.36 Ribbon Cable X-Y Replacement Procedure

It is assumed that the X/Y-Assembly has been disassembled as described in the section "[Disassembling X-Y-Axis](#)".

All other steps are described separately, see " [Overview X-Y- Repair Path](#)".

The assembly steps are described in the section "[Assembling X-Y-Axis](#)".



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 2:

To be able to remove the original Ribbon Cables, remove the clip in the middle of the X-Axis Profile.

From the upper channel in the profile, press the clip down on the right hand side and remove it in the direction shown in the picture.



Step 3:

The step to disconnect the Gas Flush Tube from the Elbow connector is described in the section "Gas Flush Tube-X, Replacement".



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 2:

To be able to remove the original Ribbon Cables, remove the clip in the middle of the X-Axis Profile.

From the upper channel in the profile, press the clip down on the right hand side and remove it in the direction shown in the picture.

Step 4:

Disengage the X/Y-Carriage from the X-Axis and disengage the Y-Axis Profile.

Replacing the Ribbon Cables requires going down to the bones of the X/Y-Carriage. Usually, the PAL System has already been in operation for a few years. Thus, it is advisable to change the Gas Flush Tube at the same time.

Details for the Gas Flush Tube are described in the section "Gas Flush Tube X-Y, complete Tube".



Step 5:

This concludes the procedure for the section on "Ribbon Cables".

As described in Step 19 of this section, the final steps to complete the Y-Axis are covered in the sections "[Gas Flush Tube X-Y, \(complete Tube\)](#)".

The Assembly of the unit follows the logical order backwards. In the section "Assembling of the X-Y-Axis " several important points are described.

All further steps are described separately, see "Overview X-Y-Axis Repair".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.36.0.0.0.1 Stepper Motor X- Axis

This section describes the maintenance and replacement of the Stepper Motor X-Axis.

Indications for Maintenance or Replacement of the Stepper Motor X-Axis are:

- Pinion fallen off or there is a loose connection to the Stepper Motor axis. (Corrections have been implemented by pinning the Pinion to the motor axis, from Revision D and onwards of the Injection Unit).
- Partially or completely shorted wires of the motor. (This error is extremely rare, search for other sources of failure as well.)
- Motor is moving in the opposite direction
- **X-Motor movement error can be caused also by:**
 - Firmware (corrupt firmware in Flash Memory, re-load a complete new back-up file)
 - Combi PAL Gas Flush Tube kinked and caught by the X/Y-Carriage Rollers
 - Defective MOTIO or Control Board
 - Defective X/Y or X/Z Ribbon Cable
 - X-Sensor PCB
 - Toothed Rack loose or misaligned

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.37 Introduction:

Generally speaking is it a very rare case that a stepper Motor fails. In most of cases other sources of the error have been identified (see above). If all these points can be excluded and the error still persists, it is advisable to send the PAL X/Y-Assembly back to the factory for inspection.

CAUTION:

Under no circumstances is it allowed to exchange the X/Y-Carriage (including the Y-Axis) with that of another X-Axis. The distance of the rollers are matched to the distance of the rails and to the toothed rack. See also the section "[XY-Limitations](#)".



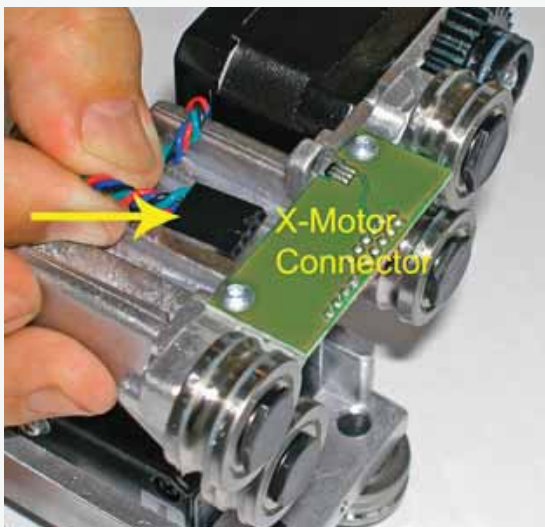
Introduction Point 1:

The picture shows the stripped down X/Y-Carriage with only the 2 stepper motors installed.

As mentioned above has it been observed that the Pinion has become loose. To check this point, insert a slotted screw driver in between the metal block and the Pinion. Press gently against the Pinion. If the fixation is loose, the Pinion will fall off right away.

This error can cause position error.

Note: At the time this effect was observed, a corrective action was taken. The Pinion was not only glued but also mechanically fixed (pinned) to the motor axis. The change occurred with Revision D for the Injection Unit.



Introduction Point 2:

Observe the orientation of the cable connector from the X-Axis Stepper Motor.

The cut-outs for connector pins have to point downwards or towards the metallic part of the X/Y-Carriage.

If the connection is made in reverse, the motor will run in the opposite direction and will go all the way to the mechanical stop of the X-Axis.

The cable harness should be tightly drilled to avoid any possibility of catching.

Note: The colors of the wires have been changed over the years. This is not a good indicator of orientation.

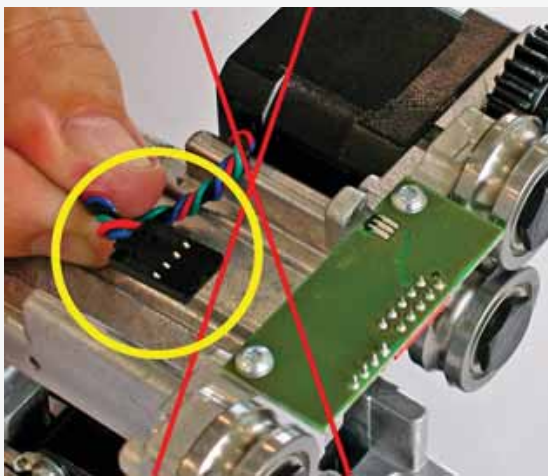
**Introduction Point 1:**

The picture shows the stripped down X/Y-Carriage with only the 2 stepper motors installed.

As mentioned above has it been observed that the Pinion has become loose. To check this point, insert a slotted screw driver in between the metal block and the Pinion. Press gently against the Pinion. If the fixation is loose, the Pinion will fall off right away.

This error can cause position error.

Note: At the time this effect was observed, a corrective action was taken. The Pinion was not only glued but also mechanically fixed (pinned) to the motor axis. The change occurred with Revision D for the Injection Unit.



1.38 Stepper Motor X-Axis Maintenance and Repair

If all the points above under "Indications" are checked and the error persists, contact CTC Analytics for further assistance. See as well the points described in the "Introduction" of this section.

For maintenance, see the section "Preventative Maintenance, PM".

See as well the section "[X-Y Limitations](#)".

1.38.0.0.0.1 Stepper Motor Y-Axis

This section describes the maintenance and replacement of the Stepper Motor Y-Axis.

Indications for Maintenance or Replacement of the Stepper Motor Y-Axis are:

- Pinion fallen off or there is a loose connection to the Stepper Motor axis. (Corrections have been implemented by pinning the Pinion to the motor axis, from Revision D of the Injection Unit).
- Partially or completely shorted wires of the motor. (This error is extremely rare, search for other sources of failure as well.)
- Motor is moving in the opposite direction.
- **Y-Motor movement error can be caused also by:**
 - Firmware (corrupt firmware in Flash Memory, re-load a complete new back-up file)
 - Combi PAL Gas Flush Tube kinked and caught by the X/Y-Carriage Rollers
 - Defective MOTIO or Control Board
 - Y-Axis Ribbon Cable pulled too far out at the moment of Z-Axis installation. Error Message "Y-Sensor not detected". (Re-organize the Y-Ribbon Cable in the Y-Axis Profile and if applicable, also check the Gas Flush Tube in the Y-Axis. To gain free access to it, remove the Y-Axis Front Cover.)
 - Defective X/Y or X/Z Ribbon Cable
 - Y-Sensor PCB
 - Toothed Rack loose or misaligned

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

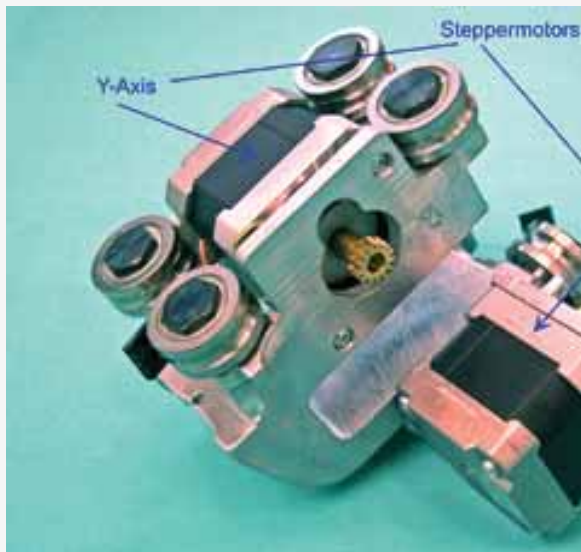
Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.39 Introduction:

Generally speaking, it is rare that a stepper Motor fails. In most cases, other sources of the error were identified (see above). If all these points can be excluded and the error persists, it is advisable to send the PAL X/Y-Assembly back to the factory for inspection.

CAUTION:

Under no circumstances is it allowed to exchange the X/Y-Carriage (including the Y-Axis) with that of another X-Axis. The distance of the rollers are matched to the distance of the rails and to the toothed rack. See also the section "[XY-Limitations](#)".



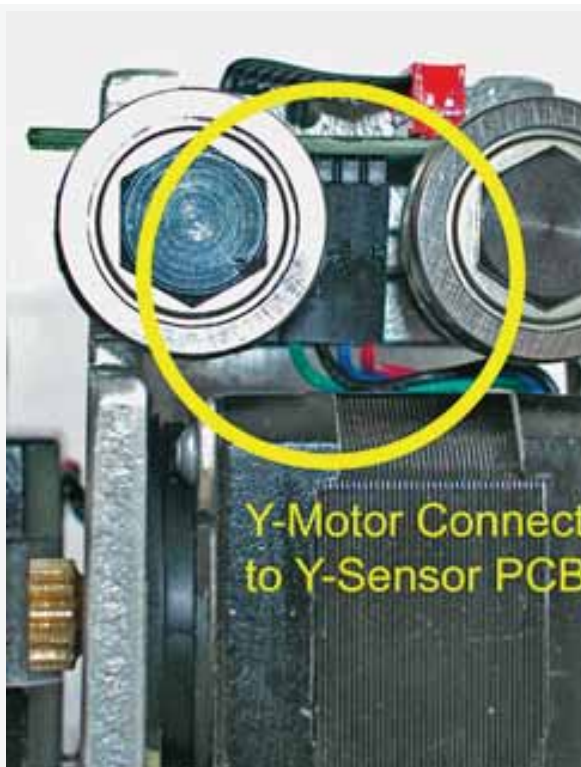
Introduction Point 1:

The picture shows the stripped down X/Y-Carriage with only the 2 stepper motors installed.

As mentioned above, it has been observed that the Pinion has become loose. To check this, insert a slotted screw driver in between the metal block and the Pinion. Press gently against the Pinion. If the fixation is loose, the Pinion will fall off right away.

This error can cause position error.

Note: At the time this was observed, a corrective action was taken. The Pinion was not only glued to the motor axis but also mechanically fixed (pinned). The change was made with the Revision D of the Injection Unit.



Introduction Point 2:

Observe the orientation of the cable connector from the X-Axis Stepper Motor.

The cut-outs for connector pins have to point downwards or towards the metallic part of the X/Y-Carriage.

If the connection is made in reverse, the motor will run in the opposite direction and will go all the way to the mechanical stop of the X-Axis.

The cable harness should be tightly drilled to avoid any possibility of catching.

Note:

The colors of the wires have been changed over the years. This is not a good indicator of orientation.

Introduction Point 2:

Another mechanical problem described above is the possibility that the Toothed Rack has been shifted.

Any adjustment of the Toothed Rack should be avoided. It is very unlikely that the factory set position gets altered during use.

The picture shows the check of the position using a depth gauge. Further details are given in the section "[X-Y Profile, side Covers](#)".

Stepper Motor Y-Axis Maintaining and Repair

If all the points under "Indications" are checked and the error persists, contact CTC Analytics for further assistance. See as well the points described in the "Introduction" of this section.

For maintenance, see the section "Preventative Maintenance, PM".

See as well the section "[X-Y Limitations](#)".

1.39.0.0.0.1 X-Y-Axes Profile and Side Covers

This section describes the maintenance and replacement of the individual parts for the X-Y-Axis profile and Side Covers.

Indications for Maintenance or Replacement of the X-Y-Axis Profile and Side Covers are:

- Transport damage, bended or twisted Profiles.
- Accident in the laboratory, such as dropping off the lab bench, etc. Bent or twisted profiles.
- Side Cover for Combi PAL shows gas leak.
- Y-Axis Front Cover shows gas leak.
- X- or Y-Sensor failure or magnet for Hall sensor in Profile broken away.
- Angle X/Y or Y/Z is not square, syringe needle tip is out of desired position.

- X-Y-Axis Profile or Side Cover errors can be caused also by:

- Combi PAL Gas Flush Tube kinked and caught by the X/Y-Carriage Rollers.
- Y-Axis Ribbon Cable pulled too far out at the moment of Z-Axis installation. Error Message "Y-Sensor not detected". (Re-organize the Y-Ribbon Cable in the Y-Axis Profile and if necessary, also check the Gas Flush Tube in the Y-Axis. To gain free access to it, remove the Y-Axis Front Cover.)
- Toothed Rack loose or misaligned.
- Parts or particles caught in Toothed Rack. Mechanical movement partially blocked.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.40 Introduction:

CAUTION:

Under no circumstances is it allowed to exchange the X/Y-Carriage (including the Y-Axis) with that of another X-Axis. The distance of the rollers are matched to the distance of the rails and to the toothed rack. See also the section "XY-Limitations".

X-Y-Profile:

no picture available

Introduction Point 1:

A damage to the Profile has been observed in the situation of typical accidents in a lab, such as dropping the instrument from the bench.

Transport damages have been observed in cases where a unit has not been shipped in the original container.

In case of any severe damage, contact CTC Analytics AG for further assistance.



Introduction Point 2:

Material flaking off from the Guide Rods or Rollers, or even corrosion, has only been seen in very rare cases where the unit has been exposed to strong mineral or volatile organic acids, or due to a lack of maintenance.

It is recommended to clean and grease the PALSystem a minimum of once a year. Use only the dedicated grease, P/N: PAL Lub (grease is part of the PM Kit). See also the section "X-Y- Troubleshooting".

no picture available

Introduction Point 1:

A damage to the Profile has been observed in the situation of typical accidents in a lab, such as dropping the instrument from the bench.

Transport damages have been observed in cases where a unit has not been shipped in the original container.

In case of any severe damage, contact CTC Analytics AG for further assistance.

Introduction Point 3:

It has been observed with earlier units that the Guide Rods (Rails) loosened at the end of the X-Axis Profile.

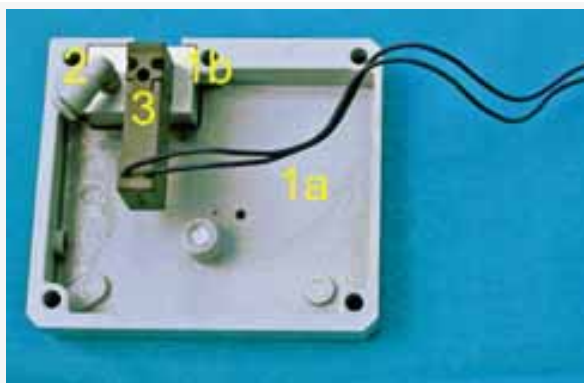
If one or more Rails are loose at the end, this does not harm the operation of the PAL System. The moving X/Y-Carriage presses the Guiding Rods back into position again.

It is possible to cement the ends with an appropriate glue and thereby fix the Rods.

If the Guiding Rods are nearly falling out of the unit, return the X-Y-Assembly back to the factory.



Side Covers:



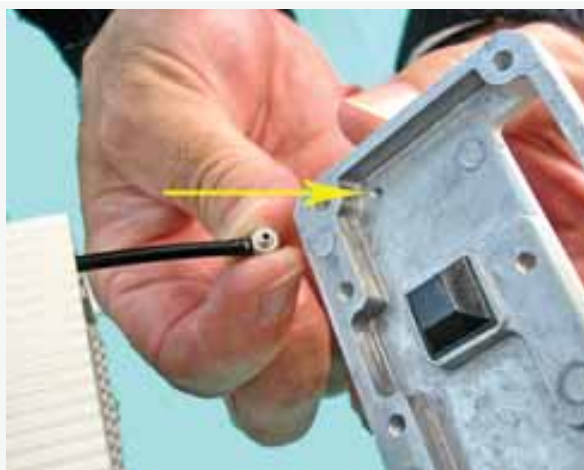
Introduction Point 6:

The X-Axis side Cover for a COMBI PAL has the Gas Distribution Block built in.

P/N: MZ: 30-11

Not included are: # 2: Elbow connector # 3: Gas Flush Valve

For more details see the section "[Gas Flush Valve](#)".



Introduction Point 7:

The Y-Axis Front Cover is prepared to accept the Gas Flush Tube from the Y-Axis.

The O-Ring in the front seals the connection to the Z-Axis.

If a gas leak is detected in the Y-Axis Front Cover, it is advisable to replace the cover.

P/N: MY 30-10

1.41 X-Y-Profile and Side Covers Repair and Maintenance Procedure

It is assumed that the X/Y-Assembly has been disassembled as described in the section "[Disassembling X-Y-Axis](#)".

All other steps are described separately, see "[Overview X-Y- Repair Path](#)".

The assembly steps are described in the section "[Assembling X-Y-Axis](#)".

**Step 1:**

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".

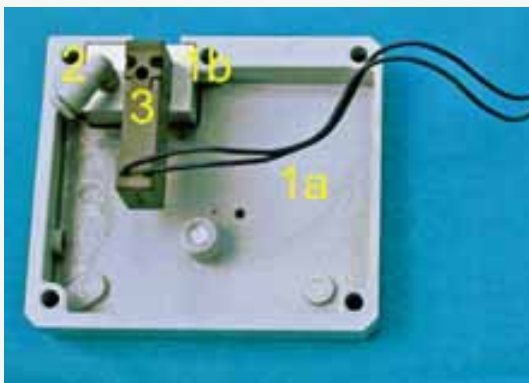
**Step 2:**

If any other disassembly step is necessary, this will depend on the type of failure.

Check in the appropriate section if a specific disassembly question arises.

The correct distance from the Toothed Rack in the Y-Axis is measured from the Rack to the outer edge of the Y-Profile: 43.6 mm +0.2/-0 mm.

Note: This distance is checked at the factory. The value is given just in case anything has been actively changed. A Depth Gauge should be used for accurate measurement.

**Step 3:**

If a gas leak at the Side Cover for the COMBI PAL is present, replace the relevant side Cover.

CAUTION:

Do not use a glue to cement the Gas Distribution Block to the cover again. Traces of volatile organic compounds can contaminate the gas system. This can lead to so-called "ghost peaks".

If a gas leak at the Side Cover for the Combi PAL is present, replace the Side Cover.

P/N: MZ 30-11

This picture shows the Gas Flush Valve assembly in the side cover. Note that the Gas Distribution Block (1b) is built in the special side cover.

1a: Side Cover incl. Gas Distribution Block; P/N MZ 30-11 1b: Gas distribution Block is built in MZ 30-11.

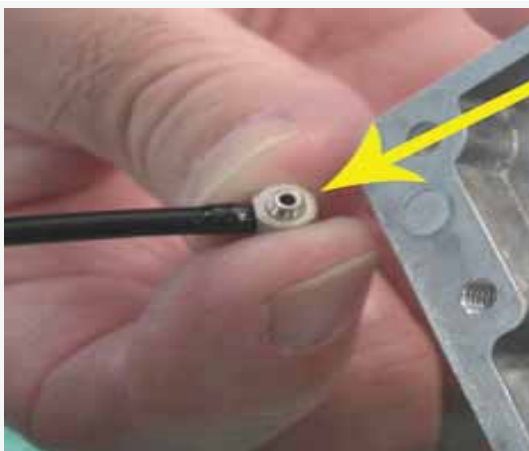
2: Elbow Adapter for Gas Flush Tube; P/N: KJL 23-M33; Gas Flush Valve including electrical cable/connector. P/N for model Combi PAL: MX 90-00 P/N for model LHX and HS PAL: MX 90-01

Note: The Distribution Block is not individually available. Do not use any glue (cement) to fix a loose part. Volatile organic compounds can contaminate the gas system. Risk of ghost peak detection.

See also the section "[Gas Flush Valve](#)".

**Step 1:**

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".

**Step 4:**

If a gas leak at the Y-Axis Front Cover is present, it is advisable to replace the cover.

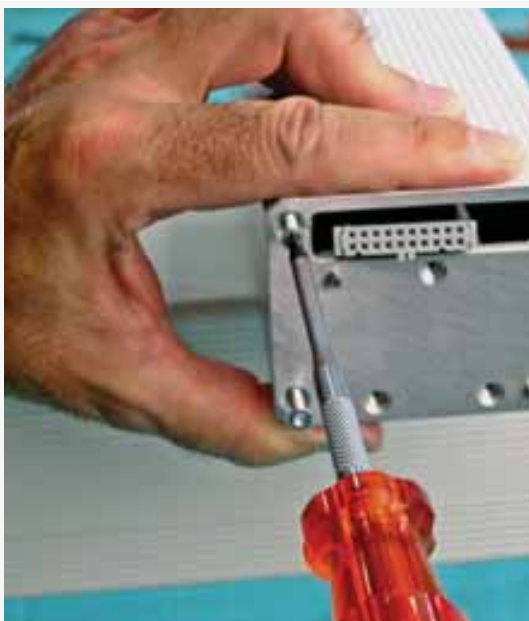
P/N: MY 30-10

CAUTION:

Do not try to fix the leak using a glue or cement. Traces of volatile organic compounds can contaminate the gas system. This can lead to so-called "ghost peaks".

In this area, a gas leak can also be caused by:

- Missing or defective Sealing Gasket from the Gas Tube Adapter. PNo.: M-3ALU-3.
- Thread of Gas Tube Adapter damaged.
- O-Ring destroyed at front side.

**Step 5:**

The front side of the Y-Axis cover is polished. Adding a layer of paint could contribute to a misalignment of the Y- and Z-Axis. The combination would not be square.

At final test in the factory is a check to verify that the Y- and Z-Axis form an angle of 90°. If for any reason it is observed that the syringe slider is not moving exactly in perpendicular fashion. Please follow these steps to correct this:

- Remove the Y-Axis Front Cover and shim either at the upper or the lower screws depending on the situation. Shimming with a material thickness of a 1/10 mm already has an impact on the angle because of the length of the entire Z-Axis.

--- Z-Axis leaning to the front side: Shim at the top screws

--- Z-Axis leaning to the back side: Shim at the lower screws.

See also Service Note # 08/2004 for related information, "Stack Drawer Opening and Closing".

**Step 1:**

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".

**Step 6:**

The purpose of the O-Ring at the Front Y-Axis Cover is to connect the gas tightly to the Injection Unit.

For the PAL models which have a Gas Flush Line installed, mainly Combi PAL Systems, this gas connection is crucial.

See the section "[XY-Axis Testing](#)" for how to test the gas tightness.

A failure (gas leak) has been observed in very few cases. If this occurs, is it advisable to replace the entire Y-Axis Front Cover.

- P/N: MY-30-11; PAL Y-Axis Front Cover.

The main reason is that the O-Ring is glued in. Removing the original O-Ring would scratch the surface, therefore compromising the seal quality. In addition, if a replacement O-Ring is glued on in the field, volatile compounds from the glue can contaminate the gas line. This would result in the presence of so-called ghost peaks in the chromatogram.



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 7:

For detailed information about the Sheet Metal Cover for the Y-Axis, see the section "[Gas Flush Tube X-Y, \(complete Tube\)](#)", starting at point 14.



Step 1:

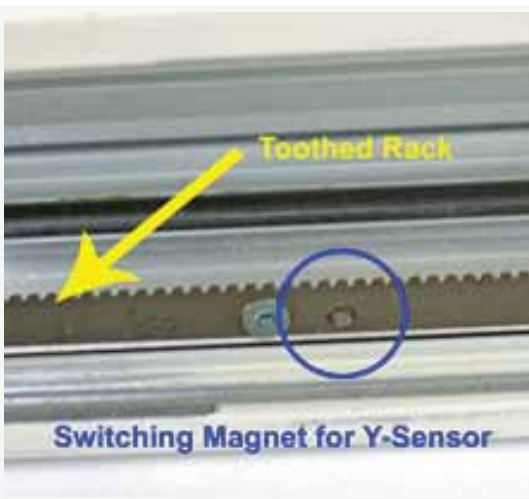
The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 8:

The Switching Magnet for the X-Sensor is mounted at the X-Y-Carriage.

It has not yet been observed that this magnet has fallen out of place or had to be replaced. In case it is necessary to replace it, contact CTC Analytics for further assistance.



Step 9:

The Switching Magnet for the Y-Sensor is mounted into the Toothed Rack of the Y-Axis.

It has not yet been observed that this magnet has fallen out of place or had to be replaced. In case it is necessary to replace it, contact CTC Analytics for further assistance.

Note: The picture has been taken from Y-Axis Profile with a special cut-out. On the regular Y-Axis Profile this part is not visible.

This concludes the procedure for the section on "X-Y-Axis Profile, Side Covers".

The Assembly of the unit follows the logical order backwards. In the section "Assembling of the X-Y-Axis " several important points are described.

All further steps are described separately, see "Overview X-Y-Axis Repair".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.41.0.0.0.1 X-Axis Position Sensor PCB

This section describes the replacement of the PCB in the X-Y System.

Indications for Maintenance or Replacement of the PCB Position Sensor X-Axis are:

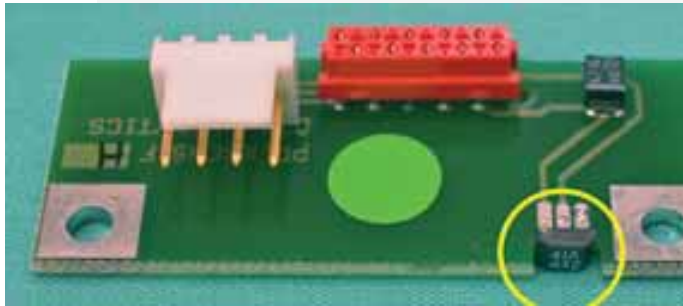
- Sensor does not respond anymore. Test: F3-Setup/Service/Test Switches.
- PCB physically damaged (example connector broken).
- Refurbishing a PAL System. Example: during replacement of the Ribbon Cables X-Y-Axis or the Gas Flush Tube.
- **Typical errors which could be related to the PCB Position Sensor Y-Axis should be checked first:**
 - **Firmware (corrupt firmware in Flash Memory, re-load a complete new back-up file).**
 - **Faulty X-Y-Ribbon Cables.**
 - **Defective MOTIO or Control Board .**
 - **Toothed Rack loose or misaligned, Position X-Axis error observed.**
 - **Combi PAL Gas Flush Tube kinked, Position X-Axis error observed.**
 - **Stepper Motor X- Axis faulty.**
 - **Stepper Motor moving in opposite direction.**

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.42 Introduction



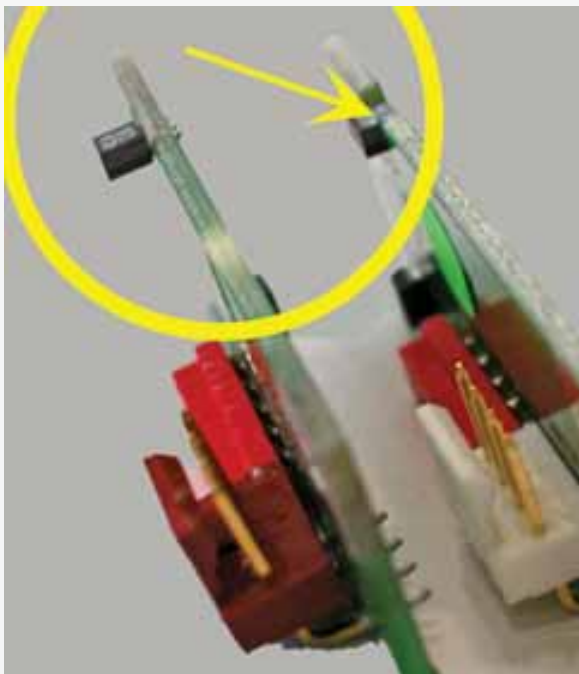
Introduction Point 1:

The picture shows the PCB Position Sensor X-Axis.

The sensor itself is marketed.

P/N: PAL XYSens; Kit includes X-and Y-Axis Position Sensors.

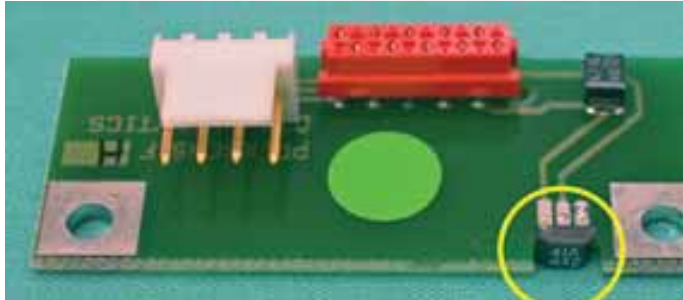
Note: The individual PCB X- or Y- Axis Position Sensor is not available. If one board has to be replaced, replacing the other board can also be done easily at the same time. The replacement of both boards is often done during the refurbishment of older PAL Systems.



Introduction Point 2:

The picture shows the older version of the Position X-Sensor PCB (left) and the current version (right).

Note the cut-out for the sensor component (arrow).



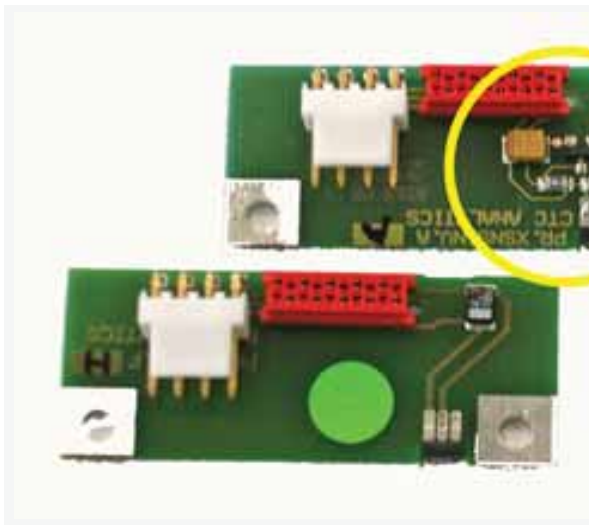
Introduction Point 1:

The picture shows the PCB Position Sensor X-Axis.

The sensor itself is marketed.

P/N: PAL XYSense; Kit includes X-and Y-Axis Position Sensors.

Note: The individual PCB X- or Y- Axis Position Sensor is not available. If one board has to be replaced, replacing the other board can also be done easily at the same time. The replacement of both boards is often done during the refurbishment of older PAL Systems.



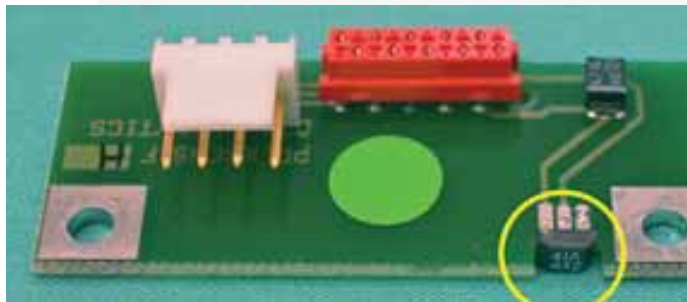
Introduction Point 3:

PAL modules with 120 cm X-Axis length and 2 Injection Units installed, example IFC PAL, require 4 PCB Positions Sensors:

- X-Axis, 1 pc
- X-Axis with reversed logic, 1 pc
- Y-Sensor, 2 pcs

The PCB X-Position Sensor with reversed logic is shown beside the standard X-sensor PCB. Note the extra components.

P/N: XYSenseDual



Introduction Point 1:

The picture shows the PCB Position Sensor X-Axis.

The sensor itself is marketed.

P/N: PAL XYSense; Kit includes X-and Y-Axis Position Sensors.

***Note:** The individual PCB X- or Y- Axis Position Sensor is not available. If one board has to be replaced, replacing the other board can also be done easily at the same time. The replacement of both boards is often done during the refurbishment of older PAL Systems.*



Introduction Point 4:

The Switching Magnet for the X-Sensor is mounted at the X-Y-Carriage.

It has not yet been observed that this magnet has fallen out of place or had to be replaced. In case it is necessary to replace it, contact CTC Analytics for further assistance.

1.43 X-Axis Position Sensor Replacement Procedure

It is assumed that the X/Y-Assembly has been disassembled as described in the section "[Disassembling X-Y-Axis](#)".

All other steps are described separately, see "[Overview X-Y- Repair Path](#)".

The assembly steps are described in the section "[Assembling X-Y-Axis](#)".



Step 1:

The steps to disassemble the X-Y-Axis is described in [Disassemble the X-Y-Axis](#)".



Step 2:

Remove the X/Y-Carriage completely from the X/Y Profile.

The Flexband and Ribbon Cables have to be removed to gain access to the carriage.

The replacement of the Position Sensor PCBs requires taking apart the assembly down to its basic components. In this case, it is advisable to replace the Gas Flush Tube and the Ribbon Cables at the same time.



Step 3:

Connect the X-Motor to the 4-pin connector of the X-Axis Position Sensor PCB.

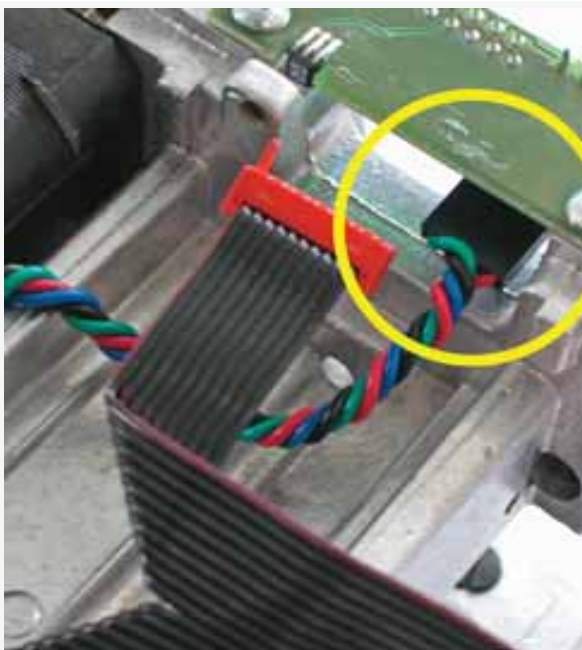
Observe the orientation of the cable connector. The open cuts for the connector pins have to point downwards, against the X/Y-Carriage.

See the picture in Step 4.



Step 1:

The steps to disassemble the X-Y-Axis is described in [Disassemble the X-Y-Axis](#)".



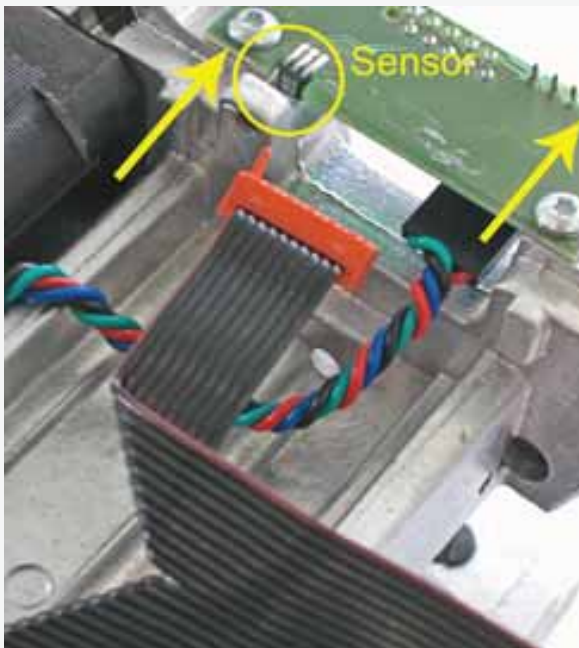
Step 4:

Motor X connection to the X-Axis Position Sensor PCB.



Step 1:

The steps to disassemble the X-Y-Axis is described in [Disassemble the X-Y-Axis](#)".

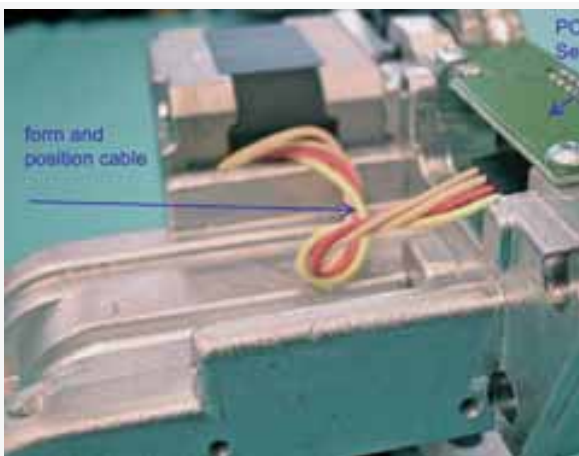


Step 5:

Press the PCB away from the metallic X/Y-carriage when tightening the two screws.

The reason for this precaution is to provide enough space for the sensor component and the blind shutter built-in the X-Profile.

Note: The colors of the wires have been changed over the years. This is not a good indicator of orientation.



Step 6:

Tighten the PCB with the screws provided.

Form the cable harness and position it tightly to the carriage.

Required Tools: Torx T10

Required Material:

- PCB X-Position Sensor, part of kit: PAL XYSens

- Screws: BN 6404 M3x6

**Step 1:**

The steps to disassemble the X-Y-Axis is described in [Disassemble the X-Y-Axis](#)".

**Step 7:**

Continue at this stage with the installation of the "[Y-Position Sensor PCB](#)", the "[Gas Flush Tube, \(complete Tube\)](#)" if applicable and the "[X-Y-Ribbon Cables](#)".

See details in the appropriate sections.

This concludes the procedure for the section on "X-Axis Position Sensor PCB".

As described in Step 7 of this section, the final steps to complete the X-Y-Axis are covered in the sections "[Y-Axis Position Sensor PCB](#)", "[Gas Flush Tube X-Y, \(complete Tube\)](#)" and "[Ribbon Cables](#)".

The Assembly of the unit follows the logical order backwards. In the section "Assembling of the X-Y-Axis " several important points are described.

All further steps are described separately, see "Overview X-Y-Axis Repair".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.43.0.0.0.1 Y-Axis Position Sensor PCB

This section describes the replacement of the PCB in the X-Y System.

Indications for Maintenance or Replacement of the PCB Position Sensor Y-Axis are:

- Sensor does not respond anymore. Test: F3-Setup/Service/Test Switches.
- PCB physically damaged (example connector broken).
- Refurbishing a PAL System. Example replacing Ribbon Cables X-Y-Axis or Gas Flush Tube.

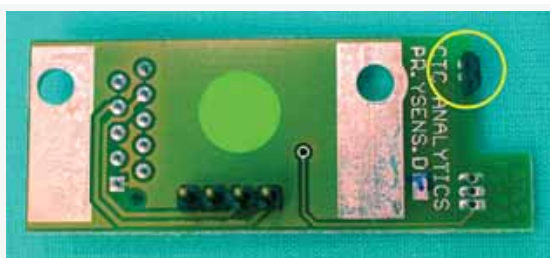
- Typical errors which could be related to PCB Position Sensor **Y-Axis** should be checked first:
 - Firmware (corrupt firmware in Flash Memory, re-load a complete new back-up file).
 - Faulty X-Y-Ribbon Cables.
 - Defective MOTIO or Control Board .
 - Toothed Rack loose or misaligned, Position Y-Axis error observed.
 - Combi PAL Gas Flush Tube kinked, Position Y-Axis error observed.
 - Stepper Motor Y faulty.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

1.44 Introduction



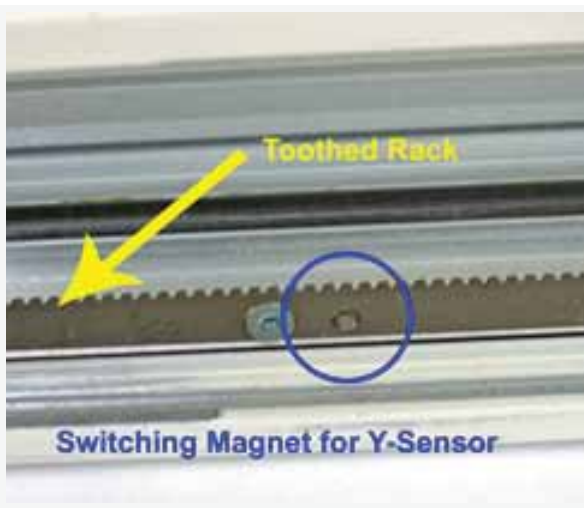
Introduction Point 1:

The Y-Axis Position Sensor PCB is shown from both sides.

The sensor component itself is marked.

PNo.: PAL XYSense; Kit includes X-and Y-Axis Position Sensors

Note: The individual PCB X - or Y- Axis Position Sensor is not available. If one board has to be replaced, the other board can also be easily replaced at the same time. The replacement of both boards is often done when an older Pal System is refurbished.



Introduction Point 2:

The Switching Magnet for the Y-Sensor is mounted into the Toothed Rack of the Y-Axis.

It has not yet been observed that this magnet has fallen out of place or had to be replaced. In case it is necessary to replace it, contact CTC Analytics for further assistance.

Note: The picture has been taken from the Y-Axis Profile with a special cut-out. On the regular Y-Axis Profile this part is not visible.

1.45 Y-Axis Position Sensor PCB Replacement Procedure

It is assumed that the X/Y-Assembly has been disassembled as described in the section "[Disassembling X-Y-Axis](#)".

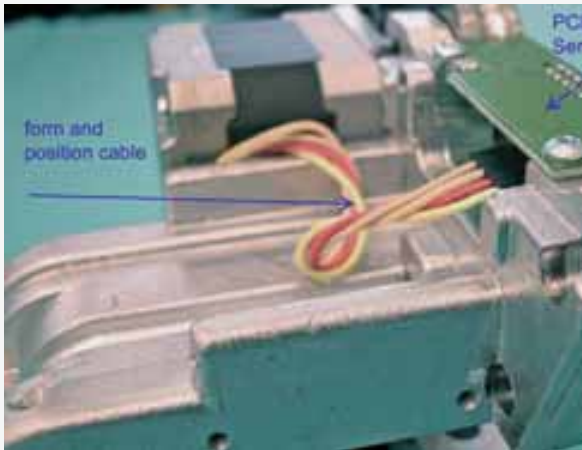
All other steps are described separately, see "[Overview X-Y- Repair Path](#)".

The assembly steps are described in the section "[Assembling X-Y-Axis](#)".



Step 1:

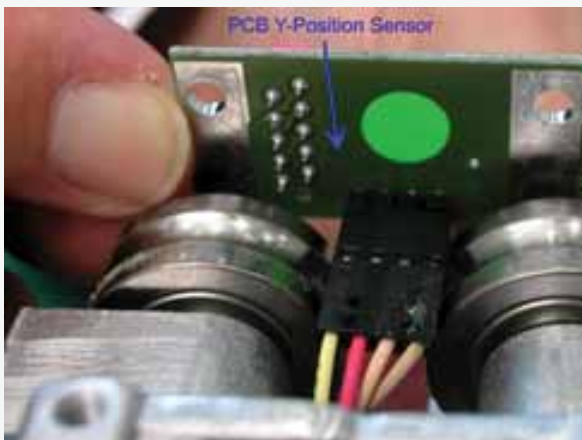
The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 2:

It is assumed that the X/Y-Carriage has been disassembled down to its basic components, and that the X-Axis Position Sensor has been installed as described in the specific section.

Remove the original Y-Sensor Position PCB but leave the grounding point at the motor untouched.



Step 3:

Connect the Y-Motor to the 4-pin connector of the Y-Axis Position Sensor PCB.

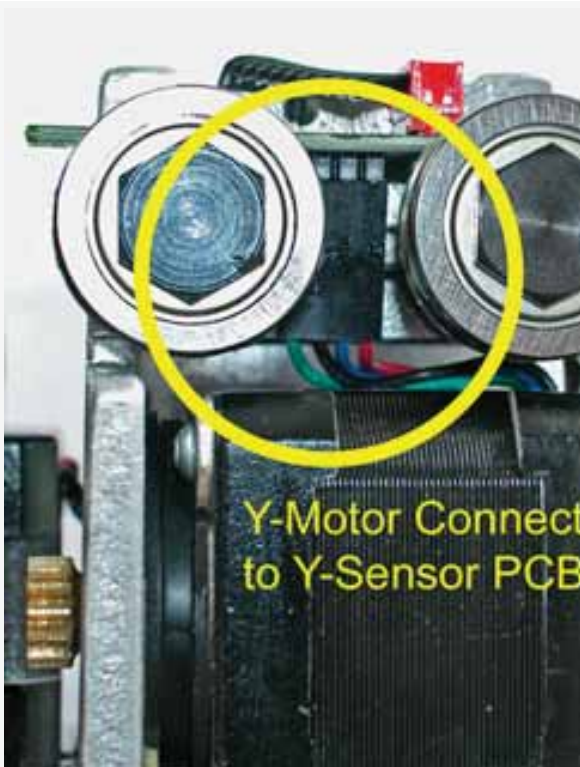
Observe the orientation of the cable connector from the Y-Axis Stepper Motor. The cut-outs for the connector pins have to point downwards against the metallic X/Y-Carriage.

See the picture under step 4.



Step 1:

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 4:

Y-Axis Stepper Motor connection to the Y-Sensor Position PCB.

If the connection is made in reverse, the motor will run in the opposite direction and will go all the way to the mechanical stop of the XY-Axis.

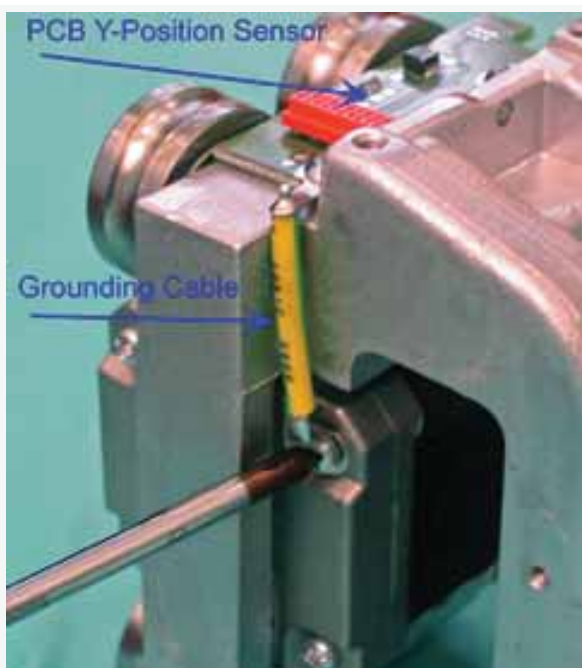
The cable harness should be tightly drilled to avoid any possibility of catching.

Note:

The colors of the wires have been changed over the years. This is not a good indicator of orientation.

**Step 1:**

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".

**Step 5:**

Ensure the contact of the Grounding Conductor with the PCB and the carriage.

CAUTION:

Remove the original Y-Sensor Position PCB but leave the grounding point at the motor untouched.

Required Tools: Torx T10

Required Material:

- PCB X-Position Sensor, part of kit: PAL XY Sens
- Screws: BN 6404 M3x6
- P/N: Grounding Conductor MX 52-00; not part of the PAL XY Sens kit.

Step 6:

Locate the Grounding Conductor from the original installation.

Note: The Grounding Conductor is not part of the PAL XY Sens kit.

The form and appearance has changed over the time. In the picture above (Step 5) a previous version is shown.

Whenever possible, use the original conductor. The shape and length has changed slightly in the past.

Do not open or change the screw connecting to the Y-Axis Stepper Motor.

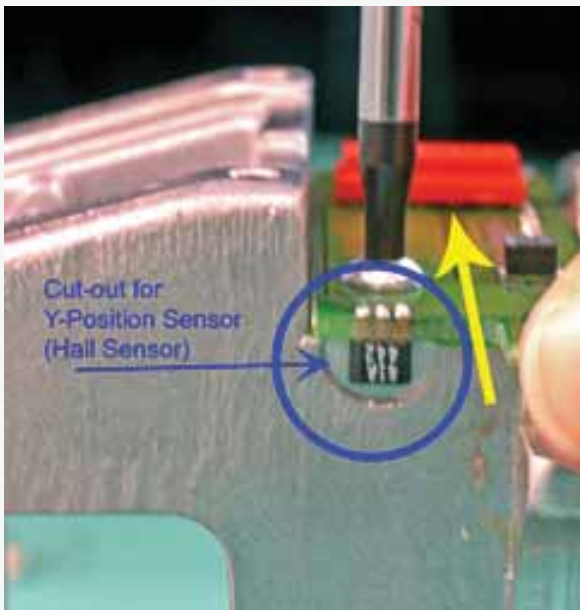
In case the Grounding Conductor has to be replaced, use the same screw for the motor connection. The length of the screw is adjusted according to the different motors used.

Note that the conductor is delivered without screws.

P/N: MX 52-00; Grounding Conductor for X/Y Carriage

**Step 1:**

The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".

**Step 7:**

Mount the Y-Axis Position Sensor PCB. Press the board from the side against the X/Y-Carriage.

CAUTION:

The reason for this pre-caution is to avoid a contact from the sensor component against the Toothed Rack built-in the Y-Axis Profile. Check this point carefully when the Y-Profile is engaged.

Note: The cut-out as shown in the picture was adjusted over the years. Earlier units had a much smaller cut-out. For older units, it is important to have enough space for the sensor against the Toothed Rack Y-Axis. However, the sensor connection should not be damaged by pressing too hard against the X/Y-Carriage.

**Step 8:**

This picture shows the situation with the Grounding Conductor and the mounting of the PCB Y-Axis Position Sensor on top of the X/Y-Carriage.



Step 1:

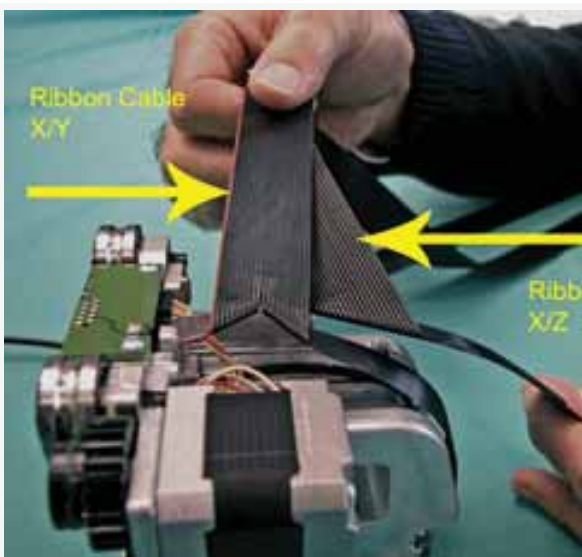
The steps to disassemble the X-Y-Axis are described in "[Disassemble the X-Y-Axis](#)".



Step 9:

Continue at this stage with the installation of the "Y-Position Sensor PCB", the "Gas Flush Tube, complete Tube" if applicable, and the "X-Y-Ribbon Cables".

See details in the corresponding sections.



Step 10:

Continue with the installation of the X-Y-Ribbon Cables.

At this stage be careful that the order of the two cables is correct.

For more details see the section "X-Y-Ribbon Cables".

This concludes the procedure for the section on "Y-Axis Position Sensor PCB".

As described in Steps 9 and 10 of this section, the final steps to complete the X-Y-Axis are covered in the sections "[Gas Flush Tube X-Y, \(complete Tube\)](#)" and "[Ribbon Cables](#)".

The Assembly of the unit follows the logical order backwards. In the section "Assembling of the X-Y-Axis " several important points are described.

All further steps are described separately, see "Overview X-Y-Axis Repair".

Testing the Injection Unit after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure".

1.45.0.0.0.1 PCB's: CPU Board | MOTIO Board | Control Board

The electronic boards are covered in the dedicated section, "[PCBs](#)".

Exceptions are the X-Y- Position Sensor Boards, which are covered in the following sections:

- '[X-Axis Position Sensor PCB](#)'
- '[Y-Axis Position Sensor PCB](#)'

1.45.0.0.0.2 Assembling the X-Y-Axes

This section describes the assembly of the PAL X-Y-Axis. The procedure covers the most critical points; less attention is given to the simpler, self-explanatory steps. In general, the steps follow the reverse order from those described in the Disassembly Procedure.

All further steps are described separately, see '[Repair Path Overview](#)'.

The Assembling Steps from this level is identical with the PM (Preventative Maintenance) Procedure for the Injection Unit.

CAUTION: ESD WARNING

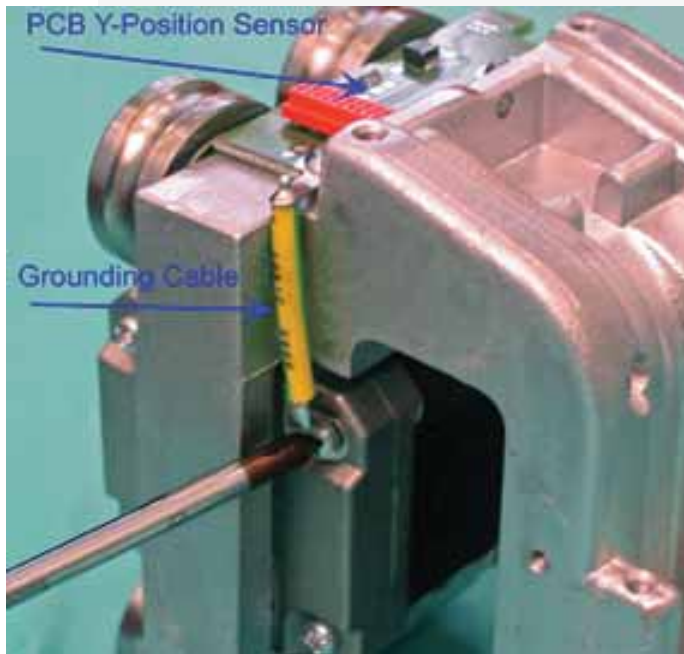
It is strongly recommended to use an ESD Strap in each case as soon as electronic parts are handled.

Not observing this basic rule can result in the erratic behavior of a component or in a damaged printed circuit board (PCB).

It is assumed that following steps have been taken as described in the sections:

- '[X-Axis Position Sensor](#)'
- '[Y-Axis Position Sensor](#)'
- '[Gas Flush Tube, \(complete Tube\)](#)'
- '[X-Y-Axis Ribbon Cables](#)'

In the assembly procedure, the most critical points are listed again.



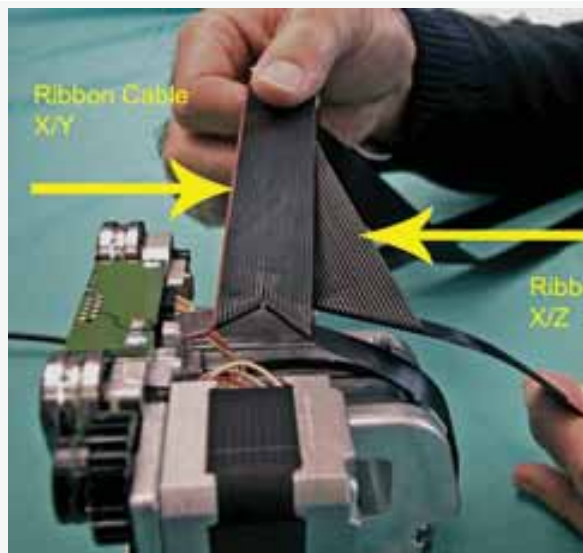
Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".

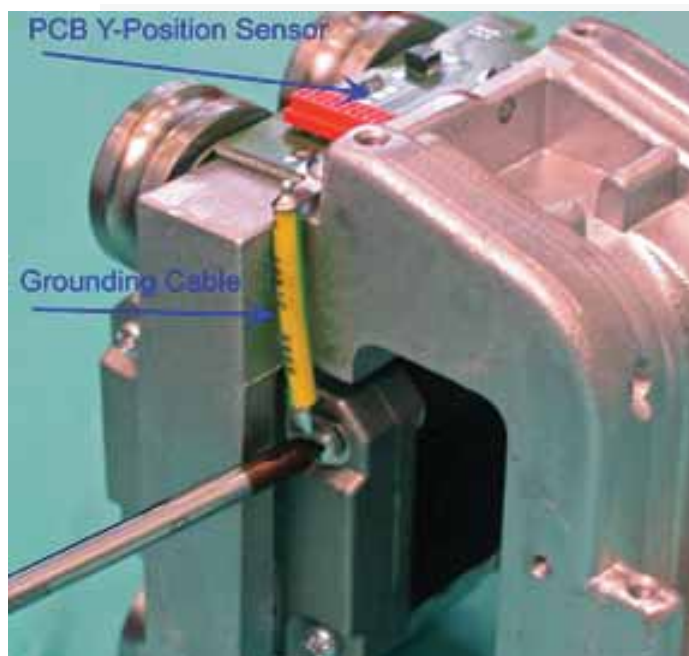


Step 2:

When re-installing the X-Y-Ribbon Cables, ensure the correct order of the cables.

If wrongly positioned, the MOTIO or Control PCB cannot be connected.

For details, see the section "[X-Y-Ribbon Cables](#)".



Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".

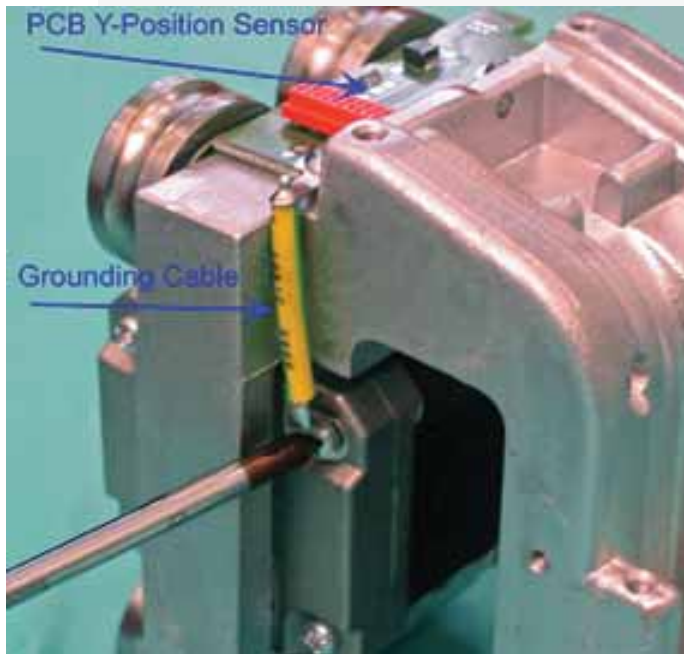


Step 3:

If the Position Sensor PCBs and/or the X-Y-Ribbon Cables have to be replaced, is it advisable to replace the entire Gas Flush Tube as well.

Note that this is only applicable for the Combi PAL.

For details, see the section "[Gas Flush Tube X-Y, \(complete Tube\)](#)".



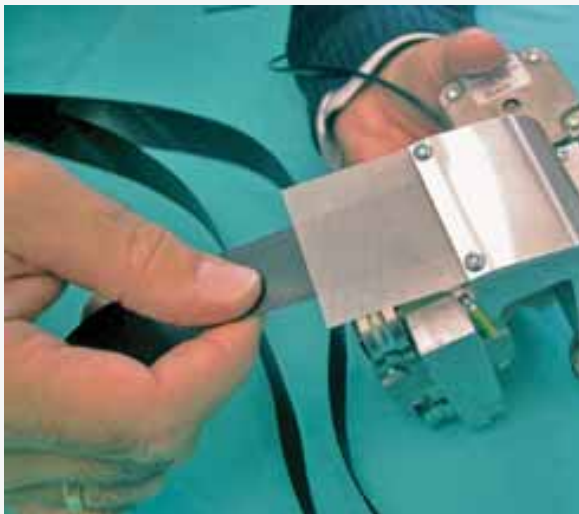
Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".

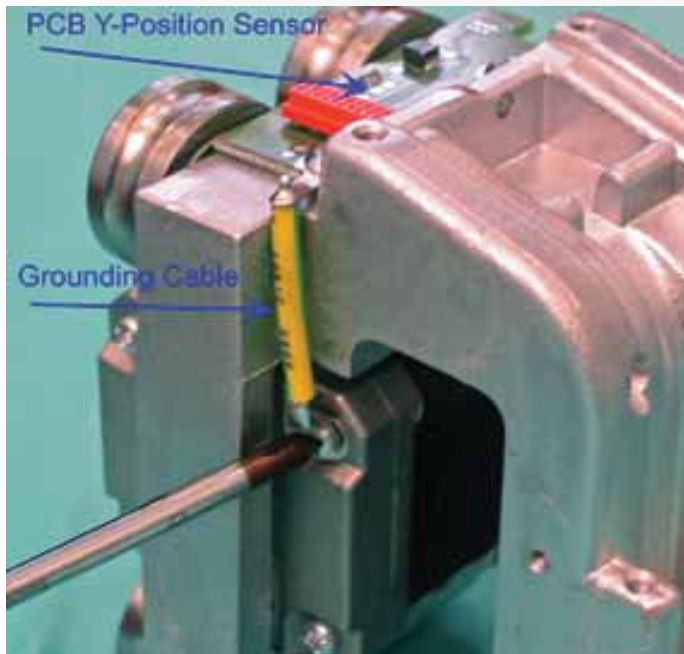


Step 4:

Always install the new Ribbon Cables only in combination with the new type of Y-Axis cover.

As shown in picture, ensure that the Ribbon Cables are not jammed or squeezed together in any position.

For details, see the section "[X-Y-Ribbon Cables](#)".



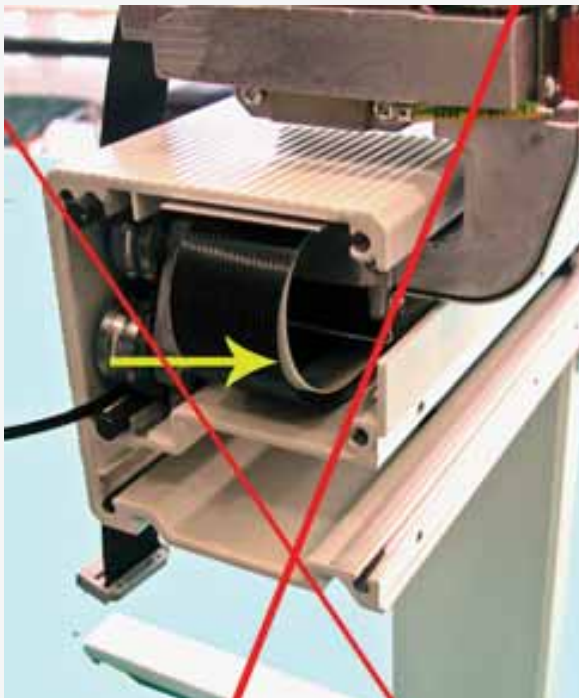
Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

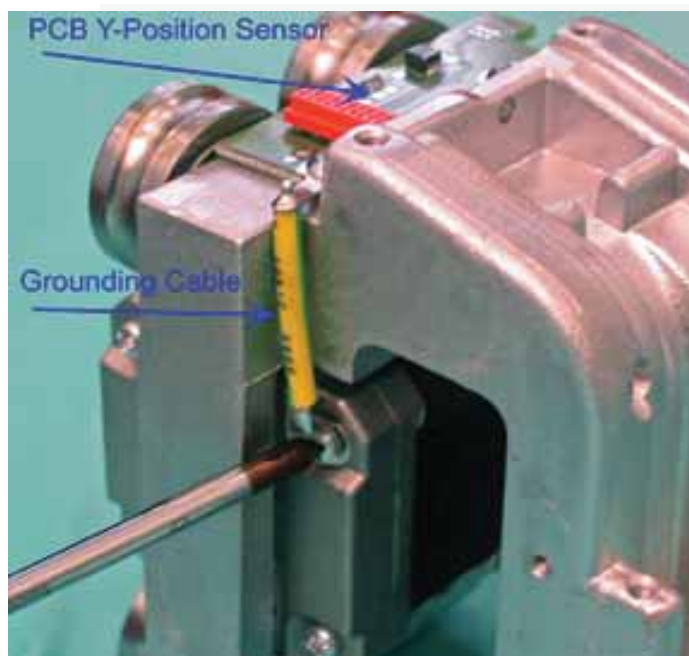
For details see the section "[Y-Axis Position Sensor](#)".



Step 5:

When installing and positioning the Ribbon Cables and the Flexband in the X-Axis, it is necessary to line up the cable bundle and it has to run smoothly and in parallel to the X-Profile.

For details, see the section "[X-Y-Ribbon Cables](#)".



Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".

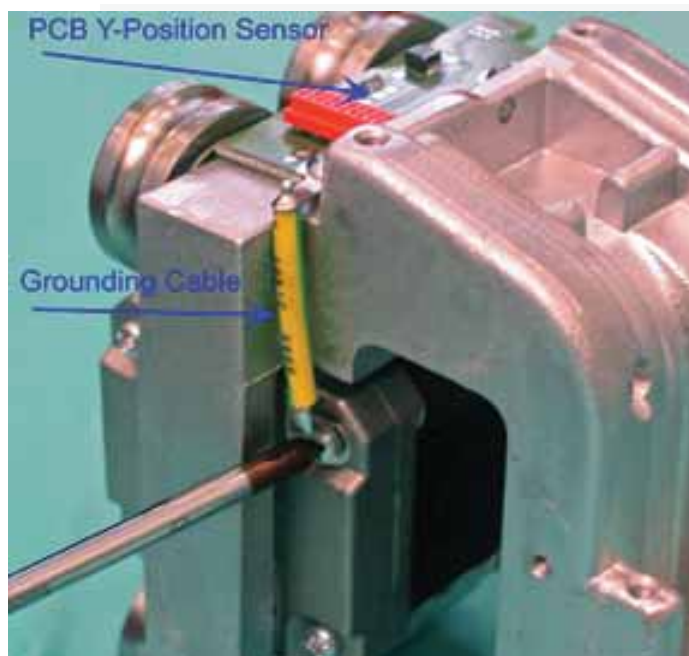


Step 6:

When replacing the Gas Flush Tube-X, cut the original (defective) tube at the position as shown in the picture.

A distance of 6 mm away from the carriage guiding hole is needed to insert the replacement tube.

For details see the section "[Gas Flush Tube-X, Replacement](#)".



Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".

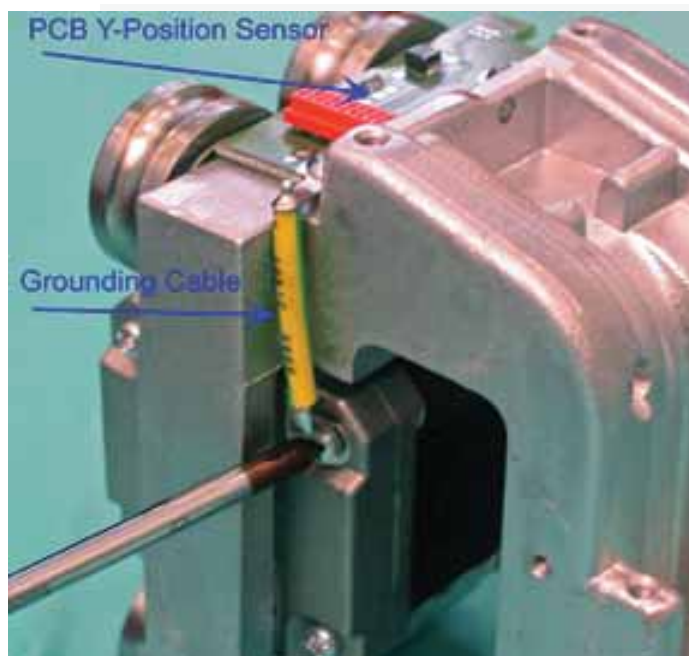


Step 7:

The replacement Gas Flush Tube-X has to be inserted into the X-Profile.

The Tube has to be placed tight around the gear wheels.

For details see the section "[Gas Flush Tube-X, Replacement](#)".



Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".

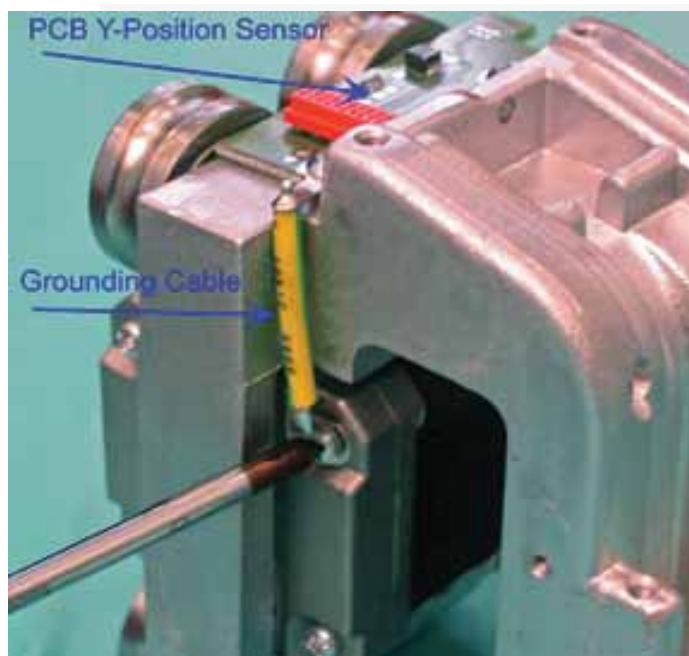


Step 8:

The bow of the Gas Flush Tube-X should lean against the wall of the X-Profile.

If the tube leans to the inside, as shown in the picture, twist the tube slightly to change the direction of the bow.

For details see the section "[Gas Flush Tube-X, Replacement](#)".



Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".

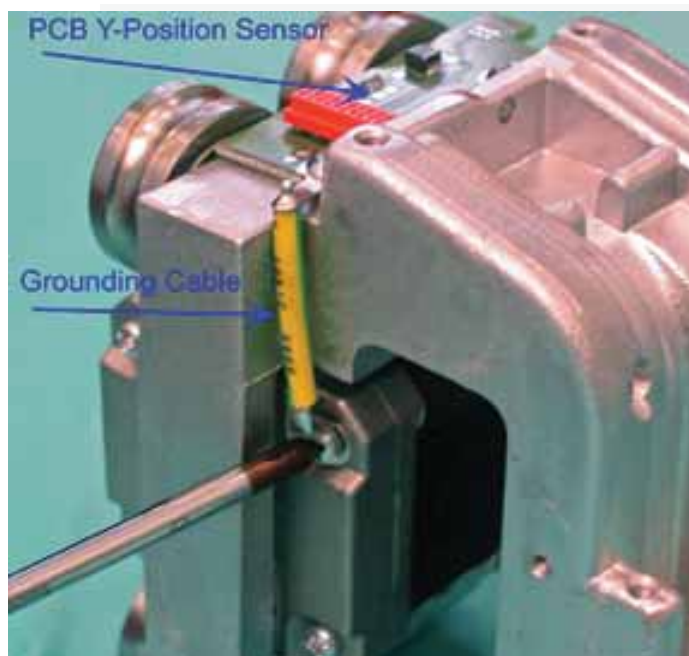


Step 9:

When inserting the Sheet Metal Cover Y-Axis, ensure that the Ribbon Cable and the Gas Flush Tube are not touched or damaged.

The connector of the Y-Ribbon Cable has to fit easily into position.

For details see the section "[Gas Flush Tube X-Y, \(complete Tube\)](#)".



Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".



Step 10:

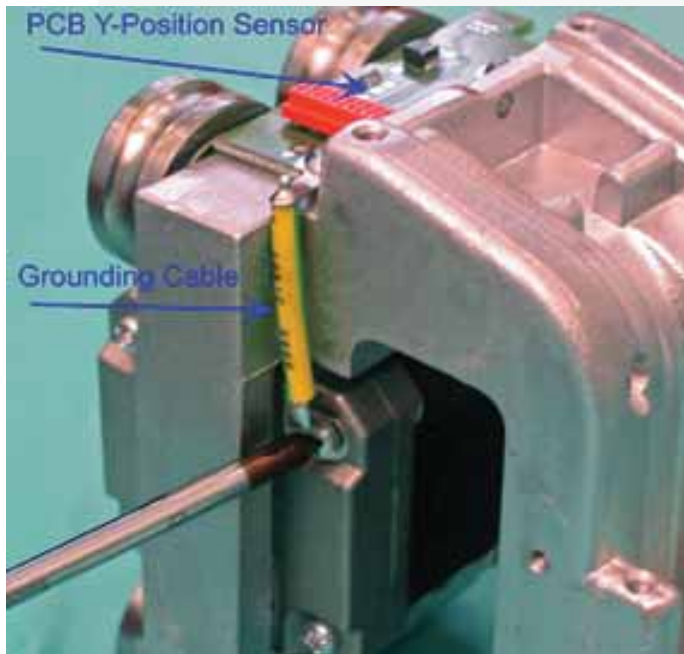
Mount the Y-Axis Front Cover with the 4 screws.

Required Tool: Torx T10

Required Material:

- Screws P/N: BN 4851 M3x20

- Y-Axis Front Cover: MY 30-10



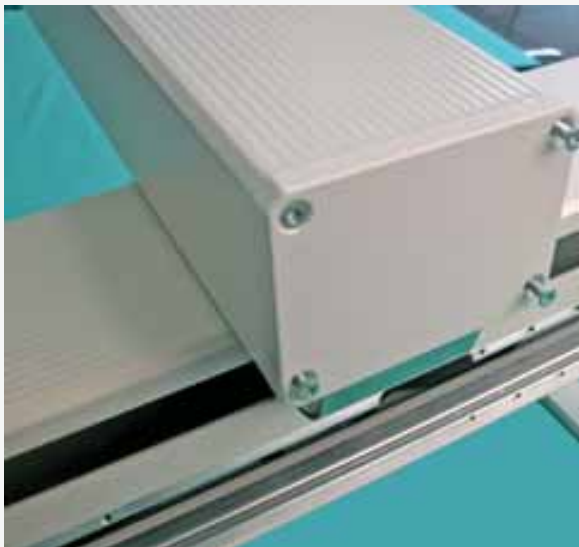
Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".



Step 11:

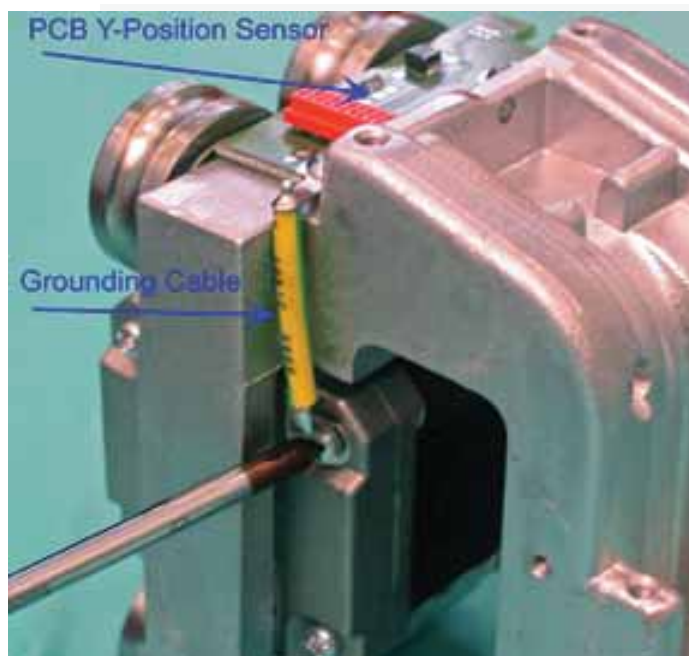
Mount the Y-Axis Back Cover with the 4 screws.

Required Tool: Torx T10

Required Material:

- Screws P/N: BN 4851 M3x20

- Y-Axis Rear Cover: MY30-11



Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".



Step 12:

For a Combi PAL model (Gas Flush Tube installed), position the X-Axis Side Cover carefully to the X-Profile.

CAUTION:

Do not kink the Gas flush tube at this point.

Do not squeeze or force the electric cable from the Gas Flush Valve in between the cover and the profile.

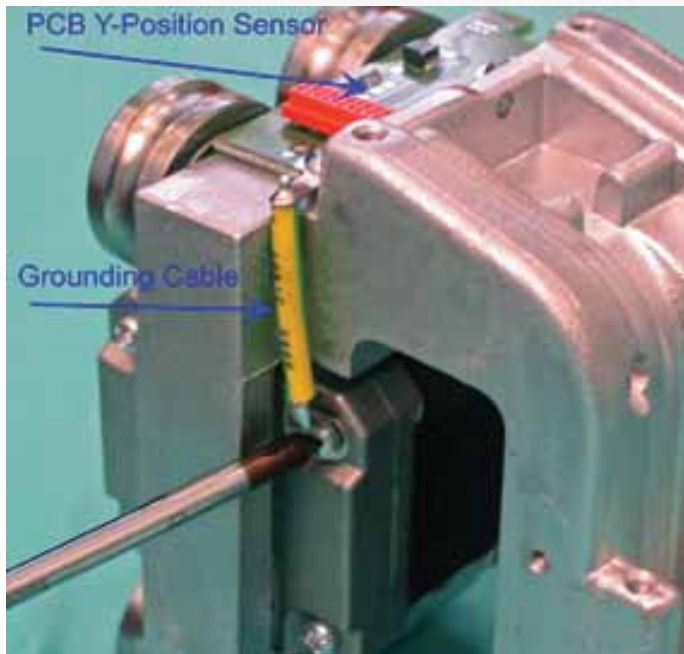
For all other PAL models, this step is not critical.

Tighten the 5 screws to fix the side Cover.

Required Tool: Torx T25 (earlier units had screws with Phillips Screw heads installed).

Required Material:

- X-Axis Side Cover with Gas Distribution Block installed (Combi PAL), P/N: MZ 30-11
- X-Axis Side Cover right hand side: P/N: MX 30-27
- Screws: P/N: BN 4851 M4x25



Step 1:

When replacing the Y-Axis Position Sensor, ensure that the grounding is connected (active).

CAUTION:

When removing the original Y-Sensor Position PCB, leave the grounding point at the motor untouched.

For details see the section "[Y-Axis Position Sensor](#)".

Step 13:

Mount the X-Axis side Cover left hand side.

Required Tool: Torx T25 (earlier units had screws with Phillips Screw head installed)

Required Material:

- X-Axis side Cover left hand side: P/N: MX 30-10

- Screws: P/N: BN 4851 M4x25

This concludes the Assembly Procedure.

It is good practice to move the Y-Z-assembly back and forth to check if there is mechanical play or mechanical hindrance, and how well the rolls are gliding.

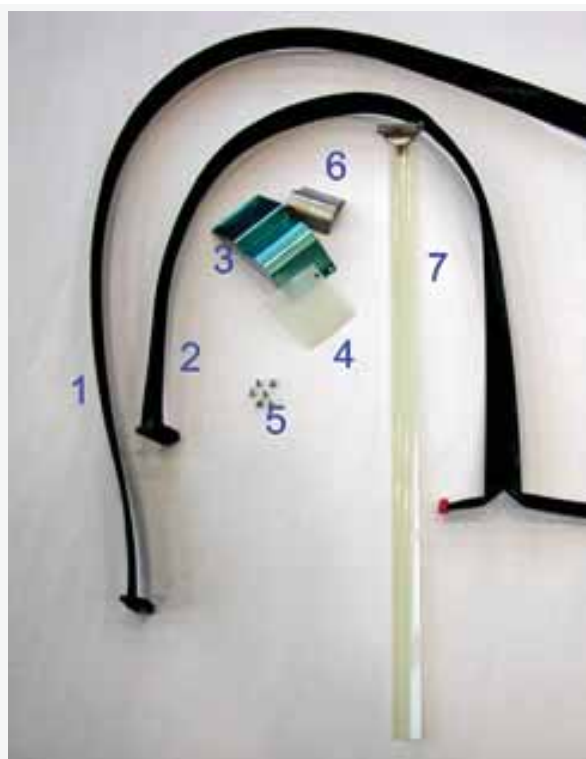
Testing the X-Y-Assembly after Repair, Overhaul or Maintenance is described in the specific section "Test Procedure X-Y".

1.45.0.0.0.3 Limitations for Repair of the X-Y- Axes

1.46 Introduction

Several factors can limit the repair of the X-Y Axes. These include the availability of spare parts, the skill of the service engineers and technical limitations specific to the system involved.

If a service engineer is not specifically trained or not extensively exposed to the PAL System, it is advisable to return the PAL X-Y-Assembly (preferably including the Z-Axis, Power Supply and Local Terminal) back to CTC Analytics for an overhaul.

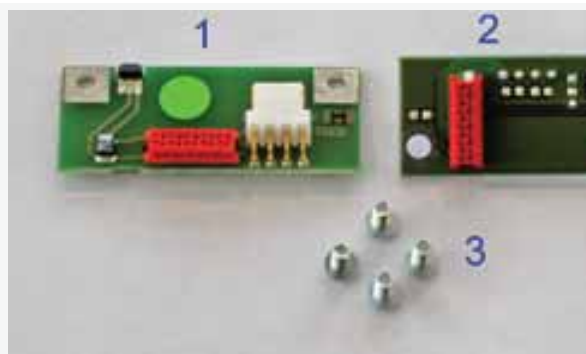


X-Y-Axes Limitations Point 1:

The X-Y- Ribbon Cables are not individually available. A Kit is available which includes the Ribbon Cables with the Cover Y-Axis (#3), the Polymer Guiding Shield and Screws (#5).

Note: The FlexBand (#7) and the Metal Angle Bracket (#6) are not part of the kit.

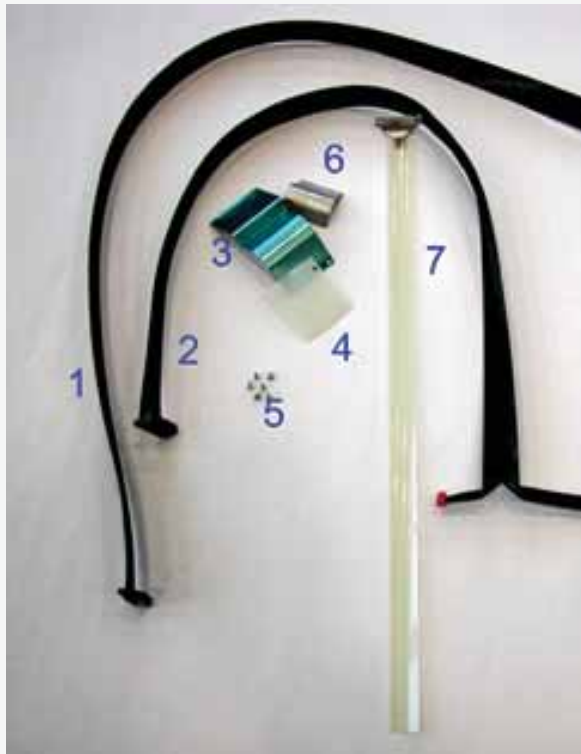
These two parts are shown in the picture only to illustrate in detail all the parts around the Ribbon Cable installation.



X-Y-Axes Limitations Point 2:

The X- and Y- Position Sensor PCBs are not individually available.

A kit is available to supply both PCBs, including the screws for repairs.

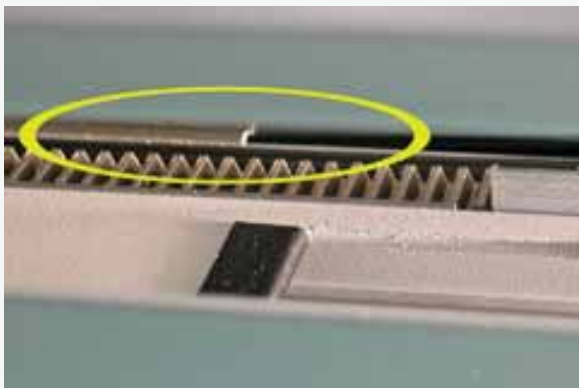


X-Y-Axes Limitations Point 1:

The X-Y- Ribbon Cables are not individually available. A Kit is available which includes the Ribbon Cables with the Cover Y-Axis (#3), the Polymer Guiding Shield and Screws (#5).

Note: The FlexBand (#7) and the Metal Angle Bracket (#6) are not part of the kit.

These two parts are shown in the picture only to illustrate in detail all the parts around the Ribbon Cable installation.



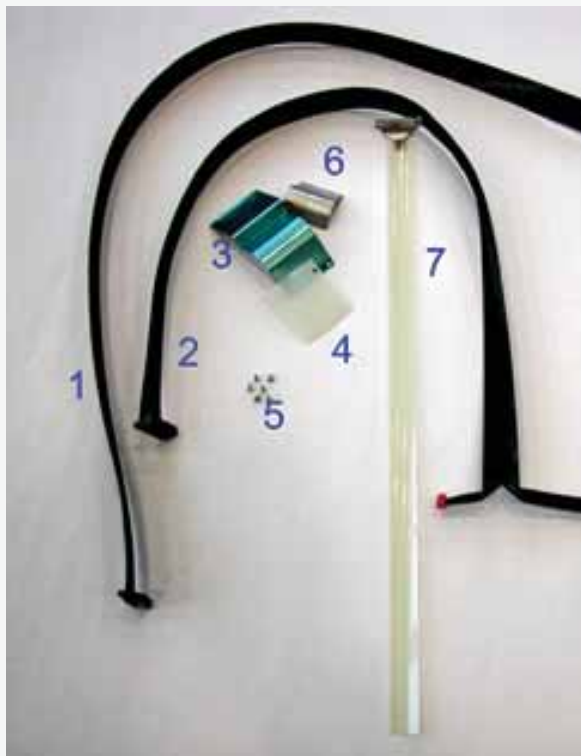
X-Y-Axes Limitations Point 3:

Toothed Rack should not be moved in position, either for the X-Axis or for the Y-Axis Assembly.

The play of the Pinions from the X- and Y- Motors is matched to the Toothed Rack.

Uncontrolled changes can lead to destruction of the entire Assembly.

In cases where an adjustment is necessary, contact CTC Analytics.



X-Y-Axes Limitations Point 1:

The X-Y- Ribbon Cables are not individually available. A Kit is available which includes the Ribbon Cables with the Cover Y-Axis (#3), the Polymer Guiding Shield and Screws (#5).

Note: The FlexBand (#7) and the Metal Angle Bracket (#6) are not part of the kit.

These two parts are shown in the picture only to illustrate in detail all the parts around the Ribbon Cable installation.

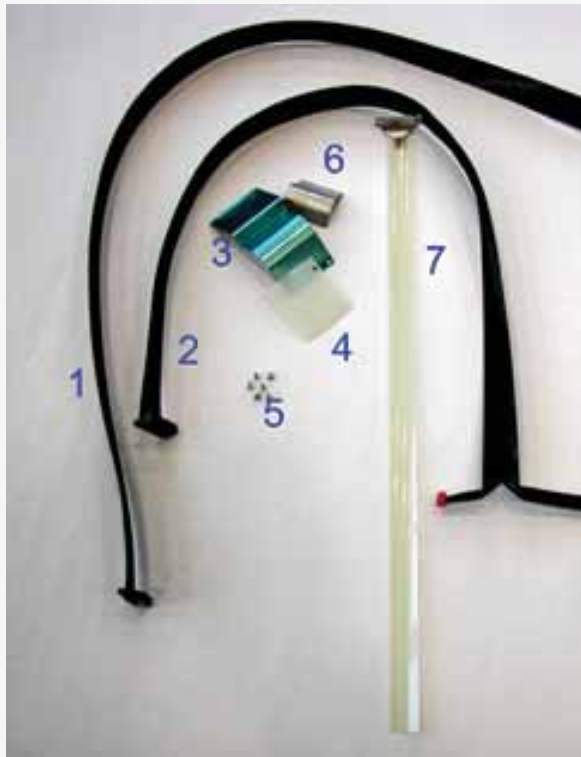


X-Y-Axes Limitations Point 4:

CAUTION:

There is a strict limitation regarding the rollers: do NOT touch the fixation. The rollers are matched with respect to the side distance against the Guide Rods in the X-Y- Assembly. The Unit can be damaged within a few months if the alignment is not correct.

The alignment can only be done in the factory using a dedicated setting gauge.

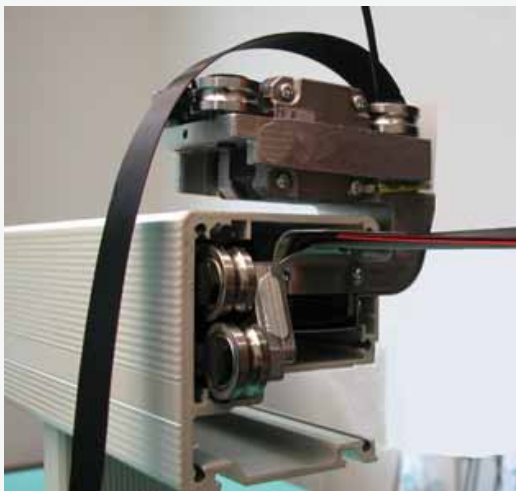


X-Y-Axes Limitations Point 1:

The X-Y- Ribbon Cables are not individually available. A Kit is available which includes the Ribbon Cables with the Cover Y-Axis (#3), the Polymer Guiding Shield and Screws (#5).

Note: The FlexBand (#7) and the Metal Angle Bracket (#6) are not part of the kit.

These two parts are shown in the picture only to illustrate in detail all the parts around the Ribbon Cable installation.



X-Y-Axes Limitations Point 3:

CAUTION:

Under no circumstances is it permitted to transfer a X/Y-Carriage (including Y-Axis) to another X-Axis.

The distance of the Guide Rollers are matched to the Guide Rods.

In addition, the play of the Pinions from X- and Y- Motors to the Toothed Racks are also matched. Exchanging such critical parts can lead to extensive damage within a short time.

1.46.0.0.0.1 Testing the X-Y-Axes

This section describes the testing the X-Y-Axis of PAL System after Repair, Overhaul, or PM (Preventative Maintenance).

Note: In the case where a Repair, an Overhaul or PM has been done on a PAL System, it is also advisable to check the Firmware level. If the Firmware is not at the current level, an upgrade is recommended whenever possible. For more details, see the section "[PAL Firmware](#)".

In the case of a Repair, it is possible that the flush memory has been stroked and that the Firmware is partially corrupt. This has been observed in situations where the fuse of the CPU or Control Board was blown.

After a repair, it is good practice to re-load the specific back-up file for the particular PAL System. If not available or not on a current level, make an upgrade with a complete backup file (including all objects, not core software only). Upgrading the Firmware only (core software) in an uncontrolled situation such as after a severe repair case, runs the risk that possibly erratic Firmware is not brought back to a secure operating level.

Test Description	Test Procedure
1. X-Y-Assembly without Injection Unit installed, unit not powered up	WARNING: Disconnect the PAL System from the power line and unplug the power cord before any maintenance or repair step is done. Also, disconnect the PAL System from any other device which forms part of the complete system. Move the Y-Z-Assembly back and forth and check the following: - The movement of the Ribbon Cables and the FlexBand. Does it form a nice bow or does the bundle almost collapse? - Is any mechanical restriction felt? Crossing over the middle section of the X-Axis (at the cut-out for the clip) is a critical section. When moving the assembly to the mechanical stop at both ends, does the carriage slide as smoothly as in the middle section? - In case of the Combi PAL or any other unit where a Gas Flush Tube is installed, check the movement of the Gas Flush Tube. Does the tube maintain a bow or does it collapse completely and risk getting caught in the rollers? Note that a slight bending is normal. Check also that the tube runs parallel to the X-Profile, and is not leaning against the inside.
2. Install the Injection Unit to the X-Y-Assembly	CAUTION: Check if the Ribbon Cable from the Y-Axis moves freely and that the connector itself nicely fits into the position of the Y-Axis Front Cover. Install the Injection Unit by not pulling the Ribbon Cable too far out of the Y-Axis Profile. After fixing the unit in place, ensure that the Ribbon Cable is "free floating", not jammed. Reach underneath the Y-Axis in the cut-out of the Profile and move the Ribbon Cable gently. <i>Note: For testing purposes, it is not necessary to install all 3 screws to mount the Injection Unit. Installing only the upper screw is sufficient for testing - but not valid for routine work.</i>
3. Power up the PAL System	Connect the local Terminal to "SER3" and the Power Supply. Other peripherals which are part of the specific PAL System do not have to be connected at this stage. Power up the system. Check if the motors start moving, and the position of the axis is referenced. Check if the Solenoid of the Z-Axis is activated and released (audible noise). Check if any error message appears during the process of powering up the system. Error messages not related to the X-Y-Z-Axis can appear for various reasons, such as modules not installed, wrong Firmware level or wrong Firmware Objects loaded, etc.
4. Test Sensors	Path: Menu/F3-Setup/Service/ Test Switches Activating this section automatically reduces the current from all stepper motors. This way all axes can be moved freely around, without loss of steps.

Test Description	Test Procedure
	Check the cross over of the Sensor for all Axes. The status of each individual Sensor given on the display of the local Terminal. Crossing over of the sensor changes the status and can be monitored right away. - Crossing point for X-Axis: Middle of the X-Axis. One exception is the Dual PAL Systems (120 cm X-Axis and two Injection Units installed). The crossing point is close to the mechanical stop at both sides. - Crossing point for Y-Axis: Sensor is positioned close to "Zero Y", or a few mm away from the X-Axis. - Crossing Point Z-Axis: Push up the syringe slider almost to the top. Other options in the section "Test Switches" are related to the Auxiliary Motor (such as the Valve Drive, etc.) <i>Note: The option "Test Switches" in the class "Service" was introduced into the Firmware from level 2.4.0. This feature not available with earlier versions.</i>
4. Test Motors	If one of the Stepper Motors was the reason for the repair, it is good practice to test the motor individually. Menu/F3-Setup/Service/Test Motors Select the motor to test, for example, X-Axis. Choose the "Start" and "End" position by manually selecting the distance you wish to move. Press "Start" and check if the motor is moving. This is a good test to run for any individual motor, independent of any other component of the PAL System. If necessary the test can be run overnight, as the actual cycles are monitored and an upper limit can be set.
5. Run an Endurance Test	- Install all remaining optional devices which are part of the dedicated PAL System, e.g. TrayHolder, Trays, Valve Drive, Wash Station, Agitator, etc. - Install the Syringe- and Plunger-Holder corresponding to the cycle for the test. - Check and if necessary teach all the positions XYZ, for all hardware options. - Program a Method at the local Terminal by using a standard cycle for injection. - Program as many jobs as required to run the PAL System overnight. Example Headspace analysis: Using Tray 1 (VT32), program a job with 32 vials from Tray 1. Add a second job with the identical Tray. Continue to add jobs, from 10 to 20 should be sufficient to keep the system busy overnight. - Ensure that the SyncSignal setting is on "Immediate". Path: Menu/Setup/Objects/SyncSignal/Start. CAUTION: Do not install a Syringe for the overnight test <i>Note: If a method other than a standard local cycle is needed for testing, use either the Cycle Composer Software or a Data Handling Software with the PAL integrated. Use the same concept as described above to run an endurance test.</i>

Test Description	Test Procedure
6. Run an Endurance Test including PAL Monitoring software	- Connect the PAL System with the provided RS 232 serial cable to a computer. - Load the "PAL Monitor Software" on the computer, preferably not on the user's PC. - Prepare the Endurance Test exactly as described under Point 5. Start the PAL and the software. - After finishing the test, the protocol can be executed. Any error or retry is monitored and stored. The protocol can also be printed out. <i>Note: For more details see the section "PAL Software".</i>
7. Gas Leak Test	The Gas Leak Test is only applicable for PAL Systems with a Gas Flush Tube installed, mainly the Combi PAL models (MZ 02-00, MZ 08-00, MZ 010-00). For the Gas Leak Test, the entire PAL System should be checked simultaneously (X-Y-Z-Axis combined). - Install the Pressure regulator and adjust the secondary pressure to 1 Bar. The standard setting for headspace analysis is 0.5 Bar. - Install the special tool to check the pressure, P/N Tool Flush. - Apply pressure to the system for a short time. Close the valve of the primary source for the gas and monitor the pressure drop over a time period of 10 minutes. The test criteria is a pressure drop of <0.2 bar over 10 minutes. <i>Note: For Tool Flush, see the section "Spare Part Kits for XY_Axis"</i> A leak can be due to any possible connection within the flush line in the entire system. Kinked Gas Flush Tubing can also contribute to a leak (a direct leak or by building up too high pressure). In the entire system, two O-Rings are used to seal. One is installed in the Y-Axis Front Cover and the second one is pressed in a socket, installed in the Syringe Slider to seal against the heated cartridge. The changing of both O-Rings is critical in the field. For more details see the following sections:- "X-Y-Axis Profile and Side Covers", Point # 4.- "Gas Flush Tube Z-Axis", Introduction Point # 2.

Note: The Service Tests "Test Head" is described in the section "[Testing Z-Axis](#)".

CAUTION:

Do not use any soap or similar solutions to test for gas leaks. Possible Contamination of Gas Flush Line.

1.46.0.0.1 Overview Upgrade Path | Spare Part Kits | PM for PAL X-Y-Axes

- [Upgrade Path for X-Y- Axes](#)
- [Spare Part Kits for X-Y-Axes](#)
- [Preventative Maintenance for X-Y-Axis](#)

1.46.0.0.1.1 Overview Upgrade Path | Spare Part Kits | PM for PAL X-Y-Axes

- [Upgrade Path for X-Y- Axes](#)
- [Spare Part Kits for X-Y-Axes](#)
- [Preventative Maintenance for X-Y-Axis](#)

1.46.0.0.1.2 Upgrade Path for X-Y- Axes

This section gives an overview of the various changes to each revision level for the PAL X-Y-Axis (assembly). Information on whether a field upgrade is possible, and on which parts have to be changed are also provided.

The definition of the Revision Level is not identical for all PAL X-Y-Axis models. Models introduced to the production line at later stages began directly with "Revision Level B" at the time of introduction.

Revision Level MXY	Modification from Previous to Indicated Revision Level	Required Parts and Steps for Upgrade to Current Level	Remarks
A	Basic Unit		Early stage of development.
B	Current level	Upgrade from Revision A to B is not applicable.	The change from Revision A to B occurred during an early stage of the PAL System development. Minor mechanical changes have been made. Various changes to all PCBs in the earlier stages led to increases in the revision level.

1.46.0.0.1.3 Spare Part Kits for X-Y-Axes

The Spare Parts and Kits listed for the X-Y-axis are available.

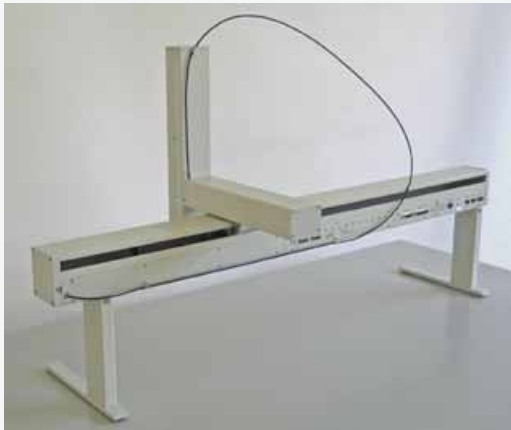
Single Parts which are not listed below are included in a kit.

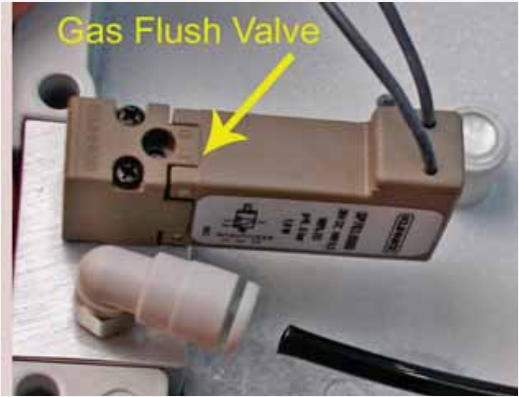
PNo.	Part or Kit Description	Remarks
MM 03-01	Pressure Regulator 0-2.5 Bar (0-35 psi)	Complete Pressure Regulator, incl. Manometer and Tube Fittings. Pressure range 0-2.5 Bar or 0-35 psi. <i>Note: The primary pressure from the gas supply exceed 5 Bar or 70 psi (inlet pressure for PAL P)</i>

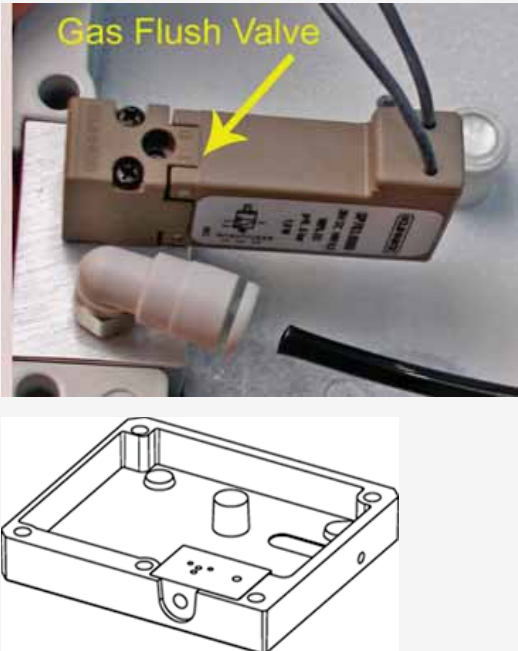
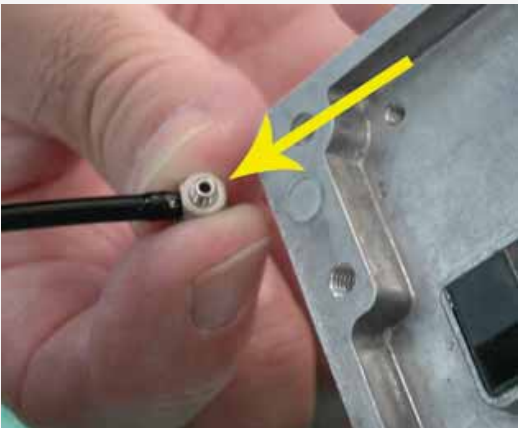
PNo.	Part or Kit Description	Remarks
		
MM 09-01	Fitting assembly PAL Adapter/Tube Connector for Pressure Regulator 	Combined PAL Adapter Tube Fittings. 1/8 " stainless steel and M5 brass connector to 1/8" tube. Gasket O-ring and copper washer included. <i>Note: The picture shows the new type of connector released in June 2007. See Service Note # 04/2007.</i> <i>For replacement, it is advisable to change the 2 gaskets.</i>
MM 015-01	Tube Connector from Pressure Regulator to Tubing, 1/8" 	Tube Connector brass, M5-1/8", including O-Ring <i>Note: The picture shows the new type of connector released in June 2007. See Service Note # 04/2007.</i> <i>For replacement, it is advisable to change the 2 gaskets.</i>

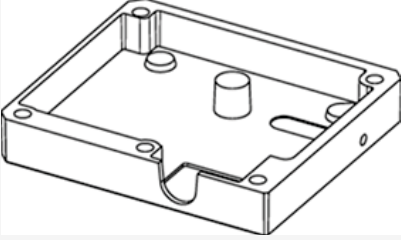
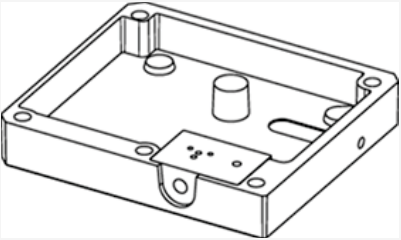
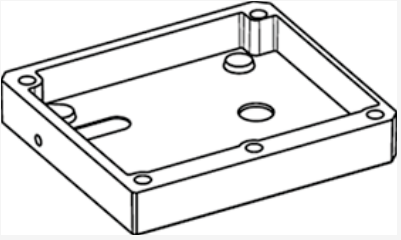
PNo.	Part or Kit Description	Remarks
D2515-25R	Manometer for Pressure Regulator, 0-2.5 Bar (0-35 psi) 	Manometer for Pressure Regulator, range 0-2.5 bar or 0-35 psi. <i>Note: The Manometer has been not changed with Fittings and sealing Gaskets.</i>
Kit Seal Flush	Kit Sealing Gaskets for Pressure Regulator, 10 pcs 	<i>Note: The picture shows the new type of connection released in June 2007. See Service Note # 04/2</i> <i>For replacement, it is advisable to change the 2 gaskets. The old style of sealing gaskets are no longer available.</i>

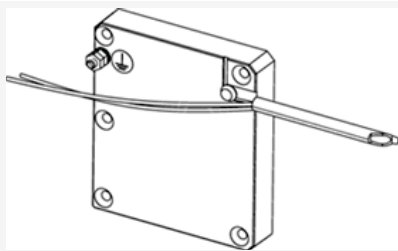
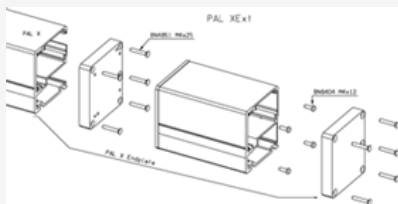
PNo.	Part or Kit Description	Remarks
PAL TubeFlushX	Replacement Kit for Flush Tube-X in PAL80 crossrail.  	Replacement Kit for Gas Flush Tube in X-Axis. Length of Tube: 97 cm. Kit includes:- Gas Flush Tube for X-Axis, Metal U to fix Tube in X-Axis Profile, 3 pcs- Instructions <i>Note: More detailed instructions are provided with the kit.</i> <i>In the kit, 2 tubes are provided. In case one tube is replaced, a second tube would be provided.</i>

PNo.	Part or Kit Description	Remarks
PAL TubeFlushXY	Replacement Kit for Gas Flush Tube for X-Y-Axis, complete Tube. 	Replacement Gas Flush Tube for the X-Y- Asse Length of Tube: 165 cm. Kit includes:- Gas Flush TubeXY, 2 pcs- Gas Tu pcs- Adapter to fix Tube in X-Axis Profile, 4 pcs <i>Note: Instructions are not included in the kit. See details.</i> <i>In the kit are 2 tubes provided. In case one tube ment procedure would a second tube be availa fixation adapter are provided as well.</i>
PAL TubeFlushLHX	Replacement Kit for Gas Flush Tube LHX PAL. No picture available (tube only).	Kit Gas Flush Tube for PAL LHX model. Kit contains only the Gas Flush Tube, length 20 See also P/N: Kit Flush LHX <i>Note: This Gas Flush Tube is connected externa short Gas Flush Tube installed in the Y-Axis Fro able. See P/N MY 31-01.</i>
Kit Flush LHX	Gas Flush Kit for LHX PAL, field upgrade kit  Field Upgrade Kit. Do not order for repair cases. <i>Note:</i> The installation of the Gas Flush Tube for LHX PAL is described in section "XY Gas Flush Tube, complete Tube", at the end of the section.	This kit is a so-called "Field Upgrade Kit". Early v not been provided with the Gas Flush option. Th and LHX PAL configuration today. The kit consists of: - MX 30-11; Side Cover X-Axis for Combi PAL - MN 03-00; Pressure Regulator - MX 90-00; Gas Flush Valve - MY-31-01; Y-Axis Font Cover incl. Gas connec - MX- 42; Blind cover for LHX PAL - PAL TubeFlushLHX; Gas Flush tube, 200 cm - various smaller parts

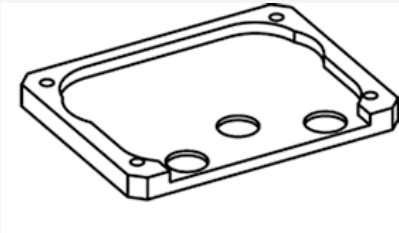
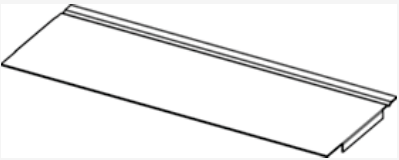
PNo.	Part or Kit Description	Remarks
KJL23-M3	Elbow Adapter for Gas Flush Tube 	Elbow adapter complete with gasket seal. Single piece. 
MX 90-00	Gas Flush Valve for COMBIPAL 	Complete kit including electrical connections and Part is obsolete. New included in 'Kit FlushVlv' o
MX 90-01	Gas Flush Valve for LHX and HS PAL <i>Note: Picture is identical with MX 90-00.</i>	Identical kit as MX 90-00 but with longer electric

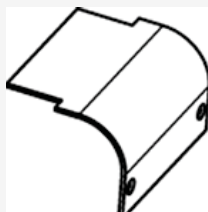
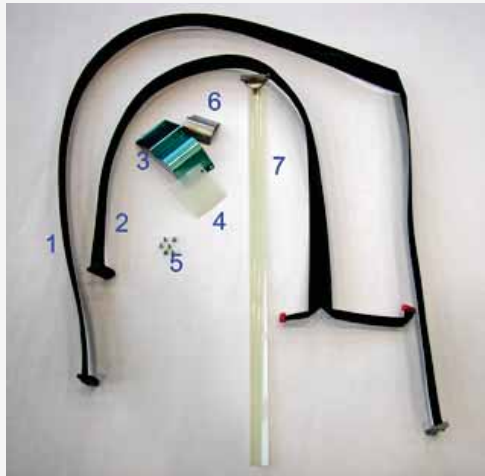
PNo.	Part or Kit Description	Remarks
Kit FlushVlv	Kit Gas Flush Valve for Combi PAL. 	Kit for PAL System. Kit includes the Gas Flush Valve and the PAL X side, incl. Gas Distribution Block. Single PNo.: MX 91-01 and MX 30-36
Kit FlushVlv-xt	Kit Gas Flush Valve for PAL COMBI-xt and PAL LHX-xt models. <i>Note:</i> <i>Pictures are identical with 'Kit FlushVlv'.</i>	Kit for PAL-xt System. Kit includes the Gas Flush Valve and the PAL X side, incl. Gas Distribution Block. Single PNo.: MX 91-01 and MX 30-36
M-3ALU-3	Gas Tube Adapter, 90 ° 	Gas Tube Adapter incl. Sealing Gasket. 

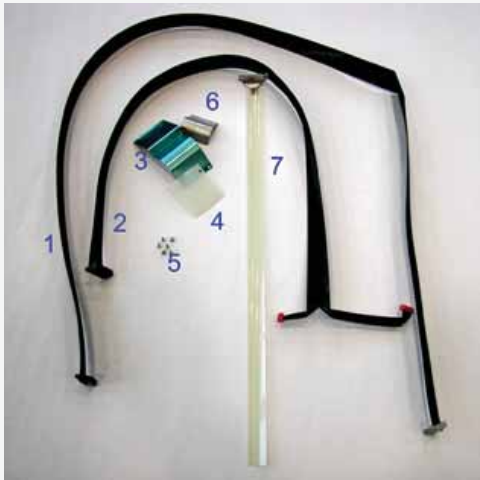
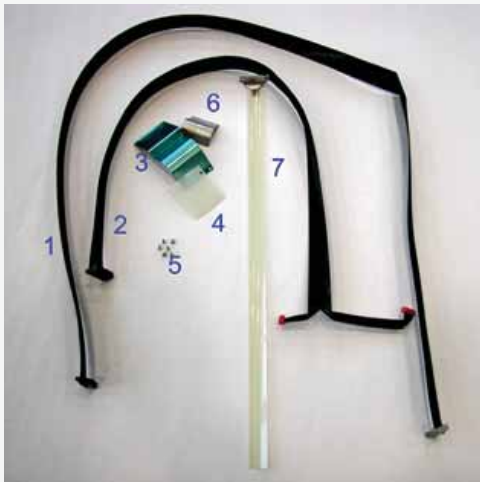
PNo.	Part or Kit Description	Remarks
MX 30-27	PAL X-Axis Side Cover Right hand side 	Side Cover without Gas Distribution Block installed. <i>Note: Without Screws BN 4851 M4x25</i>
MX 30-48-3	PAL-xt X-Axis Side Cover Right hand side <i>Note: Picture is identical with Part MX 30-27.</i> <i>PNo. MX 30-48-2 same part, branded for Thermo.</i>	Side Cover without Gas Distribution Block installed. Form slightly changed. Color in PAL-xt color. <i>Note: Without Screws BN 4851 M4x25</i>
MX 30-11	PAL X-Axis Side Cover Right hand side, incl. Gas Distribution Block 	Side Cover does include the Gas Distribution Block. <i>Note: Without Screws BN 4851 M4x25</i> <i>Part is obsolete. New included in 'Kit FlushVlv-xt', see above.</i>
MX 30-10	PAL X-Axis Side Cover Left hand side 	<i>Note: Without Screws BN 4851 M4x25</i>
MX 30-47-3	PAL-xt X-Axis Side Cover Left hand side <i>Note:</i> <i>Picture is identical with Part MX 30-10.</i> <i>PNo. MX 30-47-2 same part, branded for Thermo.</i>	Note: Without Screws BN 4851 M4x25 Form slightly changed. Color in PAL-xt color.
MX 30-41	PAL X-Axis side Cover Left hand side with Grounding Point	Side Cover has an external grounding point, used for grounding. <i>Note: Without Screws BN 4851 M4x25</i>

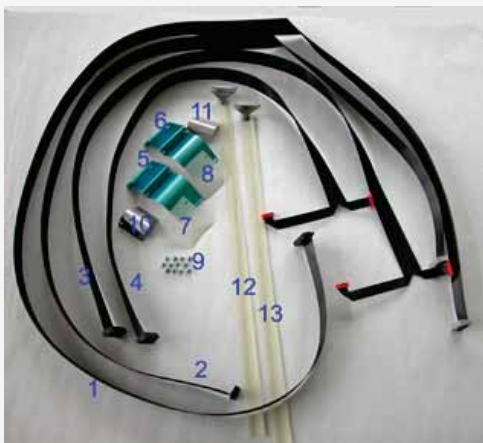
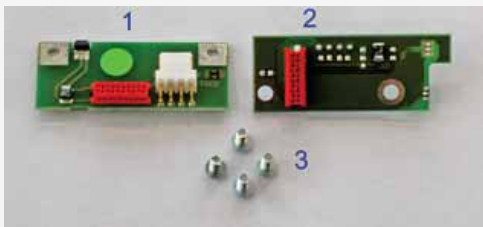
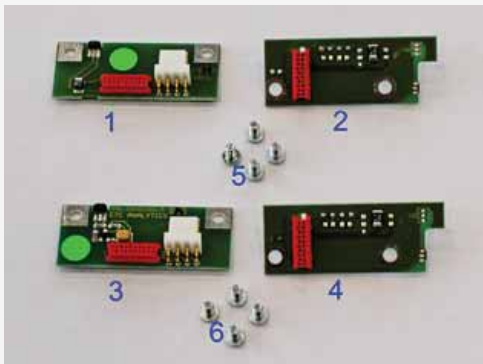
PNo.	Part or Kit Description	Remarks
		
PAL XExtR	PAL X-Axis Extension Right hand side, 126 mm 	' For more details, see the section "XY-Profile", I Note that the original X-Axis Side Cover has to be replaced by the final X-Axis Side Cover. See also service Note # 13/2004 for an example
PAL XExtR-xt	PAL-xt X-Axis Extension Right hand side <i>Note:</i> <i>Picture is identical with Part PAL XExtR..</i>	Form slightly changed. Color in PAL-xt color.
PAL XExtL	PAL X-Axis Extension Left hand side, 126 mm <i>Note: Setup for X-Axis Extension Left hand side is identical but mirror-inverted.</i>	For more details, see the section "XY-Profile", I Note that the original X-Axis Side Cover has to be replaced by the final X-Axis Side Cover. See also service Note # 13/2004 for an example
PAL XExtL-xt	PAL-xt X-Axis Extension Left hand side, 126 mm <i>Note:</i> <i>Setup for X-Axis Extension Left hand side is identical but mirror-inverted.</i>	Form slightly changed. Color in PAL-xt color.
PAL TwinKit1	PAL Twin Kit	PAL Twin Kit to mount 2 PAL Systems on top of each other. Kit consists of: - PAL X-Axis Extension Right hand side

PNo.	Part or Kit Description	Remarks
	<i>Note:</i> The diagram shows the left hand side and the back plate to lower the upper Injection Unit. The installation on the right hand side is identical, but a mirror image of this.	- PAL X-Axis Extension Left hand side - Back plate for upper Injection Unit (to enable be tioned at the same height) - Extension for Z-Ribbon Cable for upper Injecti - Various screws
PAL TwinKit1-xt	PAL-xt Twin Kit <i>Note:</i> Picture is identical with Part PAL TwinKit1...	Form slightly changed. Color in PAL-xt color.
BN 4851 M4x25	Screw for X-Axis Side Covers	<i>Note:</i> Screws are individually available.
MY 30-10	PAL Y-Axis Front Cover 	<i>Note:</i> Without Screws BN 4851 M3x20

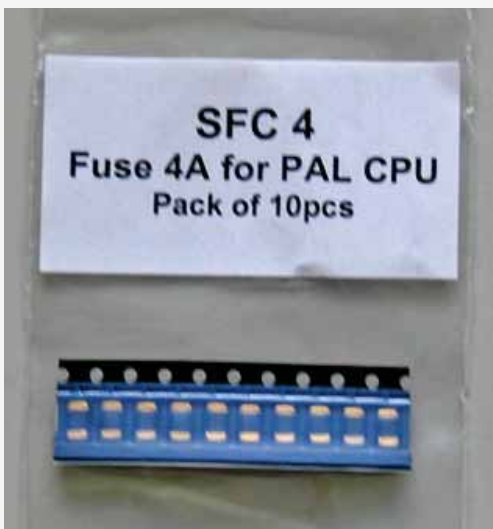
PNo.	Part or Kit Description	Remarks
MY 31-01	PAL Y-Axis Front Cover for LHX PAL including Gas Flush Tubing connections. 	Y-Axis Front Cover with cut-out for Gas Flush Tube PAL. This is a complete kit; Front Cover with gas connection quick connector installed. Tubing and connections are not individually available. The long Gas Flush Tube, guided outside along the single part. See P/N: PAL TubeFlushLHX.
MY 30-11	PAL Y-Axis Rear Cover 	<i>Note: Without Screws BN 4851 M3x20</i>
MY 30-17-3	PAL-xt Y-Axis Rear Cover <i>Note: Picture is identical with Part MY 30-11...</i>	Form slightly changed. Color in PAL-xt color.
BN 4851 M3x20	Screws for Y-Axis side Covers	<i>Note: Screws are individually available.</i>
MY 30-12	Sheet Metal Cover for Ribbon Cable, 170 mm 	Cover as used for standard Y-Axis length, for example PAL. Y-Axis length 312 mm.
MY 30-14	Sheet Metal Cover for Ribbon Cable, 215 mm	Cover as used for extended Y-Axis, for example Y-Axis length 402 mm.

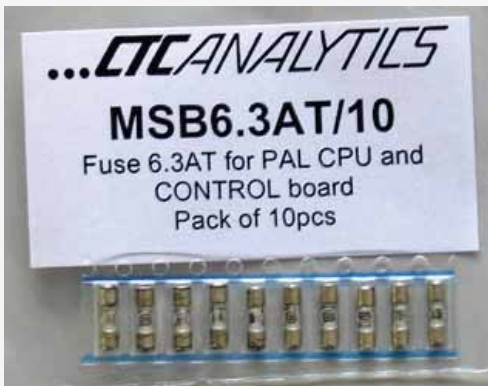
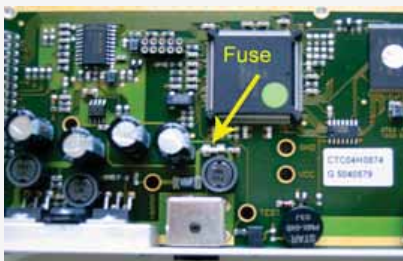
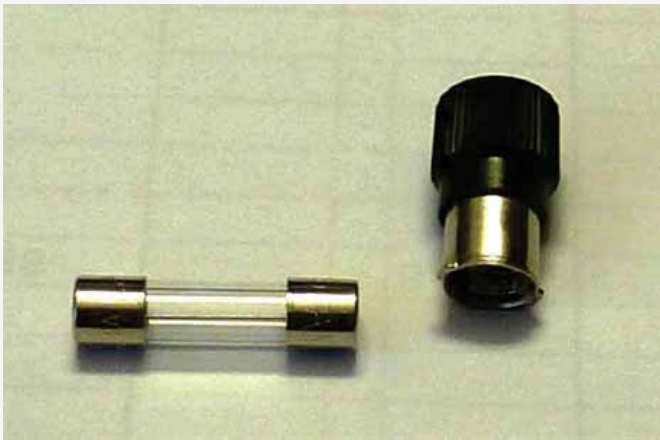
PNo.	Part or Kit Description	Remarks
		
PAL FlexBandKit1	PAL Flexband for standard PAL50/80 Models, 1 pc 	FlexBand is provided in one length. Cut in length Kit includes:- Flexband with metal bracket mount M3x6, 2 pcs
PAL FlexBandKit2	PAL FlexBand for PAL Models 120 cm length, single Z-Axis installed, 1 pc 	Flexband for PAL Models with a length of 120 cm Cut in length for Single Head, Dual Head Right c Important: Order 2 kits for a Dual Injection Unit Kit includes:- Flexband with metal bracket mount M3x6, 2 pcs
MX 20-15	Metal Angle Bracket for Ribbon Cable 	Bracket to hold Ribbon Cables and Flexband.
PAL RCbI50	Ribbon Cable Kit for PAL X-Axis 50 cm 	Kit includes: - Ribbon Cable X/Y, 760 mm, 1 pc-Ribbon Cable Axis Ribbon Cable, 1 pc-Polymer Guiding Shield 6404 M3x6, 4 pcs <i>Note: Parts # 6 and # 7 are shown in the picture parts around the Ribbon Cable installation.</i>

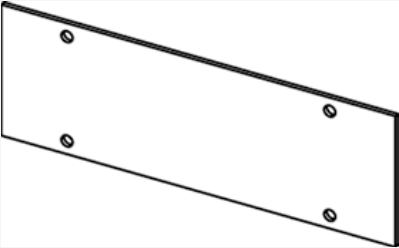
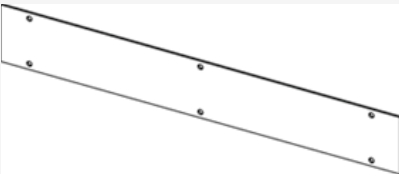
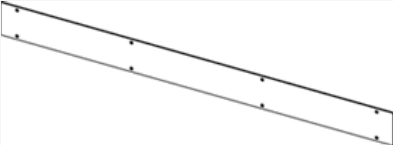
PNo.	Part or Kit Description	Remarks
PAL RCbI80	Ribbon Cable Kit for PAL X-Axis 80 cm 	Kit includes: - Ribbon Cable X/Y, 870 mm, 1 pc- Ribbon Cable X/Y, 1 pc- Polymer Guiding Shield, 1 pc- Polymer Guiding Shield, 6404 M3x6, 4 pcs <i>Note: Parts # 6 and # 7 are shown in the picture parts around the Ribbon Cable installation.</i>
PAL RCbI120	Ribbon Cable Kit for PAL X-Axis 120 cm, for Single Injection Unit PAL Models 	Kit includes: - Ribbon Cable X/Y, 1105 mm, 1 pc- Ribbon Cable X/Y, 1 pc- Polymer Guiding Shield, 1 pc- Polymer Guiding Shield, 6404 M3x6, 4 pcs <i>Note: Parts # 6 and # 7 are shown in the picture parts around the Ribbon Cable installation.</i>
PAL RCbIDual	Ribbon Cable Kit for PAL X-Axis 120 cm, for Dual Injection Unit PAL Models	Kit includes: - Ribbon Cable X/Y, 1105 mm, (right side) 1 pc- Ribbon Cable X/Z, 1785 mm, (right side) 1 pc- Ribbon Cable X/Z, 1510 mm, (left side) 1 pc- Cover Y-Axis Ribbon Cable, Y-Axis, 2 pcs- Screws BN 6404 M3x6 <i>Note: Parts # 10/11 and # 12/13 are shown in the detail all the parts around the Ribbon Cable installation.</i>

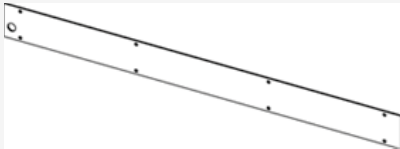
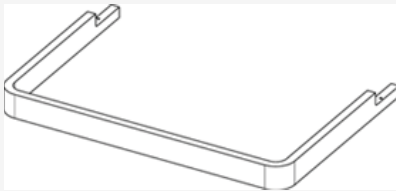
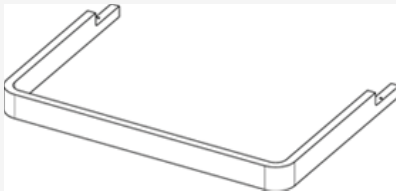
PNo.	Part or Kit Description	Remarks
		
PAL XYSens	X-Y-Axis Position Sensor PCB's, Kit 	Kit includes: - X-Axis Position Sensor PCB, 1 pc - Y-Axis Position Sensor PCB, 1 pc - Screws BN 6404 M3x6, 4 pcs
PAL XYSensDual	X-Y-Axis Position Sensor PCB's, Dual Kit for Dual Injection Unit PAL Models 	Kit includes: - X-Axis Position Sensor PCB, 1 pc ; # 1, # 3 - X-Axis Position Sensor PCB Inversed Logic, 1 - Y-Axis Position Sensor PCB, 2 pcs, # 2 and # 4 - Screws BN 6404 M3x6, 8 pcs, # 5 and # 6
MX 52-00	Grounding Conductor for X/Y Carriage 	<i>Note: Whenever possible, use the original cond. has changed slightly from earlier versions.</i> <i>The picture below shows an earlier version.</i> 

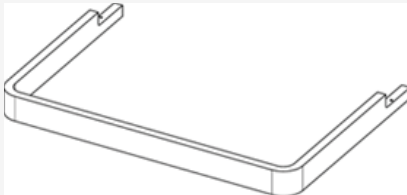
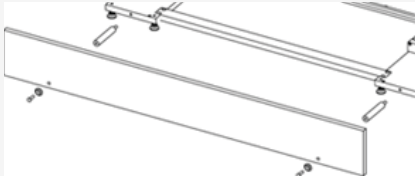
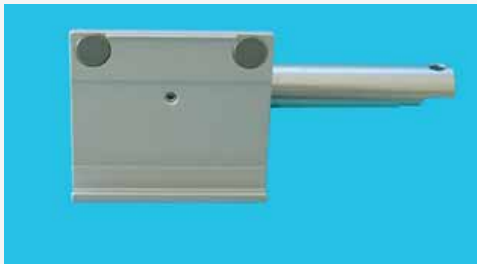
PNo.	Part or Kit Description	Remarks
		The conductor is delivered without screws. For more details, see the section "YSensPCB".
APR CPU	CPU Board for PAL System 	CPU Board for PAL models : - Combi PAL - HTS PAL - Dual Injection Unit PAL <i>Note: Replacement boards for repair cases have support group. A RMA Number has to be requested when purchasing a new board. This minimizes the costs for the user.</i>
APR MOTIO	Motor Driver and Input/Output Processing Board for PAL System  <i>Note:</i> The picture shows all 3 boards for comparison. The MOTIO Board is on the front right.	MOTIO Board for PAL models : - COMBIPAL - HTS PAL - Dual Injection Unit PAL <i>Note: Replacement boards for repair cases have support group.</i> <i>A RMA Number has to be requested. A repair is less expensive than purchasing a new board. This minimizes the costs for the user.</i>
APR Control-GC	Control Board for GC PAL  <i>Note:</i> The picture shows all 3 boards for comparison. The Control Board is the one in the back.	Single board with the combined functions of the Control-GC Board has the following limitations:- - Connector for Wash Station- Interface1 Connector devices, HS-Syringe, Agitator, etc. <i>Note: Replacement boards for repair cases have support group.</i> <i>A RMA Number has to be requested. A repair is less expensive than purchasing a new board. This minimizes the costs for the user.</i>
APR Control-HTC	Control Board for HTC PAL See picture above. <i>Note: Replacement boards for repair cases have to be handled through the support group.</i> <i>A RMA Number has to be requested. A repair is less expensive than purchasing a new board. This minimizes the costs for the user.</i>	Single board with the combined functions of the Control-HTC Board has following limitations - 1 Auxiliary Connector only - Small Connector for Wash Station, requires dedicated - Interface1 connector only
APR Control-LC	Control Board for LC PAL See picture above <i>Note: Replacement boards for repair cases have to be handled through the support group.</i>	Single board with the combined functions of the Control-LC Board has following limitations:- 1 Auxiliary Connector for Wash Station, requires dedicated Important: The Control-LC board has a fixed f

PNo.	Part or Kit Description	Remarks
	<i>A RMA Number has to be requested. A repair is less expensive than purchasing a new board. This minimizes the costs for the user.</i>	Flash Memory is key protected to prevent loading as TrayHolders, Valve Drives, etc. However, it is or Tray Types to the firmware.
APR Control-xt	Control Board for PAL-xt Systems 	This Control Board is used for all PAL-xt Models Following Interface connectors are provided: - Terminal -SER1 - LAN - MODBUS - Wash Station - Interface1 and Interface2 - AUX1 and AUX2 - Power - Fuse (T6.3A L; 250 VAC) Fuse description see
SFC 4/10	SupraFuse 4A for PAL CPU and Control Boards, pkg of 10 pcs 	Original fuse for PAL CPU and Control Boards. Is soldered to the PCB. <i>Note: The SupraFuse has been replaced in 200 connecting and reconnecting the DC cable with supply has blown the 4A SupraFuse.</i>
MSB6.3AT/10	Fuse 6.3AT for PAL CPU and Control Boards, pkg of 10	This fuse is soldered directly onto the PCB. For details, see Service Note # 06/2002. <i>Note:</i> <i>This fuse is backward compatible. Solder out the 4A and fit the new fuse in same place.</i>

PNo.	Part or Kit Description	Remarks
		
Fuse for APR Control-xt	Fuse for APR Control-xt Description: T6.3 A L; 250 VAC; 20x5 mm 	The picture shows the Fuse and the Fuse Holder board. The fuse is positioned at the backside of the board accessed and replaced. The fuse is a standard type and is locally common. It is not carried as a spare part by CTC Analytics. 
BAT VL2330	Backup Battery for PAL CPU/Control Board (1 pc)	The battery is rechargeable. Connect the board to 36 Volts over night. <i>Note: A board which has not been connected to power for months has to be reloaded first. Then, load a circuit to test the board. It is possible that some data loss can occur.</i>

PNo.	Part or Kit Description	Remarks
		
MX 30-12	Blind Cover for COMBI/HTS PAL 	Blind cover for electronic channel at back side of For Combi and HTS PAL Systems only.
MX 30-34	Blind Cover for GC PAL 	Blind cover for electronic channel at back side of For GC PAL Systems only.
MX 30-39	Blind Cover for HTX/HTXX PAL 	Blind cover for electronic channel at back side of For HTX and HTXX PAL Systems only.

PNo.	Part or Kit Description	Remarks
MX 30-42	Blind Cover for LHX PAL 	Blind cover for electronic channel at back side of for the Gas Flush Tube. For LHX PAL Systems only.
MX 30-37	Faceplate X-Axis Gas Inlet 	Faceplate to cover the gas inlet on the X-Axis for have the Pressure regulator installed. 
MX 33-00	Plexiglas Safety Guard for PAL50 	Safety Guard used for LC and HTC PAL Systems For X-Axis length 50 cm.
MX 32-00	Plexiglas Safety Guard for PAL 80 	Safety Guard used for GC, Combi and HTS PAL For X-Axis length 80 cm.

PNo.	Part or Kit Description	Remarks
MX 36-00	Plexiglas Safety Guard for PAL 120 	Safety Guard used for LHX, HTX and HTXX PA Unit. Can be used also for IFC analytical version (not bed). Leg length laid out for extended Y-Axis (4
MR 30-157	Safety Guard for IFC PAL 	Safety Guard in the form of a panel, mounted in IFC PAL prep version or Dual Bed Moving versic ing Bed, a panel can be mounted in the front an This P/N is for the panel only. The cross beam, screws and washers are not in - MR 30-158; Cross Beam for IFC PAL - MR 30-176; Cross Beam for Dual Bed, front mc - MR 30- 190; Cross Beam for Dual Bed, rear mc - Screw: BN 3803 M5x20 -Washer: BN 4879 M&
MB 20-00	Holder Assembly for PAL Control Terminal 	Holder Assembly for Control Terminal does not i PNo.: MX 37-00.
MX 37-00	Screw Kit for Safety Guard	Screws for the Holder Assembly and safety Gua

PNo.	Part or Kit Description	Remarks
		
Kit HTS-xt	Kit xt-Upgrade for HTS PAL System	Kit to Upgrade an existing HTS PAL to a PAL H' Kit consisting of: - APR Control-xt Board (incl. 10 screws BN6404) - Blind Cover (MX 30-34) - LAN Cable, Cbl RS8J-3000) - Cable Wash station (Cbl R4LX-1300) - AUX Cable (Cbl RS20R-1300) - Cable MODBUS_Serial Valve Drive (Cbl 14R-8 - User Manual and PAL-xt System CD
Kit HTC-xt	Kit xt Upgrade for HTC PAL System Note: With PNo. 'Kit HTC-xt AGI2' is an identical kit available with Agilent branded parts.	Kit to Upgrade an existing HTC PAL to a PAL H' Kit consisting of: - APR Control-xt Board (incl. 10 screws BN6404) - LAN Cable, Cbl RS8J-3000) - Cable Wash station (Cbl R4LX-1300) - AUX Cable (Cbl RS20R-1300) - Cable MODBUS_Serial Valve Drive (Cbl 14R-8 - User Manual and PAL-xt System CD

PNo.	Part or Kit Description	Remarks
Kit HTX-xt	Kit xt Upgrade for HTX PAL System	Kit to Upgrade an existing HTX PAL to a PAL HT Kit consisting of: - APR Control-xt Board (incl. 10 screws BN6404 - Blind Cover (MX 30-45) - LAN Cable, Cbl RS8J-3000) - Cable Wash station (Cbl R4LX-1300) - AUX Cable (Cbl RS20R-1300) - Cable MODBUS_Serial Valve Drive (Cbl 14R-8 - User Manual and PAL-xt System CD
Kit COMBI-xt	Kit xt Upgarde for COMBI PAL System	Kit to Upgrade an existing COMBI PAL to a PAL Kit consisting of: - APR Control-xt Board (incl. 10 screws BN6404 - Kit Flush Valve-xt (Side cover right hand side, (- Gas distribution block, Elbow connector) - Blind Cover (MX 30-34) - LAN Cable, Cbl RS8J-3000) - Cable Wash station (Cbl R4LX-1300) - AUX Cable (Cbl RS20R-1300) - Cable MODBUS_Serial Valve Drive (Cbl 14R-8 - User Manual and PAL-xt System CD
Kit LHX-xt	Kit xt Upgrade for LHX PAL System	Kit to Upgrade an existing LHX PAL to a PAL LH Kit consisting of: - APR Control-xt Board (incl. 10 screws BN6404 - Kit Flush Valve-xt (Side cover right hand side, (- tribution block, Elbow connector) - Blind Covers (MX 30-34 and MX 30-45) - LAN Cable, Cbl RS8J-3000) - Cable Wash station (Cbl R4LX-1300) - AUX Cable (Cbl RS20R-1300) - Cable MODBUS_Serial Valve Drive (Cbl 14R-8 - User Manual and PAL-xt System CD
PAL Screw Kit	not available yet.	The Screw Kit has to be defined and will be part
PAL PMKit1	Preventative Maintenance (PM) Kit for PAL HPLC Technique	Preventative Maintenance Kit for all PAL HPLC and similar or related techniques For details, see the section "PM".

PNo.	Part or Kit Description	Remarks
PAL PMKit2	Preventative Maintenance (PM) Kit for PAL GC Technique	Preventative Maintenance Kit for all PAL System or related techniques . For details, see the section " PM " .
PAL LubKit	PAL Lubrication Kit 	PAL Lubrication Kit includes: - PAL Lub (dedicated grease for PAL System, approx. 5g) - Brush for greasing This kit is part of the PM Kit
Tool Flush	Leak Test Meter for Gas Flush Line in PAL System 	Tool to check gas leak tightness for the entire PAL System. For details, see the section " XY Test ".
PAL ToolKit	Tool Kit for PAL System	Includes the necessary Tools, like Torx drivers, ...

PNo.	Part or Kit Description	Remarks
		
PAL MR-Std	Standard Support Leg, 215 mm, 2 pcs 	This standard support leg can be used to assemble from a GC onto a bench for servicing.
PAL MR-Std-xt	PAL-xt Standard Support Leg, 215 mm, 2 pcs	This standard support leg can be used to place GC onto a bench for servicing.
MR 10-00	Module clamp for PAL 	Single clamp for X-Axis. Can be used to hold a hardware object at the X-Axis, in case of a repair.

PNo.	Part or Kit Description	Remarks
USB-Ser2	USB to 2 RS232 Converter (connects PAL SER ports to USB port) 	USB/RS232 converter tested with va puter.
	LOCTIDE 243	Color: Blue Used to fix screws. <i>Note: Not provided by CTC Analytics, for inform</i>
	LOCTIDE 638	Color: Green Used to glue parts such as the Swi combination with an activator). <i>Note: Not provided by CTC Analytics, for inform</i>
	LOCTIDE 480	Color: Black Used to glue parts, such as Switchir er. LOCTIDE 480 is a quick-setting glue. No corr <i>Note: Not provided by CTC Analytics, for inform</i>

Note: Stepper Motors for X- and Y- Axis as well as Toothed Racks for X- and Y- Axis are not provided. See also the section "Limitations". Contact the CTC Support Group when failure of one of these parts occurs.

1.46.0.0.1.4 **Preventative Maintenance (PM) for the PAL X-Y-Axes Assembly**

The Preventative Maintenance (PM) for the PAL X-Y-Axes is covered in the PM Document for GC and HPLC Technique.

The following 'PM Kits' are available:

- PAL PM Kit1: PM Kit for HPLC Technique, HTS, HTC, LC PAL Systems (including PAL DLW-2 Option).
- PAL PMKitDLW for HPLC Technique. PAL systems including PAL DLW Option (not for PAL Dlw-2 Option).
- PAL PM Kit2: PM Kit for GC Technique, COMBI and GC PAL Systems.

Note: The PM Kits are identical for PAL and PAL-xt Systems.

The PM Kits contain the PM Procedure Document, the spare parts recommended to be changed annually, as well as the PAL specific Grease and a Brush.

CTC Analytics recommends to perform a PM procedure for the PAL system once a year.

For more details, see the section "[Preventative Maintenance](#)".

1.46.0.0.2 X,-Y- Axes Overview

This section covers following points:

- [X-, Y-Axes Release History](#)
- [Troubleshooting](#)
- [X-, Y--Axes Repair Path](#)
- [X-, Y-Axes Upgrade Path](#)
- [X-, Y-Axes Spare Parts](#)
- [X-, Y-Axes Preventative Maintenance \(PM\)](#)

1.46.0.1 PAL Power Supply Overview

This section 'PAL Power Supply' covers following items:

- [PAL Power Supply Overview](#)
- [PAL Power Supply Release History](#)
- [Troubleshooting](#)
- [Repair Path for PAL Power Supply](#)
- [Upgrade Path for PAL Power Supply](#)
- [Spare Parts for PAL Power Supply](#)
- [Preventative Maintenance \(PM\) for PAL Power Supply](#)

1.46.0.1.1 Overview PAL Power Supply

PowerSupplyPNo.	Used for PAL Model	Description
MN 01-00	Used for all CTC Analytics branded PAL Systems	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
MN 01-02	Used for all Thermo branded PAL Systems.	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
MN 01-02	Used for all CTC Analytics branded PAL- <i>xt</i> Systems (identical with the Agilent brand).	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
NN 01-00	New generation Power Supply. (For information only. This power supply is not yet further described in PAL SM 1.1.0)	Output: 36 V; 200W Electronic Module: SIM-Z25

1.46.0.1.1.1 Overview PAL Power Supply

PowerSupplyPNo.	Used for PAL Model	Description
MN 01-00	Used for all CTC Analytics branded PAL Systems	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
MN 01-02	Used for all Thermo branded PAL Systems.	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
MN 01-02	Used for all CTC Analytics branded PAL- xt Systems (identical with the Agilent brand).	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
NN 01-00	New generation Power Supply. (For information only. This power supply is not yet further described in PAL SM 1.1.0)	Output: 36 V; 200W Electronic Module: SIM-Z25

1.46.0.1.1.2 Overview PAL Power Supply

PowerSupplyPNo.	Used for PAL Model	Description
MN 01-00	Used for all CTC Analytics branded PAL Systems	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
MN 01-02	Used for all Thermo branded PAL Systems.	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
MN 01-02	Used for all CTC Analytics branded PAL- xt Systems (identical with the Agilent brand).	Standard Power Supply. Output: 36 V; 150 W Current Electronic Module: SIM-Z915
NN 01-00	New generation Power Supply. (For information only. This power supply is not yet further described in PAL SM 1.1.0)	Output: 36 V; 200W Electronic Module: SIM-Z25

1.46.0.1.1.3 Release History PAL Power Supply

Revision Level	Modifications from Previous Revision Level	Remarks
A	Basic Unit. supplier Amilcon.	Rev. A can be upgraded to Rev. B. This step is not recommended. A power Supply modul with revision A is at least 15 years old.
B	Power Supply Amilcon with corrections.	Improved electronic field immunity. Rev. B cannot be upgraded to a higher revision level. Change of PCB with Revision C.
C	New electronic module (PCB). Supplier SkyNet.	Description: SIM-915C.
D	Second DC Connector added.	Label of 2nd connector: AUX
E	Grounding concept changed.	
F	New color for housing.	No change on electronic part.

1.46.0.1.2 Troubleshooting the PAL Power Supply

Error Symptom	Possible Cause	Recommended Actions
No current from Power Supply	Power cable not connected. Fuse blown. Inlet Connector with loose connection.	Check cable. Replace Fuse. Check soldering of inlet connector.
Green LED not ON	Power cable not connected. Fuse blown. LED defect.	Check cable. Replace Fuse. Replace entire Power Supply module.
No current to PAL System	Fuse of Power Supply blown. Outlet connector(s) with loose connection. DC cable defect. Electronic module defect. Fuse from PAL System PCB blown.	Replace Fuse. Check soldering of outlet connector(s). Replace DC cable. Replace entire Power Supply module. Replace fuse on PCB from PAL System.
Grounding	Manipulation on grounding connection.	Safety warnings: Never modify or alter the grounding connections.

1.46.0.1.2.1 Troubleshooting the PAL Power Supply

Error Symptom	Possible Cause	Recommended Actions
No current from Power Supply	Power cable not connected. Fuse blown. Inlet Connector with loose connection.	Check cable. Replace Fuse. Check soldering of inlet connector.
Green LED not ON	Power cable not connected. Fuse blown. LED defect.	Check cable. Replace Fuse. Replace entire Power Supply module.
No current to PAL System	Fuse of Power Supply blown. Outlet connector(s) with loose connection. DC cable defect. Electronic module defect. Fuse from PAL System PCB blown.	Replace Fuse. Check soldering of outlet connector(s). Replace DC cable. Replace entire Power Supply module. Replace fuse on PCB from PAL System.
Grounding	Manipulation on grounding connection.	Safety warnings: Never modify or alter the grounding connections.

1.46.0.1.2.2 No Current from Power Supply

Possible Cause	Recommended Action	Remarks
Power cable not connected.	Check the connection of the power cable. Check the quality of the power cable, when in doubt, replace it.	Safety Warning: Be careful if the cable is connected to current power supply. Mishandling or a defective part can cause an electrical shock.
Fuse blown.	Replace Fuse.	Fuse rating: 5HT 250 VAC For how to access the fuse, see the section ' Repair Path '.
Outlet Connector with loose connection.	Check soldering of inlet connector.	While following all safety precautions, turn on the power supply and move the AC cable connector gently to ensure that no flickering occurs.

1.46.0.1.2.3 Green LED not ON

Possible Cause	Recommended Action	Remarks
Power cable not connected.	Check the connection of the power cable. Check the quality of the power cable, when in doubt, replace it.	Safety Warning: Be careful if the cable is connected to a power supply. Mishandling or a defective part can cause an electrical shock.
Fuse blown.	Replace Fuse.	Fuse rating: 5HT 250 VAC How to access the fuse, see section ' Repair Path '.
LED defect.	If the two points above are checked and the LED is still not ON, replace entire Power Supply module.	For safety reasons there are no repairable parts on the electronic module from the power supply.

1.46.0.1.2.4 No Current to PAL System

Possible Cause	Recommended Action	Remarks
Fuse blown.	Replace Fuse.	Fuse rating: 5HT 250 VAC For how to access the fuse, see the section ' Repair Path '.
Outlet connector(s) with loose connection.	Check soldering of inlet connector. With all safety pre-cautions set, turn on the power supply and move the DC cable connector gently to ensure that no flickering occurs. If in doubt, replace the entire Power Supply module.	Safety Warning: Be careful if the cable is connected to a power supply. Mishandling or a defective part can cause an electrical shock. For safety reasons there are no repairable parts on the electronic module from the power supply.
DC cable defect.	Check the connection of the DC cable. Check the quality of the DC cable, when in doubt, replace it.	Safety Warning: Pay attention if the cable is connected to current. Wrong handling or a defective part can cause an electrical shock.
Electronic module defect.	Check the electronic unit for any visible damage, burned or blown parts. When in doubt, replace the entire Power Supply module.	For safety reasons there are no repairable parts on the electronic module from the power supply.
Fuse from PAL System PCB blown.	Locate the fuse and measure out the ohmic resistance. Replace the fuse and check the unit again.	Location of fuse for PAL Systems: Mounted on CPU or Control board. Note: If APR MOTIO Board is lower than revision E.J. replace the board. Location of fuse for PAL-xt Systems: Backside of APR Control-xt board. Fuse older version: PAL SFC4 4A. Fuse new version: MSB6.3 AT

1.46.0.1.2.5 Grounding

Possible Cause	Recommended Action	Remarks
Manipulation on grounding connections.	Check if the grounding connections inside of the module are still intact as required. See example in ' Repair Path '.	Safety Warnings: Never modify or change the grounding connections.

1.46.0.1.3 Overview of the PAL Power Supply Repair path

Following overview shows the path how to reach a certain level or part for repair.

As a first step is 'Disassembling Power Supply' described. This step has to be done for all repair steps. The disassembling procedure is only described once and for all other steps it is only referred to with a link.

The same procedure is used for the assembling step.

After the assembling describes the section 'Limitation' where the limits are for field repair and followed is the test procedure for the PAL Power Supply described.

- [Disassembling Power Supply](#)
- [Replacing Fuse](#)
- [Checking Connections](#)
- [Checking Grounding Connections](#)
- [Check Cables](#)
- [Assembling Power Supply](#)
- [Limitations](#)
- [Testing PAL Power Supply](#)

1.46.0.1.3.1 Overview of the PAL Power Supply Repair path

Following overview shows the path how to reach a certain level or part for repair.

As a first step is 'Disassembling Power Supply' described. This step has to be done for all repair steps. The disassembling procedure is only described once and for all other steps it is only referred to with a link.

The same procedure is used for the assembling step.

After the assembling describes the section 'Limitation' where the limits are for field repair and followed is the test procedure for the PAL Power Supply described.

- [Disassembling Power Supply](#)
- [Replacing Fuse](#)
- [Checking Connections](#)
- [Checking Grounding Connections](#)
- [Check Cables](#)
- [Assembling Power Supply](#)
- [Limitations](#)
- [Testing PAL Power Supply](#)

1.46.0.1.3.2 Disassembling the PAL Power Supply

1.47 In this procedure is the Disassembling of the PAL Power Supply described in details.

All further steps are separately described; see ['Repair Path Overview'](#).

The assembly steps are described in ['Assembling PAL Power Supply'](#).

Note: CTC Analytics AG does provide a dedicated Tool Kit which contains the necessary screwdrivers, especially the Torx drivers.

PNo. : PAL ToolKit

WARNING:

Disconnect the PAL System from the power line and unplug the power cord before any maintenance or repair step is done.

Disconnect the PAL System also from any other device which is part of the complete system.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD strap in every case as soon as electronic parts are touched.

Not observing this basic rule can result in erratic behavior of a component or even in a damaged printed circuit board (PCB).

1.48 Introduction on the PAL Power Supply:

The PAL Power Supply has a fuse installed in the module itself on the primary side (power inlet). There is no fuse necessary on the secondary side because the power supply has a built-in power control which automatically turns the unit off and on in cases of DC voltage fluctuations above 250 V or below 80 V. This automatic control feature is also referred to as 'hick-up' mode.

Indication for Disassembling PAL Power Supply

The procedure 'Disassembling PAL Power Supply' is needed for all repair steps for the power supply.



Step 1:

Disconnect the Power Supply from the power line.

This picture shows the power inlet, primary side.



Step 2:

Disconnect the DC cable on the secondary side.



Step 3:

Remove the side (or front) cover on the primary side.

Required Tools: Torx T10

Material Description: Screws: BN11288 M3x16

Note: Screws at the side to connect the housing to the heat sink have following description and dimensions: BN 11288 M3x10.

**Step 1:**

Disconnect the Power Supply from the power line.

This picture shows the power inlet, primary side.

**Step 4:**

This does conclude the Disassembling of the PAL Power Supply.

All further steps are separately described; see 'Repair Path Overview'.

The assembling steps are described in 'Assembling PAL Power Supply'.

1.48.0.0.0.1 Replacing the Fuse

This procedure for replacing the Fuse of the PAL Power Supply does describe the replacement of the Fuse in the power supply (on primary side).

Indications for the Replacement of the Fuse are:

- No current to the PAL System
- LED is not ON

It is assumed that the PAL Power Supply has been disassembled as described in the section, '[Disassembling the PAL Power Supply](#)'.

All further steps are described separately; see 'Repair Path Overview'.

The assembly steps are described in 'Assembling PAL Power Supply'.

**Step 1:**

Disassemble the Power Supply as described in the section [‘Disassembling the PAL Power Supply’](#).



Step 2: Locate the fuse on the left hand side of the primary power connector. Lift out the fuse with a suitable tool, such as tweezers, a screwdriver or pliers. Replace the fuse.

Required Tools: see above.

Material Description: Fuse: 5HT 250 VAC

Note: Fuse is a standard fuse which can be purchased locally.

This concludes the procedure for ‘Replacing the Fuse’.

The Assembly of the unit follows the logical order of the Disassembly procedure, backwards. The section [‘Assembling the PAL Power Supply’](#) describes some important specific points.

All further steps are separately described; see [‘Repair Path Overview’](#).

To test the PAL Power supply after a repair, refer to the section [‘Test Procedure’](#).

See also the section [‘Limitations’](#) to verify that no forbidden steps have been performed during the repair of the unit.

1.48.0.0.0.2 Check Connectors

SAFETY WARNING: ELECTRICAL CONTACTS CAN CAUSE ELECTRIC SHOCKS.

This section on checking the Connectors of the PAL Power Supply provides information on how to identify a potential loose connection.

Indications to check the Connectors:

- Intermittent short circuits

It is assumed that the PAL Power Supply has already been disassembled as described in the section '[Disassembling the PAL Power Supply](#)'.

All further steps are described separately, see '[Repair Path Overview](#)'.

The assembly steps are described in '[Assembling the PAL Power Supply](#)'.

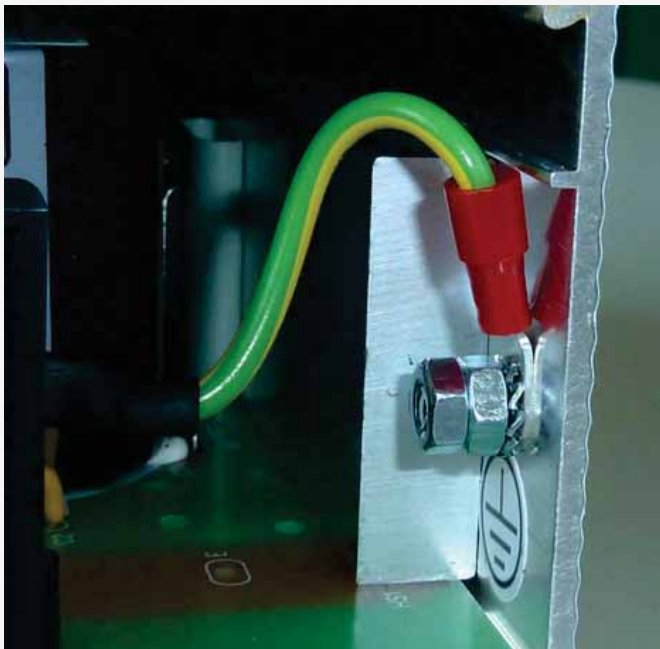


Step 1:

Disassemble the Power Supply as described in the section '[Disassembling the PAL Power Supply](#)'.

Step 2:

Check if a loose contact between the soldering of the connector and the PCB is visible. Check the 'inlet' and 'outlet' connectors.



Step 3:

Check if the grounding connection is still tight and maintains the original assembly, as shown in the picture.

See also section '[Checking Grounding Connections](#)'.

**Step 1:**

Disassemble the Power Supply as described in the section 'Disassembling the PAL Power Supply'.

**Step 4:**

After the Assembly step, connect the power supply and connect the DC cable to one of the outlet connectors (secondary side) and to the PAL System on the other side of the cable.

Turn on the power and move the cable connector gently to find out if an intermittent short can be observed. If not observed, turn off the unit, connect to the other outlet connector and repeat the steps.

If a bad connector or connection has been observed, replace the entire PAL Power Supply.

FOR SAFETY REASONS, THERE ARE NO REPAIRABLE PARTS IN THE PAL POWER SUPPLY.

This concludes the procedure for the section on 'Checking Connections'.

The Assembly of the unit follows the logical order of the Disassembly procedure, backwards.

The section '[Assembling the PAL Power Supply](#)' describes some important specific points.

All further steps are separately described; see '[Repair Path Overview](#)'.

To test the PAL Power supply after a repair, refer to the section '[Test Procedure](#)'.

See also the section '[Limitations](#)' to verify that no forbidden steps have been performed during the repair of the unit.

1.48.0.0.0.3 Check Grounding Connections

SAFETY WARNING: ELECTRICAL CONTACTS CAN CAUSE ELECTRIC SHOCKS.

This section provides information on how to verify that the grounding connections have not been altered.

Indications to check the Grounding Connections:

- An electrical charge is felt when touching the housing

It is assumed that the PAL Power Supply has already been disassembled as described in the section '[Disassembling the PAL Power Supply](#)'.

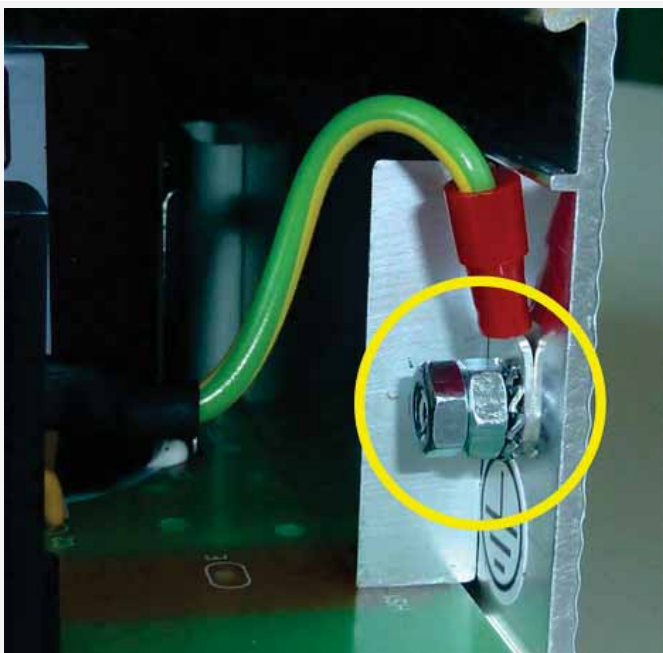
All further steps are described separately, see '[Repair Path Overview](#)'.

The assembly steps are described in '[Assembling the PAL Power Supply](#)'.



Step 1:

Disassemble the Power Supply as described in the section '[Disassembling the PAL Power Supply](#)'.



Step 2:

Check if the grounding connection is still tight and maintains the original assembly, as shown in the picture.

The correct assembly of the grounding cable to the housing of the power supply has to be in following order:

- Ring type pressure connector secured to a stud;
- Serrated lock washer (star washer);
- two nuts

Required Tools: Flat Wrench metric size: 7

Material Description: - Nuts: BN117 M4 - Serrated Lock washer: BN 781 M4

If a bad connection is observed, re-establish the original connection setup. The grounding wire has to be intact and the connection to the PCB cannot be loose.

When in doubt, contact CTC Analytics and return the unit for further checking.

This concludes the procedure for the section on 'Checking Grounding Connections'.

The Assembly of the unit follows the logical order of the Disassembly procedure, backwards.

The section '[Assembling the PAL Power Supply](#)' describes some important specific points.

All further steps are separately described; see '[Repair Path Overview](#)'.

To test the PAL Power supply after a repair, refer to the section '[Test Procedure](#)'.

See also the section '[Limitations](#)' to verify that no forbidden steps have been performed during the repair of the unit.

1.48.0.0.0.4 Check Cables

SAFETY WARNING: ELECTRICAL CONTACTS CAN CAUSE ELECTRIC SHOCKS.

This section provides information on how to verify that the cables are intact and have not been altered.

Indications to check the Cables:

- An electrical charge is felt when touching the housing
- Intermittent short circuits

The two cables involved with the PAL Power Supply are:



Power Cable (AC cable connected to the wall outlet.

This cable has to meet following safety standards:

Cable has to have the safety standard 18AWG printed on the insulation.

Connectors have to be approved and have to show the common symbols

of testing bodies such as UL.

For details see section '[Spare Parts](#)'.



DC Cable (connected from the Power Supply to the PAL System.

This cable has to meet following safety standards:

The cable itself has to be shielded along its entire length.

The connectors have to be identical with the original cable.

PNo. Cbl RS3M-2000

See also section '[Spare Parts](#)'.

•

It is important that the original cables are used. If for any reason the cables are replaced, make sure that the replacement cables meet the safety standards of the original ones.

Checking the cables means verifying that a cable is not damaged at the outside insulation throughout its entire length and that the connectors are not damaged or partially disconnected from the wiring.

It is advisable to purchase a replacement cable through CTC Analytics to ensure that the new cable meets the safety requirements. PNo and order details are provided in the section '[Spare Parts](#)'.

1.48.0.0.0.5 Assembling the PAL Power Supply

This section describes the procedure for assembling the PAL Power Supply.

All further steps are described separately; see '[Repair Path Overview](#)'.



Step1:

This is the status of the Power Supply after it has been dis-assembled in order to replace the Fuse or check a connection.



Step 2:

Attach the side cover and tighten with the original screws.

Required Tools: Torx T20

Material Description: Screws: BN 11288 M3x16



Step 3:

Power Supply assembled and ready for testing.

To test the PAL Power supply after a repair, refer to the section '[Test Procedure](#)'.

See also the section '[Limitations](#)' to verify that no forbidden steps have been performed during the repair of the unit.

1.48.0.0.0.6 PAL Power Supply Limitations

SAFETY WARNINGS: FOR SAFETY REASONS, THERE IS ONLY A LIMITED POSSIBILITY TO REPAIR A PAL POWER SUPPLY.

The points listed below have to be respected for legal and liability protection reasons. CTC Analytics does not take any responsibility in cases where these limits have been disregarded.



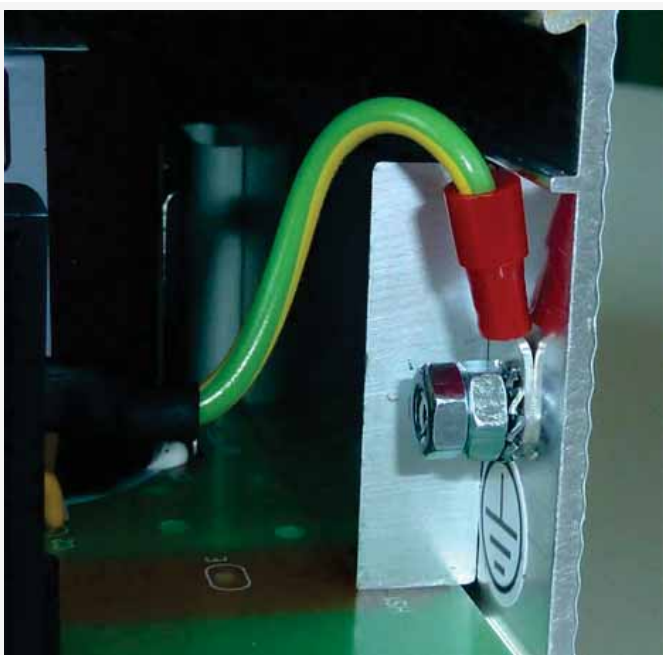
The front or side cover can be removed (inlet or primary side) to gain access to the built-in fuse.



There is no reason to open up the back cover (secondary side). There is no part that needs to be accessed for replacement on this side of the unit.



The front or side cover can be removed (inlet or primary side) to gain access to the built-in fuse.



Opening the grounding connection or manipulating the grounding in any manner is strictly forbidden.

CTC Analytics' applies a 'dielectric voltage withstanding test' to every unit, applying 2010 V for 2 seconds. Such tests are important for safety reasons. Without the instrument to perform this test in the field, a service technician cannot guarantee that a unit is safe for use.



The front or side cover can be removed (inlet or primary side) to gain access to the built-in fuse.



Removing the PCB from the housing is not useful because the grounding connection has to be opened. Doing any repair work on the PCB is strictly prohibited.

There are no repairable parts inside the power supply housing or on the PCB.

1.48.0.0.0.7 Testing of PAL Power Supply

Testing a PAL Power Supply after replacing a fuse is a fairly obvious procedure. Nevertheless, it would be helpful to identify the cause of the blown fuse.

- Was there a problem with the electrical net from the lab?
- Is the wall-outlet connection secure?
- Does the net provide the expected voltage?
- Is the zero line really zero or is there any voltage on this line?

Check all these points first before you connect the power supply again. It may be possible to use another electrical net within the same building to verify the net quality.

- Connect the power supply unit (without turning on the actual power connection) to the PAL System and then turn ON the power.
- If the unit is stable, turn OFF the power and connect it to the PAL System. Power ON again. If the entire

system runs without any problems, stop testing.

- If these points are all verified and the system powers up normally, ask the customer to keep an eye on it. It is possible that in a nearby room a highly power-consuming instrument is running and causes spikes in the electrical lines throughout the building.
- If the PAL Power Supply behaves normally but does not power up when connected to the PAL System, then check the fuse on the CPU or control board, depending on the PAL System installed.
- If the PAL Power Supply does not behave as expected, or there are doubts concerning connectors etc., return the unit to CTC Analytics. See the section 'Return Material Authorization' for instructions.

1.48.0.0.1 Overview Upgrade Path | Spare Parts | PM for PAL Power Supply

- [Upgrade Path for PAL Power Supply](#)
- [Spare Parts for PAL Power Supply](#)
- [Preventative Maintenance , PM](#)

1.48.0.0.1.1 Overview Upgrade Path | Spare Parts | PM for PAL Power Supply

- [Upgrade Path for PAL Power Supply](#)
- [Spare Parts for PAL Power Supply](#)
- [Preventative Maintenance , PM](#)

1.48.0.0.1.2 Upgrade Path for PAL Power Supply

There is no possibility to upgrade any revision level to a higher one. See also '[Release History PAL Power Supply](#)'.

If the power supply module is questionable, it is recommended to return the module back to CTC Analytics for checking or replacement.

See the section '[Return Material Authorization](#)' for instructions.

1.48.0.0.1.3 Spare Part Kits for PAL Power Supply

The following Spare Parts are available for the PAL Power Supply:.

PNo.	Part or Kit Description	Remarks
MN 01-0X	PAL Power Supply (150 W) 	The 'X' stands for the OEM version. See the section 'Overview Power Supplies'.
(Fuse)	Fuse for Power Supply : 5HT 250 VAC (5 Amp)	Fuse is a standard fuse which can be purchased locally.
Cbl RS3M-2000	DC cable, connection between PAL Power Supply and PAL System. 	Caution: Use original cable only. Cable is shielded.

PNo.	Part or Kit Description	Remarks
PALKAB-XX	Power Cable (AC) 	The 'xx' stands for the country-specific connectors. This cable is a standard cable, It is advisable to purchase this cable locally. Observe the safety rules as described in 'Repair Path –Checking Cables'. Example shows on left hand side the cable with the European Schuko connector and on the right hand side the cable with the connector for USA.
PAL SFC4	Fuse for 'APR CPU' or APR CONTROL',see section ' XY Spare Parts '	Original fuse for PAL CPU and Control Boards. Fuse is replaceable. Bracket is soldered to the PCB. <i>Note: The SupraFuse has been replaced in 2002 with the MSB6.3AT. Disconnecting and reconnecting the DC cable without turning off the power supply has blown the 4A SupraFuse.</i>
MSB6.3AT	Fuse for 'APR MOTIO' or APR CONTROL',see section ' XY Spare Parts '	This fuse is soldered directly onto the PCB. For details, see Service Note # 06/2002. <i>Note: This fuse is backward compatible. Solder out the bracket from the SupraFuse 4A and fit the new fuse in same place.</i>

1.48.0.0.1.4 Preventative Maintenance for PAL Power Supply

There is no dedicated PM task foreseen in the PM procedure for the PAL Power Supply.

Observe the general rules for maintaining the PAL System, such as cleaning on a regular basis, avoiding liquid spills around the Power Supply module, etc.

1.48.0.0.2 PAL Power Supply Overview

This section 'PAL Power Supply' covers following items:

- [PAL Power Supply Overview](#)
- [PAL Power Supply Release History](#)
- [Troubleshooting](#)
- [Repair Path for PAL Power Supply](#)
- [Upgrade Path for PAL Power Supply](#)
- [Spare Parts for PAL Power Supply](#)
- [Preventative Maintenance \(PM\) for PAL Power Supply](#)

1.48.0.1 Overview Handheld Control Terminal for PAL System

This section covers following points:

- Overview Control Terminal Models
- Release History Control Terminal
- Troubleshooting
- Repair Path for Control Terminal
- Upgrade Path for Control Terminal
- Spare Parts for Control Terminal
- Preventative Maintenance for Control Terminal

1.48.0.1.1 Overview Handheld Control Terminal for PAL System

Terminal PNo.	Used for PAL Model	Description
MB 01-00	Used for all CTC Analytics branded PAL Systems	Standard Terminal
MB 01-01	Used for all Thermo branded PAL Systems.	
MB 01-02	Used for all CTC Analytics branded PAL-xt Systems. (identical for Agilent Brand	Specify Protection foil for branding.

Note: OEM specific Protection Foils (logo and color) are available. For repair or replacement of the control terminal, specify the brand.

1.48.0.1.1.1 Overview Handheld Control Terminal for PAL System

Terminal PNo.	Used for PAL Model	Description
MB 01-00	Used for all CTC Analytics branded PAL Systems	Standard Terminal
MB 01-01	Used for all Thermo branded PAL Systems.	
MB 01-02	Used for all CTC Analytics branded PAL-xt Systems. (identical for Agilent Brand	Specify Protection foil for branding.

Note: OEM specific Protection Foils (logo and color) are available. For repair or replacement of the control terminal, specify the brand.

1.48.0.1.1.2 Release History for Handheld Control Terminal

Revision Level	Modification from Previous to Indicated Revision Level	Remarks
1	Basic Unit	upgrade to higher level not possible and not recommended.
2	minor fabrication changes	upgrade to higher level not possible and not recommended.
3	minor fabrication changes	upgrade to higher level not possible and not recommended.
4	minor fabrication changes	upgrade to higher level not possible and not recommended.
5	minor fabrication changes	upgrade to higher level not possible and not recommended.
6	LCD Display with back light	upgrade to higher level not possible and not recommended.
7	LCD Display with back light. Black characters and white background	Revision 6 can be upgraded to Revision level 7. Use the Spare Part Kit.

1.48.0.1.2 Troubleshooting for Handheld PAL Control Terminal

Error Symptom	Possible Cause	Recommended Action
<u>No display, black screen.</u>	Spiral cable from Terminal not connected to the dedicated serial connector. LCD Display Unit defective. PCB from Terminal defective. Spiral cable defective. PAL System in 'Loader Mode'. Fuse from PAL System blown. CPU or Control Board from PAL System defective.	Check the cable connections. Check LCD display unit. Check the Terminal on another system. Check cable. Check if LED on PAL system flashes. Check Fuse on PAL System. Check the PCB's from the PAL System.
<u>LCD Display shows lines, dots</u> or has any other unusual display.	LCD Display Unit mounted too close to protective foil. LCD Display defective. PAL System in 'Loader Mode'	Check distance between LCD and Foil. Check the LCD on another system. Check if LED on PAL System flashes.
<u>Bad contrast of display.</u>	Potentiometer setting shifted.	Adjust Contrast of Display
<u>Terminal Control Knob turns tight or loose.</u>	Protection Foil defective. Holding screw loose. Terminal contaminated with sticking material.	Check condition of foil. Check movement of Selector Wheel. Check for any contamination.
<u>Terminal Holder or Safety Guard defective.</u>	Holder bent Magnets from Holder lost Safety Guard damaged or broken	Replace entire holder. Glue the magnets into holder. Replace safety Guard
<u>Terminal Spiral Cable defective.</u>	Cable or cable connectors damaged.	Check the cable.

1.48.0.1.2.1 Troubleshooting for Handheld PAL Control Terminal

Error Symptom	Possible Cause	Recommended Action
<u>No display, black screen.</u>	Spiral cable from Terminal not connected to the dedicated serial connector. LCD Display Unit defective. PCB from Terminal defective. Spiral cable defective. PAL System in 'Loader Mode'. Fuse from PAL System blown. CPU or Control Board from PAL System defective.	Check the cable connections. Check LCD display unit. Check the Terminal on another system. Check cable. Check if LED on PAL system flashes. Check Fuse on PAL System. Check the PCB's from the PAL System.
<u>LCD Display shows lines, dots</u> or has any other unusual display.	LCD Display Unit mounted too close to protective foil. LCD Display defective. PAL System in 'Loader Mode'	Check distance between LCD and Foil. Check the LCD on another system. Check if LED on PAL System flashes.
<u>Bad contrast of display.</u>	Potentiometer setting shifted.	Adjust Contrast of Display
<u>Terminal Control Knob turns tight or loose.</u>	Protection Foil defective. Holding screw loose. Terminal contaminated with sticking material.	Check condition of foil. Check movement of Selector Wheel. Check for any contamination.
<u>Terminal Holder or Safety Guard defective.</u>	Holder bent Magnets from Holder lost Safety Guard damaged or broken	Replace entire holder. Glue the magnets into holder. Replace safety Guard
<u>Terminal Spiral Cable defective.</u>	Cable or cable connectors damaged.	Check the cable.

1.48.0.1.2.2 No display, black screen on Control Terminal

Possible Cause	Recommended Action	Remarks
Spiral cable from Terminal not connected to the dedicated serial connector.	Check the connection from the spiral cable at the Terminal side and at the PAL side. If available use a second spiral cable to verify.	PAL System: Connector 'SER3' PAL-xt System: Connector 'Terminal'
LCD Display Unit defective.	Check the LCD unit. If available, use a second terminal to verify.	Replace the LCD unit as described in 'Repair Path'
PCB from Terminal defective.	If available, use a second Terminal to verify.	Replacing the PCB is rarely necessary and is not foreseen for field repair. Return Terminal.
Spiral Cable defective.	Check the cable or connectors for any damage. If available, use a second cable to verify.	See the section 'Spare Parts' for details.
PAL System in 'Loader Mode'.	Check if the LED at the CPU or Control Board is flashing.	If the red LED flashes, turn off the unit and power up again after 30 seconds. If the LED continues flashing, load a new Firmware Backup file. For details, see the section ' PAL Software – PAL Firmware and/or PAL Loader '.
Fuse from PAL System blown.	Check the fuse built into the PCB in the PAL System.	PAL System: Fuse mounted on the PCB from CPU or Control Board. PAL-xt System: Fuse at backside of the Control Board. Older version fuse: PAL SFC4 4A . New version fuse: MSB6.3 AT .
CPU or Control Board from PAL System defective.	If the board is still working, fuse intact, try to load a new Firmware Backup file. If this is not successful, replace the board and send the defective one back for checking to CTC Analytics.	

1.48.0.1.2.3 LCD Display shows lines, dots or has any other unusual display

Possible Cause	Recommended Action	Remarks
LCD Display mounted too close to protective foil.	Check if the dotted lines disappear if the LCD is further away from the protective foil.	See ' Repair Path ' for details.
LCD Display defective.	Replace the LCD unit and if available use a second terminal to verify.	See the section ' Repair Path ' for details.
PAL System in 'Loader Mode'.	Check if the LED at the CPU or Control Board is flashing.	If the red LED flashes, turn off the unit and power up again after 30 seconds. If the LED continues flashing, load a new Firmware Backup file. For details, see the section 'PAL Software - PAL Firmware and/or PAL Loader'.

1.48.0.1.2.4 Bad Contrast of Display

Possible Cause	Recommended Action	Remarks
Potentiometer setting shifted.	Adjust contrast of Display.	See the section ' Repair Path ' for details.

1.48.0.1.2.5 Terminal Control Knob turns tight or loose

Possible Cause	Recommended Action	Remarks
Protective Foil defective.	Check the condition of the protective foil.	Is the foil damaged, does a part stick up and prevent smooth operation of the selector wheel?
Holding screw of selector wheel loose.	Check if the selector wheel turns loosely. Does turning correspond with cursor selection?	See the section ' Repair Path ' for details.
Terminal contaminated with stick-ing material.	Check for any contamination of the terminal.	Cleaning could be difficult for example if after a spill substances stick to the inside of the housing and on the PCB.

1.48.0.1.2.6 Terminal Holder or Safety Guard defective

Possible Cause	Recommended Action	Remarks
Holder bent.	If for any reason the Terminal Holder is broken or bent, replace the entire Holder Assembly. Check if the drilling hole for the screw in the side cover is damaged as well.	See the section ' Spare Parts ' for details.
Magnets from Holder lost.	The magnets can be glued into place again using a LOCTIDE 638 (green). If the magnets are lost, replace the Holder.	See the section ' Spare Parts ' for details.
Safety Guard damaged or broken.	If the Safety Guard is broken or partially damaged, replace it to ensure the protection and the secure mounting of the Terminal Holder.	See the section ' Spare Parts ' for details.

1.48.0.1.2.7 Control Terminal Spiral Cable defective

Possible Cause	Recommended Action	Remarks
Spiral Cable or cable connectors damaged.	Check the cable or connectors for any damage. If available, use a second cable to verify.	See the section ' Spare Parts ' for details.

1.48.0.1.3 Overview of Handheld Control Terminal Repair Path

The following section outlines the steps on how to access a certain level or part for repair.

As a first step, 'Disassembling the PAL Terminal' is described. This step has to be done first before all other repairs. The disassembly procedure is only described once, and for all other repairs steps it is only referred to with a link.

The same procedure is used for the assembly step.

After the assembly procedure, the section 'Limitations' describes the limits of field repair. The following section describes the test procedure for the PAL Terminal.

- [Disassembling PAL Control Terminal](#)
- [Adjusting Contrast](#)
- [Replacing Display Unit](#)
- [Removing the Selector Wheel](#)

- [Checking Cables](#)
- [Checking Holder and Safety Guard](#)
- [Assembling PAL Control Terminal](#)
- [Limitations](#)
- [Testing of PAL Control Terminal](#)

1.48.0.1.3.1 Overview of Handheld Control Terminal Repair Path

The following section outlines the steps on how to access a certain level or part for repair.

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- [Disassembling PAL Control Terminal](#)
- [Adjusting Contrast](#)
- [Replacing Display Unit](#)
- [Removing the Selector Wheel](#)
- [Checking Cables](#)
- [Checking Holder and Safety Guard](#)
- [Assembling PAL Control Terminal](#)
- [Limitations](#)
- [Testing of PAL Control Terminal](#)

1.48.0.1.3.2 Disassembling the handheld PAL Control Terminal

This section describes the Disassembly of the PAL Terminal in detail.

All further steps are described separately; see '[Repair Path Overview](#)'.

The assembly steps are described in '[Assembling the PAL Terminal](#)'.

Note: CTC Analytics AG provides a dedicated Tool Kit which contains the necessary screwdrivers, especially the Torx drivers.

PNo. : PAL ToolKit

WARNING:

Disconnect the PAL System from the power line and unplug the power cord before any maintenance or repair step is done.

Disconnect the PAL System also from any other device which is part of the complete system.

CAUTION: ESD WARNING

It is strongly recommended to use an ESD strap when handling electronic parts.

Not observing this basic rule can result in the erratic behavior of a component or even in a damaged printed circuit board (PCB).

Introduction to the PAL Handheld Control Terminal:

The Terminal has an LCD unit installed which can be adjusted for better contrast or replaced if necessary. The PCB itself rarely fails, so that a repair procedure for the service technician is usually not necessary. Return the Terminal back to CTC Analytics in the event of such a rare failure.

Indication to disassemble the PAL Terminal:

- The PAL Terminal must be disassembled before any repair or adjustment steps done on the terminal.



Step 1:

Turn off the power from the PAL System.

Disconnect the PAL Terminal from the spiral cable.

This picture shows the isolated Terminal.

1.48.0.1.3.3 Adjusting the LCD Contrast

When to adjust the LCD Contrast:

- Weak or insufficient contrast of the LCD

It is assumed that the PAL Power Supply has already been disassembled as described in the section '[Disassembling the PAL Control Terminal](#)'.

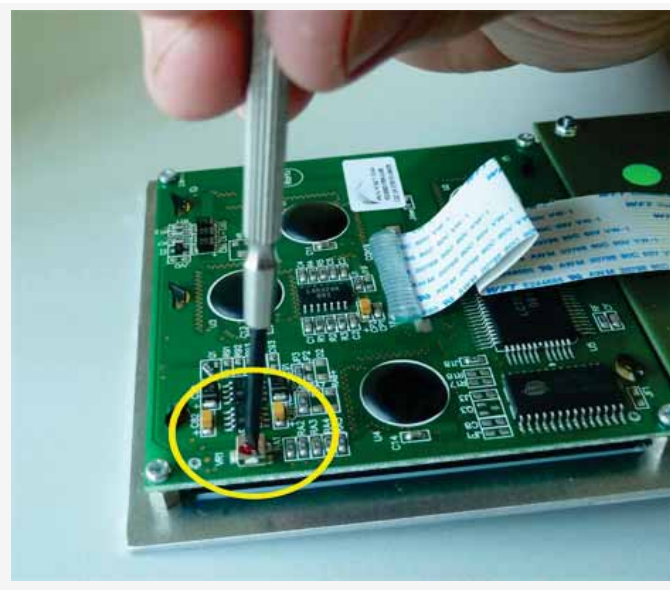
All further steps are described separately, see '[Repair Path Overview](#)'.

The assembly steps are described in '[Assembling the PAL Control Terminal](#)'.



Step 1:

The steps to disassemble the Terminal are described in '[Disassembling PAL Terminal](#)'.



Step 2:

Locate the potentiometer, shown in the picture.

Make the necessary adjustment of the LCD display.

Assemble the unit and test it with the PAL System.

Required Tools: Slotted Screw Driver (as fine as possible)

Material Description: none.

This concludes the procedure for the section on 'Adjusting the LCD Display'.

The Assembly of the unit follows the logical order of the Disassembly procedure, backwards.

The section '[Assembling the PAL Control Terminal](#)' describes some important specific points.

All further steps are separately described; see '[Repair Path Overview](#)'.

To test the PAL Control Terminal after a repair, refer to the section '[Test Procedure](#)'.

See also the section '[Limitations](#)' to verify that no forbidden steps have been performed during the repair of the unit.

1.48.0.1.3.4 Replacing the LCD Display

Indications to replace the LCD Display:

- The LCD Display shows lines, dots or has any other unusual display. See Step 5 below.
- The LCD Display is dark

The above points can also occur if the PAL System is in the so-called 'Loader Mode' or if the fuse on the PAL PCB is blown.

Refer first to the section '[Troubleshooting](#)' to verify that the LCD Display is indeed the source of the problem.

It is assumed that the PAL Power Supply has been disassembled as described in the section, '[Disassembling the PAL Control Terminal](#)'.

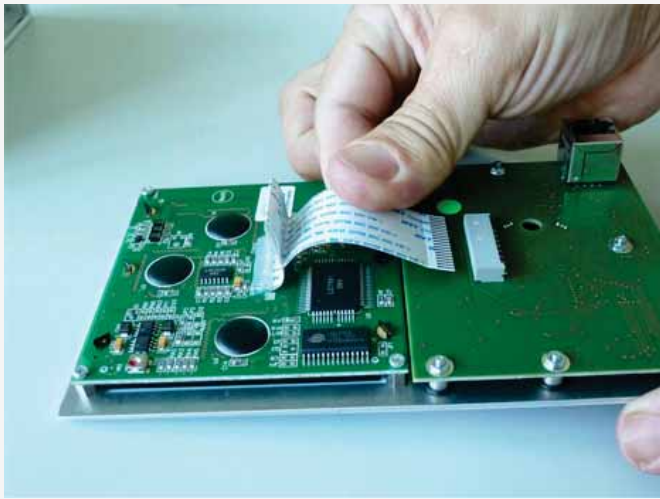
All further steps are described separately; see '[Repair Path Overview](#)'.

The assembly steps are described in '[Assembling PAL Control Terminal](#)'.



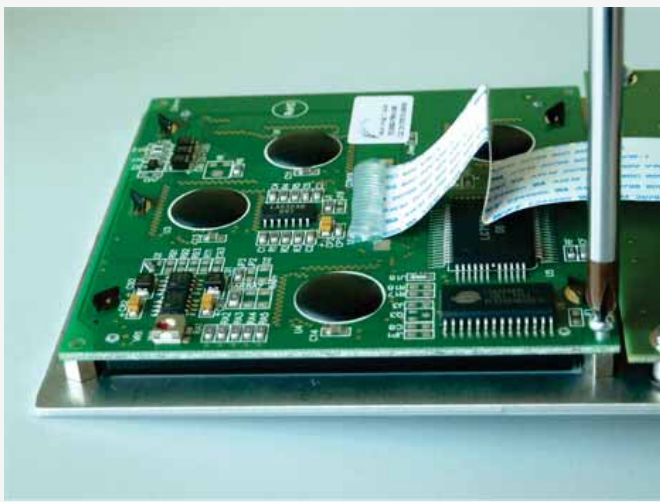
Step 1:

The steps to disassemble the Terminal are described in 'Disassembling the PAL Terminal'.



Step 2:

Disconnect the ribbon cable from the Display PCB.



Step 3:

Remove the screws in the four corners.

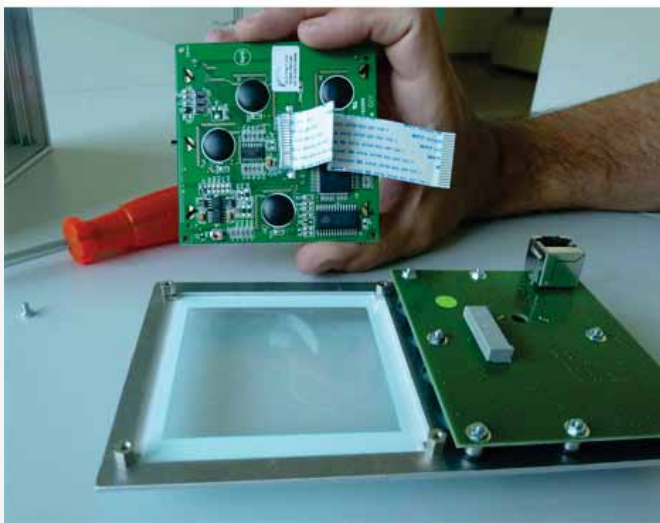
Required Tool: Crosstip Screwdriver (Philips)

Material Description: Screws BN 381 M2.5x4 (crosstip screw head)



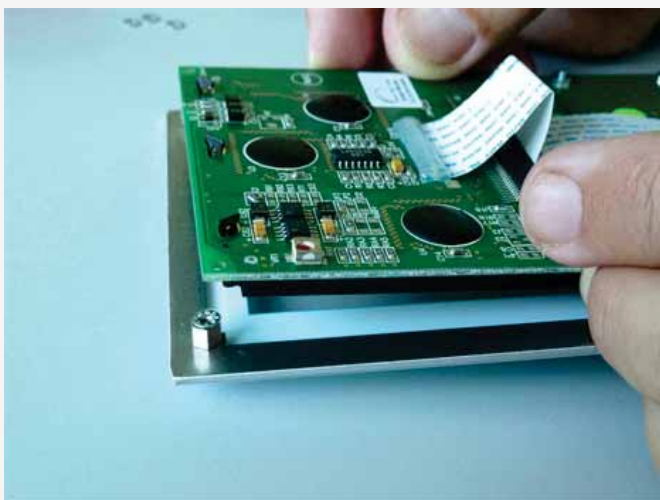
Step 1:

The steps to disassemble the Terminal are described in 'Disassembling the PAL Terminal'.



Step 4:

Remove the entire LCD assembly.



Step 5:

Insert a replacement LCD Assembly.

Required Tools: Crosstip Screwdriver (Philips)

Material Description:

- Kit LCD Repl, consisting of:

LCD Assembly, ribbon cable, 4 spacers

4 washers, 4 screws. (see Step 7 below).



Step 1:

The steps to disassemble the Terminal are described in 'Disassembling the PAL Terminal'.



Step 6:

Important: Beginning with Revision 7, the LCD Assembly is thicker than earlier revisions. It is likely that if an older terminal has to be repaired, two additional spacers are required. The extra spacers are part of the LCD Exchange Kit.



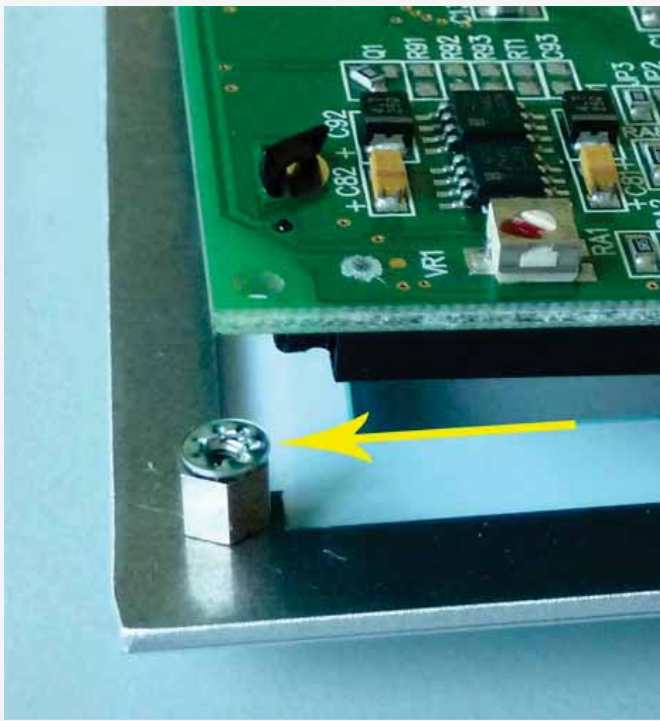
Step 6 contd.:

This picture shows detailed the two spacers needed for the replacement LCD unit.



Step 1:

The steps to disassemble the Terminal are described in 'Disassembling the PAL Terminal'.



Step 6 contd.:

Note: It is important that the LCD itself has enough space away from the protective foil. If there is contact, dots or lines may be observed. In some cases, this can be remedied by inserting a washer in between the LCD assembly and the existing single spacer.



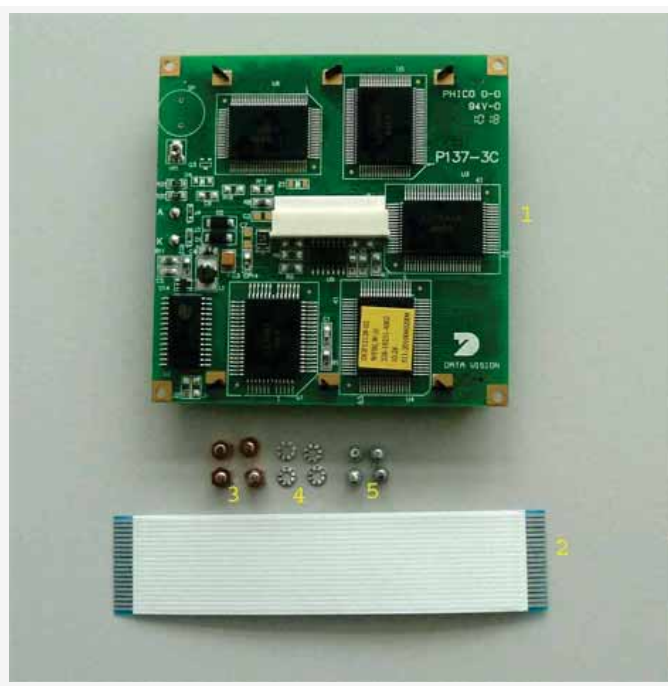
Step 6 contd.:

This pictures shows the difference in height of an older LCD model (Revision 6) and the new type on the right hand side, Revision 7.



Step 1:

The steps to disassemble the Terminal are described in 'Disassembling the PAL Terminal'.



Step 7:

The replacement Kit for the Terminal LCD module consists of:

- # 1: LCD Module
- # 2: Flat cable
- # 3: 4 Spacers
- # 4: 4 Serrated Lock Washers (star washers)
- # 5: 4 Screws



Step 1:

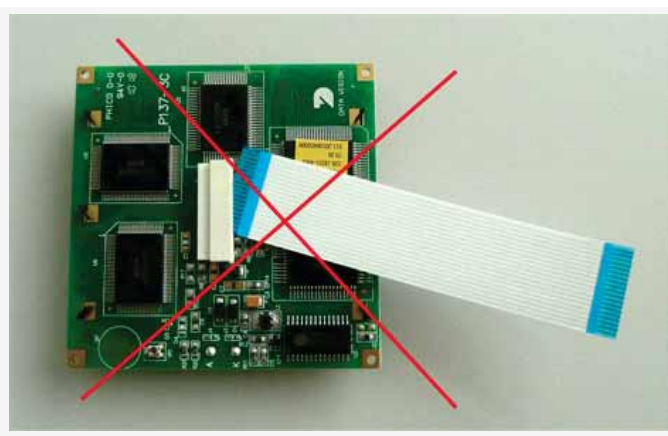
The steps to disassemble the Terminal are described in 'Disassembling the PAL Terminal'.



Step 8:

Insert the flat cable into the connector as shown in the figure.

Connect the other side to the connector of the Terminal PCB.



Step 8 contd.:

Connecting the flat cable this way (blue color as indicator) is wrong. No contacts provided.

Install the LCD Display observing the precautions with the space needed in-between the LCD module and the protection foil. See Step 6 for details.

This concludes the procedure for the section on 'Replacing the LCD Display'.

The Assembly of the unit follows the logical order of the Disassembly procedure, backwards.

The section 'Assembling the PAL Control Terminal' describes some important specific points.

All further steps are separately described; see '[Repair Path Overview](#)'.

To test the PAL Control Terminal after a repair, refer to the section '[Test Procedure](#)'.

See also the section '[Limitations](#)' to verify that no forbidden steps have been performed during the repair of the unit.

1.48.0.1.3.5 Removing the Selector Wheel from the Control Terminal PCB

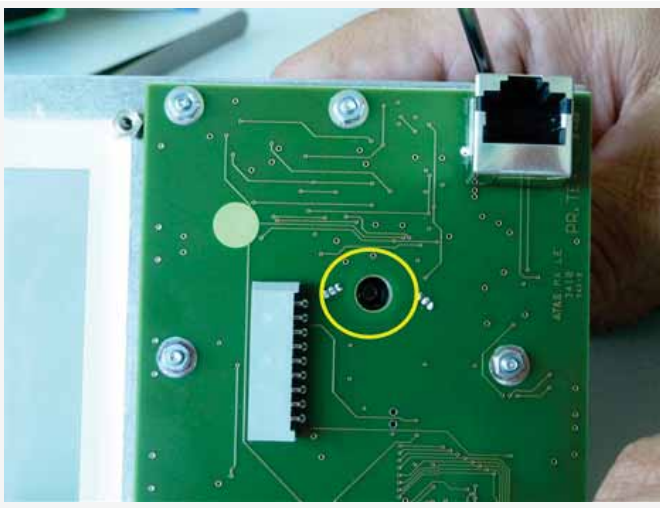
Indications to remove the Selector Wheel:

- Wheel is blocked by a damaged Protection Foil
- Wheel is loose. Wheel movement does not correspond to the Cursor movement.
- Wheel is stiff to turn because of a spill. Cleaning internal parts of the Terminal.



Step 1:

The steps to disassemble the Terminal are described in '[Disassembling the PAL Terminal](#)'.



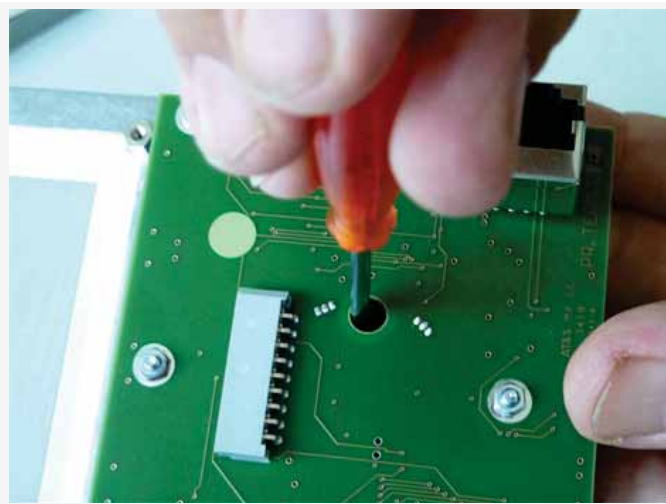
Step 2:

Locate the hidden screw in the middle of the Terminal PCB as shown in the picture.



Step 1:

The steps to disassemble the Terminal are described in 'Dis-assembling the PAL Terminal'.



Step 3:

Loosen the screw.

Required Tools: .Screw Driver Torx T6

Material Description: none.



Step 4:

After loosening the screw, the Selector wheel can be removed from the center axis.

This concludes the procedure for the section on 'Removing the Selector Wheel'.

The Assembly of the unit follows the logical order of the Disassembly procedure, backwards.

The section '[Assembling the PAL Control Terminal](#)' describes some important specific points.

All further steps are separately described; see '[Repair Path Overview](#)'.

To test the PAL Control Terminal after a repair, refer to the section '[Test Procedure](#)'.

See also the section '[Limitations](#)' to verify that no forbidden steps have been performed during the repair of the unit, and to learn which parts are not available for field repair.

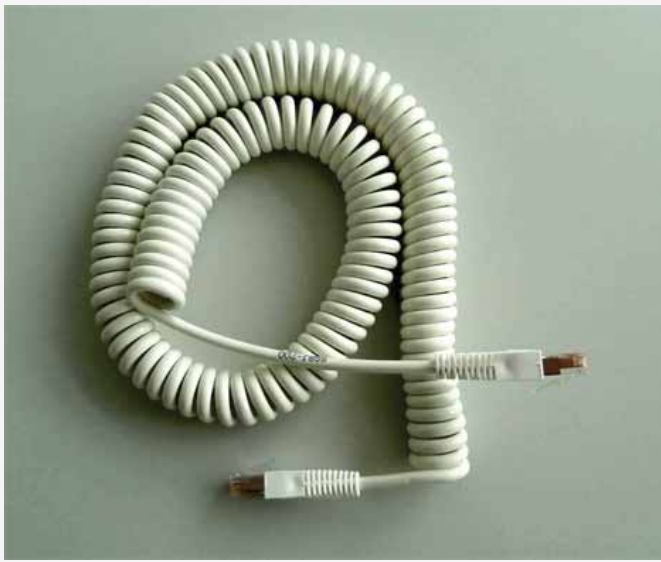
1.48.0.1.3.6 Checking Spiral Cable

This section provides information on how to verify that the Cable of the PAL Terminal is intact and has not been altered.

Indications to check the Cable:

- Intermittent short circuits
- Display black

A black display could also occur if the PAL System is in the so-called 'Loader Mode' or if the fuse on the PAL PCB is blown. Refer first to the section '[Troubleshooting](#)' to verify that the LCD Display is indeed the source of the problem.



Spiral Cable (connected from the PAL Terminal to the PAL System).
PNo and order details are provided in the section '[Spare Parts](#)'.

1.48.0.1.3.7 Checking Terminal Holder and Safety Guard

The goal of this procedure is to check the condition of the Terminal Holder and the Safety Guard..

Indications to check the Terminal Holder and Safety Guard:

- Terminal does not hold its position
- Holder is bent or broken
- Safety Guard is damaged

**Step 1:**

If for any reason the Terminal Holder is broken or bent, replace the entire Holder Assembly.

If the magnets are not installed in the holder, the PAL Terminal does not hold its position and can easily fall down.

The magnets can be glued into place again by using a LOCTIDE 638 (green) glue.

If the magnets are lost, replace the Holder.

For details see section ['XY-Spare Parts'](#).

**Step 2:**

Screws for Holder and safety Guard. For details see section ['XY-Spare Parts'](#).

Check whether the drilling hole for the screw in the side cover is also damaged.

**Step 1:**

If for any reason the Terminal Holder is broken or bent, replace the entire Holder Assembly.

If the magnets are not installed in the holder, the PAL Terminal does not hold its position and can easily fall down.

The magnets can be glued into place again by using a LOCTIDE 638 (green) glue.

If the magnets are lost, replace the Holder.

For details see section '[XY-Spare Parts](#)'.

**Step 3:**

If the Safety Guard is broken or partially damaged, replace it to ensure the protection and the secure mounting of the PAL Control Terminal.

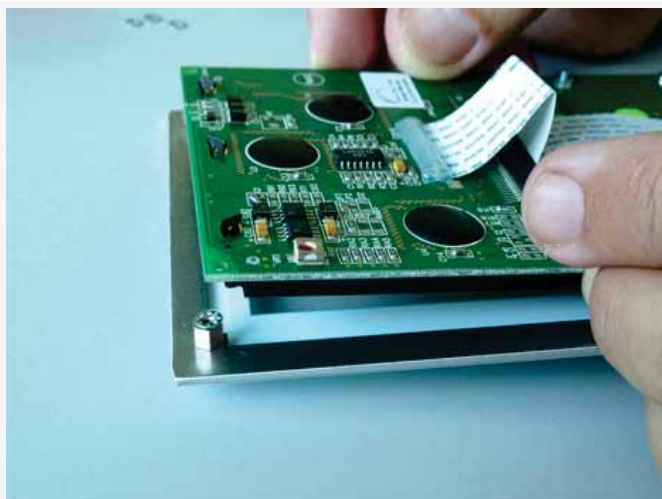
See the section '[XY-Spare Parts](#)' for order information.

1.48.0.1.3.8 Assembling the handheld PAL Control Terminal

This section describes the assembly of the PAL Terminal.

All further steps are described separately; see '[Repair Path Overview](#)'.

Note that not every detail is described; only the important points are listed in this section.



Ensure that there is enough space between the LCD Assembly and the Protection Foil.

See above in the section 'Replacing the LCD Display', Step 5.

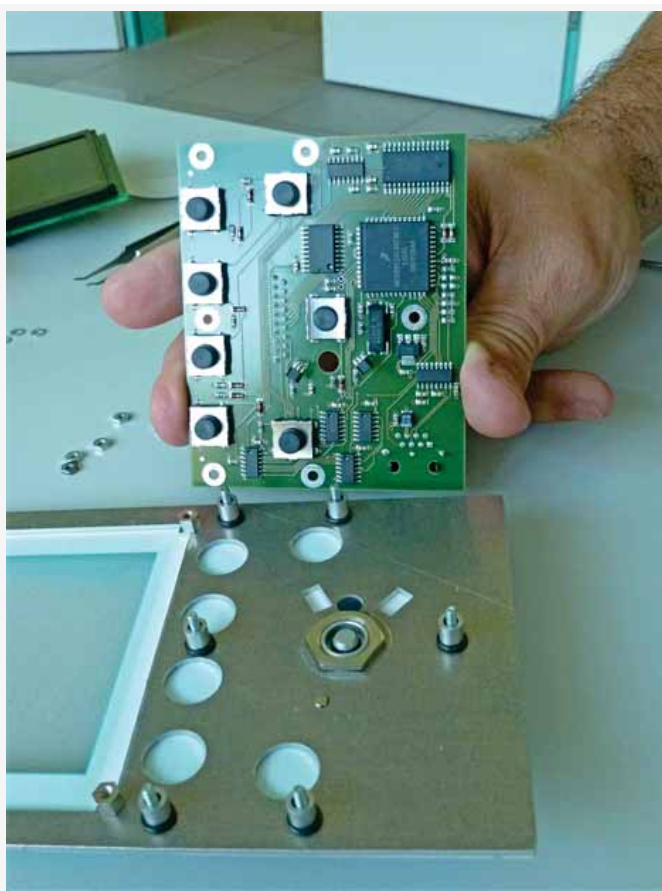


Pay attention to the ribbon cable when inserting the full assembly into the terminal frame.

To test the PAL Control Terminal after a repair, refer to the section '[Test Procedure](#)'.

See also the section '[Limitations](#)' to find out which parts are not available for field repair.

1.48.0.1.3.9 Limitations



Replacing the Terminal PCB is rarely necessary. Therefore no replacement kit for this field repair is provided.

If the Terminal PCB needs to be replaced, return the entire PAL Terminal unit back to CTC Analytics.

See the section 'Return Material Authorization' for instructions.

If the Protection Foil is damaged or dirty and needs replacing, contact CTC Analytics and specify the revision number of the Terminal and the brand, e.g. CTC colors or an OEM brand.

Removing the old Protection Foil is very tedious and requires patience. Use a dedicated solvent mix as provided e.g. to remove glue from labels.

Safety Warning: Use gloves to protect your fingers.

1.48.0.1.3.10 Testing a repaired PAL Control Terminal

IMPORTANT: MAKE SURE THAT THE POWER IS TURNED OFF.

Test the repaired or re-tuned PAL Terminal by connecting it back to the PAL System.

After the electrical connections are made, turn the power ON.

If the display shows up as expected, showing a clear picture with good contrast, then select different menus for example in the category 'Utilities' in order to verify that the display shows no dots or extra lines in different menu screens.

If the PAL Terminal does not behave as expected, or if there are doubts concerning the PCB, test the unit whenever possible with another PAL System.

If still no satisfactory results are achieved, return the unit to CTC Analytics. See the section '[Return Material Authorization](#)' for instructions.

1.48.0.1.4 Overview Upgrade Path | Spare Part Kits | Preventative Maintenance (PM)

This section provides information on:

- [Upgrade Path for PAL Control Terminal](#)
- [Spare Parts for PAL Control Terminal](#)
- [Preventative Maintenance, PM](#)

1.48.0.1.4.1 Overview Upgrade Path | Spare Part Kits | Preventative Maintenance (PM)

This section provides information on:

- [Upgrade Path for PAL Control Terminal](#)
- [Spare Parts for PAL Control Terminal](#)
- [Preventative Maintenance, PM](#)

1.48.0.1.4.2 Upgrade Path for PAL Control Terminal

There is no upgrade possibility for any earlier revision to a higher level. An 'Upgrade path' is possible from revision 6 to 7, see section '[Terminal Release History](#)'.

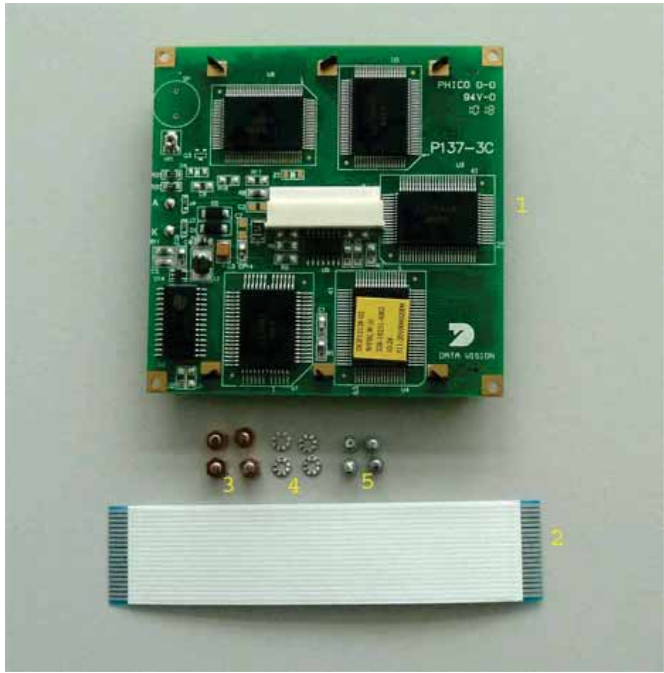
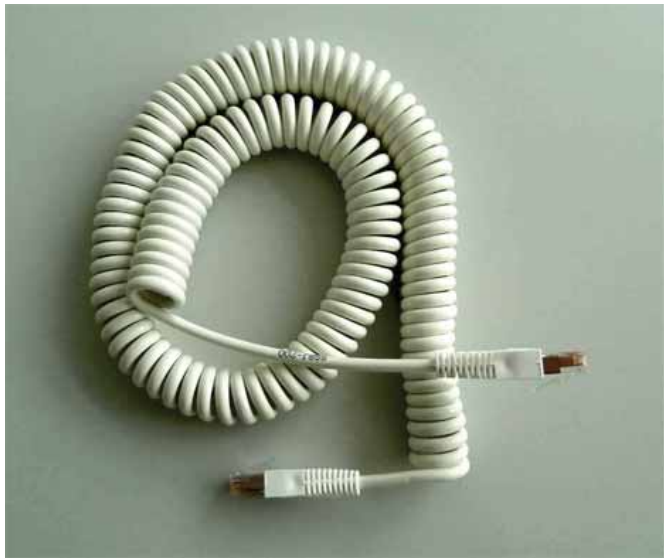
If the terminal module is questionable, it is recommended to return the module back to CTC Analytics for checking or replacement.

See the section '[Return Material Authorization](#)' for instructions.

1.48.0.1.4.3 Spare Parts and Kits for PAL Control Terminal

The following Spare Parts and Kits are available for the PAL Control Terminal:

PNo.	Part or Kit Description	Remarks
PAL TermCTC or PAL TermCTC-xt	PAL Terminal 	OEM branded Terminals upon request. PNo. MB 01-0X The 'X' stands for the OEM version. See the section 'Overview PAL Terminal'.
Kit LCD Repl	Kit PAL Control Terminal LCD Display for Replacement	Kit consisting of: - #1: LCD Module - #2: Flat Cable : FFC 1.25-1-116 - #3: 4 Spacers

PNo.	Part or Kit Description	Remarks
		: MB 30-16A ; M2.5-4.5 - #4: Serrated Lock Washers (star washers) BN 782 M2.3 - #5: 4 Screws BN 381 M2.5x4
Cbl SS8J-700	Spiral Cable Cable 8p shielded, RJ45 connectors, 700 mm long. Connects LCD Terminal with PAL System. 	

Note: For other spare parts mentioned in this section, such as Holder or Safety Guards, see the section 'Spare Parts for the X-Y Axis'.

1.48.0.1.4.4 Preventative Maintenance, PM, for PAL Control Terminal

There is no PM task specifically for the PAL Terminal.

Observe the general rules for maintaining the PAL System, such as cleaning on a regular basis, avoiding liquid spills around the terminal module, etc.

1.48.0.1.5 Overview Handheld Control Terminal for PAL System

This section covers following points:

- Overview Control Terminal Models
- Release History Control Terminal
- Troubleshooting
- Repair Path for Control Terminal
- Upgrade Path for Control Terminal
- Spare Parts for Control Terminal
- Preventative Maintenance for Control Terminal

1.49 Overview PAL PCBs | Electronic Boards

The various PCBs from the PAL System are covered in following sections:

- [PCB Injection Unit](#)
- [X-Sensor Switching PCB](#)
- [Y-Sensor Switching PCB](#)
- The PCB's listed below are not described in detail. Order information are given in '[X-Y Spare Parts](#)'.
- PAL MOTIO Board
- PAL CPU Board
- Control-GC
- Control-HTC
- Control-LC
- Control-**xt**

1.49.1 Overview PAL PCBs | Electronic Boards

The various PCBs from the PAL System are covered in following sections:

- [PCB Injection Unit](#)
- [X-Sensor Switching PCB](#)
- [Y-Sensor Switching PCB](#)
- The PCB's listed below are not described in detail. Order information are given in '[X-Y Spare Parts](#)'.

-
- PAL MOTIO Board
 - PAL CPU Board
 - Control-GC
 - Control-HTC
 - Control-LC
 - Control-**xt**

1.50 Overview PAL PCBs | Electronic Boards

The various PCBs from the PAL System are covered in following sections:

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- [X-Sensor Switching PCB](#)
- [Y-Sensor Switching PCB](#)
- The PCB's listed below are not described in detail. Order information are given in '[X-Y Spare Parts](#)'.
- PAL MOTIO Board
- PAL CPU Board
- Control-GC
- Control-HTC
- Control-LC
- Control-**xt**

1.51 Cables and Interface Connectors Overview

This section describes the Cables and the Interface Connectors for the PAL System:

The Cables and Interfaces are not described yet.

The Specification for the [PAL Interface connectors](#) are provided.

1.51.1 Cables and Interface Connectors Overview

This section describes the Cables and the Interface Connectors for the PAL System:

The Cables and Interfaces are not described yet.

The Specification for the [PAL Interface connectors](#) are provided.

1.51.2 Cables for PAL System - Overview

The description of the Cables will be included in the next edition of the Service Manual.

1.51.3 Connector to PAL Interfaces - Overview

The description of the PAL Input/Output Connectors will be included in the next edition of the Service Manual.

The specification for the [PAL Interface connectors](#) are provided.

1.51.4 Specifications of the PAL System Input/Output

1.51.4.1 Interface 1,2 and Wash Station Connector Control Board (HTC and LC PAL)

1.51.4.1.1 TTL-IN 1-3

TTL compatible signal.

The signal has to be compatible with TTL-standard. Recommended 0 Volt / +5 Volt level.

The input has a one shot protection against higher voltage. The following circuit has a pull-up resistor with 4.7 kOhm to +5 Volt (Vcc).

1.51.4.1.2 TTL-Out 1-3

TTL compatible signal.

The maximum ballast per output is +/- 10 mA. The signal has 0 Volt / + 5 Volts levels.

1.51.4.1.3 Opto-In 1 + 2

This input can be used with up to +36 Volts.

The threshold voltage is approximately 1.85 Volt.

Active State High =<1.5 VDC Active State Low => 2.5 VDC VAC

1.51.4.1.4 SW-Out 1 + 2

Relay-output.

Maximum switching ratings: 0.5 A @ 36 VDC /VAC

Minimum switching ratings: 10uA @ 10 mVDC

Active State High = < 1.5 VDC

Active State Low = > 2.5 VDC

1.51.4.1.5 Power-Out 1 + 2

PWM Driver

The outputs are adjustable according the minimum / maximum values allowed within the Firmware settings.

The ports are current controlled, and reach a voltage up to + 36 V.

WARNING: THERE IS NO PROTECTION FOR SHORT CIRCUITS OR AGAINST VOLTAGE.

1.51.4.1.6 AUX - Port (Auxiliary)

Motor Phases:

The port is prepared to run a two-phase stepper motor. The port is protected against short circuits between each other (AUX1 and AUX2) and the ground. The port is not protected against higher voltage.

Position Sensor Signal:

This input is prepared for an open-collector sensor. The circuit is dimensioned with a 4.7 kOhm resistor to +5 V (Vcc).

The input has a one-shot protection against higher voltage.

Temperature Measurement:

The circuit is prepared for direct connection to a PT1000 temperature sensor.

Heater Output:

The heater output contains a high-side driver and can handle up to 1.5 A.

The output voltage is +36 V.

1.51.4.1.7 Gas Flush Valve Connector

The output contains a low-side driver (BC846) and can handle an absolute maximum current of 100 mA.

The circuit is connected to +36 V and has no protection circuit, but has a flywheeling diode for small inductive loads.

1.52 PAL Software Overview

This section covers the following topics:

1.52.1 PAL Firmware

1.52.1.1 PAL Firmware Overview

Links to the following topics concerning PAL Firmware are given here:

- [PAL Firmware Release History](#)
- [PAL Firmware Error or Exemption Codes](#)
- [PAL Firmware Overview - Short Description - Tips & Hints](#)

1.52.1.2 PAL Firmware Release History

The release History of PAL Firmware from levels 2.2.7 up to level 2.5.2 is given below.

Release details for Firmware levels up to 2.2.7 are listed in a technical note, available from the CTC Analytics secure web page.

1.52.1.2.1 Firmware Version 3.0

A new level 3.0 of the PAL Firmware has been released for the MALDI Spotting Device.

A new Firmware class "Tool" was added to the Firmware to enable handling the MALDI Tool for spotting.

As a consequence of this new Firmware class, it became necessary to add new parameters to all TrayHolder Firmware Objects. The current version of "PAL OBJECT MANAGER", Revision K or higher, includes this special class of Trayholder Firmware Objects, see "Maldi Option (Firmware 3-x-x).

Note: In all cases where a Tool such as MALDI is used, the special Firmware Objects from Level 3.0 onwards are required.

1.52.1.2.2 PAL Firmware Release History, Version 2.2 to 2.5.

CTC Technical Note: PAL Firmware Release History Version 2.2.7 to 2.5.2

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CTC Technical Note

**Titel: PAL Firmware Release History
Version 2.2.7 to 2.5.2**

Author: Heiner Scherrer

Date: 2006/05/03

PAL Firmware Release History for level lower than FW 2.2.7: See "Firmware Release History 2.2.7".

N	Support for Dilutor added: New object class „Dilutor“ New utility function „Dilutor“ New Atom DILUTE
N	New hidden Atom GET_CPU_NO to read the CPU board serial number
N	Added function „Test Switches“ in Service menu
N	New hidden Atom RSTRT to restart PAL
E	An error number is added in front of an error message so it can be better interpreted by a host system.
E	Position error retries are added to the internal log file
C	Error „Limit Switch Always On“ when referencing Agitator
E	Z axis can loose steps if needle is released and bumps against an object -> Current for Z axis is set to "Penetration Current"

Version 2.4.0

N	Support for Multi Position Valve Drives added: New object class „SerValve“ New Events „Vlv-MV0“ ... „Vlv-MV9“
N	Atom TIMETABLE added to allow switching of output signals and MultiPos Valve Drives in the background
N	Support for Output Expansion Box added
N	Local cycle „GC-InjS“ added
N	Local cycle „LC-Cut“ added
E	On-the-fly checking of limit switches to improve position reliability
E	“Injected” signal can be activated when injection valve is switched
C	Checking of syringe overfilling corrected for syringes < 10µl
C	Atom SWITCH_INJ position TOGGLE did not work for AUX2

CTC Technical Note: PAL Firmware Release History Version 2.2.7 to 2.5.2

Version 2.5.0

N	Maintenance counters for Plunger Strokes and Injections added: Menu/Info/Maintenance Exceeded limit is displayed in status line New Atoms SET_PLG_LIM, GET_PLG_LIM, GET_PLG_STROKES, RES_PLG_STROKES SET_INJ_LIM, GET_INJ_LIM, GET_INJ_COUNT, RES_INJ_COUNT
N	Added Atoms for easier tray type setting from host: GET_TRAY_TYPES (TrayName) SET_TRAY_TYPE (TrayName, TrayTypeName)
N	Vial transport with blocked needle guide. Mode "Needle".
N	Second Dilutor can be used
N	Support for Fraction Collection added: New Atom FRACT_COLLECT
N	New atoms added for more flexible use of the Dilutor: ASPIRATE_DIL, DISPENSE_DIL, SWITCH_DIL_VLV
N	Atom MOVETO_OBJ_S added
N	Private Atom CHANGE_SYR and SET_ACT_SYR added
E	Added item "Path Speed" to Motor Y to allow smoother stack opening and closing
E	Extended limits for Motor X to ± 950 mm, Motor Y to ± 420 mm and Penetration to 150 mm to support IFC, LHX and HTX PAL
E	Fine adjustment of trays can be done in Menu/Utilities/Trays, X-Y-Z Offset Position 1.
E	During filling strokes, a delay of 50% of "Pullup Delay" is inserted after ejecting the syringe
E	Exceptions are shown on the status line for a short time
E	Operation without terminal connected is possible
E	Improved timing for GC injection
E	CLEANUP (Reset Injectors) only switches valves to standby and does no more initialize valve drives
C	Path movement corrected for Motor Y / Strategy = Retract
C	"Volume out of Range" error for PUT_SAMPLE with volume < 1 μ l
C	Strip-off distance for magnetic vials with diameter > 50 mm corrected
C	Close Agitator after errors like "No Vial" or "Collision before object"
C	Since 2.4.0 X-Axis was not initialized at CLEANUP (Reset X/Y/Z)

Version 2.5.1

E	If a framed command is received plain text is ignored for the following 5 seconds. This avoids that partial frames are interpreted as plain text.
C	Loading an object list with Object Manager which included the object "Waste" was not possible in 2.5.0
C	The last position of a MultiPos Valve Drive could not be selected
C	For distances < 50 the acceleration was fixed to 4, lower values were ignored
C	The local SPME cycle did not check the Sync Signal "Inject" before injection
C	If a DILUTE command was aborted with CANCEL an error 140 was reported

Version 2.5.2

C	Error #115 did not return error description (Vial not found)
C	Round off error for volume 1.2 μ l syringe corrected

C. PAL Firmware Release History

1. Version 2.5.3 to 2.6.8

PAL Firmware Release History for Version 2.5.2 or lower see Technical Note
 PAL Release History Version 2.2.7 to 2.5.2.

Key	Case Description	FW Version
C	Tray Type VT54, Strip-off magnetic vial caps corrected.	2.5.3
C	'GET_SAMPLE' and 'PUT_SAMPLE' within same Stack drawer. Keep drawer open during sample handling..	2.5.3
C	Corrected error when Motor Acceleration was set to 1.	2.5.4
C	Z-Axis movement for repeated sending of atom 'FRACT_COLLECT' corrected.	2.5.4
C	Agitator AUX2: Error_Zero_Division=118 eliminated	2.5.5
E	Autocorrecting of X-, Y-Axes after collision can be turned off. New parameter in 'F3-Setup System': 'Stop XY Error'. ON: Automated recovery turned off. Recommended for critical application fields, such as clinical analysis. OFF: Automated recovery turned on.	2.6.2
C	Minor corrections for above described feature in special cases.	2.6.7
C	Injection time jitter for sending signal 'Injected' eliminated for plunger positions 'PlgUp' and 'PlgDown' (System Inj Signal).	2.6.8
E	New parameter for Atom READ_BARCODE, 'Stop after Read'. (0 = Off, 1 = On). If activated, the vial is transported to the Barcode Reader; the code is read and stored. The PAL continues with the next step, without returning the vial to the original Tray position.	2.6.8

Explanations:

Key:

C: Corrections
 E: Enhancement
 N: New Feature

FW Version: Correction made in PAL Firmware Version



Technical Note
 PAL and PAL-*xt* Firmware Release History
 PAL FW Version 2.5.2 to 2.6.9
 PAL FW Version 3.0 to 3.0.7
 PAL-*xt* FW Version 4.0.0 to 4.1.2

2. Version 3.0.0 to 3.0.5

Key	Case Description	FW Version
N	New Object Class 'Tool' added. Application e.g. MALDI and MHE. In FW version 3.0.X all parts related to GC technique eliminated. FW Version 3.0.X can be used for HPLC technique only. Exemption: Dedicated FW Backup for MHE application.	3.0.0
N	Possible Tray inclination in Z-Axis can be corrected. New structure for Tray Type. For details see Addendum for PAL User Manual 'MALDI Option'.	3.0.0
N	New Item 'Pattern' in Tray Type. Staggered positions in Tray with + 50% of position difference possible.	3.0.0
N	New mode 'CONT' for Dilutor added, continuous pumping.	3.0.0
C	Firmware classes 'Serial Valves' and 'OutExpBox' in PAL model 'LC PAL' inhibited.	3.0.5

Note: This PAL Firmware version will be frozen at version 3.0.5.

Explanations:

Key:

C: Corrections
 E: Enhancement
 N: New Feature

FW Version:

Correction made in PAL Firmware Version

C. PAL Firmware Release History

1. Version 4.0.0 to 4.2.0

No.	Key	Case Description	Firmware Version
1	N	LAN communication (TCP/IP) added.	4.0.0
2	E	System Parameters and Local Cycle selection can be set by Object Manager Version 2.2.1 or higher.	4.0.0
3	E	For Serial Valves mode 'High Speed' or 'High Torque' can be selected.	4.0.0
4	N	Possible Tray inclination in all three axes (X,Y,Z) can be corrected. New structure for Tray Type. For details see PAL- <i>xt</i> User Manual.	4.0.0
5	N	Tray Type new items 'ZSlideOffRetr' and 'YSlideOffDist'. Paths to move away from a vial in Z- and Y-direction is selectable.	4.0.0
6	N	A200S emulation eliminated.	4.0.0
7	E	Standby Temperature can be set either with 'OFF' or '-2147483647' (-MAX_LONGINT).	4.0.0
8	E	Read-out of temporary CPU Serial number enabled.	4.0.0
9	E	Active Plunger path movement detection.	4.0.0
10	N	Limited visibility of class 'Motor' on Extended User Level (F3-Setup Objects Motors) to access in 'Y-Motor' the parameters 'Strategy' and 'Path Speed'.	4.0.0
11	N	New item in 'Y-Motor': XY-Simul. Simultaneous movement of X- and Y-motors with individual motor speed settings.	4.0.0
12	E	Mode 'Vial PrePressure' is used by Atom 'GET_SAMPLE'. (FW version <4.0.0: 'Vial PrePressure' was only in standalone mode active.)	4.0.0
13	E	Range for Vial Penetration in SPME cycle extended from 5 to 38 mm (default 17 mm). Maximum penetration is only possible in mode 'Out of Tray' (Needle guide blocking). The SPME CC macros and CE cycles are adapted, Revision 02.	4.0.0
14	N	In Tray Type item 'Pattern' new 'Staggered+' and 'Staggered-' selectable. Staggered position in second Tray row either +50% or -50% off compared to first row. Row = sampling direction. For details see PAL- <i>xt</i> User Manual.	4.0.0
15	N	Z-Motor Injection Penetration Speed separated in: - 'Inj Penet Spd' = Injection penetration speed (no change). - 'Inj Retr Spd' = Injection Retract Speed. New parameter to provide flexibility for faster retraction of syringe needle from injector if required by application.	4.0.0
16	N	PAL DLW Option implementation. New Atom 'RINSE_INJ'. Activation of DLW Actuator to allow solvent flow control.	4.0.0
17	N	New type 'DLW' for Wash Station added. PAL DLW Option.	4.0.0
18	N	New type 'Active' for Wash Station added. Active Wash Station Revision B, new PCB required.	4.0.0
19	C	Motor X-Axis Limit corrected to allow X-Axis >80 cm.	4.1.0
20	C	Error in teaching (Setup Objects) Objects Tray 'dzCol' corrected. Inclination Z-Axis for column position.	4.1.0
21	C	Round off error for volume of 1.2 µL syringe corrected.	4.1.1

22	C	Text in Firmware Exception Code 14 changed to 'String to Number Conversion Error' (from 'Number to String Conversion Error').	4.1.2
23	C	Correction of internal clock handling in cases of battery replacement.	4.1.3
24	C	Round off error for total syringe volume if volumes are added together.	4.1.3
25	E	Absolute value and slope of heating curve adjustable for all 'AUX' and Syringe heaters, recalibration.	4.1.3
26	C	Test Head in section 'F3-Setup Service' for FW version 4 corrected and enhanced. Results and interpretation are different to FW versions 2 and 3.	4.1.3
27	C	Utilities Wash Station Needle Penetration enabled if Wash Syringe is selected.	4.1.3
28	C	SPME fiber movement corrected in situation of 'Abort'.	4.1.3
29	C	Tracking of traveled path for X- and Y-Axes corrected in FW version 4 (Log File read-out).	4.1.3
30	E	IP Address is displayed if DHCP mode is selected in LAN communication.	4.1.3
31	N	Limited visibility of class 'Motor' on Extended User Level (F3-Setup Objects Motors) to access in 'Z-Motor' the parameters 'Penetr Speed', 'Inj Penetr Spd' and 'Inj Retr Spd'.	4.1.3
32	C	X-, Y-, Z -axes stepper motor parameters optimized for smooth operation with noise abatement.	4.1.3
33	C	Error using module 'Dilutor' eliminated. Error message: 'Mv1v-1-C' Not found (Exception 011).	4.1.3
34	N	Atoms to support SGE Syringe Park Station of SGE's XCHANGE Option added. WARN_SOUND; SGE_PICK; SGE_PARK	4.2.0

2. Known Bugs

Key	Case Description	FW Version to be corr.
L	Barcode Reader Type LS1220 installed on PAL-xt System. The Barcode Reader cannot be operated in combination with Serial Valve Drives (Multiposition Valve Drive). The Barcode Reader and the Multiposition Valve Drives are connected to 'MODBUS'. The daisy chaining protocol cannot address the different modules.	open

Explanations:

Key:

C: Corrections
 E: Enhancement
 N: New Feature
 L: Limitation

Firmware Version:

Error corrected in PAL Firmware Version as listed.

FW Version to be corr.

Bug correction foreseen in Firmware version as listed.

1.52.1.3 PAL Firmware Error or Exemption Codes



C. PAL Firmware Error Codes up to Firmware Version 4.2.0

Error Code No.	Error Message
0	Okay = No Error
1	FPGA not present error
2	FPGA configuration error
3	External Event is INPUT only
4	Items list is full
5	Duplicate Object Name found
6	Table String is empty
7	Table String Index is invalid
8	Table String is too long
9	Object list is full
10	Invalid Terminal Firmware
11	Object Name not found
12	Real Time Clock bad Data read
13	Number to String Conversion Error
14	String to Number Conversion Error
15	Object Level too deep
16	Too many Items per Object
17	Item Name not found
18	Axis Position Error
19	Module Trigger not valid
20	Module CRC not valid
21	MenuProc Index out of Range
22	MenuProc Address contains NIL Pointer
23	FuncProc Address contains NIL Pointer
24	Invalid Function Key
25	Invalid MenuTable Index
26	MenuTable Pointer contains NIL
27	Invalid Object Focus in GetItemPtr
28	Invalid Item Focus in GetItemPtr
29	Invalid Select String Array Index
30	Unknown Select Array
31	Invalid Select String Index
32	Requested Select String is empty
33	Select String is too long
34	Invalid Batch Name
35	Object is not on expected Position
36	A200S Protocol non Decimal Digit Received
37	A200S Protocol invalid Termination Character
38	Unknown Object Class
39	No Index found for requested SSL_String
40	Command Value out of Range
41	Parameter Value out of Range
42	HostComm Parser found Invalid Keyword
43	Invalid StrToNum Conversion
44	Parser missing Parameters
45	Invalid Character in Numeric Parameter
46	Parameter Value out of Range
47	Invalid Baud rate Selected
48	PAL Status is <> PAL_IDLE



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PAL Firmware Error Codes FW 4.2.0

Error Code No.	Error Message
51	Invalid Plunger Move Detection Parameter
52	Answer Count Needle Magnet not valid
53	Invalid Needle Magnet Parameter
54	Answer Count Head Tool ID not valid
55	Invalid Head Tool Parameter
56	Answer Count Head Board Revision Level invalid
57	Invalid Head Board Revision Level Parameter
58	Answer Count Heater Power Count Invalid
59	Invalid Heater Power Parameter
60	Load Firmware not successful
61	RS232 Communication Parameter Error
62	RS232 Channel already Open
63	RS232 Channel not Open
64	RS232 Channel Timeout While Reading / Writing
65	RS232 Parity Error
66	RS232 Framing Error
67	RS232 Overrun Error
68	RS232 RX fifo overflow
69	No serial Channel defined for requested Function
70	Unknown Data Type detected
71	Unknown Item Element detected
72	Unknown Temp Channel
73	Unknown RPM Channel
74	Temperature out of Range
75	Invalid Cycle Detected
76	Answer Count Heater GetRawTemp invalid
77	Invalid Heater GetRawTemp Parameter
78	Parenthesis "(" expected
79	Parenthesis ")" expected
80	Current is too high
81	Speed is too high
82	Acceleration is too high
83	Target position is below low_limit_steps
84	Target position is above high_limit_steps
85	No Syringe Found
86	Syringe Volume out of Range
87	Tray Index out of Range
88	Not Appropriate Object Class
89	Temperature is out of Heater Limits
90	Motor Axis Target Position Error
91	Motor Current Fault Phase A
92	Motor Current Fault Phase B
93	Motor Current Fault Both Phases
94	PAL is in PAL_ERROR Status
95	Syringe ID Mismatches
96	Timeout when waiting for answer
97	Answer too big, buffer overflow
98	Timeout during send, SW error
99	Checksum error in received frame
100	Wrong toggle bit in rx frame



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PAL Firmware Error Codes FW 4.2.0

Error Code No.	Error Message
101	Invalid procedure parameter >127
102	Could not load head firmware
103	Motio Fault
104	Unknown Atom
105	Not Implemented
106	Object Name is too long max. 8 Characters
107	Object Named 'None' requested
108	No Syringe installed
109	Invalid SoftTimer
110	SoftTimer Timeout occurred
111	ReportLog Index out of Bounds
112	Invalid Vial Transport Mode
113	Invalid Barcode Mode
114	Memory Full
115	Found No Vial
116	Address Error detected
117	Bus Error detected
118	Zero Division detected
119	Spurious Interrupt detected
120	Format Error and uninitialized Interrupt
121	Input Voltage below trip point
122	Unknown Motor
123	Temperature Sensor failed
124	Valve Position Error
125	Restricted Object Class
126	Heaters are not supported by this Hardware
127	Invalid Host Frame State detected
128	Invalid Host Sequence Number detected
129	Invalid Host Frame Data detected
130	Host Frame ETX Expected
131	Is Not a Hexadecimal Digit
132	Invalid Host Frame Length detected
133	Invalid Host Checksum detected
134	Unexpected STX detected
135	Unexpected ETX detected
136	Unexpected Character detected
137	Needle Guide not Released
138	Wrong Dilutor Syringe inserted
139	Axis stuck on Limit Switch
140	Axis could not detect Limit Switch
141	Axis Low Limit Error
142	Axis High Limit Error
143	Axis Target Position Error
144	Motor Current fault
145	Time Table Full
146	No Tray found at this position
147	Z-Axis Collision Error
148	Mandatory Parameter Missing
149	Invalid Vici Valve Drive
150	Invalid Vici Valve Position



Technical Note

PAL Firmware Error Codes FW 4.2.0

Error Code No.	Error Message
151	Invalid Vici Valve Status
152	Aux Motors are not supported by this Hardware
153	OutExpBox is currently disabled
154	Output currently used by OutExpBox
155	Invalid Dilutor Motor Status
156	Serial Valves are currently disabled
157	Serial Valve Communication Error
158	Invalid Object Name
159	Invalid Tray Type Group
160	Invalid manual syringe selection
161	Stop on XY Position Error
162	Object used by other object
163	Plunger Position Error Detected
164	Duplicate syringe ID found
165	Washstation is not of type DLW
166	Pick Syringe failed (Plunger)
167	Pick Syringe failed (Solenoid)
-1	Unknown Exception received

1.52.1.4 PAL Firmware Overview - Short Description - Tips & Hints:

Note: See also the section on Tips & Hints for the ["PAL Loader"](#) and ["PAL Object Manager"](#) software.

1.52.1.4.1 PAL Firmware Short Description

- Core Software - Firmware only - Resident in Flush Memory

The PAL Firmware by itself can be considered the core software.

The file size is approximately 800 KB, the extension is *.sss.

- Firmware Objects - Resident in RAM

The Firmware core software resides in the Flush memory (Flash-EEPROM).

In order to operate the PAL System, the so-called Firmware Objects have to be added to the core software. Examples of Firmware Objects are Syringes, TrayHolders, Stacks, Valve Drives, etc. Even the Stepper Motors are (self-creating) Firmware Objects.

The Firmware Objects are resident of the RAM (Random Access Memory).

- Complete Backup File

A so-called "complete backup file" is a compiled file of the core software and the various firmware objects. The file size is approximately 1.5 MB, the file extension *.sss.

A "complete backup file" from a specific PAL System can be obtained or generated using the PAL LOADER Software.

Every bit and byte from the specific PAL System is included in this backup file. This includes the Methods (local methods), Jobs, all settings, including Sync Signal, Events, etc. All XYZ- Positions, Needle Penetration, and other Object parameters are also saved. The compiled file cannot be broken up. An example is a Method, which cannot be extracted from the backup file.

- Firmware Level Numbering

The PAL Firmware is numbered and identified with 3 digits.

Example: Firmware 2.5.2

Explanation:

- The first digit, for example "2": Denotes the version or Firmware main level. This level is only changed if major changes in the firmware structure are made. An example is the addition of a new firmware class "Tool" for Mald. This would augment the Firmware version (or level) to "3".
- The second digit, for example "5": Denotes a Revision. This secondary level is increased if new features are implemented. For an example, see the ["Release History for PAL Firmware"](#).
- The third digit, for example "2": Denotes an Edition. This tertiary level is increased by the addition of minor "bug-fixing" revisions. For an example, see the ["Release History for PAL Firmware"](#).

The backup file name includes the firmware main level and the revision level of the Firmware Object. Example: HTS0-2-5-2_K.sss.

The annex "_K" refers to the revision level of the Firmware Objects. See also the section ["PAL FW Name Convention"](#).

Note:

To identify a firmware backup file from its file name, see the section "[FW Name Convention](#)".

1.52.1.4.2 Firmware Tips&Hints

- Firmware Versions

The PAL System requires PAL Firmware Version 2.X.X and for special applications such MALDI, the version 3.0.X.

The PAL-xt System requires PAL Firmware Version 4.1.X or higher.

- Backup File

It is highly recommended to perform a backup (PAL LOADER Software) after an installation of a PAL System. If any uncontrolled changes are made, or damage by an electrical spike (as an example) corrupts the firmware, the user will always have a fast way to recover. The original "complete backup file" has to be re-loaded (Update with PAL LOADER Software), and the PAL System will be up and running within a few minutes.

If the settings or the configuration are changed, a new backup file should be made and stored.

- Firmware Errors

Corrupted Firmware can behave in various manners. Only a part of the file can be corrupt and a specific object could create a problem. In such a case, re-load the original complete backup file to test if the error disappears.

In our experience, firmware errors related to an object can often be eliminated by re-loading the complete backup file. Of course, other relevant sources of error should first be eliminated. Typical cases are :

- Plunger Sensor not detected
- Head Communication Error
- Vial not detected
- etc.

In the sections "[Troubleshooting](#)" for the individual modules, the possible causes are listed. Re-loading a complete new backup file is the most logical first step. Many errors can be eliminated with a new firmware backup file, and furthermore this step is quick and easy, and can be done by the customer himself.

Another case is if an Error Code is reported on the message line of the display (local Terminal). The exemptions or [Error Codes](#) are listed in this section of the PAL Service Manual.

A clear picture gives an error code "**STR**" visible on the message line of the display (local Terminal). "STR" is shortened from "String". The firmware received an unexpected string which could not be handled. This is a clear indication of corrupt firmware. Re-load a complete backup file to fix the problem.

- Isolating the PAL System from any other software to narrow down the source of error.

It is good practice to isolate the PAL System from any other software integration.

Run the PAL system as a standalone system by synchronizing with the SyncCable Start/Stop. Create a Method and a Job through the local Terminal.

If the error no longer occurs, check the integration of the PAL System with other software packages (such as data handling software).

If the same error occurs from the standalone PAL System, the source of error is clearly limited to the PAL System.

- Re-Loading Firmware (Core Software) only or a Complete Backup File?

There is a general rule that in all cases when erratic behavior of the PAL System is observed, a "Complete Backup File" should be used. Loading only the Core software would not affect the RAM where the objects are located. If an error is related to a Firmware Object, the error will not be eliminated.

If the "personal" backup file from the specific PAL System is re-loaded, the XYZ-positions are already known and need not be taught again. This is one of the major advantages of always storing a backup file for every PAL System.

In case a complete new backup file has to be loaded, follow the procedure as if for a new installation.

- Which criteria have to be fulfilled to load Firmware only (Core software)?

Loading firmware only (core software) is permitted in cases of bug-fixing where the currently used firmware level is identical at the secondary level. Example: FW 2.2.4 is in use and bug fixing done using FW 2.2.7.

Do not load a Firmware level where the difference in the secondary level is higher. Example: FW 2.2.4 in use, upgrading to FW 2.5.2 (not recommended).

Such a large step is not recommended. New features (e.g. new objects) have been created in the development of the higher version. The existing firmware objects are constantly maintained and it is possible that default values have been changed. Loading core software only would eliminate the possibility to take advantage of the improvements.

- Can a Firmware level be downgraded?

DOWNGRADING A FIRMWARE LEVEL USING THE CORE SOFTWARE ONLY IS FORBIDDEN.

Example: downgrading from Firmware revision (level) 2.5 to level 2.2. The definition of the secondary level is the addition of new features. In firmware level 2.3, the Dilutor option has been added. If the firmware is downgraded from level 2.5, the commands (Atoms) for the Dilutor operation would no longer be part of the firmware. The Firmware Object "Dilutor" would still exist but the firmware would not be able to address it.

IF ONE HAS TO DOWNGRADE THE FIRMWARE FOR ANY REASON, THE ONLY ACCEPTABLE WAY IS TO LOAD A "COMPLETE BACKUP FILE", EITHER A PREVIOUS FILE FROM THE SPECIFIC PAL SYSTEM OR A COMPLETELY NEW FILE.

- Which steps have to be taken at the moment of re-loading a Backup-File?

A general rule is: Before touching the Firmware, a backup must be performed.

USE THE PAL LOADER SOFTWARE BUTTON "BACKUP" AS A VERY FIRST STEP.

This saves the current status of the PAL System and allows recovery of this status in case of problems.

The next steps listed are pre-cautions before one performs an "Upgrade":

- Are the local Methods documented?

- Is a non-standard Object used? Example: a self-created TrayType. Are these non-standard objects documented? Can they be added again after an upgrade?

- Is a so-called "PAL Emulation mode" used? Early PAL software integration looked at the PAL system as if it were model A200S (first generation Autosampler from CTC Analytics). If this is the case, the name conventions for the Methods and Tray names have to be observed. See the Technical Note "Remote Control".

After this pre-cautions have been checked, perform the **Update by using the PAL LOADER Software**.

The following steps have to be checked after the update:

- XYZ -Positions have to be taught. For details, see the PAL USER MANUAL.
- Re-enter the Method parameter if the PAL System is used in standalone mode.

- Re-enter any self-created TrayTypes, if applicable.
- Re-enter the PAL S/N. After the update will it display "XXXXXX". Path: Menu/F3-Setup/Ident
- Check the TrayType and the corners of the Trays from the section "Utilities". Check with the customer as to which TrayTypes will be used in the routine work.
- Check the Syringe Detection. Path: Menu/F3-Setup/System/Syringe Detection ON
- Install the required syringe.

Synchronization with another Analytical Instrument and Software:

- Check the Sync Signal settings. Path: Menu/Setup/Objects/Sync Signal/Start/
- Check the Events. Path: Menu/Setup/Objects/Events/TTL-In1/active high or Low?

For the synchronization, it is important to distinguish how the PAL System is integrated with another software (Data Handling System).

If the PAL System is fully integrated within the other software, then the software controls the PAL System via the RS232 communication. "SyncSignal" and "Events" settings should be on default, for example "Immediate". Examples for this type of integration are:

- Thermo Xcalibur , level 1.2 or higher
- Varian Star, level 6.4.3 or higher (requires PAL Firmware level 2.4.0 or higher)

For other integrations, control via the synchronization cable is necessary. Check the manufacturer's recommendations.

Test the Entire System

-Run a test with 3 vials to ensure that the synchronization is functioning correctly.

Note: If for any reason a mistake has been made during the process of updating the firmware, is it always possible to return to the original status using the Backup File which was prepared before beginning this procedure.

1.52.1.5 PAL Firmware Backup File Name Convention

FW = Firmware

The PAL Firmware Backup Files have dedicated abbreviations which describe the firmware configuration or describe which Firmware Objects are loaded.

Example: HTS0 and HTS9.

The "HTS0" is a HTS PAL FW Backup file with a basic configuration which includes following FW Objects:

- **Valve Drive connected to Auxiliary 1 and a 6-Port Injection Valve (VICI/Valco C2V Cheminert and W-Type)**
- 100 ul syringe
- Fast Wash Station

The "HTS9" is a HTS PAL Firmware Backup File with a very basic X-Y-Z configuration. Firmware Objects are not included. This is an open configuration which can be used for a specific customized system. Example: MultiPosition Valve Drive(-s), Active Wash Station, Cooled Stack or different Syringe volumes.

The FW Objects have to be loaded using the PAL Object Manager Software. For more details, see the section ["PAL Object Manager Software"](#).

Ordering such a system allows the customer to specify the individual components (hardware objects) for a dedicated PAL System.

Note: This explanation for the model type "9" is simplified. Strictly speaking, the basic FW Objects are loaded. The statement "no FW Objects loaded" actually refers to the obvious FW Objects, e.g. a Valve, Syringe, Tray-Holder, etc.

Note: See also the section "[FW Tips&Hints](#)" for an explanation of "Firmware Level Numbering"

The annex to the file name "_K" (as example "HTS0-2-5-2_K.sss" refers to the revision level of the PAL Firmware Object.

Examples are listed below. A similar table is given with the CD-ROM "PAL System Software", section "Loader\Backup Files". The CD-ROM is part of the shipment with every PAL system.

1.52.1.5.1 Name Convention for HPLC PAL Systems:

PAL Models for HPLC Technique	Backup File	X-Axis(cm)	PAL Firmware Objects Loaded
HTS0	2-5-2-HTS0_K.sss	80	6-Port Valve and Valve Drive (Aux), 100 ul Syringe, Fast Wash Station
HTS9	2-5-2-HTS9_K.sss	80	None
HTC0	2-5-2-HTC0_K_K.sss	50	6-Port Valve and Valve Drive (Aux), 100 ul Syringe, Fast Wash Station
HTC9	2-5-2-HTC9_K.sss	50	None
HTX9	2-5-2-HTX9_K.sss	120	None
LC PAL	2-5-2-LC1_K.sss	50	6-Port Valve and Valve Drive (Aux), 100 ul Syringe, Wash Large
LC PAL	2-5-2-LC2_K.sss	50	6-Port Valve and Valve Drive (Aux), 100 ul Syringe, Fast Wash Station

PAL Models for Maldi Tech- nique	Backup File	X-Axis (cm)	PAL Firmware Objects Loaded
HTS9	3-0-2-HTS9_K.sss	80	None. FW prepared for the MALDI Tool requires special FW Objects for TrayHolders. See also the section " PAL FW Release History ".
HTC9	3-0-2-HTC9_K.sss	50	None. FW prepared for the MALDI Tool requires special FW Objects for TrayHolders. See also the section " PAL FW Release History ".

PAL Models for GC Technique	Backup File	X-Axis (cm)	PAL Firmware Objects Loaded
LHS0	2-5-2-LHS0_K.sss	80	10 ul Syringe ,Wash Station, GC-Inj1Liquid Injection only.
Combi PALorLHS2	2-5-2-LHS2_K.sss	80	10 ul liquid and 2.5 ml Headspace Syringes, WashStation, 2 TrayHolders and TrayTypes VT98 and VT32, Agitator, GC Inj1.Liquid and Headspace Technique.
LHX9 PAL	2-5-2-LHX9_K.sss	120	None
GC PAL	2-5-2-GC1_K.sss	80	10 ul Syringe ,Wash station,TrayHolder and TrayType VT98, Agitator, GC-Inj1 Liquid Injection only.
GC9 PAL	2-5-2-GC9_K.sss	80	None

Note: The PAL Firmware Backup Files listed above are examples only, but nevertheless represent the current situation (August 2007).

PAL Firmware Backup Files for PAL-xt Systems



Quick Guide for PAL and PAL-*xt* System for PAL System Backup Files

Printing History

Edition 1 May 2010

PAL System Backup Files

The CD contains a set of standard instrument firmware backup files. To load a PAL Firmware for a particular configuration, browse the CD folders 'Backup File GC' or 'Backup Files HPLC' and save the selected file to hard disk.

Add additional PAL Firmware Objects by using the PAL Object Manager Software as required. For details, see 'Quick Guide for PAL Object Manager'.

The PAL-*xt* System requires PAL Firmware version 4.1.X or higher and the electronic board 'APR Control-*xt*'.

The Firmware version 4.1.X contains a new Firmware Object structure. It is mandatory to use the corresponding PAL Object Lists for the various firmware versions, as shown below:

- PAL System Firmware Versions 2.X.X
PAL Object Lists Rev. L
- PAL System Firmware Version 3.0.X
PAL Object Lists Rev. L
See specific Object Lists for this FW Version 3.0.X.
- PAL-*xt* System Firmware Version 4.1.X (or higher)
PAL-*xt* Object Lists Rev. B (or higher)

Definitions of PAL Firmware Backup Files

A backup file including the number '9' in the name is dedicated to the specified PAL model but does not contain PAL Firmware Objects for Tray, Tray Holder, Syringes, Wash Station, etc. Example: 'HTC9'.

This backup file is used to configure a PAL System for a specific application by adding PAL Firmware Objects which are often not included in standard PAL configurations, such as a 4-Valve Injection Block.

A backup file including the numbers '0', '1' or '2' in the name reflects a standard PAL System configuration. The PAL Firmware Object Lists for the standard objects are included in the backup file.



Quick Guide for
GC PAL / PAL GC-*xt*
PAL Backup Files

A character at the end of the file name, such as '-B' reflects the PAL Object Lists version (Revision B).

Backup Files for PAL-*xt* System

LC PAL Model	Backup File	X-Axis	Valve	Syringe	Wash Station
PAL HTS- <i>xt</i>	4-1-2-HTS-xt-DLW_B.sss	80 cm	6-port	100 µL	PAL DLW Option
PAL HTS9- <i>xt</i>	4-1-2-HTS9-xt.sss	80 cm			
PAL HTC- <i>xt</i>	4-1-2-HTC-xt-DLW_B.sss	50 cm	6-port	100 µL	PAL DLW Option
PAL HTC9- <i>xt</i>	4-1-2-HTC9-xt.sss	50 cm			
PAL HTX- <i>xt</i>	4-1-2-HTX-DLW_B.sss	120 cm	6-port	100 µL	PAL DLW Option
PAL HTX9- <i>xt</i>	4-1-2-HTX9-sss	120 cm			
PAL IFC P Right- <i>xt</i>	4-1-2-IFC Right-xt.sss	120 cm	6-port	var. Injection syringes	WashFast
PAL IFC P Left- <i>xt</i>	4-1-2-IFC Left-xt.sss	120 cm		var. SP-syringes	
PAL IFC A Right- <i>xt</i>	4-1-2-IFC Right-xt.sss	120 cm	6-port	var. Injection syringes	WashFast
PAL IFC A Left- <i>xt</i>	4-1-2-IFC Left-xt.sss	120 cm		var. SP-syringes	
PAL Dual Right- <i>xt</i>	4-1-2-Dual-Right-xt.sss	120 cm	6-port	var. Injection syringes	WashFast
PAL Dual Left- <i>xt</i>	4-1-2-Dual-Left-xt.ss	120 cm	6-port	var. Injection syringes	
GC PAL Model	Backup File	X-Axis	Tray	Syringe	Wash Station
PAL LHS0- <i>xt</i>	4-1-2-LHS0-xt_B.sss	80 cm	VT98	10 µL	WashStd
PAL COMBI- <i>xt</i>	4-1-2-LHS2-xt_B.sss	80 cm	VT98/VT3 2	10 µL/ 2.5. mL	WashStd
PAL LHX9- <i>xt</i>	4-1-2-LHX9-xt_B.sss	120 cm			
PAL LHS- <i>xt</i> Basic	4-1-2-LHS-xt_Basic.sss	80 cm			
PAL GC- <i>xt</i>	4-1-2-GC1-xt_B.sss	80 cm	VT98	10 µL	WashStd
PAL GC9- <i>xt</i>	4-1-2-GC9-xt_B.sss	80 cm			
PAL GC- <i>xt</i> Basic	4-1-2-GC-xt_Basic.sss	80 cm			

PAL IFC P: PAL IFC Preparative Model

PAL IFC A: PAL IFC Analytical Model

The files listed above are generic Firmware backup files and not dedicated PAL OEM versions.

1.52.2 PAL Loader

1.52.2.1 PAL Loader Software Overview

The following topics concerning the PAL Loader are covered:

- [PAL Loader Release History](#)
- [PAL Loader Explanations and Hints](#)

1.52.2.2 PAL Loader Software Release History



C. PAL Loader (PC Software) Release History

1. Version 1.0.0 to 2.1.1

No.	Key	Case Description	Software Version
1		Original PAL Loader (PC) Software	1.0.0
2	C	Error '4005' eliminated	1.0.1
3	E	New compiled	1.0.1
4	N	LAN Communication enabled	2.1.0
5	C	COM ports selected in a non consecutive order is allowed.	2.1.0
6	E	COM port range expanded to 1-9 .	2.1.0
7	N	'Drag&Drop' functionality enabled for firmware file selection in 'UPGRADE' mode.	2.1.0
8	E	COM port range >9 selectable.	2.1.1
9	E	Name of update file (PAL Firmware file) used is displayed in 'Update.log' file (Loader Log file; ini-file).	2.1.1

2. Known Bugs

Key	Case Description	SW Version to be corr.
---	No bug known till today	---

Explanations:

Key:

C:	Corrections
E:	Enhancement
N:	New Feature

Software Version:

Error corrected in PAL Loader (PC) Software Version as listed.

SW Version to be corr.

Bug correction foreseen in PAL Loader (PC) software version as listed.

1.52.2.3 PAL Loader Software - Short Description - Tips & Hints

Note: General information on PAL Firmware and backups/updates are given in the section "[PAL Firmware Tips&Hints](#)". See also the section "[PAL Object Manager Tips&Hints](#)".

Establishing a Serial Communication:

The usage and functionality of the PAL Loader software are described in the "PAL User Manual".

Please note the following important points:

- The software has to be installed on a read/writable drive (network drives are not allowed), and cannot be operated directly from the CD-ROM. During this process, temporary files are created and stored.
- If the serial communication cannot be established from the computer to the PAL System, check the following points:
 - Is the serial port from the computer functional?
 - If no RS 232 (serial) port is available, use a USB/RS232 converter. Use the recommended type, evaluated by CTC Analytics AG (see the section "[XY Spare Part Kits](#)").
 - Check the RS 232 port identification. Note that only ports from 1 to 4 are valid.

Forcing the PAL System into the so-called Loader Mode:

If basic conditions are met and communication from the PC to the PAL System nevertheless cannot be established, the PAL System must be forced into so-called 'Loader mode'.

This action may be necessary if the PAL Firmware is partially corrupt.

The following steps are necessary to force the "Loader Mode" manually:

- Turn OFF the power from PAL System
- Turn ON the power again
- Turn OFF the power from PAL System within a time window of approximately 3 to 5 seconds again (turn off before the start-up logo is displayed on the screen)
- Turn ON the power again

Indication of a successful activation of 'Loader Mode' is the blinking red LED at the rear of the PAL X-axis.

For more details see 'Addendum for PAL Loader Software', Section 'Troubleshooting'.

LED signals:

- **Turned off:** Flash memory is in normal working mode.
- **Blinking (or Flashing):** Flash memory is enabled in "Loader Mode", ready for an Update or Backup of the Flash Memory.
- **Constantly On:** A Backup or Update of the Flash Memory and RAM is in progress.

Erratic Behavior of Software or Flash memory:

In case the LED continues blinking after performing an Update of the PAL Firmware:

- Turn off the PAL System and power up again after approx. 30 seconds.
- If this action has no effect, load a Firmware backup file again.
- If still not successful, de-install the CPU or Control Board from the PAL System. One assumption is that a magnetic charge is disturbing the system performance. This has been sometimes observed in

combined HPLC-MS Systems (check the grounding on the system). Remove the board and try to load a new Firmware backup file "on-the-fly" (load a complete backup file - not core software only). "On-the-fly" means connecting the PAL Terminal, DC Cable /Power Supply and the RS 232 Cable.

- If these actions are still not successful, change the CPU or Control Board. One potential reason for this problem is that the Flash memory can no longer be accessed for the installation of the PAL LOADER software, (a defective processor). However, such cases are rare. The Board has to be returned to the factory for inspection, accompanied by a detailed error description and RAM Number.

OBSERVE THE GENERAL RULES FOR EMC SAFETY.

1.52.3 PAL Object Manager

1.52.3.1 Object Manager Software Overview

The following topics concerning the PAL Object Manager Software are covered in these sections:

Related topics:

- [Object Manager Release History](#)
- [PAL Object Manager - Short Description - Tips&Hints](#)

1.52.3.2 Object Manager Software Release History

C. PAL Object Manager Software Release History

1. Version 1.0.0 to 2.2.1

No.	Key	Case Description	Software Version
1		Original PAL Object Manager Software	1.0.0
2	E	Software new compiled. Minor structural changes.	2.0.0
3	E	Internal version	2.1.0
4	C	Dots in file name or folder are allowed	2.2.0
5	C	Blocking COM Port. The 'Port in use' problem that occurred at the start of the program on some systems has been corrected.	2.2.0
6	C	COM ports selected in a non consecutive order is allowed.	2.2.0
7	E	COM port range expanded to 1-9 and 1-20.	2.2.0
8	C	Print functionality improved.	2.2.0
9	C	Error 'Access Violation' at 'Restart PAL' eliminated.	2.2.0
10	E	Number of items per Object increased from 20 to 24 to match with PAL- xt Firmware.	2.2.0
11	N	LAN Communication enabled	2.2.0
12	C	LAN communication error 'Invalid Keyword' eliminated	2.2.1

2. Known Bugs

Key	Case Description	SW Version to be corr.
---	No bug known till today	---

Explanations:

Key:

C:	Corrections
E:	Enhancement
N:	New Feature

Software Version:

Error corrected in Object Manager Software Version as listed.

SW Version to be corr.

Bug correction foreseen in Object Manager software version as listed.

1.52.3.3 Object Manager 'Object Lists' Release History

1.52.3.3.1 PAL Object Lists

Revision Level	Modifications to Previous Revision Level	Remarks
A to F	Various modifications to various classes	Used in early revisions of PAL Firmware Backups
G	Consolidated version	Used with PAL Firmware Revision 2.2
H	Updated revision. Syringe Speeds, Volumes and Wash Station settings adapted to the recommended PAL Method parameters.	Intermediate release. This revision was not used with factory backup releases.
J	Default settings for all objects verified and adjusted. Released with PAL Firmware Revision 2.5.2.	Object Classes completed. All known PALFirmware Objects were added to the list.
K	Syringe Plunger Stepper Motor settings changed. TrayHolders and TrayTypes for PAL Firmware Revision 3.x.x added. MALDI application.	Current for Plunger Motor Driver "MPigMed" and MPigHigh" was increased. This provides more reserve for the plunger movement of the X-Type syringes. The new firmware class "Tool" was adapted with new parameters for the TrayHolders. New TrayTypes added for MALDI Plates. Released June 2007.
L	Valve Rheodyne PD7991: new settings	

1.52.3.3.2 PAL-xt Object Lists

Revision Level	Modifications to Previous Revision Level	Remarks
A	Internal version of Object Lists	New structure for Tray Types.
B	First Release for PAL-xt Systems	
C	Settings for Stepper motors modified.	

1.52.3.4 PAL Object Manager Software Tips & Hints

Note: For Tips & Hints on "[PAL Firmware](#)" or "[PAL Loader](#)" software, refer to the corresponding sections.

PAL Systems require PAL Object Lists K or higher. PAL Firmware 2.X.X or 3.0.X.

PAL-xt Systems require PAL-xt Object Lists B or higher. PAL-xt Firmware 4.1.X or higher.

1.52.3.4.1 Overview

PAL Object Manager is used to load a PAL Firmware Object to the RAM which interacts with the PAL Firmware in the Flash Memory.

A Firmware Object List contains the complete set of PAL Firmware Objects which are needed for a new PAL-Module or Option (e.g. Syringes, Trays, TrayTypes, Stacks, Valves, etc.)

After loading a new PAL Firmware Object List into the PAL RAM, all other classes (e.g. Methods, Jobs, etc.) remain unchanged. An exception is the positioning of the new object, where the XYZ-positions have to be re-taught (if applicable).

Before using the PAL System, it must be switched OFF and ON again to initialize the interface. This is valid for all modules which require a motor, including Valve Drives, Agitator, etc.

1.52.3.4.2 Tips & Hints

The PAL OBJECT MANAGER Software has to be installed on a read/writable drive (network drives are not allowed), and cannot be operated directly from the CD-ROM. During the installation process, temporary files are created and stored.

The PAL OBJECT MANAGER Software requires a standard serial communication (RS 232). The so-called "Loader Mode" is not required (used for PAL LOADER Software only).

The method for establishing a reliable serial connection is described in the section ["PAL Loader Tips&Hints"](#). The same principles are applicable here. Testing the serial communication is easier with the PAL LOADER Software.

The serial communication can fail if a parameter is actively selected from the local Terminal. Example: Menu/Setup/Objects/SynSignal/Start/"Source activated" or highlighted. To be on the safe side, always press function key "F4" for "Home". This brings the software back to the main menu.

To check if a newly-loaded Firmware Object has been added to the RAM, select the corresponding class. The new object will always be added to the end of the list. Example: after adding a new Tray Holder "MTHolder", check Menu/Setup/Objects/Tray Holder. For certain Object classes, the Firmware Service Level has to be accessed. Typical examples are Tray Types or Syringes. Tray Types are only accessible at the Service Level. The 'active' syringe is visible on the user level but all other syringe objects loaded are visible on the service Level.

The service Level is accessible with the following path: Menu/F3-Setup/Objects/"F3-Setup": Select "Setup". Press function key "F3". Activate "Setup".

To delete a Firmware Object, select the Service Level and the corresponding Object class. For example, to delete a syringe: Path: Menu/F3-Setup/Objects/Syringes. Use the function key to delete the unused syringe. The syringe can only be deleted if it is not linked to a local Method and a Job.

To delete "simple" Objects such as a Syringe or TrayType, check that there are no direct links to the Object (e.g. methods or jobs). This is fairly obvious and can be performed easily. However, deleting a Stack or a cooled Stack can be very tedious. The TrayHolder "Stack" is linked to the class "Trays" and to the class "TrayType". In this case, please observe the order when deleting the classes, one after the other (e.g. from TrayType to Trays, and to TrayHolder).

It is often faster to re-load the backup file and restart from scratch. See also the section "PAL Firmware Tips&Hints", which explains the importance of creating a Backup file before making any alterations at the Firmware level.

1.52.4 PALStatistic Report

1.52.4.1 PAL Statistics Report - Overview

- [PAL Statistics Report Release History](#)
- [PAL Statistics Report Tips & Hints](#)

1.52.4.2 PAL Statistics Report Release History

Rev. Level	Modifications to Previous Revision Level	Remarks
Build 1.0.0.1	Build for Firmware Version 2.2.x	CTC internal use only
Build 1.0.02	Build for Firmware Version 2.3.x	CTC internal use only
Build 1.0.03	Build for Firmware Version 2.4.x	CTC internal use only
Build 1.0.0.4	Build for Firmware Versions 2.2.x to 2.5.x	First release version. Software checks the Firmware level and reads out the data that has been made available on this particular level.

1.52.4.3 PAL Statistics Reports Tips & Hints

Connect the PC to the PAL System and press the button "Make Report". The sections below describe the various parameters you will receive.

The Log File contains a list of the last actions performed. For example, you can see the manual change of a XYZ-Position, if this was the last action performed. Note that the deletion or addition of an Object is not recorded in this list.

If the Log File is too long and one would like to save only a specific section, highlight that section and add it to the "Comments". Approximately 10 lines can be printed out. See the example below.

For testing purposes, the Log File can be erased: Log File\Options\Reset PAL Log File. This helps to better monitor a particular test phase.

If the Firmware version is lower than 2.3 will some fields not be readable. The field will be filled out with "UNKOWN" or stays empty. See example below.

One could also reset the "CPU Statistics": Log File\Options\Reset CPU Statistics. This will zero all the counters, allowing you to start a test series, for example. See the report below.

The various counters or messages are explained in the table below.

PAL Statistics Report

Date/Time: 8/17/2007 6:16:21 PM

Snr:120215

Page: 1

Operator: Bruno Baltensperger

System: Firmware Version: 2.5.2 SysUptime [hh:mm:ss]: 544:18:58

CPU Serial Number: 01F00057

Total Plg Strokes: 49

Total Cycles: 9

Total Inj Counts: 68

X,Y-Axis:	X-Distance [m]: 31	X-Retries: 2	Invalid Z-Collision: 65
	Y-Distance [m]: 17	Y-Retries: 3	Retry Needle Blocking: 0
	Z-Distance [m]: 41	Z-Retries: 36	VlvStdbbyActivErr: 0
	Plg-Distance [m]: 7	Plg-Retries: 0	VlvActivStdbbyErr: 0
	Aux1-Distance [m]: 1	Aux1-Retries: 2	
	Aux2-Distance [m]: 0	Aux2-Retries: 0	

Z-Axis:	Transactions: 21173247	Toggle Errors: 0	Firmware Load Retries: 0
	Repeats: 0		Total Barcodes: 0
	Rx Timeouts: 0		Barcode Retries: 0
	BCC Errors: 0		

CPU:	FPGA Config OK: 28	Address Error: 0	Format Error: 0
	NMI Count: 27	Bus Error: 0	Spurious IRQ: 0
	Inv Backup Code: 0	Zero Division Error: 0	

Comments:

1.52.4.3.1 PAL Statistics Report Software Explanations:

Firmware Read-outSystem	Codes Description
Firmware Version	Actual Firmware
CPU Serial Number	PCB Serial Number from FLUSH Memory
Report_Cycle1_Count	Cycle Loop counter (all Methods)
R-Total_Sys_Seconds	Total System up time (seconds)
Total Plg Strokes	Total number of Plunger Strokes
Total Inj Counts	Total number of Injection Counts
Firmware Read-outX-Y- Axis	Codes Description
Report_M_ACCU_X	Motor X Total Meters Accumulator
Report_M_ACCU_Y	Motor Y Total Meters Accumulator
Report_M_ACCU_Z	Motor Z Total Meters Accumulator
Report_M_ACCU_Plg	Motor Plg Total Meters Accumulator
Report_M_ACCU_Aux1	Motor Aux1 Total Meters Accumulator
Report_M_ACCU_Aux2	Motor Aux2 Total Meters Accumulator
R_POS_X_RETRY	Number of Position X Retries
R_POS_Y_RETRY	Number of Position Y Retries
R_POS_Z_RETRY	Number of Position Z Retries
R_POS_Plg_RETRY	Number of Position Plg Retries
R_POS_Aux1_RETRY	Number of Position Aux1 Retries
R_POS_Aux2_RETRY	Number of Position Aux2 Retries

Firmware Read-outX-Y- Axis	Codes Description
R_INV_Z_Coll	Invalid Z-Collision detected
R_RETRY_NDL_BLOCKING	Retry to unlock the Needle Guide Blocking
R_VLV_STDBY_ACTIV_ERR	Switch Valve from Standby to Active Pos Error
R_VLVACTIV_STDBY_ERR	Switch Valve from Active to Standby Pos Error
Firmware Read-outZ- Axis	Codes Description
R_HD_TOT_TRANSACTION	Head Communication SPI Total Transaction
R_HD_TOT_REPEATS	Head Communication SPI Total Repeats
R_HD_TOT_RX_TIMEOUT	Head Communication SPI Total RxTimeouts
R_HD_TOT_BCC_ERRORS	Head Communication SPI Total BccErrors (Block Check Characters)
R_HD_TOT_TOGGLE_ERRORS	Head Communication SPI Total Toggle Errors
R_HEAD_COMM_RETRY	Load HeadFirmware Retry Count (Injection Unit-Head)
R_HD_TOT_BARCODE	Total Barcode read Counter
R_RETRY_BARCODE	Total Barcode Retries
Firmware Read-outCPU	Codes Description
Report_FPGA_CONFIG_OK	Sytem Startup Counter (Power ON)

Firmware ReadoutCPU	Codes Description
R_NMI_COUNT	NMI-Interrupt Counter if input Voltage < 33VDC(Power OFF, System loops and beeps with 100Hz)
R_BACKUP_CODE	Invalid Firmware Backup detected if CPU<> actual Hardware code.(Example LC or GC PAL with limited configuration)
R_ADDR_ERR_COUNT	CPU Address Error (Hardware problem, system loops and beeps with 2000 Hz)
R_BUS_ERROR	CPU Data Bus Error(Hardware problem, system loops and beeps with 1000 Hz)
R_ZERO_DIVISION	CPU Zero Division Error(Hardware problem, system loops and beeps with 4000 Hz)
R_FORMAT_ERROR	CPU Format Error(Hardware problem, system loops and beeps with 8000 Hz)
R_SPURIOUS_IRQ	CPU spurious IRQ Error(Hardware problem, system loops and beeps with 6000 Hz)

Example with 'Comments' added:

PAL Statistics Report

Date/Time: 8/17/2007 6:19:31 PM

Snr:120215

Page: 1

Operator: Bruno Baltensperger

System: Firmware Version: 2.5.2 SysUptime [hh:mm:ss]: 544:22:23

CPU Serial Number: 01F00057

Total Plg Strokes: 49

Total Cycles: 9

Total Inj Counts: 68

X,Y-Axis:	X-Distance [m]: 31	X-Retries: 2	Invalid Z-Collision: 65
	Y-Distance [m]: 17	Y-Retries: 3	Retry Needle Blocking: 0
	Z-Distance [m]: 41	Z-Retries: 36	VlvStdbbyActivErr: 0
	Plg-Distance [m]: 7	Plg-Retries: 0	VlvActivStdbbyErr: 0
	Aux1-Distance [m]: 1	Aux1-Retries: 2	
	Aux2-Distance [m]: 0	Aux2-Retries: 0	

Z-Axis:	Transactions: 21175453	Toggle Errors: 0	Firmware Load Retries: 0
	Repeats: 0		Total Barcodes: 0
	Rx Timeouts: 0		Barcode Retries: 0
	BCC Errors: 0		

CPU:	FPGA Config OK: 28	Address Error: 0	Format Error: 0
	NMI Count: 27	Bus Error: 0	Spurious IRQ: 0
	Inv Backup Code: 0	Zero Division Error: 0	

Comments: Test for Software PAL Statistics Report

2.5.2

01F00057

Print Date: 2007/08/17 17:41:53

Site Name: CTC, System Name: PAL, System SNo: XXXXXX

2007/08/17 10:33:26 Job 02 started: Method D

Tray Stk2-12, Vial 1-1, Count = 1, Increment = 1

Example Print-out with PAL Firmware Version 2.2.7:

PAL Statistics Report

Date/Time: 8/17/2007 6:08:42 PM

Snr:128488

Page: 1

Operator: B.Baltensperger

System: Firmware Version: 2.2.7 SysUptime [hh:mm:ss]: 1321:41:17

CPU Serial Number: UNKNOWN Total Plg Strokes: UNKNOWN

Total Cycles: 5720 Total Inj Counts: UNKNOWN

X,Y-Axis:	X-Distance [m]: 9988	X-Retries: 0	Invalid Z-Collision: 401
	Y-Distance [m]: 3285	Y-Retries: 0	Retry Needle Blocking: 2
	Z-Distance [m]: 10447	Z-Retries: 0	VlvStdbyActivErr: 26
	Plg-Distance [m]: 3436	Plg-Retries: 0	VlvActivStdbyErr: 0
	Aux1-Distance [m]: 1009	Aux1-Retries: 0	
	Aux2-Distance [m]: 6	Aux2-Retries: 0	

Z-Axis:	Transactions: 16471406	Toggle Errors: 0	Firmware Load Retries: 0
	Repeats: 0		Total Barcodes: 0
	Rx Timeouts: 0		Barcode Retries: 0
	BCC Errors: 0		

CPU:	FPGA Config OK: 407	Address Error: 0	Format Error: 0
	NMI Count: 254	Bus Error: 0	Spurious IRQ: 0
	Inv Backup Code: 0	Zero Division Error: 0	

Comments:

Example after 'Reset CPU Statistics':

PAL Statistics Report

Date/Time: 8/17/2007 6:12:52 PM

Snr:128488

Page: 1

Operator: B.Baltensperger

System:	Firmware Version:		SysUptime [hh:mm:ss]: 00:00:00	
	CPU Serial Number: UNKNOWN		Total Plg Strokes: UNKNOWN	
	Total Cycles:		Total Inj Counts: UNKNOWN	
X,Y-Axis:	X-Distance [m]:		X-Retries: 0	Invalid Z-Collision: 0
	Y-Distance [m]:		Y-Retries: 0	Retry Needle Blocking: 0
	Z-Distance [m]:		Z-Retries: 0	VlvStdbyActivErr:
	Plg-Distance [m]:		Plg-Retries: 0	VlvActivStdbyErr: 0
	Aux1-Distance [m]:		Aux1-Retries: 21	
	Aux2-Distance [m]:		Aux2-Retries: 0	
Z-Axis:	Transactions:		Toggle Errors:	Firmware Load Retries:
	Repeats:			Total Barcodes:
	Rx Timeouts:			Barcode Retries:
	BCC Errors:			
CPU:	FPGA Config OK:		Address Error:	Format Error:
	NMI Count:		Bus Error:	Spurious IRQ:
	Inv Backup Code: 0		Zero Division Error:	

Comments: Test Combi PAL

1.52.5 Cycle Composer

1.53 PAL Integration with other Data Handling Systems

1.53.1 (Third Party Systems)

The listing below provides information on the various means of integration of the PAL System with external data handling systems.

Note: This listing was released in December 2009. Updates will be provided with upcoming releases of the PAL Service Manual.

CTC Analytics

PAL Third Party Software Integration Overview (Revision 3, December 2009)					
Company	Application	Software Product	Run Basic Cycles	Create and run Custom Cycles	Remarks
Agilent	GC, LC, LCMS SQ	ChemStation Version B.04.02	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Agilent	GCMS SQ	ChemStation MSD Version E.02.00	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Agilent	LC & GC	EZChrom Version 3.3.2	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Agilent	GCMS	MassHunter Version B.04.00	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Agilent	LCMS TOF, QTOF	MassHunter Version B.02.01	included in MassHunter	PAL CycEdit required	PAL control included and bundled with the system
Bruker	LCMS TOF, QTOF	Compass Version 1.2	included in Compass	PAL ICC-CE required	PAL control included and bundled with the system
ABI Sciex	LCMS	Analyst Version 1.4 and up	included in Analyst	PAL ICC-CE required	PAL control included and bundled with the system
Thermo	LCMS, GCMS TOF, QTOF	Xcalibur Version 2.1	included in Xcalibur	included in Xcalibur	PAL control included and bundled with the system
Thermo	LC & GC	ChromQuest Version 5.0	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Thermo Cohesive	LCMS	Aria TLX-4 multiplex	included in Aria	included in Aria	PAL control included and bundled with the system
Waters	LC & GC	Empower2 build2154 and up	optional driver from CTC required	included in driver PAL DrvEmp	PAL control is an add-on and is a CTC product
Waters	LCMS, GCMS TOF, QTOF	MassLynx Version 4.1	included in MassLynx	PAL ICC-CE required	PAL control included and bundled with the system
Dionex	LC	Chromeleon Version 6.8	optional driver from Dionex required	covered by the optional driver	PAL control is an add-on and is a Dionex product
Dionex	GC	Chromeleon Version 6.8	optional driver from Dionex required	covered by the optional driver	PAL control is an add-on and is a Dionex product
Shimadzu	GC, GCMS	GC-/GCMS Solution Version 2.53 SU1	Cycle Composer from CTC required	Cycle Composer required	PAL control by Cycle Composer and contact closure
Shimadzu	LC, LCMS	LC-/LCMS Solution Version 5.x	included	PAL ICC-CE required	PAL control included and bundled with the system
Merck Hitachi	LC & GC	EZChrom Version 3.3.2	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
DataApex	LC & GC	Clarity Version 2.8	optional driver from DataApex required	PAL ICC-CE required	PAL control is an add-on and is a DataApex product
Varian	LC & GC	Galaxie Version 1.9	included in Galaxie	included in Galaxie	PAL control included and bundled with the system
Leco	GCMS	ChromaTOF Version 4.2		N/A	Contact Leco
Justice Laboratory Software	GC & LC	Chrom Perfect Version 5.5.x		N/A	Contact Justice Laboratory Software

Explanations:

- Cycle Composer
- Cycle Editor
- PAL ICC-CE

1.53.2 PAL Integration with other Data Handling Systems

1.53.2.1 (Third Party Systems)

The listing below provides information on the various means of integration of the PAL System with external data handling systems.

Note: This listing was released in December 2009. Updates will be provided with upcoming releases of the PAL Service Manual.

CTC Analytics

PAL Third Party Software Integration Overview (Revision 3, December 2009)					
Company	Application	Software Product	Run Basic Cycles	Create and run Custom Cycles	Remarks
Agilent	GC, LC, LCMS SQ	ChemStation Version B.04.02	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Agilent	GCMS SQ	ChemStation MSD Version E.02.00	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Agilent	LC & GC	EZChrom Version 3.3.2	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Agilent	GCMS	MassHunter Version B.04.00	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Agilent	LCMS TOF, QTOF	MassHunter Version B.02.01	included in MassHunter	PAL CycEdit required	PAL control included and bundled with the system
Bruker	LCMS TOF, QTOF	Compass Version 1.2	included in Compass	PAL ICC-CE required	PAL control included and bundled with the system
ABI Sciex	LCMS	Analyst Version 1.4 and up	included in Analyst	PAL ICC-CE required	PAL control included and bundled with the system
Thermo	LCMS, GCMS TOF, QTOF	Xcalibur Version 2.1	included in Xcalibur	included in Xcalibur	PAL control included and bundled with the system
Thermo	LC & GC	ChromQuest Version 5.0	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
Thermo Cohesive	LCMS	Aria TLX-4 multiplex	included in Aria	included in Aria	PAL control included and bundled with the system
Waters	LC & GC	Empower2 build2154 and up	optional driver from CTC required	included in driver PAL DrvEmp	PAL control is an add-on and is a CTC product
Waters	LCMS, GCMS TOF, QTOF	MassLynx Version 4.1	included in MassLynx	PAL ICC-CE required	PAL control included and bundled with the system
Dionex	LC	Chromeleon Version 6.8	optional driver from Dionex required	covered by the optional driver	PAL control is an add-on and is a Dionex product
Dionex	GC	Chromeleon Version 6.8	optional driver from Dionex required	covered by the optional driver	PAL control is an add-on and is a Dionex product
Shimadzu	GC, GCMS	GC/GCMS Solution Version 2.53 SU1	Cycle Composer from CTC required	Cycle Composer required	PAL control by Cycle Composer and contact closure
Shimadzu	LC, LCMS	LC-/LCMS Solution Version 5.x	included	PAL ICC-CE required	PAL control included and bundled with the system
Merck Hitachi	LC & GC	EZChrom Version 3.3.2	optional driver from Agilent required	PAL CycEdit required	PAL control is an add-on and is a Agilent product
DataApex	LC & GC	Clarity Version 2.8	optional driver from DataApex required	PAL ICC-CE required	PAL control is an add-on and is a DataApex product
Varian	LC & GC	Galaxie Version 1.9	included in Galaxie	included in Galaxie	PAL control included and bundled with the system
Leco	GCMS	ChromaTOF Version 4.2		N/A	Contact Leco
Justice Laboratory Software	GC & LC	Chrom Perfect Version 5.5.x		N/A	Contact Justice Laboratory Software

Explanations:

- Cycle Composer
- Cycle Editor
- PAL ICC-CE

1.54 Spare Parts. Kits and Syringes Overview

Further detail on the Spare Parts and Kits are given in the individual sections.

1.54.1 Syringes

The syringes are described in Service Notes # 02 -05 /2000

Updated information will be added in the near future.

1.54.2 Spare Parts and Kits

The Spare Parts and Kits are described in the following sections:

- [Injection Unit, Z-Axis](#)
- [X-Y-Axis](#)
- [Power Supply PAL System](#)
- [Handheld Terminal or Local Terminal](#)
- Cables, Connectors

1.55 PAL Specification Overview

The section on "PAL Specification" covers the following points:

1.55.1 Safety Information

1.55.1.1 Safety Information

Note: See also the chapter "SM Basic Documents" in the section "[Safety Warnings](#)" for more information.

1.55.1.1.1 [General Safety Information](#)

See the corresponding section.

1.55.1.1.2 [Electrical Hazards](#)

See the corresponding section.

1.55.1.1.3 Disposal of Parts

Disposal of all electronic parts, namely electronic modules or batteries, have to be performed according to applicable local and/or national regulations.

Details are also outlined in the "PAL User Manual".

See also the section "[Return Material Authorization](#)".

1.55.1.1.4 EMC Interferences

Never use cables other than the ones provided by CTC Analytics AG, to ensure proper functionality and compliance with safety and EMC regulations.

See also the section "[ESD Strap](#)".

1.55.1.1.5 Safety Symbol Description

The Safety symbols are described in detail in the PAL User Manual.

1.55.1.1.6 Chemical or Solvent Information

Observe the general safety rules when handling chemicals. In case of any doubt, consult a professional for assistance.

See also the "Optimization" section, under the subsection "Tips & Hints for HPLC Technique".

1.55.2 Specifications

1.55.2.1 Specifications Overview

The following Specifications are covered in this section:

- [Declaration of Conformity](#)
- [Physical Specifications](#)
- [Electrical Specifications](#)
- [Operating and Environmental Requirements](#)
- [Performance Specifications](#)

1.55.2.2 Declaration of Conformity

1.55.2.2.1 Overview Conformity Certificates

Two certificates are provided with each delivery of a PAL System or a major PAL Module (e.g. a Cooled Stack).

These certificates are placed in the PAL USER MANUAL.

- [Declaration of Conformity](#)
- [Certificate of Test Conformity](#)

1.55.2.2.2 Declaration of Conformity

The "Declaration of Conformity" certificate states that the PAL System complies with international safety and EMC regulations.

This certificate is provided with each instrument, and is specific to the serial number of each individual system delivered. It is placed in the PAL USER MANUAL.

1.55.2.2.2.1 Example: Certificate for the COMBI PAL

Note: This is an example only, the content or layout may change without notice.

DECLARATION OF CONFORMITY

Legal Identity: CTC Analytics AG
CH-4222 Zwingen
Industriestrasse 20
Switzerland
Tel: +41 61 765 81 00
Fax: +41 61 765 81 99

Declares under sole responsibility that the following
product as originally delivered

Product Name PAL System

Model Type Combi PAL

Serial Number _____

complies with the requirements of the following
applicable European Directives and carries the CE marking
accordingly: Low Voltage Directive 72/73/EEC
(amended by EEC 93/68/EEC)
EMC Directive 89/336/EEC
(amended by EEC 93/68/EEC)

and conforms with the following product standards:

EMC: IEC 61326:2002
EN 61326 :1997 +A1:1998 +A2:2001 +A3:2003
FCC 47CFR Part. 15

Safety: IEC 61010-1:2001 / EN 61010-1:2001
UL 61010A -1 : 2004 2nd Edition
CAN/CSA C22.2 No. 61010-1:2004 2nd Edition

Date of Validity: June 15/2006

Name of Authorized Signatory: Hansjörg Cueni
Position in Company: Managing Director

Signature:  _____

1.55.2.2.3 Certificate of Test Conformity

A "Certificate of Test Conformity" is provided with each instrument and major PAL Module (e.g. a Cooled Stack). This certificate is provided with each instrument, and is specific to the serial number of each individual system delivered.

The certificate is placed in the PAL USER MANUAL.

1.55.2.2.3.1 Example: Certificate for the COMBI PAL

Note: This is an example only, the content or layout may change without notice.



CTC Analytics AG
Industriestrasse 20
CH-4222 Zwingen
Switzerland

Telephone: +41 (0)61 765 8100
Telefax: +41 (0)61 765 8199
E-Mail: support@ctc.ch
Internet: www.ctc.ch

Certificate of Test Conformity

COMBI PAL System

SNo. 1212240

Component of PAL System	PNo. Rev.	Serial No.
PAL System (X-,Y- Axes)	MXV 02-01B	1212240
Injection Unit	MZ 02-00E	13446
Agitator	MH 01-00B	11776
SPME Fiber Conditioning Station	MH 02-01A	n/a
Barcode Reader	LS1220	n/a
CPU Board	C.H	10D0436
MOTIO Board	E.K.	10C0317
Terminal	D.E. Rev.7	
Power Supply	MN 01-00F	
PAL Firmware	2.5.2	
PAL Objects	K	

CTC Analytics AG herewith certifies that the PAL System has successfully passed our production quality test. Functional tests have been carried out individually for standalone parts during various stages of the manufacturing process. The PAL System, as ordered, has been put through a defined stress-test cycle. The equipment functions were tested according to our internal Acceptance Test Procedures.

Component of PAL System	Test	Test Results
Power Supply, incl. DC-Cable	Electrical Safety Check Dielectric Voltage Withstand Test	☐ passed ☐ n/a
X-, Y-, Z-Axes	Mechanical Performance Motor Tests Sensor Tests Gas Line Leak Test	☐ passed ☐ n/a
Terminal, incl. Cable	LCD Display Check Functional Check	☐ passed ☐ n/a
Agitator, incl. Cable	Mechanical Movements Cable Test Heating Rate and Temperature Accuracy	☐ passed ☐ n/a
Syringe Cartridge	Syringe Detection and Identity Heater Contacts Heating Rate and Temperature Accuracy	☐ passed ☐ n/a
SPME Fiber Conditioning Station	Heating Rate and Temperature Accuracy Gas Line Leak Test	☐ passed ☐ n/a
Barcode Reader	Configuration and Functional Test	☐ passed ☐ n/a
PAL Objects (Tray Holders, etc)	Objects mounted in position and tested with the PAL System	☐ passed ☐ n/a
		☐ passed ☐ n/a

Explanations: ☒ passed = Test passed
☒ n/a = not applicable

Final Test	Date: 22.06.2010	Visum:
Software Configuration vs. Order	Date: 22.06.2010	Visum:
Packed and shipped	Date: 22.06.2010	Visum:

1.55.2.3 Physical Specifications

1.55.2.3.1 Physical Specifications

The Physical Specifications are outlined in the PAL USER MANUAL.

1.55.2.4 Electrical Specifications

1.55.2.4.1 Electrical Specifications

The electrical specifications are outlined in the PAL USER MANUAL.

The Specifications for the '[PAL System Input / Output](#)' are covered in the section '[Cable and Connectors](#)'.

1.55.2.5 Operational and Environmental Requirements

1.55.2.5.1 Operating and Environmental Requirements

The Operating and Environmental Requirements are outlined in the PAL USER MANUAL.

See also the section "[Site Requirements](#)".

1.55.2.6 Performance Specifications

1.55.2.6.1 Performance Specifications Overview

The following Performance Specifications are covered in this section:

- [Gravimetric Test](#)
- [GC Liquid Injection Technique](#)-
 - High Split Ratio Technique
 - Low split or On-Column Injection Technique
- [GC Headspace Injection Technique](#)
- [HPLC Full- and Partial-Loop Injection Technique](#)
- [Formula used for Calculation of Performance Specifications](#)

1.55.2.6.2 Performance Specification Gravimetric Test

SYSTEM Specifications

Gravimetric Test

Syringe Volume	Specification	Test Conditions
10 µL	Repeatability Relative Standard Deviation s-rel: 0.20 %	15 times 8 µL Water transferred into target vial.
100 µL	Repeatability Relative Standard Deviation s-rel: 0.15 %	100 µL Water transferred in a target vial.
	Linearity Correlation Coefficient R: ≥0.9999	6 levels and 3 replicates of each level. 5,10,25,50,75,100 µL
1000 µL	Repeatability Relative Standard Deviation s-rel: 0.10 %	500 µL Water transferred in a target vial.
	Linearity Correlation Coefficient R: ≥0.9999	6 levels and 3 replicates of each level. 50,100,250,500,750,1000 µL
2500 µL	Repeatability Relative Standard Deviation s-rel: 0.10 %	1000 µL Water transferred in a target vial.
	Linearity Correlation Coefficient R: ≥0.9999	8 levels and 3 replicates of each level. 125,250,500,750,1000,1500,2000,2500 µL

General Remarks:

- Number of specimens for repeatability tests: n =7
- For each target vial a source vial is specified.
- Temperature and barometric pressure not taken into consideration.
- Repeatability but not Accuracy determined
- Balance: Precisa Switzerland Model XB 120A (d=0.1 mg)

1.55.2.6.3 Performance Specifications GC Liquid Injection Technique

PAL SYSTEM | GC PAL | Combi PAL

Chromatographic Test: High Split Ratio | Retention Gap | Solvent iso-Octane

Specification:

- Repeatability: Relative Standard Deviation s-rel: 0.30 %
- Carry-over: not applicable

General Remarks:

- Number of specimens for Repeatability Tests: n = 20
- Carry-over: Test: Remaining solvent in syringe can not be eliminated from injection to injection.

Test Conditions:

Test Sample: iso-Octane puriss., 2 mL vials filled to 50 % of nominal content
Syringe: Hamilton Art. No.: 203205 | CTC Art. No.: SyrC L10-26S-AS

PAL Parameter Settings:

CYCLE	GC-Inj	Fill Strokes	5
SYRINGE 1	0 µL	Pullup Del	5 s
Sample Volume	1.0 µL	Inject to	GC Inj1
Air Volume	0.5 µL	Inject Speed	50 µL/s
Pre Cln Slv1	3	Pre Inj Del	500 ms
Pre Cln Slv2	0	Pst Inj Del	500 ms
Pre Cln Spl	2	Pst Cln Slv1	3
Fill Volume	5 µL	Pst Cln Solv2	0
Fill Speed	2 µL/s		

Eject speed 50 µL/s (Syringe Parameter)

GC Agilent 6890:

- Injector: split/splitless, Liner: Single Taper 4 mm ID, Silanized glass wool packing (P/N HP 5062-3587)
Temperature: 200 °C
Split Ratio = 1:1000
- Detector: FID
Temperature 300 °C
Fuel Gases: Make-up Gas N2 25 ± 2 mL/min, Air 400 ± 30 mL/min, H2 30 ± 2 mL/min
- Column: Retention Gap (uncoated fused silica column).
Length 5m, OD 0.375 mm, ID 0.100 mm,
Supplier: BGB Switzerland, P/N BGB TSP 1003755
Column Oven Temperature: 200 °C, Runtime 0.5 min
Carrier Gas: Helium 0.2 mL/min, approx. 23 psi column head pressure.

Data Acquisition System: Agilent ChemStation Rev. 6.03

PAL SYSTEM | GC PAL | Combi PAL

Chromatographic Test: Split Mode | Analytical Column | Alkene Test Mix

Specification:

- Repeatability: Relative Standard Deviation s-rel: **0.80 %**
- Carry-over: **< 0.080 %**

General Remarks:

- Number of specimens for Repeatability Tests: n= 8
- Repeatability determination based on C14 Peak
- Carry-over Test: Peak < 1 area count, not detectable.

Test Conditions:

Test Sample: Alkene Test Mix C14,C15,C16 | 0.3 µg dissolved in iso-Octane.
2 mL vials filled to 50 % of nominal content

Syringe: Hamilton Art. No.: 203205 | CTC Art. No.: SyrC L10-26S-AS

PAL Parameter Settings:

CYCLE	GC-Inj	Fill Strokes	5
SYRINGE	10 µL	Pullup Del	5 s
Sample Volume	1.0 µL	Inject to	GC Inj1
Air Volume	0.5 µL	Inject Speed	50 µL/s
Pre Cln Slv1	3	Pre Inj Del	500 ms
Pre Cln Slv2	0	Pst Inj Del	500 ms
Pre Cln Spl	2	Pst Cln Slv1	3
Fill Volume	5 µL	Pst Cln Solv2	0
Fill Speed	2 µL/s		

Eject speed 50 µL/s (Syringe Parameter)

GC Agilent 6890:

- Injector: split/splitless, Liner: Single Taper 4 mm ID, silanized glass wool packing (P/N HP 5062-3587)
Temperature: 250 °C
Split Ratio = 1:50
- Detector: FID
Temperature 300 °C
Fuel Gases: Make-up Gas N2 25 ± 2 mL/min, Air 400 ± 30 mL/min, H2 30 ± 2 mL/min
- Column: 5% Phenyl-95% Methyl-Silicon. HP5. Length 30m, ID 0.320 mm, Filmthickness 0.25 mm
Supplier: Agilent, P/N HP 5182-9733
Column Oven Temperature: 80 °C, hold 1 min, 15 °C/min to 200 °C, hold 1 min, Runtime 10 min
Carrier Gas: Helium 2.0 mL/min

Data Acquisition System: Agilent ChemStation Rev. 6.03

1.55.2.6.4 Performance Specifications GC Headspace Technique

PAL SYSTEM | GC PAL | Combi PAL

Chromatographic Headspace Test: High Split Ratio | Retention Gap | Solvent iso-Octane

Specification:

- Repeatability: Relative Standard Deviation s-rel: 1.00 %
- Carry Over: 0.050 %

General Remarks:

- Number of specimens for Repeatability Tests: n= 7
- 10 µL are measured by using a glass capillary, Drummond Microcaps (Supplier Supelco, P/N P-1924)

Test Conditions:

Test Sample: Iso-Octane, puriss., Microcaps Glass Capillary hold with Tweezers, filled and put into 20 mL Headspace vial, sealed immediately.

Syringe: Hamilton Art. No.: 203084 | CTC Art. No.: Syrc HS 2.5 -23-5

PAL Parameter Settings:

CYCLE	HS-Inj	Fill Speed	100 µL/s
SYRINGE	2.5HS	Pullup Del	1 sec
Sample Volume	500 µL	Inject to	GC Inj1
Incubat Temp	80 °C	Inject Speed	500 µL/s
Incubat Time	7 minutes	Pre Inj Del	500 ms
Agi Speed	250 rpm	Pst Inj Del	1 s
Agi On Time	5 s	Syr Flushing	90 s
Agi Off Time	2 s	GC-Runtime	60 s
Syringe Temp	85 °C		

GC Agilent 6890:

- Injector: split/splitless, Liner: Single Taper 4 mm ID, Silanized glass wool packing (P/N HP 5062-3587)
Temperature: 250 °C
Split Ratio = 1:100
- Detector: FID
Temperature 300 °C
Fuel Gases: Make-up Gas N2 25 ± 2 mL/min, Air 400 ± 30 mL/min, H2 30 ± 2 mL/min
- Column: Retention Gap (uncoated fused silica column). Length 5m, OD 0.375 mm, ID 0.100 mm
Supplier: BGB Switzerland, P/N: BGB TSP 1003755
Column Oven Temperature: 200 °C, Runtime: 1.0 min
Carrier Gas: Helium 0.1 mL/min, approx. 14 psi column head pressure.

Data Acquisition System: Agilent ChemStation Rev. 6.03

1.55.2.6.5 Performance Specifications HPLC Technique Full- and Partial-Loop Injection Technique

PAL SYSTEM | LC PAL | HTC PAL | HTS PAL

Chromatographic Test: Loop Overfill and Partial Loop Filling

Specification:

Syringe Volume	Specification	Test Conditions
100 µL	Repeatability Loop Overfill Relative Standard Deviation s-rel : 0.10 %	Loop size 20 µL Loop fill volume: 80 µL
100 µL	Repeatability Partial Loop Filling Relative Standard Deviation s-rel : 0.20 %	Loop size 20 µL Loop fill volume: 10 µL
100 µL	Linearity Correlation Coefficient R: > 0.9999	5 levels and 3 replicates of each level. 4,6,8,10,12 µL (20 to 60 % of loop size)
100 µL	Carry Over: Test < 0.05 %	Blank after full loop injection

General Remarks:

Number of specimens for Repeatability Tests: n = 9
Carry Over: Test: Peak < 1 area count, not detectable.

Test Conditions:

Test Sample: Benzophenone, Supplier Fluka P/N 12750,
50 mg/mL dissolved in in Water : Methanol = 50 : 50
Blank Solution: Water : Methanol = 20 : 80
Vials: 2 mL standard Autosampler vials, crimped. Vials filled to 50% of nominal content.
Syringe: Hamilton Art. No.: 203077 | CTC Art. No.: Syt C G100-225-3

PAL Parameter Settings:

CYCLE	LC-Inj	Pullup Del	500 ms
SYRINGE	100 µL	Inject to	LC Vlv1
Sample Volume	80 / 10 µL	Inject Speed	10 µL/s
Air Volume	0 nL	Pre Inj Del	500 ms
Pre Cln Slv1	1	Pst Inj Del	500 ms
Pre Cln Slv2	0	Pst Cln Slv1	2
Pre Cln Spl	2	Pst Cln Slv2	0
Fill Speed	10 µL/s	Vlv Cln Slv1	2
Fill Strokes	3	Vlv Cln Slv2	0

Eject Speed 200 µL/s (Syringe Parameter)

HPLC System Agilent 1100

HPLC Pump: Binary system, Flow Rate: 1.0 mL/min
HPLC Detector: Variable UV-VIS , Wavelength for Detection: 258 nm
Without Degassing and Column Heater
Column: Zorbax XDB-C8, Length: 150 mm, ID 4.6 mm, 5 mm particle size, end-capped
Art. No.: HP 993967906
Mobile Phase: Water : Methanol = 20 : 80
Wash Solvent: Water : Methanol = 50 : 50

Data Acquisition System: Agilent ChemStation Rev. 6.03

1.55.2.6.6 Performance Specifications Calculation

SYSTEM Formulas used to calculate the Specification Values

Injection Precision - Repeatability Relative Standard Deviation and Standard Uncertainty

Mean Value (average). Average of measured area counts.

$$\bar{x} = \frac{\sum x_i}{n}$$

$\bar{x}$ = Mean Value of area counts.

x_i = Peak area counts, i th observation of n

n = Number of injections, calibration points.

Standard Deviation

$$SD = \sigma_{n-1} = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

σ_{n-1} = Standard Deviation

Relative Standard Deviation

$$\text{Precision \%RSD} = \frac{SD \times 100}{\bar{x}}$$

RSD = Relative Standard Deviation

1.56 Site Requirements for PAL Systems

The site requirements for the various PAL Systems and Modules are not yet covered in this section.

Related information can be found in the following documents:

- PAL User Manual - Specifications
- Installation Qualification (IQ) Document

See also the section on Specification under "[Operation and Environmental Requirements](#)".

1.57 Overview: Release History of the PAL System

The Release History of the PAL System is divided into two sections:

1.57.1 Release History for PAL Hardware

The Release History for PAL Hardware is covered in the individual sections.

Use the link function to find the appropriate section.

1.57.2 Release History for PAL Basic Components:

- [Z-Axis, Injection Unit](#)
- [X-Y-Axis](#)
- [PAL Power Supply](#)
- [PAL Local Terminal, Display, "Game-Boy"](#)
- Cables
- Electronic Boards (PCB's):
 - APR CPU
 - APR MOTIO
 - APR Control-LC
 - APR Control-HTC
 - APR Control-GC
 - APR Head
 - APR X-Sensor
 - APR Y-Sensor

1.57.3 Release History for PAL Modules:

- PAL CStack
- PAL TrayCooler

1.57.4 Release History for PAL Software

The Release History for the various PAL Software packages is covered in the individual sections.

Use the link function to find the appropriate section.

- [PAL Firmware](#)
- [PAL Loader](#)
- [PAL Object Manager](#)

- PAL CPU Statistics, Test Software
- Cycle Composer

General information on the various PAL Software packages are available in the section "[PAL Software](#)".

1.58 Service Notes - Technical Notes - Information

All published information related to the PAL System, including "Service Notes" and "Technical Notes", are available from the CTC Analytics secure web page.

For Password information, contact the CTC Analytics sales or support groups.

The Service Notes and Technical Notes are also available on the CD-ROM for the PAL Service Manual. These will be updated with each release of the Service Manual.

1.59 PM Overview

1.59.1 PM: Preventative Maintenance

PM Kits have been designed for the GC and HPLC Techniques.

1.59.2 PAL System PM Document Release History

1.59.2.1 HPLC Technique

Edition	Date	Author	Reason for Change
Revision A	April 1999	LEAP Technologies Inc., USACTC Analytics AG	PM check-sheet(considered as Revision A)
Revision B	June 2000	CTC Analytics AG Bruno Baltensperger	PM checks strictly differentiated for repair and update work. Checks described in more detail. PM Document part of "PAL PM Kit for HPLC".
Revision C	May 2002	CTC Analytics AG Bruno Baltensperger	Replacement of Flex Band supporting the X-Axis ribbon cable is if the older model is installed.
Revision D	October 2008	CTC Analytics AG Bruno Baltensperger	Flex Band removed as spare in PM Kit. PM document adapted to PAL Service Manual instructions. Minor format and content changes.
Revision E	December 2008	CTC Analytics AG Bruno Baltensperger	Non-standard objects added, e.g. Dilutor, Agitator, etc. Minor format and content changes.
Revision F	May 2010	CTC Analytics AG Bruno Baltensperger	PAL- xt System added. PAL DLW Option added. Minor format and content changes.
Revision G	October 2010	CTC Analytics AG Bruno Baltensperger	PAL DLW-2 Option added. Minor format and content changes.

1.59.2.2 GC Technique

Edition	Date	Author	Reason for Change
Revision A	January 2002	CTC Analytics AG Bruno Baltensperger	Preventative Maintenance (PM) Document for PAL Systems.GC Technique.
Revision B	October 2008	CTC Analytics AG Bruno Baltensperger	Flex Band removed as spare in PM Kit. PM document adapted to PAL Service Manual instructions. Minor format and content changes.
Revision C	December 2008	CTC Analytics AG Bruno Baltensperger	Non-standard objects added, e.g. Dilutor, Valve Drives, etc.Minor for- mat and content changes.
Revision D	October 2010	CTC Analytics AG Bruno Baltensperger	PAL- xt System added.PAL ITEX-2 Option added.Minor format and con- tent changes.

1.59.3 PAL PM Kit Release History

1.59.3.1 PAL PM Kit1 for HPLC Technique

Edition	Date	Author	Reason for Change
Revision A	April 1999	LEAP Technologies Inc., USACTC Analytics AG	PM check-sheet(considered as Revision A)
Revision B	June 2000	CTC Analytics AG Bruno Baltensperger	PM checks strictly differentiated for repair and update work. Checks described in more detail. PM Document part of 'PAL PM Kit for HPLC'.
Revision C	May 2002	CTC Analytics AG Bruno Baltensperger	Flex Band as spare added to Kit.
Revision D	November 2006	CTC Analytics AG Bruno Baltensperger	Tension Cord for Needle Guide, MZ 30-22 eliminated. Various minor formal and content changes.
Revision E	October 2008	CTC Analytics AG Bruno Baltensperger	Flex Band removed as spare in PM Kit.

1.59.3.2 PAL PM KitDLW for HPLC Technique

Edition	Date	Author	Reason for Change
Revision A	May 2010	CTC Analytics AG Bruno Baltensperger	PM Kit for HPLC Technique including PAL DLW Option. Not to be used for PAL DLW-2 Option.

1.59.3.3 PAL PM Kit2 for GC Technique

Edition	Date	Author	Reason for Change
Revision A	January 2002	CTC Analytics AG Bruno Baltensperger	Preventative Maintenance (PM) Document for PAL Systems.GC Technique.
Revision B	May 2002	CTC Analytics AG Bruno Baltensperger	Flex Band as spare added to Kit.
Revision C	November 2006	CTC Analytics AG Bruno Baltensperger	Tension Cord for Needle Guide, MZ 30-22 eliminated.Variou minor formal and content changes.
Revision D	October 2008	CTC Analytics AG Bruno Baltensperger	Flex Band removed as spare in PM Kit.

1.59.4 PM Kit for HPLC Technique - Description

- PAL PM Kit1: PM Kit for HPLC Technique, HTS, HTC, LC PAL Systems (including PAL DLW-2 Option).
- PAL PMKitDLW for HPLC Technique. PAL Systems including PAL DLW Option (not for PAL DLW-2 Option).
- PAL PM Kit2: PM Kit for GC Technique, COMBI and GC PAL Systems.

Note: The PM Kits are identical for PAL and PAL-xt Systems.

The PM Kits contain the PM Procedure Document, the spare parts recommended to be changed annually, and the PAL-specific grease and brush.

CTC Analytics recommends performing a PM procedure on the PAL system once a year.

For more details, see the section "Preventative Maintenance".

Additional detailed information will be provided with the next release of the PAL Service Manual.

1.59.5 PM Kit for GC Technique - Description

- PAL PM Kit1: PM Kit for HPLC Technique, HTS, HTC, LC PAL Systems (including PAL DLW-2 Option).
- PAL PMKitDLW for HPLC Technique. PAL Systems including PAL DLW Option (not for PAL DLW-2 Option).
- PAL PM Kit2: PM Kit for GC Technique, COMBI and GC PAL Systems.

Note: The PM Kits are identical for PAL and PAL-xt Systems.

The PM Kits contain the PM Procedure Document, the spare parts recommended to be changed annually, and the PAL-specific grease and brush.

CTC Analytics recommends performing a PM procedure on the PAL system once a year.

For more details, see the section "Preventative Maintenance".

Additional detailed information will be provided with the next release of the PAL Service Manual.

1.60 IQ | OQ | PQ | PV Overview

The Qualification Procedures are described in separate documents for the GC and HPLC Techniques.

The basic concept is explained by the following keywords:

1.60.1 IQ: Installation Qualification

This is the first test of a newly-purchased instrument, upon delivery and installation.

The IQ is a functional test.

Some examples of items that are tested include the following:

- does the unit correspond with the instrument ordered?
- is the unit intact, with no transport damage?
- is the shipment complete?

A functional test is then performed to verify that the unit performs as expected.

The test is carried out by the supplier or his representatives using their own procedure.

1.60.2 OQ: Operational Qualification

The OQ is the second decisive test performed during the handover of a newly-purchased unit.

For many PAL Systems, chromatography is the most commonly-used application. Therefore, a chromatographic test is executed. In cases where the PAL System is delivered as a single module of an entire analytical system, a modular test can be performed. Such a modular test may be a gravimetric test, as described for the GC technique.

The test is carried by the supplier or his representatives using their own procedure.

1.60.3 PQ: Performance Qualification

The PQ test should be done regularly by the customer, no less than once a year.

The PQ is a check of whether the entire system is suitable for the requirements of the analytical work performed.

It is customers responsibility to fulfill PQ as part of local and international guidelines.

1.60.4 PV: Performance Verification

In cases where the customer needs further support from the supplier (manufacturer) to perform the PQ procedure, the PQ test will be replaced by a PV test.

The main difference is that the supplier will perform his own test, and will not use the test according to the customer's SOP (Standard Operating Procedure). The customer has to accept the supplier's test procedure before the PV test can be executed.

Even if this procedure is selected by the customer, it is his responsibility to fulfill PV as part of local and international guidelines.

The PV test used by CTC Analytics is identical to the OQ test, with identical test requirements and procedures. This concept is also used by many other manufacturers, to simplify the qualification test procedures for each instrument.

1.60.5 IQ|OQ|PQ|PV Release History

1.60.5.1 IQ|OQ|PQ|PV for HPLC Technique

Edition IQ Procedure	Date	Author	Reason for Change
Revision A	September 1998	CTC Analytics AG	First Protocol, Validation Report.
Revision B	September 2000	CTC Analytics AG Bruno Baltensperger	New PAL model HTC PAL included. System Interface Box for IQ Procedure eliminated. Cycle Composer and Drivers included. Minor format and content changes.
Revision C	December 2008	CTC Analytics AG Bruno Baltensperger	Section IX 'Environmental and Power Requirements' removed. Non-standard Objects added, e.g. Dilutor, Agitator, etc. Minor format and content changes.
Revision D	May 2010	CTC Analytics AG Bruno Baltensperger	PAL- xt System added. PAL DLW Option added. Minor format and content changes.
Revision E	October 2010	CTC Analytics AG Bruno Baltensperger	Empower2 Driver added. PAL DLW-2 Option added. Minor format and content changes.
Edition OQ PQ PV Procedure	Date	Author	Reason for Change
Revision A	April 2000	CTC Analytics AG	PAL System Validation Report. Operational Qualification. Initial Report.

Edition OQ PQ PV Pro- cedure	Date	Author	Reason for Change
Revision B	October 2000	CTC Analytics AG Bruno Baltensperger	Document of Instrument Qualification (OQ).C- ontains more detailed description of tests.O- ptional tests included.
Revision C	December 2008	CTC Analytics AG Bruno Baltensperger	Optional Gravimetric Test added to OQ/PQ/PV Documentation.Rev. A. Non-standard Objects for HPLC technique added.Minor format and content changes.
Revision DRev- ision B Gravimetric Test	May 2010	CTC Analytics AG Bruno Baltensperger	PAL- xt System added. PAL DLW Option added. Minor format and content changes.
Revision ERe- vision C Grave- metric Test	October 2010	CTC Analytics AG Bruno Baltensperger	PAL DLW-2 Option added.Minor for- mat and content changes.

1.60.5.2 IQ|OQ|PQ|PV for GC Technique

EditionIQ Pro- cedure	Date	Author	Reason for Change
Revision A	December 2001	CTC Analytics AG Bruno Baltensperger	Document for Instrument Qual- ification of PAL Systems for GC Technique.
Revision B	December 2008	CTC Analytics AG Bruno Baltensperger	Section IX 'Environmental and Power Requirements' removed.Non-standard Objects added, e.g. Dilutor, Valve Drive, etc.Minor format and content changes.
Revision C	October 2010	CTC Analytics AG Bruno Baltensperger	PAL- xt System added.SPME Option added.PAL ITEX-2 Option added.E- mpower2 Driver added.Minor format and content changes.

EditionOQ PQ PV Procedure	Date	Author	Reason for Change
Revision A	December 2001	CTC Analytics AG Bruno Baltensperger	Document of Instru- mentOperational Qualification (OQ),Performance Qualification (PQ),Performance Verification (PV),Gravimetric Test.
Revision B	December 2008	CTC Analytics AG Bruno Baltensperger	Non-standard Objects for GC technique added. Minor format and content changes.
Revision C	October 2010	CTC Analytics AG Bruno Baltensperger	PAL- xt System added. SPME Option added. PAL ITEX-2 Option added. Empower2 Driver added. Minor format and content changes.

1.60.6 IQ|OQ|PQ|PV for HPLC Technique - Description

1.60.6.1 IQ: Installation Qualification

This is the first test of a newly-purchased instrument, upon delivery and installation.

The IQ is a functional test.

Some examples of items that are tested include the following:

- does the unit correspond with the instrument ordered?
- is the unit intact, with no transport damage?
- is the shipment complete?

A functional test is then performed to verify that the unit performs as expected.

The test is carried out by the supplier or his representatives using his own procedure.

An important part of the IQ procedure is "Familiarization of the System". The supplier should introduce the customer to the system and familiarize him with the operation and function of the unit.

1.60.6.2 OQ: Operational Qualification

The OQ is the second decisive test performed during the handover of a newly-purchased unit.

For many PAL Systems, chromatography is the most commonly-used application. Therefore, a chromatographic test is executed. In cases where the PAL System is delivered as a single module of an entire analytical system, a modular test can be performed. Such a modular test may be a gravimetric test, as described for the GC technique.

The test is carried by the supplier or his representatives using his own procedure.

The test procedure includes the description of full and partial loop injections. Other tests, e.g. the Warm-up, Vial Identification (vial location correct identified), Serial Communication and other tests ensure that the system performs as expected.

1.60.6.3 PQ: Performance Qualification

The PQ test should be done regularly by the customer, no less than once a year.

The PQ is a check of whether the entire system is suitable for the requirements of the analytical work performed.

The PQ is carried out by the customer using his procedure. It is customers responsibility to fulfill PQ as part of local and international guidelines.

1.60.6.4 PV: Performance Verification

In cases where the customer needs further support from the supplier (manufacturer) to perform the PQ procedure, the PQ test will be replaced by a PV test.

The main difference is that the supplier will perform his own test, and will not use the test according to the customer's SOP (Standard Operating Procedure). The customer has to accept the supplier's test procedure before the PV test can be executed.

Even if this procedure is selected by the customer, it is his responsibility to fulfill PV as part of local and international guidelines.

The PV test used by CTC Analytics is identical to the OQ test, with identical test requirements and procedures. This concept is also used by many other manufacturers, to simplify the qualification test procedures for each instrument.

1.60.7 IQ|OQ|PQ|PV for GC Technique - Description

1.60.7.1 IQ: Installation Qualification

This is the first test of a newly-purchased instrument, upon delivery and installation.

The IQ is a functional test.

Some examples of items that are tested include the following:

- does the unit correspond with the instrument ordered?
- is the unit intact, with no transport damage?
- is the shipment complete?

A functional test is then performed to verify that the unit performs as expected.

The test is carried out by the supplier or his representatives using his own procedure.

An important part of the IQ procedure is "Familiarization of the System". The supplier should introduce the customer to the system and familiarize him with the operation and function of the unit.

1.60.7.2 OQ: Operational Qualification

The OQ is the second decisive test performed during the handover of a newly-purchased unit.

For many PAL Systems, chromatography is the most commonly-used application. Therefore, a chromatographic test is executed. In cases where the PAL System is delivered as a single module of an entire analytical system, a modular test can be performed. Such a modular test may be a gravimetric test, as described for the GC technique.

The test is carried by the supplier or his representatives using his own procedure.

The Gravimetric Test is a modular test, meaning that the PAL System is tested independently from the entire analytical system. A specific amount of water is taken from a source vial and deposited into a calibrated target vial. Seven replicates are performed to enable calculation of the relative standard deviation.

For the chromatographic test, in situations where the entire system is known, procedures are described for split, split-less or on-column and the headspace technique. The decision on which test procedure to select has to be done according to the equipment and specific needs for routine work.

Other tests, like e.g. Warm-up Test, Vial Identification (vial location correct identified), Serial Communication Test and many other shall provide confidence that the system performs as expected. These tests are identical for the Gravimetric and the Chromatographic test procedure.

1.60.7.3 PQ: Performance Qualification

The PQ test should be done regularly by the customer, no less than once a year.

The PQ is a check of whether the entire system is suitable for the requirements of the analytical work performed.

The PQ is carried out by the customer using his procedure. It is his responsibility to fulfill PQ as part of local and international guidelines.

1.60.7.4 PV: Performance Verification

In cases where the customer needs further support from the supplier (manufacturer) to perform the PQ procedure, the PQ test will be replaced by a PV test.

The main difference is that the supplier will perform his own test, and will not use the test according to the customer's SOP (Standard Operating Procedure). The customer has to accept the supplier's test procedure before the PV test can be executed.

Even if this procedure is selected by the customer, it is his responsibility to fulfill PV as part of local and international guidelines

.

The PV test used by CTC Analytics is identical to the OQ test, with identical test requirements and procedures. This concept is also used by many other manufacturers, to simplify the qualification test procedures for each instrument.

1.61 Safety Information

General Safety Information

The following general safety precautions must be observed during all phases of operation, maintenance, service and repair of the PAL System and other devices connected to complete the system. Failure to comply with these precautions or with specific warnings elsewhere in this PAL SM violates the safety standards of design, manufacture and intended use of the PAL System or the complete system. CTC Analytics is not responsible or liable

for the compliance to these requirements by its authorized representatives, any other technical persons, or the customer.

The PAL System is a Safety Class I instrument with a power supply for protective grounding (earthing) and has been manufactured and tested according to international safety standards.

For detailed Safety Information, see the following sections:

- [Safety Warnings](#)
- [Return Material Authorization, RMA](#)
- [Using ESD Strap](#)
- [Specifications - Safety Information](#)
- PAL User Manual

2 Optimization and Troubleshooting

Optimizing the PAL System for Highest Performance

In this section are tips and hints provided for most widely used applications for the PAL system.

Recommended method parameters are given for the HPLC and for the GC technique. The recommendations can be logically transferred to other application fields where a syringe has to be aspirated and ejected.

For the HPLC application are the individual chapters from the poster "Tips and Hints for the HPLC Technique" listed.

Questions concerning gas type, quality and safety warnings for the GC Headspace Technique are covered in this specific section.

2.1 Injection Cycles | Recommended Parameters | Overview

- HPLC Technique
 - [LC-Inj Cycle](#)
 - [LC-Cut Cycle](#)
- GC Technique
 - [GC-Inj Cycle \(Liquid Injection\)](#)
 - [GC-InjS Cycle \(Sandwich, Liquid Injection\)](#)
 - [HS-Inj Cycle \(Headspace\)](#)
 - [SPME Cycle \(Solid Phase Micro Extraction, Fiber Technique\)](#)

2.1.1 Injection Cycles | Recommended Parameters | Overview

- HPLC Technique
 - [LC-Inj Cycle](#)
 - [LC-Cut Cycle](#)
- GC Technique
 - [GC-Inj Cycle \(Liquid Injection\)](#)
 - [GC-InjS Cycle \(Sandwich, Liquid Injection\)](#)
 - [HS-Inj Cycle \(Headspace\)](#)
 - [SPME Cycle \(Solid Phase Micro Extraction, Fiber Technique\)](#)

2.1.2 Injection Cycle Recommended Parameters

HPLC Technique | LC-Inj Cycle

Method Cycle	Recommended PAL Method Parameters
LC-Inj	
CYCLE	LC - Inj
SYRINGE	100 µl
Sample Volume	80 µl
Air Volume	0 nl
Pre Cln Slv1	1
Pre Cln Slv2	0
Pre Cln Spl	2
Fill Speed	10 µl/s
Fill Strokes	3
Pullup Del	3-10 s
Inject to	LC Vlv1
Inject Speed	10 µl/s
Pre Inj Del	500 ms
Pst Inj Del	500 ms
Pst Cln Slv1	2
Pst Cln Slv2	0
Vlv Cln Slv1	2
Vlv Cln Slv2	0

Example for the following conditions:

- Loop Size 20 µL, overfill 3 - 5 times
Partial Loop filling: Allowed sample volume range 20 - 60% of loop content for loops ≤ 100 µL
Larger Loops: 20 - 80% of loop content
- Syringe:
Syr X G100 - 22S - 3: Gauge 22S limits fill speed to max 20 µL/s (5-20 µL/s depends on viscosity of solve
Syr X G100 - 22 - 3: Gauge 22 allows fill speed up to 200 µL/s (depends on viscosity of solvent)
- Eject speed for 100 µL Syringe: 50 to 150 µL/s (Utilities/Syringe)
- Pre - and post Washing:
Use Solvent 1 and 2 for samples with components of extremely different polarities.
Samples containing proteins should not contact organic solvents.
- Wash Steps for biological samples:
1st Wash Cycle: Aqueous solvent
2nd Wash Cycle: Organic solvent

1st Wash Cycle before next sample:
Pre-wash with aqueous solvent (eliminate organic solvents in Syringe and Valve)

HPLC Technique | Cut Cycle

Method Cycle	Recommended PAL Method Parameters	Remarks
LC-Cut		
CYCLE	LC - Cut	
SYRINGE	100 µl	
Sample Volume	80 µl	
Air Volume	0 nl	
Pre Cln Slv1	1	
Pre Cln Slv2	0	
Pre Cln Spl	2	
Fill Speed	5 µl/s	
Fill Strokes	3	
Pullup Del	3-10 s	
Inject to	LC Vlv1	
Inject Speed	5 µl/s	
Pre Inj Del	500 ms	
Pst Inj Del	500 ms	
SplTransfDel	Sample Transfer Delay	Time needed to transfer sample from Loop onto 2nd valve (pre - or analytical column)
Pst Cln Slv1	2	
Pst Cln Slv2	0	
Vlv Cln Slv1	2	
Vlv Cln Slv2	0	
Cut Valve	LC Vlv 2	Specify name of 2nd valve, switching valve
Cut Delay		Time needed for clean-up. Switch to backflush sample, to analytical column or detector
MinCondTime		Minimum Conditioning Time: Time needed to condition pre - column on 2nd valve

LC-Cut Cycle controls 2 valves.

LC Valve1: Injection valve with loop.

LC Valve2: Switching valve.

- Example 1: Pre - column for sample clean-up, backflushing to analytical column. Cut Delay > 0.
- Example 2: 10 - port valve with 2 analytical columns. Loading column 1, condition column 2. Valve toggle after Cycle time. Loading column 2, condition column 1. Cut Delay = 0

GC Technique | GC-Inj Cycle

Method Cycle	Recommended PAL Method Parameters		
	Split Injection	On-Column Injection PTV Inject Cold	Packed Columns Flush Vaporising
Liquid			
CYCLE	GC -Inj	GC -Inj	GC -Inj
SYRINGE	10 µl	10 µl	10 µl
Sample Volume	1.0 µl	1.0 µl	1.0 µl
Air Volume	0.5 to 1.0 µl	0.5 to 1.0 µl	0.5 to 1.0 µl
Pre Cln Slv1	3	3	3
Pre Cln Slv2	0	0	0
Pre Cln Spl	2	2	2
Fill Volume	5 µl	5 µl	5 µl
Fill Speed	2 µl/s	2 µl/s	2 µl/s
Fill Strokes	5	5	5
Pullup Del	5 s	5 s	5 s
Inject to	GC Inj1	GC Inj1	GC Inj1
Inject Speed	50 µl/s	1 to 5 µl/s	5 to 20 µl/s
Pre Inj Del	0 ms	0 ms	0 ms
Pst Inj Del	0 ms	3 to 5 s	5 to 20 s
Pst Cln Slv1	3	3	3
Pst Cln Slv2	0	0	0

- Eject Speed for 10 µL Syringe: 30 -50 µL/s (Utilities / Syringe)
- Pre Clean Solvent 2 is used for samples with components of extremely different polarities.
- Pre Injection delay is used for highly viscous samples. Length of time needle heated in hot injector.
- Needle Penetration Injector (Utilities / Injector). Value differs from injector manufacturer to manufacturer.

GC Technique | GC-InjS Cycle

Method Cycle	Recommended PAL Method Parameters		
	Split Injection	On-Column Injection PTV Inject Cold	Packed Columns Flush Vaporising
Sandwich			
CYCLE	GC -InjS	GC -InjS	GC -InjS
SYRINGE	10 µl	10 µl	10 µl
Sample Volume	0.2 to 1 µl	0.2 to 1 µl	0.2 to 2 µl
Solvent Plug	0.5 to 1 µl	0.5 to 1 µl	0.5 to 1 µl
Slv Source	Wash	Wash	Wash
IntStandard	0 to 1 µl	0 to 1 µl	0 to 1 µl
Std Source	Standard	Standard	Standard
Air Gap(s)	0.5 to 1.0 µl	0.5 to 1.0 µl	0.5 to 1.0 µl
AirVolumeNdl	0.8 to 1.0 µl	0.8 to 1.0 µl	0.8 to 1.0 µl
Pre Cln Slv1	3	3	3
Pre Cln Slv2	0	0	0
Pre Cln Spl	2	2	2
Fill Speed	2 µl/s	2 µl/s	2 µl/s
Pullup Del	3 to 5 s	3 to 5 s	3 to 5 s
Inject to	GC Inj1	GC Inj1	GC Inj1
Inject Speed	30 - 50 µl/s	1 - 5 µl/s	5 - 20 µl/s
Pre Inj Del	0 ms	0 ms	0 ms
Pst Inj Del	0 ms	3 to 5 s	5 to 20 s
Pst Cln Slv1	3	3	3
Pst Cln Slv2	0	0	0
– Sandwich Cycle: Mainly used to inject sample Volumes < 1.0 µL with a 10 µL Standard Syringe. – Solvent Plug: Select Source vial e.g. Position 'Wash' from Wash Station – IntStandard: Select Source Vial for Internal Standard or Reagent Solution e.g. Position 'Standard' from Wash Station, Internal Standard will be drawn into the Syringe separately (not from one sample solution) – Reagent: Example: Esterification of organic acids spontaneous in hot injector			

GC Technique | HS-Inj Cycle

Method Cycle	Recommended PAL Method Parameters	
Headspace		Incubation temperature: Value depends on application. Consider boiling point of solvent.
CYCLE	HS - Inj	
SYRINGE	1.0 or 2.5 HS	Note 1: Incubation time: The incubation time has to be established with method development.
Sample Volume	500 µl	
Incubat Temp	35 to 200 °C	
Incubat Time	Note 1	
Agi Speed	250 rpm	Syringe temperature: Value depends on application. Usually same or similar temperature as selected for Agitator. Use extra Syringes for different applications / temperatures.
Agi On Time	5 s	
Agi Off Time	2 s	
Syringe Temp	35 to 150 °C	
Fill Speed	100 to 200 µl/s	Note 2: GC Runtime: GC - Runtime, time needed for GC from Ready-status until Ready-status is reached again (Cycle Time).
Pullup Del	10 to 20 s	
Inject to	GC Inj1	
Inject Speed	250 - 500 µl/s	Safety warning: Solid sample may contain moisture (e.g. soil). 10% water heated to 200 °C develops extremely high pressure in the sample vial.
Pre Inj Del	0 ms	
Pst Inj Del	10 to 30 s	
Syr Flushing	60 to 120 s	
GC-Runtime	Note 2	

GC Technique | SPME Cycle

Method Cycle	Recommended PAL Method Parameters	Remarks
SPME		
CYCLE	SPME	
SYRINGE	Fiber	
Pre Inc Time	0 to several minutes	Pre incubation time to equilibrate sample before Fiber is inserted
Incubat Temp	35 to 200 °C	Application and fiber dependent
Agi Speed	250 to 750 rpm	Speed for pre-incubation process only
Agi On Time	5 s	On time for pre-incubation process and extract time
Agi Off Time	2 s	Off time for pre-incubation process and extract time
Vial Penetr	22 to 31 mm	Adjust sample volume in vial accordingly
Extract Time	open	Application dependent method development (ab-adsorbition)
Desorb to	GC Inj1	
Inj Penetr	35 to 45 mm	Depends on type of injector
Desorb Time	2 to 5 min	Thermal desorbition within msec, longer time for fiber cleaning
Fiber Bakeout	0	If time is > 0: Fiber Conditioning Station will be used for cleaning
GC-Runtime	open	GC Cycle time from 'ready-to-ready' status

Part No.: PAL FirmOverCombi-I

2.2 HPLC Technique - Optimization

Injection Cycle Parameters [Recommended Method Parameters](#) for HPLC Cycles

Related Topics

- [Valve Type and Characteristics](#)
- [Valve Type, Bore Size versus Valve Volume](#)
- [General Rules for Loop Filling](#)
- [Low Volume Pick-up](#)
- [Plumbing Diagram for W- and Cheminert Valve Types](#)
- [Nuts and Ferrules](#)
- [Tubing Internal Diameter versus Flow Rate](#)
- [Needle Guide and Needle Seal](#)
- [Syringes and Needles](#)
- [Microtiter / Deepwell Plates and Piercing Foils](#)
- [Example of Plumbing Diagrams for Micro/Nano Flow Applications](#)
- [Carry Over | Troubleshooting Check List](#)

1. Valve Type and Characteristics

Valve P/N	No. of Ports Valve Type Inlet Port	Valve Bore Size in mm	Tube Connect. in inch	Stator P/N Material	Rotor P/N Material	Flow Rate Range	Remarks
C2V-3006-CTC-K	6 C Vertical port	0.75	1/16	C2V-3C06 sst	C2-30R6 Valcon H	5 to 100 mL/min	Preparative application Bore size requires needle Gauge 19 Max. pressure 5000 psi/340 bar
DC6WK-K	6 W Vertical port	0.40	1/16	na sst	SSAC6W Valcon H	0.5 to 5.0 mL/min	Valve for standard HPLC application. Column ID 4 mm, flow 1 mL/min Max. pressure 5000 psi/340 bar
C2V-2346-CTC-K	6 C Vertical port	0.40	1/16	C2V-2C46 PAEK	C2-23R6 Valcon E	0.5 to 5.0 mL/min	Biocompatible Valve for standard HPLC flow rates Max. pressure 5000 psi/340 bar
C2V-1006D-CTC-K	6 C Vertical port	0.25	1/16	C2V-1C06 sst	C2-10R6 Valcon H	10 to 500 µL/min	Valve for semi-micro columns ID 1 and 2 mm Max. pressure 5000 psi/340 bar
C2V-1346D-CTC-K	6 C Vertical port	0.25	1/16	C2V-1C46 PAEK	C2-13R6 Valcon E	10 to 500 µL/min	Biocompatible Valve for semi-micro columns, ID 1 and 2 mm Max. pressure 5000 psi/340 bar
C2V-0006D-CTC-K	6 C Vertical port	0.15	1/16	C2V-0C06 sst	C2-00R6 Valcon H	100 nL/min to 100 µL/min	Injection Valve for micro columns Vertical port bore 0.25 mm, reduced to 0.15 mm at bottom Max. pressure 5000 psi/340 bar
C2V-0346D-CTC-K	6 C Vertical port	0.15	1/16	C2V-0C46 PAEK	C2-03R6 Valcon E	100 nL/min to 100 µL/min	Biocompatible Injection Valve for micro columns. Vertical port bore 0.25 mm, reduced to 0.15 mm at bottom. Max. pressure 5000 psi/340 bar
CN2-4346D-CTC	6 C No vertical port	0.10	1/32	CN2-4C46 PAEK	CN2-43R6 Valcon E	10 nL/min to 10 µL/min	Biocompatible Valve for column switching only. Stator sst. wetted parts PAEK
C72VX-1696D-CTC-K	6 C Vertical port	0.25	1/16	C72V-1C96 N60C	C72-16R6 Valcon E3	10 to 500 µL/min	Valve for ultra-high pressure use Max. pressure 15 000 psi/1030 bar
C72VX-6696D-CTC-K	6 C Vertical port	0.15	1/16	C72V-6C96 N60C	C72-66R6 Valcon E3	100 nL/min to 100 µL/min	Valve for ultra high pressure use Max. pressure 15 000 psi/1030 bar
PD7991	6 R Vertical port	0.20	1/16	7991-005 Ti-plated with SPC-1	7991-999 PEEK blend RPC-10	10 to 500 µL/min	Valve for ultra high pressure use Vertical port bore 0.25 mm, reduced to 0.20 mm at bottom. Max. pressure 15 000 psi/1030 bar

Listing is not complete. Only most common valve types listed. Other configurations, such as 10-port or internal loop valves, are available.

Key and Remarks to the Table "Valve Type and Characteristics":

P/N:

- "CTC": Specific modifications for CTC Analytics AG.
- "-K": indicates a kit containing nuts, ferrules, Needle Guide, Needle Seals and Teflon waste tubing.

Valve type:

- W-Type: Conical rotary valve, VICI/Valco.
- C = Cheminert-type : Flat plate rotary valve, VICI/Valco
Plumbing for two different valve types is shown below.
- R = Rheodyne, flat plate rotary valve.

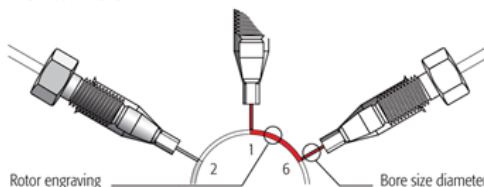
Bore Size: Valve connection port inlet/outlet path diameter.
See graphic at right.

Stator: sst = Stainless steel, N60 (corresponds to SS316)
N60C Stator coated for UHPLC use.
PAEK polymer related to well-known PEEK material.

Rotor material:

- Valcon H: Reinforced carbon fiber composite PTFE lubricated, inert engineered polymer. Standard material from VICI/Valco.
- Valcon E: Polyarylether ketone/Teflon (PAEK/Teflon) material if biocompatibility is required.
- Valcon T: Polyimide (Vespel)/PTFE/carbon composite.
A choice when high temperature is required.
- Valcon E3: Wear resistant coating for UHPLC (proprietary, VICI/Valco).

For material-specific information and limitations consult VICI/Valco product information bulletin.



2. Valve Type, Bore Size versus Valve Volume

Valve volume specification:

Loop overfill (full loop): 2 ports and 1 engraving

Partial loop filling: 1 port and 1 engraving.

Sample loss at injection, Valve contribution (not overfill volume)

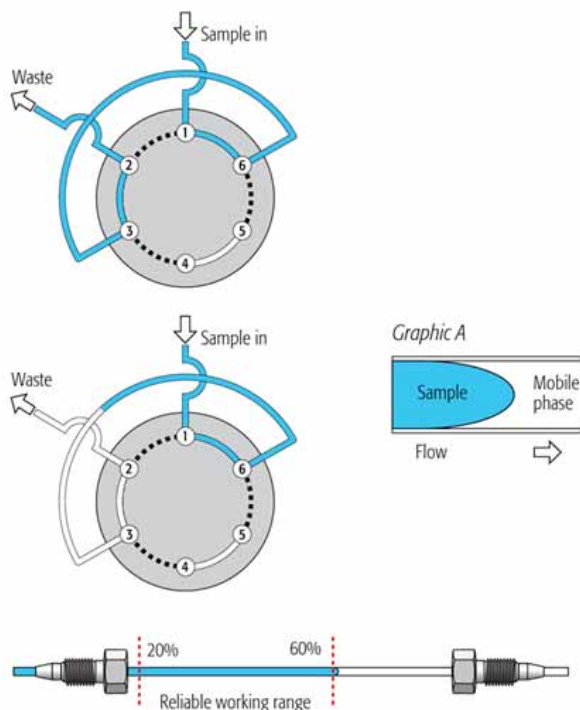
Loop overfill (full loop): Content of 2 ports and 1 engraving

Partial loop filling: Content of 1 port, engraving is injected.

Valve Bore Size and Valve Type	Volume for Port, Engraving		Valve Volume for Partial Loop	Valve Volume for Loop Overfill
0.75 mm Cheminert, sst	Port: 1 Engraving:	2725 nL 1173 nL Other ports: 2725 nL	6623 nL	3898 nL
0.40 mm W-Type, sst	Port: 1 Engraving:	155 nL 390 nL Other ports: 155 nL	545 nL	700 nL
0.40 mm Cheminert, sst	Port: 1 Engraving:	615 nL 170 nL Other ports: 220 nL	1005 nL	785 nL
0.40 mm Cheminert, PAEK	Port: 1 Engraving:	650 nL 170 nL Other ports: 345 nL	1165 nL	820 nL
0.25 mm Cheminert, sst	Port: 1 Engraving:	320 nL 70 nL Other ports: 75 nL	465 nL	390 nL
0.25 mm Cheminert, PAEK	Port: 1 Engraving:	290 nL 70 nL Other ports: 130 nL	490 nL	360 nL
0.15 mm Micro Cheminert, sst	Port: 1 Engraving:	273 nL 40 nL Other ports: 30 nL	343 nL	313 nL
0.15 mm Micro Cheminert, PAEK	Port: 1 Engraving:	514 nL 40 nL Other ports: 40 nL	594 nL	554 nL
0.10 mm Nano Cheminert, PAEK	Port: 1 Engraving:	8 nL 13 nL Other ports: 8 nL	29 nL	21 nL

All values are theoretical values. Values may change without notice and are provided by VICI/Valco.
Rheodyne PD 7991: Port to port volume: 195 nL, 294 nL for vertical port (Port 1).

3. General Rules for Loop Filling



Full loop injection:

Overfill Loop 3 to 5 times.

Example 1: Small loop size: Loop 20 μL . Volume needed to fill loop 60 to 100 μL .

Example 2: Large loop size: Loop 200 μL . Use at least 300 μL to fill the loop

Partial loop filling:

Reliable working range: 20 to 60% of loop content.

Example: Small loop size: Loop 20 μL . 4 to 12 μL sample volume.

Loops with larger volume can be filled within a range of 20 to max. 80% of loop content (200 μL or larger).

Disregarding the rules will result in poor repeatability.

The reason for these rules is the principle of hydrodynamic flow patterns in the solvent front reaching the loop inlet and outlet. See *graphic A left*

Injection speed:

Example for a 20 μL loop: Injection speed is 5 to 10 $\mu\text{L}/\text{s}$.

Higher speed will cause turbulence in the loop, resulting in poor repeatability.

Injection speed is a PAL method parameter and must be adjusted for the type of solvent (viscosity and boiling point), loop size, or rather loop internal diameter, and the valve bore size.

See the recommended method parameters listed in the PAL firmware software overview.

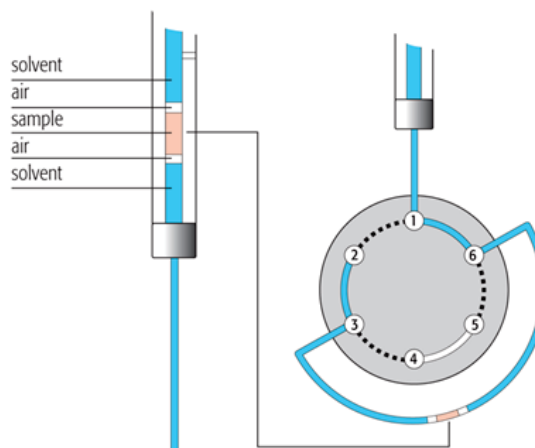
4. Low Volume Pick-up

If a limited amount of sample solution is available, use of “low volume pick-up” mode is recommended. The sample solution is embedded in a solvent sandwich separated by small air gaps. The sample plug is positioned mid-loop.

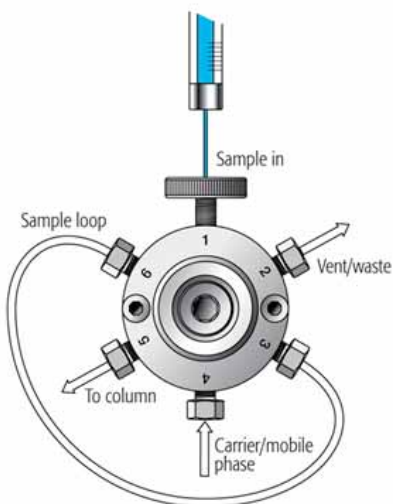
Important:

Use a solvent with a lower elution power than the starting composition of the mobile phase gradient.

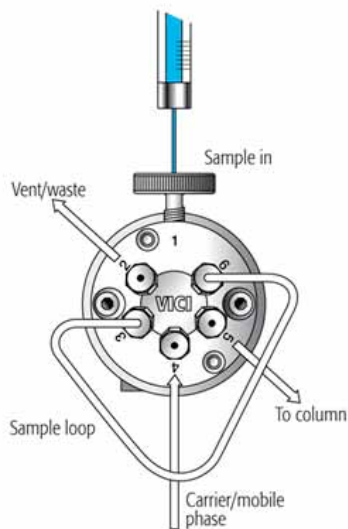
A sample macro for the Cycle Composer software is available from any CTC Analytics representative. The macro is written with built-in flexibility to adapt to syringe, loop, and sample volumes.



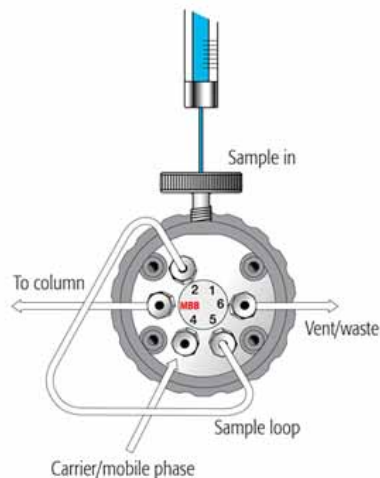
5. Plumbing Diagram for the W-and Cheminert- Valve Types



VICI/Valco W-Type Valve
Conical rotary valves
(No biocompatible version available)



VICI/Valco Cheminert Type Valve
Flat plate rotary valve
(Biocompatible version available)



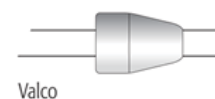
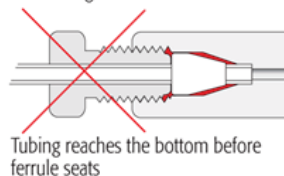
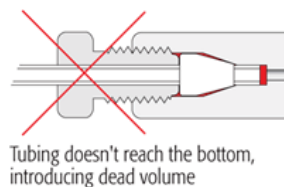
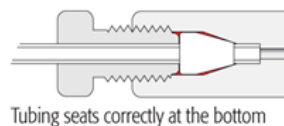
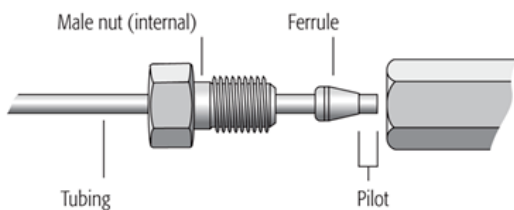
Rheodyne PD7991-K
15 000 psi /1030 bar Flat plate rotary valve
Rheodyne Make-Before-Break® (MBB)
technology features reduced pressure
transients during valve actuation

6. Nuts and Ferrules

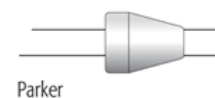
- Do not use a nut or a ferrule from a vendor other than specified for the product.
- While tightening the nut, keep tubing tightly positioned to ensure correct pilot distance.
- Do not over-tighten the nut / ferrule.
- Do not reuse an installed nut / ferrule for any other connection.
- Eliminate trapped air by installing nut / ferrule in wetted ports only.

Disregarding these basic rules will lead to:

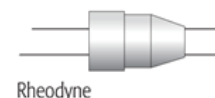
- Dead volume
- Peak deformation or peak splitting
- Carry-over effect



Valco



Parker



Rheodyne



Swagelok

7. Tubing Internal Diameter versus Flow Rate

The tubing internal diameter must be adjusted to flow rate, valve type, and application to avoid high backpressure or chromatographic irregularities.

Tubing ID

Points to consider are:

- Delay volume of entire HPLC System
- Time needed for gradient to go active at column inlet
- Adjust tubing diameters and length:
 - Solvent reservoir to pump: Cavitation?
 - Pump head to mixing-T: Low backpressure
 - Mixing-T to injection valve: Low backpressure; as short as possible
 - Valve to column: ID as small as possible, considering backpressure
 - Column to detector: ID as small as possible (if possible, smaller than # 4 considering backpressure)

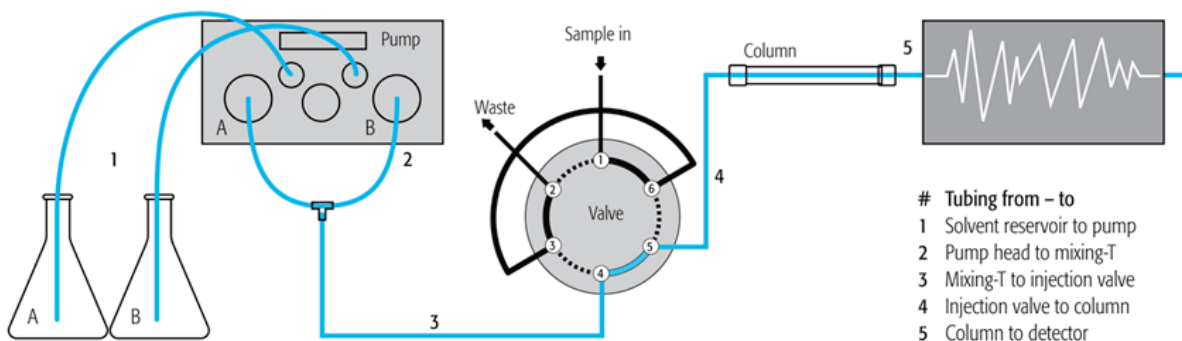
Tubing Internal Diameter versus Tubing Volume

Examples are calculated for a tube length of 100 mm.

Tubing inch	Tubing in mm	Tubing volume
0.040	1.00	78.55 μL
0.020	0.50	19.64 μL
0.010	0.25	4.91 μL
0.005	0.13	1.33 μL
0.0025	0.064	0.32 μL

Valve Type Bore Size in mm	Flow Rate Range from – to	Tubing ID inch / mm	Tubing from – to # see diagram below
0.75 mm	5 to 100 mL/min Preparative application	0.25" / 6.35 mm 0.040" / 1.0 mm	1: Reservoir 2–5: Same ID for entire HPLC system plumbing to avoid backpressure
0.40 mm	0.5 to 5 mL/min Standard HPLC Column ID 4 mm	0.125" / 3.18 mm 0.020" / 0.50 mm 0.010" / 0.25 mm	1: Reservoir 2–3: Pump to Valve 4–5: Valve to Detector
0.25 mm	10 to 500 $\mu\text{L}/\text{min}$ Standard HPLC Column ID 1 to 2 mm	0.040" / 1.0 mm 0.010" / 0.25 mm 0.005" / 0.13 mm	1: Reservoir 2–3: Pump to Valve 4–5: Valve to Detector
0.15 mm	100 nL to 100 $\mu\text{L}/\text{min}$ Micro flow application	0.020" / 0.50 mm 0.020" / 0.50 mm 0.005" / 0.13 mm 0.005" / 0.13 mm	1: Reservoir 2: Pump Head to Mixing –T 3: Mixing-T to Valve 4–5: Valve to Detector
0.10 mm	10 nL to 10 $\mu\text{L}/\text{min}$ Nano flow application Fused silica 50 μm	0.020" / 0.50 mm Fused silica 50 μm 3–5: Fused silica 25 μm	1: Reservoir 2: Pump Head to Mixing –T Mixing-T to Detector flow rates > 1 $\mu\text{L}/\text{min}$ 3–5: Mixing-T to Detector flow rates < 1 $\mu\text{L}/\text{min}$

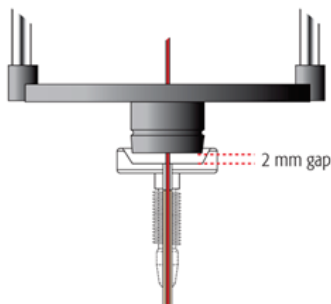
Data for Tubing IDs are recommendations only. Variations depend on the application, mobile phase, flow rate, column ID and sample load.



8. Needle Guide and Needle Seals

Positioning of Injection Unit on Valve Needle Guide

Position Injection Unit approx. 2 mm above bottom of Valve Needle Guide.

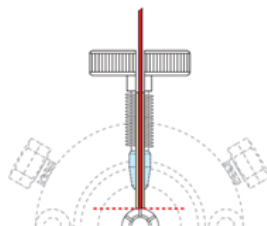


Effect if Injection Unit is not positioned correctly

- Loss of steps from Z-stepper motor. (PAL will recover steps at point of axis-referencing.)
- Possibility that next object in cycle will not be detected (if next step follows directly without axis-referencing. Example: Wash Station)

Needle Seal and Needle Guide

- Change the Needle Seal at regular intervals
- Do not use steel ferrules for a PAEK valve stator
- Select the appropriate Needle Seal/Guide as listed in the table below

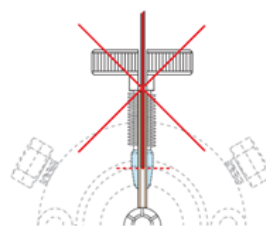


Effect if Needle Seal is not tight

- Loss of sample or no sample transfer to valve
- Filling injection port (Port 1) with sample solution
- Carry-over

Needle Penetration in Valve Inlet Port

- Path: Menu/Utilities/Injectors/F3 – move to injector
 - Activate "Needle Penetration"
 - Move needle down slowly until a clearly audible click occurs
 - Motor pressure release 2 steps up
 - Check position again
- Correct position shown in graphic (Needle Seal)



Needle Penetration in wrong position

- If needle is too high: No seal possible. Carry-over
- If needle is too low: Needle tip hits top of valve body. Possible needle distortion

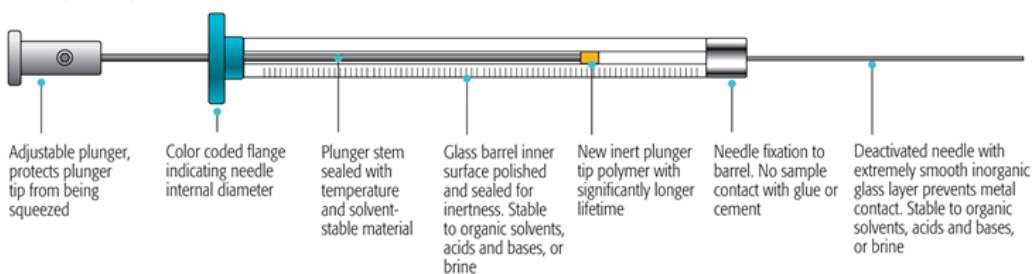
Needle Guide and Seals replacement information

P/N	Description	Remarks
PAL NdlSeal	Needle Seal Gauge 22	Transparent FEP tubing with sst ferrule
PAL NdlSealP	Needle Seal for PAEK Valve Gauge 22	PEEK ferrule to protect PAEK valve stator Transparent FEP tubing
PAL NdlSealR	Needle Seal 22 Rheodyne	Transparent FEP tubing with sst Rheodyne ferrule
PAL NdlSeal-19	Needle Seal Gauge 19	Blue colored Teflon tubing to differentiate from Gauge 22, sst. ferrule
MV 30-12	Needle Guide for Gauge 22 Needles	sst material
MV 30-30	Needle Guide for Gauge 22 Needles	PEEK material for PAEK valve
MV 30-52	Needle Guide for Gauge 19 Needles	Groove in rim to differentiate from Gauge 22 type. sst. material

9. Syringes and Needles

CTC Analytics **X**-Type Syringe developed for:

- High throughput applications
 - Biological samples/drug discovery/proteomics
 - Practically zero carry-over
- EX**tra long life and **EX**tra low carry-over
No metal contact
Inert, smooth surface

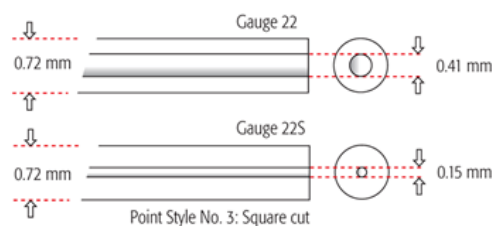


Syringe max. vol. ml	CTC	Hamilton		Syringe description			
	Article No.	P/N	Description	Glass OD mm	Gauge	Point style (PST)	Remarks
X-Type syringes, SyrX - for high throughput and biocompatible applications							
25	SyrX G25-22S-3		1702 CTC (22S/3) inert	7.7	22S	3	Metal flange: red color
50	SyrX G50-22S-3		1702 CTC (22S/3) inert	7.7	22S	3	Metal flange: red color
100	SyrX G100-22S-3		1710 CTC (22S/3) inert	6.6	22S	3	Metal flange: red color
100	SyrX G100-22-3		1710 CTC (22/3) inert	6.6	22	3	Metal flange: blue color
C-Type syringes, SyrC - standard HPLC syringes							
10	SyrC G10-22S-3	203194	1701 CTC (22S/3)	6.6	22S	3	Metal flange
25	SyrC G25-22S-3	203075	1702 CTC (22S/3)	7.7	22S	3	Metal flange
100	SyrC G100-22S-3	203077	1710 CTC (22S/3)	6.6	22S	3	Metal flange
100	SyrC G100-22-3	203235	1710 CTC (22/3)	6.6	22	3	Metal flange
250	SyrC G250-22-3	203079	1725 CTC (22/3)	7.7	22	3	Metal flange
500	SyrC G500-22-3	203349	1750 CTC (22/3)	7.7	22	3	Metal flange
1000	SyrC G1000-22-3	203081	1001 CTC (22/3)	7.7	22	3	Glass flange
2500	SyrC G2500-22-3	203083	1002 CTC (22/3)	9.5	22	3	Glass flange
5000	SyrC G5000-22-3	203085	1005 CTC (22/3)	13.5	22	3	Glass flange

G = Gastight/ Plunger Teflon, | Plunger Tip for **X**-Line: Teflon/Polymer mix | Replacement plungers are available at CTC.

X-Type Syringes are sold exclusively by CTC. Flange color indicates needle internal diameter. Example: Gauge 22 blue or Gauge 22S red.

Syringe Needles / Standard Needle for HPLC Technique:



Needle Gauge 19: OD 1.04 mm. Mandatory for prep valve with bore size 0.75 mm. (Needle with Gauge 22 fits into valve bore.)

Needle gauge versus fill speed and Needle volume

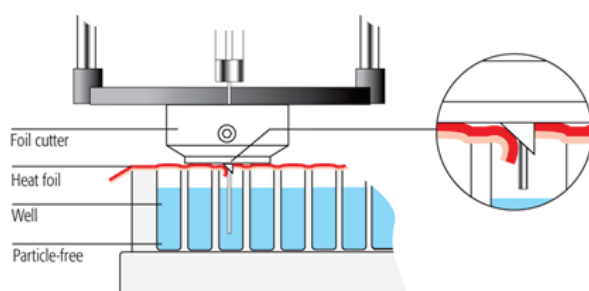
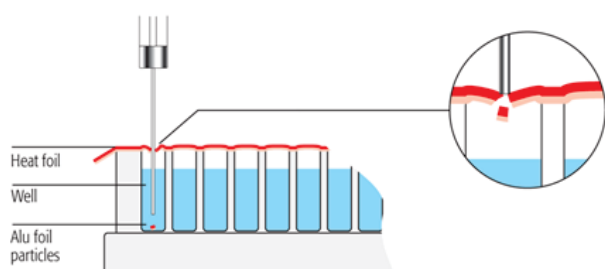
Needle gauge	Fill speed ¹⁾	Time to fill a syringe	Needle volume ²⁾
Gauge 22S	5 to 10 $\mu\text{L/s}$	10 to 20 s	0.90 μL
Gauge 22	200 $\mu\text{L/s}$	0.5 s	6.73 μL

Example: 100 μL syringe

¹⁾ Maximum fill speed before cavitations are observed.
Fill speed example with solvent water / methanol (1:1)

²⁾ Needle volume for 51 mm standard needle

10. Microtiter / Deepwell Plates and the Piercing of Foils



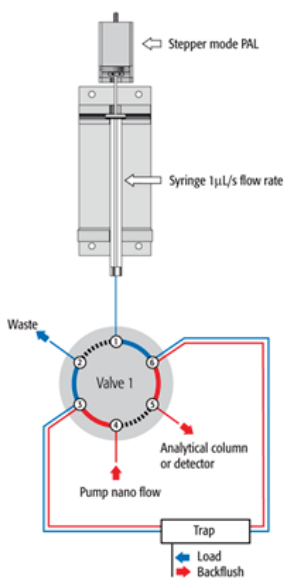
- Foil cutter: Article No. MSZ 02-01
 - Foil cutter can be used for all types of heat foils
 - Do not use the adhesive seal foils
- Organic solvents, such as DMSO, can dissolve glue

11. Examples of Plumbing Diagrams for Micro/Nano Flow Applications

- Transferring sample in μL range easier to handle than in nL range.
- Transfer sample first to a trap to focus with a "high flow rate".
- Use partial loop filling to minimize loss of sample.
- Adjust sample and wash solvent to chromatographic strength of mobile phase.
- Use a backflush mode to optimize transfer from trap to next device.
- First wash step for biological samples must be with aqueous medium followed by organic solvent.
- Last wash step must be with aqueous medium (achieved with a "pre-wash" directly before next injection).
- Trap can be used for sample preparation.
 - Example:
 - Eliminate buffer/salt or high molecular weight compounds.
 - Solid Phase Extraction (SPE)
 - Restricted Access Material (RAM)
 - Molecular Imprint Polymer (MIP)

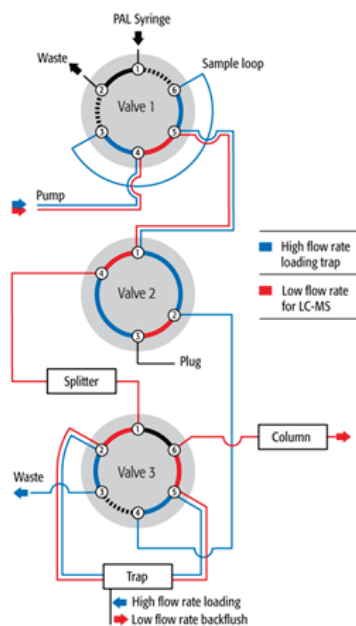
PAL System used as a Syringe Pump

- Loop is replaced with a cartridge or trap.
- PAL System used as a Syringe Pump to load the cartridge or trap.
- Slow deposition of the sample solution, 1 mL/s.
- Advantage: Simple setup. Only one valve and one HPLC pump required.



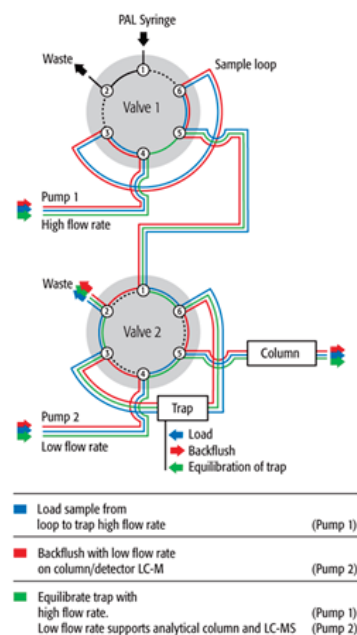
Valve System, Single Pump with Splitter

- Sample transfer with high flow rate.
- Control of the analytical flow rate with the splitter device after valve switches.
- Place splitter as close as possible to column.
- Advantage: One pump system required.
- Disadvantage: 3-valve setup. Splitter must work reliably.



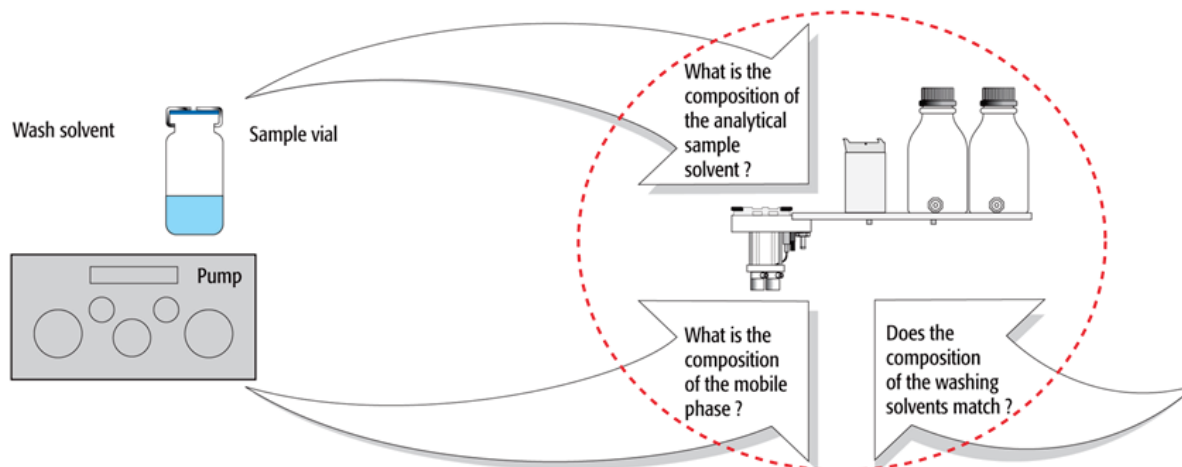
Valve System and Two-pump Setup

- Two pumps are operated independently of each other.
- High flow rate for fast sample transfer on trap.
- Low flow rate optimized for LC-MS application.
- Mobile phase from first pump reconditions the trap.
- Advantage: Clean design with ease of troubleshooting.
- Two dedicated flow ranges (pumps).
- Disadvantage: Two pumps required.



12. Carry-over | Troubleshooting

Carry-over and repeatability



Wash steps for biological samples:

- 1st Wash cycle: Aqueous solvent
- 2nd Wash cycle: Organic solvent.
- 1st Wash cycle before next sample:
Pre-wash with aqueous solvent
(Eliminate organic solvents in syringe and valve).

No.	Important points to check	Influence on carry-over	Influence on repeatability	Remarks
1	Wash solvents: Does the wash solvent match?	!	!	See Point 12 above
	Wash solvent in Loop for next injection: Is the chromatographic strength adjusted to the Mobile Phase?		!	Avoid organic solvents with high elution potential remaining in loop
2	Valve system! Is the valve intact?	!	!	Are any leaks observed?
	Is the waste line open?	!	!	At loop fill, observe movement and speed of solvent front.
	Is the backpressure at normal level?	!	!	
	Can the valve be activated?	!	!	Menu/Utilities/Injectors/LC Vlv (F1)
	Is the Valve Type (dimensions) appropriate for the flow rate?	!	!	See Point 1
3	Needle seal: Is the seal tight?	!	!	Does the seal fit in size? Gauge 22/19? See Point 8
4	Needle penetration: Is needle penetration in valve inlet port adjusted?	!	!	Is the Injection Unit needle guide (Z-Axis) correctly positioned? See Point 8
5	Nuts and ferrules: Are only matched nuts and ferrules used?	!	!	Are the tubings cut square and are they open without any restriction?
	Are all connections remade (dead volume)?	!	!	See Point 6
6	Loop injection: Full loop injection: Is the loop overfilled 3 to 5 times?		!	See Point 3
	Partial loop filling: Is the rule of 20 to 60% of the loop content applied?		!	Consider also the valve volume as indicated in Point 2
7	Syringe: Is the plunger tight? Is the syringe intact?	!	!	
	Is a change to the X-Type syringe indicated?	!	!	High throughput applications? High affinity of a compound for metal?
8	Material replacement: Tubing: sst to PEEK or fused silica?	!	!	Compare flow rate vs. tubing ID. See No. 7, directly above.
	Valve rotor: Is a change from Valcon H to Valcon E indicated?	!	!	See Point 1
	Valve body: Is a change from sst to PEEK indicated?	!	!	Observe material advantages and limitations. Product information is available from supplier.
9	PAL method parameters: Syringe fill speed: Cavitation?		!	Gauge 22S or 22? See Point 9
	Pullup delay: Is the time long enough?		!	
	Injection speed: Is the loop fill speed too high?	!	!	For recommendations see the PAL firmware overview or the PAL User Manual.
	Eject speed: Is the syringe eject speed high enough?		!	Eject speed is a syringe parameter. Air bubbles are ejected during fill strokes.
10	HPLC column: Is the inlet frit clean/replaced?	!	!	HPLC System backpressure?
11	HPLC system parameters: Column and trap Is the selected equilibration time long enough? Is column equilibration timed correctly?		!	General rule is to flush the column/trap 5 to 10 times with the starting condition of the gradient
12	Detection and integration: Is the peak detection and integration verified?		!	Peak tailing? Baseline assignment? S/N ratio? Area rejected? Peak slope detection?
	Is the signal within the dynamic linear range of the detector?		!	Linearity?

2.3 GC Headspace Technique - Gas Type, Quality, Safety and General Consideration

SAFETY WARNING:

The main application where gas is required in combination with the PAL System is headspace analysis. For this and any other application is to our knowledge always an inert gas required. Helium or Nitrogen are the common used gases.

FOR SAFETY REASON DO NOT USE A REACTIVE GAS, SUCH AS HYDROGEN !

Which Gas shall be used for GC Headspace Analysis?

The gas selected for the headspace technique is commonly Helium. It is important that an inert gas is selected, not only for safety reasons but also to keep the analyte as it is, not risking any uncontrolled reaction. Helium is less soluble in Water than Nitrogen. This is the main reason that for Headspace devices based on loop injection or similar inlet system is always Helium to first choice. For this technique has the vial to be pressurized to be able to fill the loop. This is not necessary for the syringe headspace technique if a single point analysis is performed. For this technique can Nitrogen be selected as the flush gas. The gas is used only to clean the syringe, it has no influence on the extraction or equilibration of the analyte. For multiple headspace extraction (MHE) it is advisable to use Helium as well. For this technique is the vial pressurized as well as known from the loop based systems.

Is an independent gas supply mandatory?

Nitrogen is either the carrier gas for packed columns and is often used as a make-up gas for GC detectors. Helium is used as the carrier gas for capillary columns. In other words are the 2 gas types directly available from the GC system. It is therefore very normal to tee-up the gas line and make a direct connection to the PAL Pressure Regulator.

Nitrogen is generally speaking less expensive than Helium.

From the user side is often the question asked, if one can observe a disturbance of the detector baseline at the moment the Gas Flush Valve is activated. One has to consider that the Gas Flush Valve is activated at the start of a sequence to eliminate possible ambient air accumulated in the syringe. During the routine run is the syringe flushed for cleaning right after the injection of the headspace sample. In these moments of activating the Gas Flush Valve would a possible disruption of the base line not have a chromatographic influence. The chromatogram has not been started yet or the first peaks are not expected at time zero.

In general has no relevant disturbance of the base line been observed nor reported, not even using sensitive detection systems like MSD.

For which other applications is the gas supply used as well?

For the GC technique are beside the static headspace two other sample preparation techniques wide spread:

- SPME, Solid Phase Micro Extraction. The fiber can be cleaned in the dedicated Fiber Bake-out Station provided as an option for the PAL System. This device does require a gas supply as well. The SPME Fiber can not be exposed to higher temperature without damaging the coating at the fiber. For more details see section "Fiber Bake-out Station".

- ITEX, In-Tube Extraction. Cleaning the trap material is achieved with a combination with gas and elevated temperature. The gas connection and flow path is done exactly the same way as for static headspace. Gas inlet to the syringe via the heated syringe cartridge to the side hole of the syringe.

For both techniques, SPME and ITEX, can Nitrogen or Helium be used for cleaning, depending on availability and maybe cost (in some countries is Helium extremely expensive). Important is that an inert gas is selected.

For the HPLC technique is a wide used sample preparation technique SPE, Solid Phase Extraction. For certain steps, it can be necessary to dry the SPE cartridge. For this task and to force a solvent through the cartridge bed would also an inert gas, preferable Nitrogen, be used. Often is the concept of the side hole from the headspace syringe a practical way to supply the gas at the right spot at time. This means that the gas connections, as used for the headspace technique, can be transferred to such special applications - even in the HPLC field. (Note, that SPE and related techniques are customized special applications.)

Pressure Setting with Pressure Regulator:

As described above under Safety warnings, is the main application for the gas supply the headspace technique. The setting for the Pressure Regulator should be 0.5 Bar as described in the PAL USER MANUAL.

Using a higher pressure, does cause a stress to all connections within the system. One does not reach a higher flow rate if the pressure is increased. The limiting factor is the syringe needle which is the restriction in the flow path.

For further information see section "[XY-Pressure Regulator](#)" and

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