HEWLETT-PACKARD

HP 35656A

Module Description

Programmable DAC Module

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Programmable DAC Module

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8600 Soper Hill Road Everett, Washington 98205-1298 U.S.A.

CERTIFICATION

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Ground The Instrument

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

Do Not Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Service or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

Do Not Substitute Parts or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

Dangerous Procedure Warnings

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

Warning

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

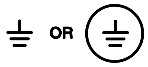
Safety Symbols

The following safety symbols are used throughout this manual and in the instrument. Familiarize yourself with each symbol and its meaning before operating this instrument.

General Definitions of Safety Symbols Used On Equipment or In Manuals.

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked.)



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

Warning

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.

Caution

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Note

The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

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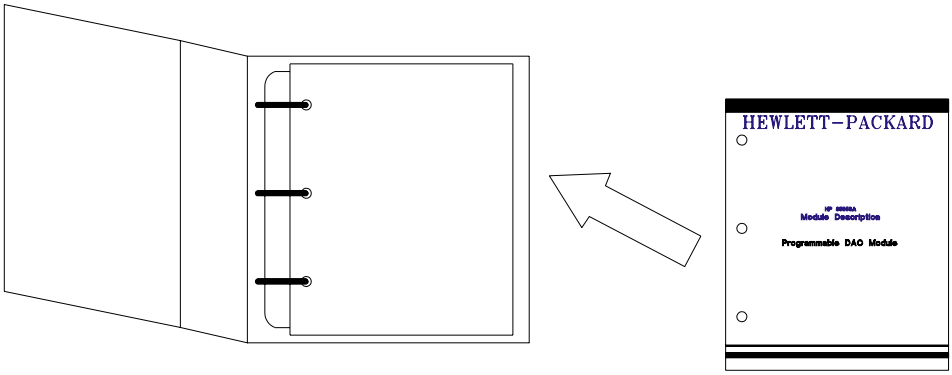

Note

You may wish to keep this document in the binder containing your HP 3565S System Reference or HP 3566A/3567A Measurement Hardware Service Manual. It is similar to the chapters in the those books which describe other modules of the HP 3565S system.

This document contains the following information for the HP 35656A Programmable DAC module:

- Theory of Operation
- Specifications
- Disassembly
- Replaceable Parts

Introduction

The HP 35656A Programmable DAC (Digital-to-Analog Converter) module is a versatile source module for the HP 3565S Dynamic Signal Analysis System. It is used to create an arbitrary time-varying output signal based on a digital representation of the signal. This module is especially useful for applications in the area of vibration control.

Theory of Operation

The HP 35656A Programmable DAC module is used to create an arbitrary time-varying output signal, based on input data that represents the output voltage. The data is sent from a host computer and is stored in a buffer. The data is then sent to a Signal DAC where it is converted into voltage. The rate at which the data is sent to the Signal DAC is controlled by a variable timebase. Programmable filters and attenuators allow additional control of the output signal.

The HP 35656A has a number of output mode (see the HP 35656A Programming Reference for the complete list). There are several basic types of output mode:

- Continuous modes, where data is sent to the HP 35656A continuously. This allows output of general signals.
- Periodic modes, where data representing just one period is sent and the HP 35656A is set to repeat (in a loop) the output specified by that data. This produces a periodic output.
- Sine mode, where the output consists of sine waves generated internally by the HP 35656A.
- User mode, where the output is controlled by a 56000 assembly language program downloaded by the user.

The following paragraphs provide an overview of how the HP 35656A Programmable DAC module works internally. Refer to the block diagram in figure 1.

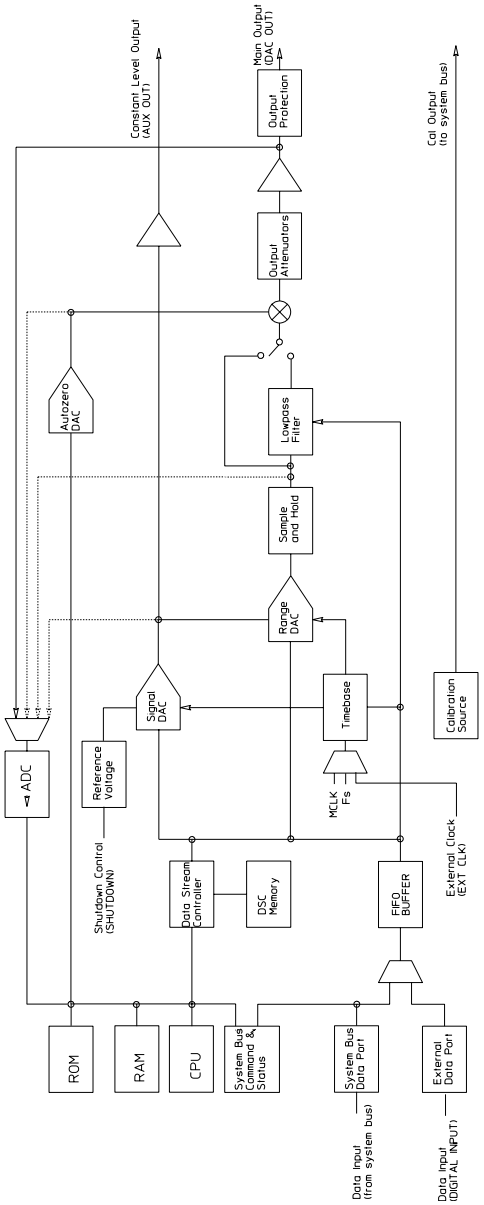

Figure 1. HP 35656A Programmable DAC block diagram

CPU and System Bus

The operation of the module is controlled by its CPU (Central Processing Unit). The module CPU communicates with the host computer by way of the System Bus Data Port and HP-IB/Signal Processor module.

Data Input Interface

Data can be input through either of the two input ports. The System Bus Data Port allows the system controller module to download data to the Programmable DAC Module. The External Data Port lets you send data directly from the host computer to the Programmable DAC Module using a GPIO compatible interface. Both data ports are 16 bits wide and will accept data at 2.5 MHz. The data is read into a 2K ⎫16 bit FIFO (First In First Out) buffer. The buffer can generate a signal indicating that it is empty, half-full, or at overflow. The system controller or host computer can use these signals to manage the flow of data.

Data Stream Controller

The Data Stream Controller is the circuitry which controls the flow of data within the Programmable DAC Module. It reads the data out of the FIFO buffer, separates control and signal data, and manages the transfer of data to the Signal and Range DACs.

Signal and Range DACs

This section consists of two digital-to-analog converters, each of which takes a 16-bit digital input and a voltage reference, and produces an analog voltage output. The output of the first (Signal) DAC is fed to the reference of the second (Range) DAC so that the total output is the product of the two.

The output of the Signal DAC depends on the value represented by the 16 bits at the Signal DAC's digital input at the time it is clocked to accept input. This is a two's complement number called N_s which can take on the following values:

$$-32768 \leq N_s \leq 32767$$

The output of the Signal DAC also depends on the level of voltage at its reference input (normally five volts). A gain stage doubles this voltage and allows the output to be a maximum of ±10 volts.

The output of the Range DAC depends on the value represented by the 16 bits at the Range DAC's digital input at the time it is clocked to accept input. This is a binary number called N_r which can take on the following values:

$$0 \leq N_r \leq 65535$$

The output of the Range DAC also depends on the level of voltage at its reference input (which is the output of the Signal DAC).

The total analog output can be written as:

$$\text{output signal} = \text{Range DAC output} \times \text{Signal DAC output} \times \text{full scale}$$

or:

$$\text{output signal} = \frac{N_s}{32768} \times \frac{N_r}{65536} \times \text{full scale}$$

where full scale can be 10.0, 1.0, or 0.1 volts.

Programmable Lowpass Filter

The output lowpass filter removes unwanted frequency content above the maximum desired frequency. The filter can be programmed for a cut-off frequency from 200 Hz to 51.2 kHz in 200 Hz steps. Typically the cut-off frequency is F_s (the sample clock) divided by 2.56. You can also bypass this filter.

Output Attenuators

The output attenuators set the full scale range. The full scale range can have values of 10.0, 1.0, or 0.1 volts. The full scale range setting is the maximum voltage that the module output will produce when both the Signal DAC and the Range DAC are at maximum output.

Variable Timebase

The HP 35656A Programmable DAC Module has a variable timebase that you can use to vary the rate at which data is clocked into the Signal DAC. The timebase can use one of three references:

- The HP 3565S system clock (MCLK) generated by the system controller module. Its frequency is 19,922,944 Hz.
- The sample clock (F_s) generated on the HP 35650 mainframe by dividing (MCLK) by 76. This is a 262,144 Hz signal used as a sample clock for all mainframes in the system.
- A user-supplied external clock.

The reference can be divided by any integer from 1 to 2^{24}–1 (which is 16,777,215). The maximum timebase frequency is 131,072 samples per second.

The advantage of using MCLK is that by using a higher reference frequency it is possible to generate a larger variety of output frequencies (greater resolution). The advantage of using F_s is that the output of the Programmable DAC can be synchronized directly to the system's input modules.

Autozero

When the DAC circuits are set for an output of zero volts there is normally a small dc offset still present in the analog circuitry. To counteract this offset the CPU (via the Analog-to-Digital Converter or ADC) reads the uncorrected voltage and sends a signal to the Autozero DAC to provide a compensating dc offset. Autozero is automatically performed whenever the CPU changes the filter, output attenuator, variable timebase, or output mode.

Shutdown

The reference voltage to the Signal DAC is normally five volts. The shutdown control circuit can smoothly ramp this voltage down to zero to provide a smooth, safe shutdown of the module's analog output under emergency conditions. Shutdown occurs under the following conditions:

- The inner connector of the SHUTDOWN BNC connector is grounded.
- A shutdown signal is present on the System Bus.
- An HPIB command for shutdown is issued.

Output Protection

The output protection circuit protects the module against overvoltage applied to the output connector. You can read the status of the protection circuit from the module status register.

Note

When you are using the HP 35656A Programmable DAC module you may hear a clicking sound from the action of the relays in the output protection circuit. This sound is normal and has no adverse effect on the module's output. The action of the relays may sometimes result in the output being grounded.

Calibration Source

The calibration source circuits generate a very accurate calibration signal that you can use to characterize the amplitude and phase response of the HP 35652A, HP 35652B, or HP 35655A input modules. The calibration source output is a short binary sequence with energy concentrated in multiple frequencies. This calibration signal is connected to the System Bus CAL line. The Programmable DAC's main output can also be routed to the System Bus CAL line.

Note

The calibration source puts out a trigger signal on the System Bus. To avoid incorrect triggering, set the Programmable DAC to the Ignore Trigger mode when the calibration source is being used.

Diagnostics

The ADC (analog-to-digital converter) reads analog signals from various parts of the circuitry within the module and converts them to digital signals that can be read by the CPU. The CPU can then use this information to provide diagnostics.

Hardware Storage and Shipment

For information on storing and shipping HP 3565S measurement hardware, such as the HP 35656A Programmable DAC module, see the chapter entitled ''General Information.''

Specifications: HP 35656A Programmable DAC module

Abbreviations

The following abbreviations are used in the specifications below:

dBc	Decibels referred to the carrier (fundamental amplitude)
F_s	Sample frequency generated by the HP 35656A programmable timebase
V_p	Volts peak

Signal Output Characteristics

Amplitude:

Full scale amplitudes: 10 V_p, 1V_p, and 0.1 V_p

Amplitude resolution: $(1/2)^{16}$ ⎱full scale amplitude [$(1/2)^{16}$ ℜ 0.00001526]

Output current:

⎛50 mA maximum (–8 V_p < V_{out} <+8 V_p)

Output impedance:

< 1Ω nominal

Capacitive load:

.01 µF maximum

DC offset (after autozero):

10 V range: 2.0 mV maximum

1 V range: 0.5 mV maximum

0.1 V range: 0.2 mV maximum

Signal Characteristics

Signal DAC resolution:

16 bits

Harmonics and subharmonics (sine output, filter bandwidth at $F_S/3.6$):

Sine output frequency < 1 kHz: <–68 dBc

Sine output frequency < 10 kHz: <–48 dBc

Auxiliary Inputs and Outputs

Shutdown input and external sample clock:

TTL levels and impedances

Constant level output:

Level: 1 V peak maximum (fixed)

Impedance (10 kHz): < 1.5Ω nominal

Environmental

Ambient Temperature: 0 to 55°C

Relative Humidity: Can be operated in environments with relative humidity ®95% at 40°C. The module should be protected from temperature extremes that can cause condensation.

Altitude: Up to 4572 meters (15,000 feet)

Disassembly

Introduction

This section shows you how to disassemble your HP 35656A Programmable DAC. The major subassemblies of the module are shown in figure 2.

Note

This section is intended for technicians and others who are familiar with working on electronic equipment.

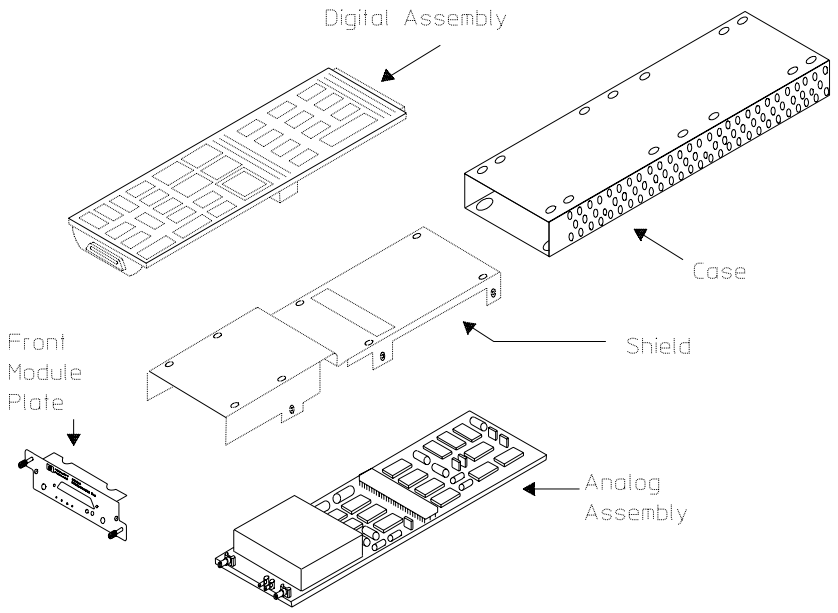

Figure 2. HP 35656A Programmable DAC
(See the following pages for disassembly instructions.)

Required Tools

You will need the following tools to disassemble your HP 35656A Programmable DAC:

- 1/4 inch nut driver (1/4 inch ℜ6.3 mm)
- 7 mm nut driver (7mm ℜ9/32 inch)
- #1 pozidriv screwdriver (pozidriv is a type of cross-head screwdriver)
- small flat-blade screwdriver (about 1/8 inch or 3 mm)
- 5/8 inch deep socket (a 16 mm socket can also be used). The socket must be deep enough to accommodate the front BNC connectors.

Caution

To protect circuits from static discharge, remove or replace measurement hardware assemblies only at static-protected work stations.

HP 35656A Programmable DAC Disassembly.

Warning

Unplug the mainframe power cord before beginning disassembly, if not you may injure yourself or damage the equipment.

Procedure

1. Loosen the two thumb screws on the front module plate and pull the module out of the mainframe.

   (For steps 2 through 4, refer to figure 3.)

2. Using the pozidriv screwdriver, remove the six screws from the sides of the module case (three on each side). Notice that there is a lock washer on each screw. Set the screws and lock washers aside to use in re-assembly.

3. Using the flat-blade screwdriver, loosen the two retaining screws on the rear plate of the module case until they move freely. These screws are attached to the rear plate and do not need to be completely removed.

4. Using the flat-blade screwdriver, loosen the two retaining screws on the front plate. These screws are attached to the front plate and do not need to be completely removed.

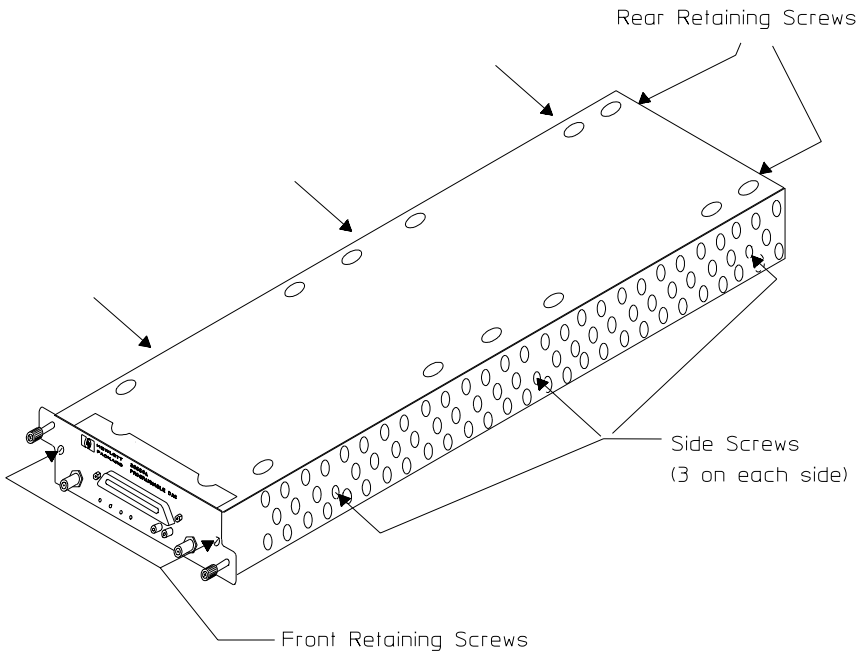

Figure 3. Removing Screws to Begin Disassembly

5. (Refer to figure 4.) Slide the inner assembly out of the module case.
   (For steps 6 through 9, refer to figure 5.)

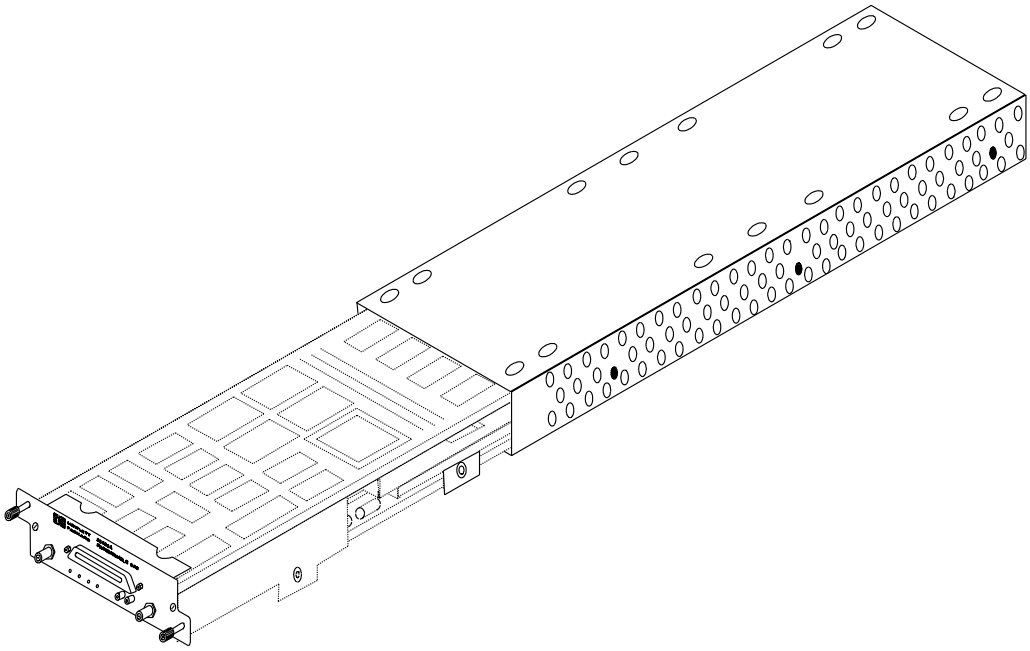

Figure 4. Sliding Circuit Board Assembly from Case

6. Using the 5/8 inch (or 16 mm) deep socket, remove the hex nuts from the BNC connectors.

7. Using the 7 mm nut driver, remove the two small hex-head screws, one on each side of the wide digital input (GPIO) connector.

8. Using the 1/4 inch nut driver, remove the two small hex nuts, one each from the EXT CLK and AUX OUT connectors.

9. Remove the front module plate by pulling it away from the rest of the assembly.

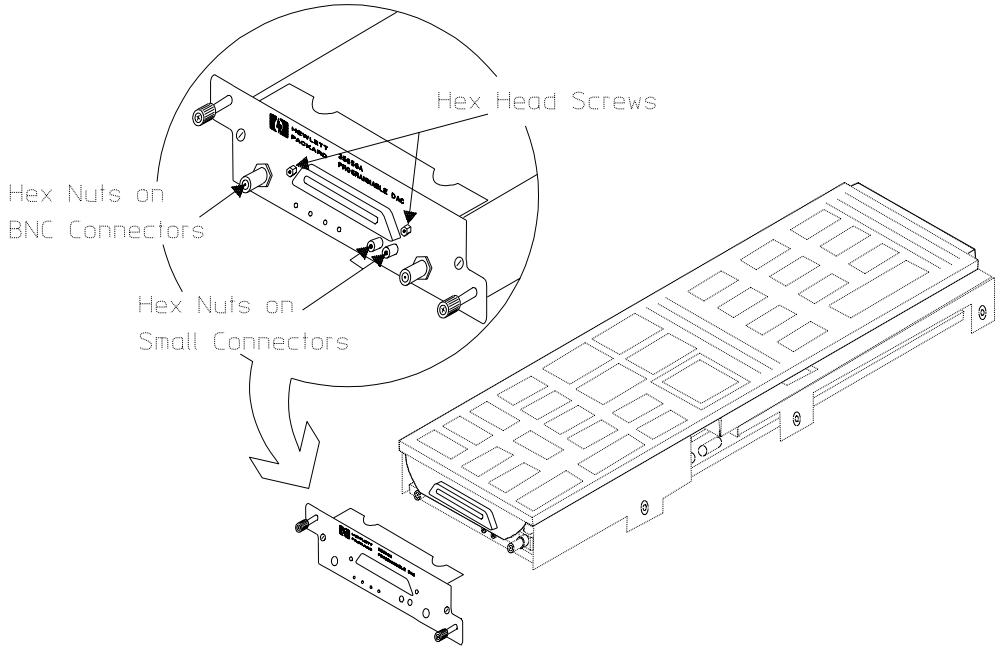

Figure 5. Removing the Front Module Plate

Note

The hex nuts on the BNC connectors and on the EXT CLK and AUX OUT connectors are not designed to be flush with the surface of the front plate. When you re-assemble them later, tighten them only until you feel resistance indicating they are tight. Do not try to tighten them down to the surface of the plate.

Note

When re-assembling the module make sure that all of the front panel LEDs are aligned to come through the holes in the front panel.

10. (Refer to figure 6.) Using the pozidriv screwdriver, remove the eight screws that attach the digital assembly to the shield. Remove the digital assembly. (The digital assembly is the printed circuit board which has the wide GPIO connector attached to it.)

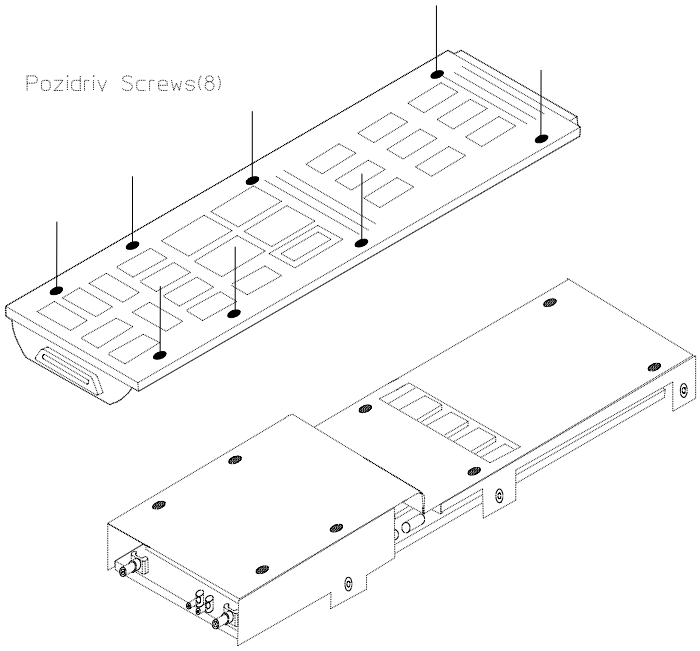

Figure 6. Removing the Digital Assembly

11. (Refer to figure 7.) Using the pozidriv screwdriver, remove the eight screws that attach the analog assembly to the shield. Remove the analog assembly. (The analog assembly is the printed circuit board which has the front BNC connectors attached to it.)

This completes the HP 35656A Programmable DAC disassembly procedure.

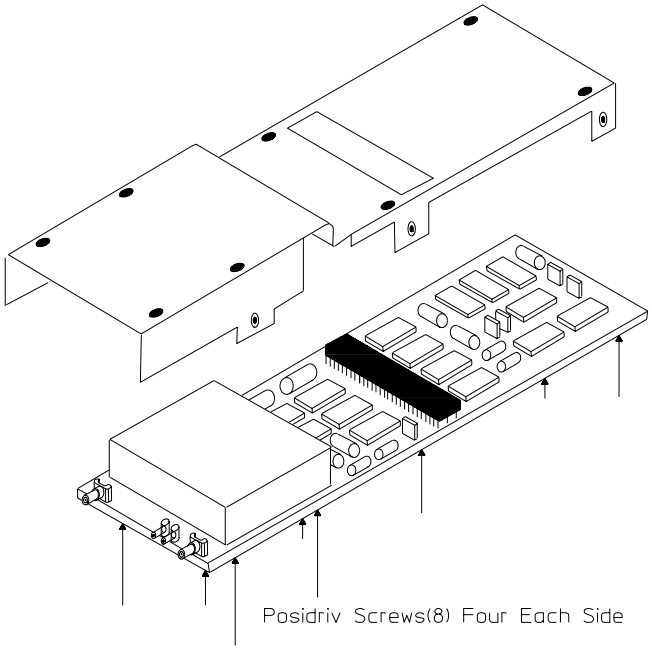

Figure 7. Removing the Analog Assembly

Replaceable Parts

This section provides ordering information for replaceable parts associated with the HP 35656A Programmable DAC module. Table 1 lists exchange printed circuit assemblies. Table 2 lists the remaining replaceable parts.

Note

See the ''General Information'' chapter for more information on ordering parts.

Table 1. HP 35656A Programmable DAC module Exchange Assemblies

Reference Number	Description	HP Part Number	Exchange Part Number
A1	Digital	35656-66501	35656-69501
A2	Analog	35656-66502	35656-69502

Table 2. Programmable DAC module Replaceable Parts

HP Part Number	C D	Qty	Description
35656A	3	1	Programmable DAC module
35656-66501	5	1	Digital assembly
35656-66502	6	1	Analog Assembly
35656-01202	7	1	Shield—Sheet Metal
35650-64490	1	1	Module case
35656-60202	1	1	Front Panel Assembly
35650-44191	7	1	Rear module plate
35656-34301	6	1	Serial Plate
0380-0644	1	2	Standoff—hex 0.327 in. long 6-32 thd m/f
0380-1949	4	4	Standoff—Hex 11mm long M3.0)0.5 thd m/f
0380-1958	5	4	Standoff—hex 6mm long M3.0)0.5 thd m/f
0380-2046	4	4	Standoff—hex 19mm long M3.0)0.5 female
0380-2093	0	4	Standoff—hex 14mm long M3.0)0.5 thd
1390-0498	8	4	Fastener—captive screw M3.0)0.5 thd
0515-0924	0	18	Screw—machine 6 mm long M3.0)0.5 thd
0515-1121	1	4	Screw—machine 6 mm long M2.5)0.5 thd
0515-0972	8	2	Screw—machine 4 mm long M2.5)0.5 thd
2190-0644	3	18	Washer—lock 3.0)IT
2190-0584	0	8	Washer—lock 3.0 HLC
2190-0008	3	2	Washer—lock no.6)IT
35656-12701	4	2	Bushing—BNC connector
35656-12702	4	2	Bushing—SMB connector
03335-61627	9	2	Cable—female BNC
35656-61602	7	1	Cable—assembly interface
35650-48313	3	1	Packing—carton
35650-48312	2	2	Packing—tray
35650-48311	1	2	Packing—foam cushion
35656-90001	0	1	Documentation—Programmable DAC

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Hewlett-Packard Sales and Service Offices

To obtain Servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office listed in HP Catalog, or contact the nearest regional office listed below:

In the United States

California
P.O. Box 4230
1421 South Manhattan Avenue
Fullerton 92631

Georgia
P.O. Box 105005
2000 South Park Place
Atlanta 30339

Illinois
5201 Tollview Drive
Rolling Meadows 60008

New Jersey
W. 120 Century Road
Paramus 07652

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Hewlett-Packard (Canada) Ltd.
17500 South Service Road
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Kirkland, Quebec H9J 2M5

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