



OCXO+Rb

QRb Sync

10 MHz or 100 MHz GPS/GNSS-DISCIPLINED LOW PHASE NOISE OCXO Rb CLOCK

Industry Leading ULN Oscillators
and Disciplined Rb Combined

Exceptional Phase Noise

Excellent Stability

Low-G-Sensitivity

Internal Vibration Isolation Options



Auto-Adaptive Smartiming+ SAASM/Non-SAASM
GPS/GNSS Disciplining Technology @ 1 ns Resolution

APPLICATIONS

- High Dynamic Platforms
- Tactical Helicopter
- Tactical Airborne
- Drone (UAV/UGA)
- Shipboard
- Ground Communications
- Mobile Satcom
- Tactical Aerial Radar

"Quietly the Best"



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KEY FEATURES

• Frequency-Disciplined Outputs	10 MHz or 100 MHz (2 Outputs of Selected Frequency) - Frequency outputs to 500 MHz upon request
• Single Power Supply Voltage	+16 ±1 VDC
• Compact Size with Internal Vibration Isolation Options	
– Rb & OCXO Hard Mounted	6 x 5.7 x 1.1" (152.4 x 144.78 x 27.94 mm) (a)
– Rb Hard Mounted; OCXO Vibe Isolated	6 x 5.7 x 1.1" (152.4 x 144.78 x 27.94 mm) (b)
– Rb & OCXO Vibe Isolated	6 x 5.7 x 1.4" (152.4 x 144.78 x 35.56 mm) (c)
• Initial Frequency Accuracy at Power-On	±5E-8 (until OCXO locks to Rb)
• Frequency Offset Over Op Temp Range	<1E-10 over 0°C to +50°C
• Short-Term Stability	2E-11 at 1 sec
• Auto-Adaptive SmartTiming+ SAASM/Non-SAASM GPS/GNSS Disciplining Technology	
– REF Input	1PPS from SAASM/Non-SAASM GPS/GNSS
– REF Locking Resolution	1 ns
– REF Disciplining/Filtering/Controlling	Auto Adaptive
• Smart Loop Time Constant	280 - 100,000 sec, programmable
– REF Locking Mode (User Settable)	Sync or Track
– REF Types (PRS/Stratum 1 Source)	GPS, Cesium, E1/T1, eLoran, Maser
– OUT-Disciplined Time	1 PPS (2 Outputs)
– OUT Frequency Accuracy/Stability	
• PRS/Stratum 1 Locked	1E-12, typical
• Holdover (No PRS)	<5E-11/month
– OUT Time Accuracy/Stability	
• GPS Locked	<50 ns
• Holdover (No GPS)	< 2 µs/48 hrs or < 1 µs/24 hrs
• Power Consumption	34 Watts during warm-up 15 Watts, steady state @ +25°C
• Warm-up Time	< 10 min, setting time < 30 min (a & b) < 12 min, setting time < 30 min (c)
• Ultra-Low Aging	< 5E-11/ month
• Ultra-Low Phase Noise Output	<u>10 MHz</u> or <u>100 MHz</u> -165 dBc/Hz -176 dBc/Hz
• Test Vibration Profile	0.01 g ² /Hz random, 10-2000 Hz* *Testing can be completed using customer provided vibration profile upon request
• RS232 Standard Interface	Control & Monitoring Commands, 9600 b/s
• Weight	< 3 lbs (a & b) < 4 lbs (c)

Notes:

- (a) Both Rb and OCXO are hard mounted within the assembly (no vibration isolation). Static or sine vibe environment applications.
- (b) Rb is secured directly to assembly floor and OCXO is mounted on vibration isolation tray for use in dynamic environments.
- (c) Both Rb & OCXO are mounted on vibration isolation trays for high vibration & shock level applications.



**STANDARD 10 MHz MODEL
SPECIFICATIONS**

PART NUMBER		501-30428*		501-30429		501-30430			
		* Specify part number 501-30427 if there are no environmental concerns and if vibe/shock testing is not required.							
DESCRIPTION		Both Rb & 10 MHz OCXO Hard Mounted		Rb Hard Mounted; 10 MHz OCXO Vibe Isolated		Both Rb & 10 MHz OCXO Vibe Isolated			
APPLICATIONS		Static or Sine Vibration Environments		Dynamic Environments; Significant Random Vibration		Dynamic Environments; High Random Vibration & Shock			
ELECTRICAL SPECIFICATIONS									
Frequency		10 MHz, sine							
Number of Outputs		2							
Output Level		+10 ±2 dBm, each output							
Output Load Impedance		50 ohms							
Harmonics		≤ -30 dBc							
Spurious		≤ -80 dBc							
Initial Accuracy at Turn-On		±5E-8 until OCXO locks to Rb							
Aging, Free-Running Freq Accuracy @ +25°C		≤ 5E-11/month after 30 min settling time							
Short Term Stability		1 second	2.00E-11						
		10 seconds	2.00E-11, typical						
Frequency Offset Over Op Temp Range		≤ 1E-10, 0°C to +50°C							
Settling Time		≤ 30 minutes							
Warm-up Time		≤ 10 minutes				≤ 12 minutes			
Phase Noise L(f), dBc/Hz		Static		Dynamic** (no vibe isolation)		Static		Dynamic** (~50 Hz vibe isolation system)	
	Offset								
** Expected performance considering Test Vibration Profile. Testing can be completed using customer provided vibration profile upon request.	1 Hz	-105***	-85***	-105***	-85***	-105***	-85***		
	10 Hz	-135	-95	-135	-95	-135	-95		
	50 Hz	-145	-108	-145	-104	-145	-104		
	100 Hz	-155	-114	-155	-125	-155	-125		
	1 kHz	-164	-134	-164	-164	-164	-164		
	2 kHz	-164	-141	-164	-164	-164	-164		
*** Expected, not measured.	10 kHz	-165	-165	-165	-165	-165	-165		
	100 kHz	-165	-165	-165	-165	-165	-165		
Supply Voltage		+16 ±1 VDC							
Warm-up Power		34 Watts, typical							
Steady State Power		15 Watts, typical @ +25°C							
MECHANICAL SPECIFICATIONS									
Size (L x W x H)		6 x 5.7 x 1.1" (152.4 x 144.78 x 27.94 mm)					6 x 5.7 x 1.4" (152.4 x 144.78 x 35.56 mm)		
Mechanical Layout		See Figure 1					See Figure 2		
Weight		≤ 3 lbs (1.36 Kg)					≤ 4 lbs (1.81 Kg)		
Mounting		Helicoil, #4-40 (0.180" deep), on base, 4 places							
Connectors		RF Input / Outputs: SMA(f) ; Power & Monitoring: (2) 9-pin D-sub							
COMMUNICATION INTERFACE									
RS-232		See commands for control & monitoring below, including timing & locking control functions VMGA messages							
Protocol Speed		9600, n, 8, 1							



STANDARD 100 MHz MODEL SPECIFICATIONS

PART NUMBER		501-30432*		501-30433		501-30434	
		* Specify part number 501-30431 if there are no environmental concerns and if vibe/shock testing is not required.					
DESCRIPTION		Both Rb & 100 MHz OCXO Hard Mounted		Rb Hard Mounted; 100 MHz OCXO Vibe Isolated		Both Rb & 100 MHz OCXO Vibe Isolated	
APPLICATIONS		Static or Sine Vibration Environments		Dynamic Environments; Significant Random Vibration		Dynamic Environments; High Random Vibration & Shock	
ELECTRICAL SPECIFICATIONS							
Frequency		100 MHz, sine					
Number of Outputs		2					
Output Level		+10 ±2 dBm, each output					
Output Load Impedance		50 ohms					
Harmonics		≤ -30 dBc					
Spurious		≤ -80 dBc					
Initial Accuracy at Turn-On		±5E-8 until OCXO locks to Rb					
Aging, Free-Running Freq Accuracy @ +25°C		≤ 5E-11/month after 30 min settling time					
Short Term Stability	1 second	≤ 2.00E-11					
	10 seconds	≤ 5.00E-11					
Frequency Offset Over Op Temp Range		≤ 1E-10, 0°C to +50°C					
Settling Time		≤ 30 minutes					
Warm-up Time		≤ 10 minutes				≤ 12 minutes	
Phase Noise L(f), dBc/Hz							
	Offset	Static	Dynamic** (no vibe isolation)	Static	Dynamic** (~50 Hz vibe isolation system)	Static	Dynamic** (~50 Hz vibe isolation system)
** Expected performance considering Test Vibration Profile. Testing can be completed using customer provided vibration profile upon request.	1 Hz	-70***	-64***	-70***	-64***	-70***	-64***
	10 Hz	-100	-74	-100	-74	-100	-74
	50 Hz	-120	-87	-120	-81	-120	-81
	100 Hz	-130	-93	-130	-100	-130	-100
	1 kHz	-155	-113	-155	-143	-155	-143
*** Expected, not measured.	2 kHz	-160	-119	-160	-155	-160	-155
	10 kHz	-176	-172	-176	-172	-176	-172
	100 kHz	-176	-176	-176	-176	-176	-176
Supply Voltage		+16 ±1 VDC					
Warm-up Power		34 Watts, typical					
Steady State Power		15 Watts, typical @ +25°C					
MECHANICAL SPECIFICATIONS							
Size (L x W x H)		6 x 5.7 x 1.1" (152.4 x 144.78 x 27.94 mm)				6 x 5.7 x 1.4" (152.4 x 144.78 x 35.56 mm)	
Mechanical Layout		See Figure 1				See Figure 2	
Weight		≤ 3 lbs (1.36 Kg)				≤ 4 lbs (1.81 Kg)	
Mounting		Helicoil, #4-40 (0.180" deep), on base, 4 places					
Connectors		RF Input / Outputs: SMA(f) ; Power & Monitoring: (2) 9-pin D-sub					
COMMUNICATION INTERFACE							
RS-232		See commands for control & monitoring below, including timing & locking control functions VMGA messages					
Protocol Speed		9600, n, 8, 1					

**TYPICAL
SPECIFICATIONS****SMARTIMING+® GPS/GNSS DISCIPLINING & FILTERING**

1 PPS INPUT (PPSREF)				
Input Level		Logic High = +2.0 VDC, min to +5.5 VDC, max Logic Low = 0 VDC, min to +0.8 VDC, max		
Number of Inputs		1 (J3)		
Pulse Width at Logic High		20 ±1 µsec		
Rise / Fall Time		≤ 20 nsec / ≤ 1 µsec (10% to 90%)		
Source & Input Load Impedance		50 ohms, nominal		
Reference Types		GPS, E1/T1, Cesium, eLoran, Maser		
Disciplining & Filtering		Auto-adaptive thru the SmarTiming+® technology (request Whitepaper)		
Disciplining Modes		Sync (phase alignment) or Track (frequency alignment)		
Architecture Model		See Spectratime SRO-100 Manual		
1 PPS OUTPUTS (PPSOUT)				
Number of 1 PPS Outputs		2 (J4, J5)		
Start-up Time		10 seconds to 1 PPS Output		
Output Level		CMOS 0-5V		
Pulse Width at Logic High		400 µsec max ±40 µsec supply		
Rise / Fall Time		≤ 5 nsec / ≤ 50 nsec (20% to 80%)		
Input to Output Offset		≤ 70 nsec ±2 nsec		
Jitter		±5 nsec		
Output Load Impedance		50 ohms, nominal		
BIT OUTPUTS (TTL Compatible)				
PLL Lock (OCXO to Rb)		Status "0" indicates locked		
1 PPS Lock		Status "1" indicates locked and ready		
PPSOUT	Holdover Time Stability	< 1µs / 24 hrs	< 3µs / 24 hrs	< 7µs / 24 hrs
	Temperature Window	Within ±2°C	Within 20°C	Within 40°C
	(After learning phase > 10 t)			
SMART LOOP TIME CONSTANT		Auto-Adaptive - 280 to 100,000 seconds		
	Phase/Frequency	Sync/Trak Mode		
	User Settable	RS-232 Command Interface		

ENVIRONMENTAL

VIBRATION	Lock Acquisition & Lock Holding MIL-STD-810F, Table 514.5C-6, General Exposure		
TEST VIBRATION PROFILE, OPERATING	0.01 g ² /Hz random, 10-2000 Hz Testing can be completed using customer provided vibration profile upon request (duration, amplitude, frequency range)		
DYNAMIC PHASE PERTURBATIONS	Custom profile available upon request (x degree per y interval under given vibration, temp & shock profiles)		
G-SENSITIVITY	10 MHz OCXO Models: ≤2E-10/g per axis, typical 100 MHz OCXO Models: ≤3E-10/g per axis, typical - Can be specified to 1E-10/g per axis on some models - Effective g-sensitivity to ≤5E-12/g @ 2 kHz offset with 50 Hz vibe isolation system, typical		
OPERATING TEMPERATURE	0° to +50°C, standard (other temperature ranges are available upon request)		
EXPOSURE TEMPERATURE	Normal operation after exposure from -40°C to +55°C		
OPERATING & NON-OP PRESSURE	0.82 to 15.10 psia		
HUMIDITY, SALT FOG	Conformal coat PCBs, 0 to 90%, condensing		
OPERATING ALTITUDE	Sea level up to 50,000 ft (15.24 Km)		

SCREENING

VIBRATION, NON-OPERATING	MIL-HDBK-2164, Figure 3, Z axis
THERMAL, NON-OPERATING	MIL-STD 202G, Method 107, Cond A, 1 hour dwell
SHOCK, OPERATING	30g, 11ms, half sine Testing can be completed using customer provided shock specs upon request (g level, duration, # of pulses, pulse format)

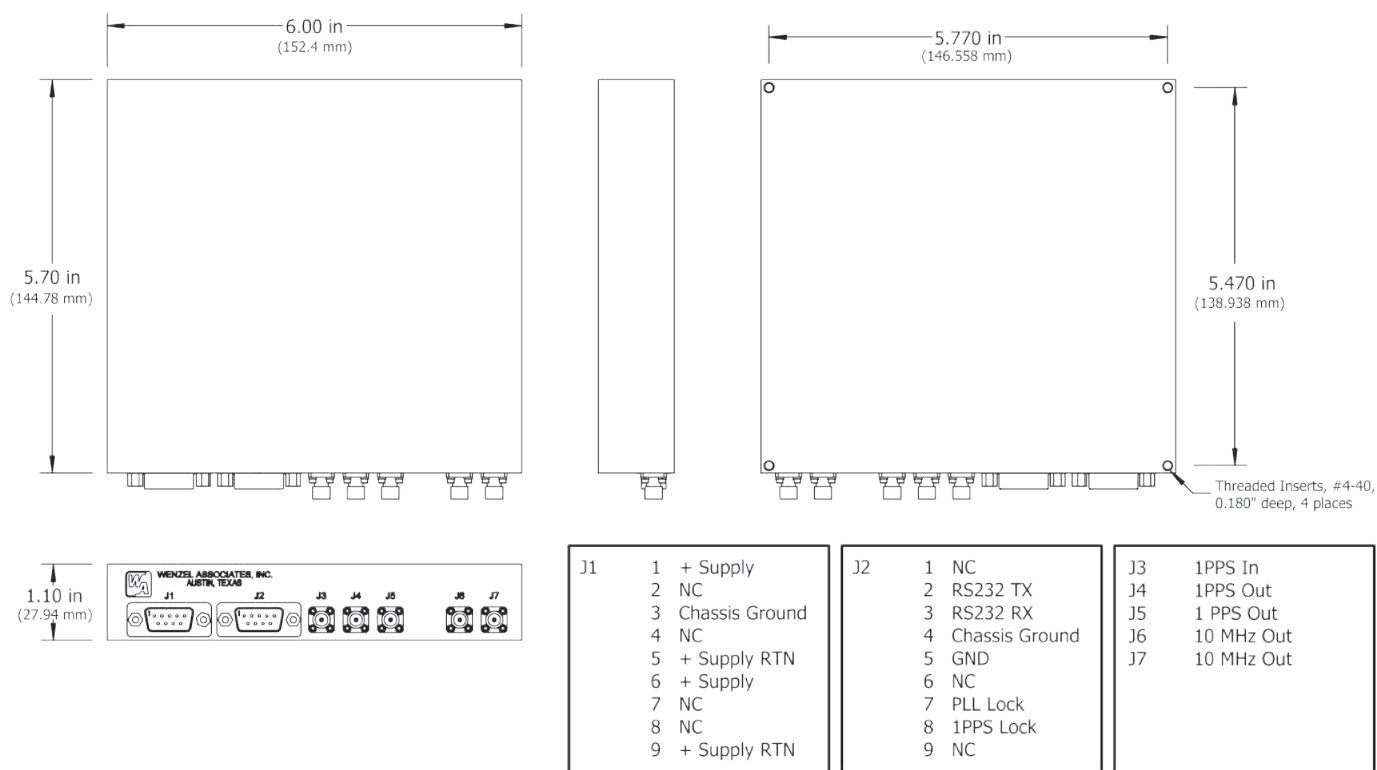


FIGURE 1

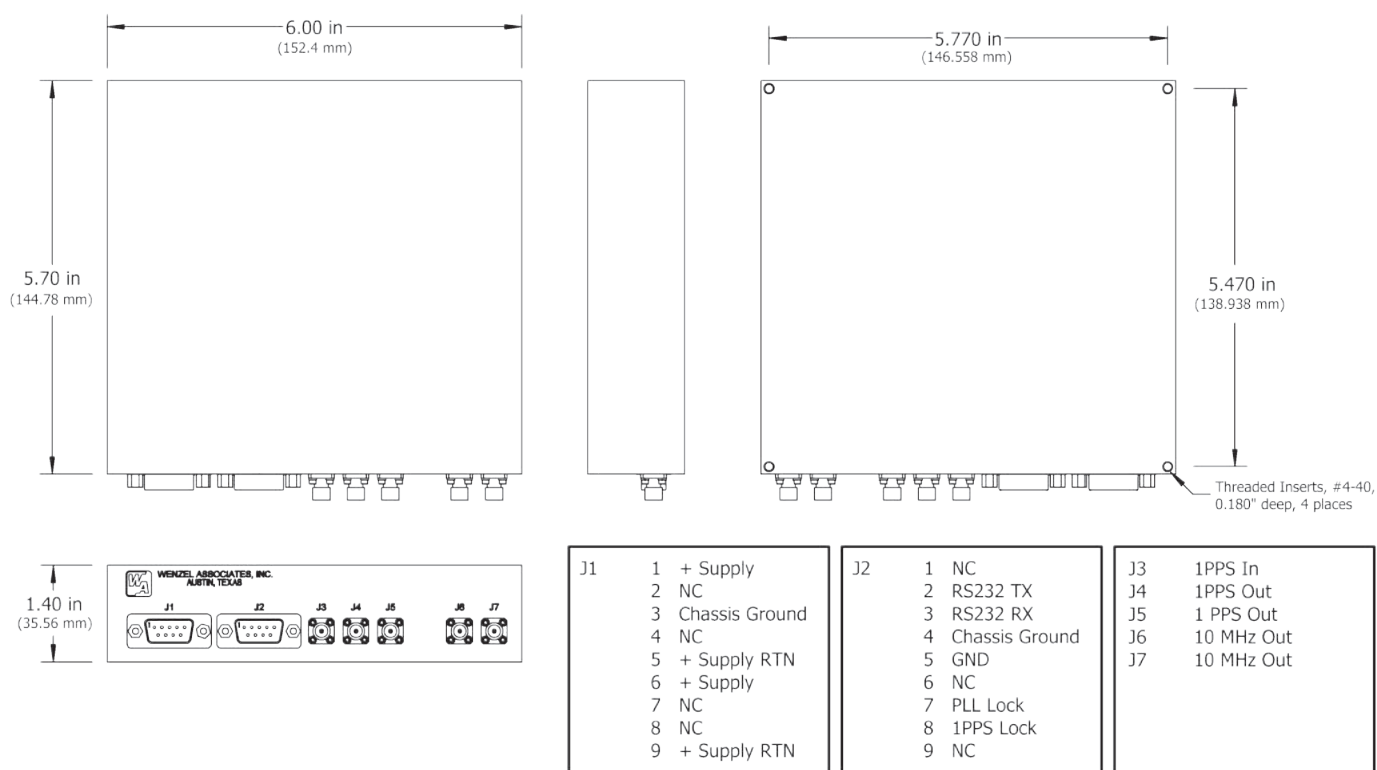


FIGURE 2

REVISION TRACKING LIST			
Software Revision			Hardware Revision
Date	Version	Comment	
01 APR 2014	1.096	Initial Release for QRb Sync	

FREQUENCY ADJUSTMENT & MONITORING FUNCTIONS
The operating and monitoring parameters of the QRb Sync are accessible for read and write operations through the serial RS-232 port (9600 bits/sec., no parity, 1 start bit, 8 data bits, 1 stop bit). There are 2 basics commands, which are <i>M</i>, <i>Cxxxx</i> <i>M</i><CR><LF>: monitors the basic internal signals of the atomic clock. The returned answer looks like: <i>HH GG FF EE DD CC BB AA</i> <CR> <LF> Where each returned byte is an ASCII coded hexadecimal value, separated by a <Space> character. All parameters are coded at full scale. <i>HH</i>: Read-back of the user provided frequency adjustment voltage on pin 2 (0 to 5V) <i>GG</i>: reserved <i>FF</i>: peak voltage of Rb-signal (0 to 5V) <i>EE</i>: DC-Voltage of the photocell (5V to 0V) <i>DD</i>: varactor control voltage (0 to 5V) <i>CC</i>: Rb-lamp heating current (Imax to 0) <i>BB</i>: Rb-cell heating current (Imax to 0) <i>AA</i>: reserved <i>Cxxxx</i><CR><LF> *: output frequency adjustment through the synthesizer, by steps of 5.12×10^{-13}, where <i>xxxx</i> is a signed 16 bits word in hexa coded ASCII. This value is automatically stored in an EEPROM as last frequency which is applied after RESET or power-ON operation. In Track mode this correction is not in use. The function FCsddddd does the same. But the data format is different. * Warning :: This command is acting into non-volatile memory. Numbers of commands sent during the whole unit life time limited to 10,000 in total (all commands cumulated).

QRb Sync – STANDARD RS-232 CONTROL & MONITORING COMMANDS

TIMING & LOCKING CONTROL FUNCTIONS				
Using the same data interface, the smart QRb Sync 37 models can accept the following basic ASCII commands: Data is in decimal ASCII code.				
Command Name	Syntax Command	Data Field (if any)	Response Syntax	Response Data (if any)
Identification	ID<CR><LF>	-	TNTSRO-aaa/rr/s.ss<CR><LF>	aaa: 100 rr: revision number s.ss: software version
Serial number	SN<CR><LF>	-	xxxxxx<CR><LF>	xxxxxx : 6 digits serial nbr
Status	ST<CR><LF>	-	s<CR><LF>	s:Status s=0 :warming up s=1 :tracking set-up s=2 :track to PPSREF s=3 :synch to PPSREF s=4 :Free Run. Track OFF s=5 :FR. PPSREF unstable s=6 :FR. No PPSREF s=7 :factory used s=8 :factory used s=9 :fault or Rb OOL
Set Tracking PPSINT - PSSREF	TRx<CR><LF> *	x=0 : Track never * x=1 : Track now x=2 : Track ever * x=3 : Track now + ever * x= ? : Interrogation	x<CR><LF>	x:Tracking commands status x=0 : Track OFF x=1 : Track ON (when Status 9 -> 4
Set Synchronizatio n PPSOUT – PPSINT	SYx<CR><LF> *	X=0 : Synch. never * x=1 : Synch. now x=2 : Synch. ever * x=3 : Synch. now + ever * x= ? : Interrogation	x<CR><LF>	x:Synch. commands status x=0 : Synch. OFF x=1 : Synch. ON (When Status 1 -> 2)
Set PPSOUT delay	DEdddddd<CR><LF>	ddddddd=delay by 133ns step. Max 7499999 DE0000000 :synch to PPSREF	ddddddd<CR><LF>	ddddddd=delay by 133ns step. Max 7499999
Set PPSOUT Pulse Width	PWdddddd<CR><LF> *	ddddddd=pulse Width by 133ns step. Max 7499999 PW0000000: no pulse	ddddddd<CR><LF>	ddddddd=Pulse Width by 133ns step. Max 7499999 0000000: no pulse
Time of day	TD<CR><LF>	-	hh:mm:ss<CR><LF>	hh:hours mm:minutes ss:seconds
Set time of day	TDhh:mm:ss<CR><LF>	hh:Hours mm:Minutes ss:seconds	hh:mm:ss<CR><LF>	hh:hours mm:minutes ss:seconds
Date	DT <CR><LF>	-	yyyy-mm-dd	yyyy : year mm : month dd : day
Set date	DT yyyy-mm-dd<CR><LF>	yyyy : year mm : month dd : day	yyyy-mm-dd	yyyy : year mm : month dd : day
Beat every second on serial port.	BTx<CR><LF>	x=0 : Stop beat x=1 : Effective Time interval PPSOUT vs PPSREF x=2 : Phase comparator x=3 : Both x=1 & x=2 x=4 : Beat Time of day x=5 : Beat status x=6 : Beat <CR><LF> x=7 : Beat Date, Time, Status x=A : Beat NMEA \$PTNTA, x=B : Beat NMEA \$PTNTS,B,	ddddddd<CR><LF> or sppp<CR><LF> or ddddddd sppp<CR><LF> or hh:mm:ss<CR><LF> s<CR><LF> <CR><LF> yyyy-mm-dd hh:mm:ss s	ddddddd : delay in 133ns step sppp:phase error in ns s: +/- signe hh:hours mm:minutes ss:secondes s: status yyyy:year, mm:month, dd:day
Set frequency adjustment	FCsdddd<CR><LF> *	s=+/- signe dddd = limited within range : +32767/-32768 FC ?????? : interrogation	sdddd<CR><LF>	s: +/- signe dddd : freq. Adj. in 5.12 x 10 ⁻¹³ steps

QRb Sync – STANDARD RS-232 CONTROL & MONITORING COMMANDS

Command Name	Syntax Command	Data Field (if any)	Response Syntax	Response Data (if any)
Set frequency save. Integral part, when Status = 2, 3	FSx<CR><LF> *	x=0 : never save x=1 : save every 24 hours x=2 : save right now x=3 : save actual freq. now x= ? : interrogation	x<CR><LF>	x=0 : never save x=1 : save every 24 hours
Set Tracking Window	TWddd<CR><LF> *	ddd = Half Tracking Window by 133ns step. From 1 to 255 ddd = ??? : interrogation	ddd<CR><LF>	ddd : Half Tracking Window by 133ns step.
Set no Alarm Window	AWddd<CR><LF> *	ddd = Half no Alarm Window by 133ns step. From 1 to 255 ddd = ??? : interrogation	ddd<CR><LF>	ddd : Half no Alarm Window by 133ns step.
Set tracking phase loop time constant	TCdddddd<CR><LF> *	dddddd = Time constant in seconds (001000 to 999999) TC000000 : change to auto. (<)TC001000 : no change	Ddddddd<CR><LF>	dddddd : time constant in seconds
Set module customization	MCsxx [cc...c] <CR><LF> *	s = L : Load parameter s = S : Store parameter ccc...c * s = B : Load start behaviour s = A : Activate msg at start * s = C : Cancel msg at start * s = H : Load Help s = T : Load Data Type xx = 00..FF: msg number, ccc...c : new welcome message, up to 24 characters	cc...c<CR><LF> or d<CR><LF> or xy<CR><LF>	ccc...c : response to MCLxx or to MCHxx. d : 0, 1 response to MCBdd or xy : Data Type, response to MCTxx, x=0 RAM, x=1 eeprom, x=2 Flash, y=0 Byte, y=1 sByte, y=2 Word, y=3 sWoord, ... y=8 string ASCII, y=9 strng binary
Set phase comparator Offset	COsddd<CR><LF> *	s : +/- signe ddd : limited with range + 127 / - 128 CO???? : interrogation	sddd<CR><LF>	s : +/- signe ddd : offset in approx 1 ns steps
View PPSRef Sigma	VS<CR><LF>		ddd.d<CR><LF>	ddd.d : Sigma of PPSRef in ns. In tracking, Status 2, 3.
View Time constant	VT<CR><LF>		dddddd<CR><LF>	dddddd : Loop time constant now in use, in ns.
Raw phase adjust	RAsddd<CR><LF>	s : +/- signe ddd : limited with range + 127 / - 128	sddd <CR><LF>	s : +/- signe ddd : raw phase just asked in 133 ns steps
Reset micro controller	RESET<CR><LF>			(Identification & welcome message, GPS binary)

* Warning : These commands are acting into non-volatile memory. Numbers of commands sent during the whole unit life time limited to 10,000 in total (all commands cumulated). But TR1 followed by TR0 and SY1 followed by SY0 do not write in NVM.

PIN # 4 & 5 STATUS LEVELS

Status	Pin # 4	Pin # 5	
	Xtal not locked to Rb line	Track/Sync Alarm	
	Rb Lock (open collector)	In Track Mode (TTL + 1K)	In Synch Mode (TTL + 1k)
s=0 :warming up	Low (<0.2 V / 5 mA)	High	High
s=1 :tracking set-up	High	High	High
s=2 :track to PPSREF	High	Low	High
s=3 :synch to PPSREF	High	High	Low
s=4 :Free Run. Track OFF	High	High	High
s=5 :FR. PPSREF unstable	High	High	High
s=6 :FR. No PPSREF	High	High	High
s=7 :factory used	High	High	High
s=8 :factory used	High	High	High
s=9 :fault or Rb OOL	Low (<0.2 V / 5 mA)	High	High

NMEA 0183 Format (BTA, BTB)	
\$PTNTA,yyyymmddhhnnss,q,T3,rrrrrr,sfff,s,x,y*CS<CR><LF>	
yyyy: year; mm:month; dd: day; hh: hour; nn: minute; ss: second; q: quality, 0: Rb line not locked, 1: Free Run, 2: Disciplined; T3: format descriptor; rrrrrr: effective time interval PPSOUT vs PPSREF; sfff:phase comparator; s: Status; x,y: reserved; CS: checksum.	
\$PTNTS,B,s,ffff,iiii,aaaa,x,y,s,cccccc,ggg.gg,x,y*CS<CR><LF>	
s: Status; ffff: actual frequency; iiii: holdover frequency; aaaa: average frequency on 24 hours; x,y: reserved; cccccc: loop time constant; ggg.gg: sigma; x,y: reserved; CS: checksum.	