E10-Y8

Rubidium Frequency Reference

USER'S HANDBOOK

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1 Safety Considerations

1.1 General

This product and related documentation must be reviewed for familiarisation before operation. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired.

1.1.1 Before Applying Power

Verify that the product is set to match the available charger and the correct fuse is installed.

1.1.2 Before Cleaning

Disconnect the product from operating power before cleaning.

> **WARNING**
>
> **Bodily injury or death may result from failure to heed a warning. Do not proceed beyond a warning until the indicated conditions are fully understood and met.**

> **CAUTION**
>
> **Damage to equipment, or incorrect measurement data, may result from failure to heed a caution. Do not proceed beyond a caution until the indicated conditions are fully understood and met.**

1.2 Voltage, Frequency and Power Characteristics

1.2.1 Universal Full Range AC Input Power Adaptor

Class II power (no earth)

Overvoltage, short circuit & over temperature protection

GS, UL/cUL & CE approval

Voltage 100 - 240V AC

Frequency 50 - 60Hz

Power characteristics 600mA Max

Output Voltage 15V DC 1.2A

1.2.2 Unit Power Requirements

Input Voltage	12Vdc – 18Vdc
Input Current	1.7A max

1.3 Environmental Conditions

1.3.1 Temperature

Operating (ambient)	-20ºC to +50ºC
Storage	-20ºC to +40ºC

1.3.2 Magnetic Field

Sensitivity	$\leq 2x10^{-11}$/ Gauss
Atmospheric Pressure	-60m to 4000m
	$<1x10^{-13}$/ mbar

1.4 Cleaning Instructions

To ensure long and trouble free operation, keep the unit free from dust and use care with liquids around the unit.

Be careful not to spill liquids onto the unit. If the unit does get wet, turn the power off immediately and let the unit dry completely before turning it on again.

Never spray cleaner directly onto the unit or let liquid run into any part of it. Never use harsh or caustic products to clean the unit.

2 Rubidium Frequency Reference

2.1 Rubidium Frequency Reference

A Rubidium frequency reference owes its outstanding accuracy and superb stability to a unique frequency control mechanism. The resonant transition frequency of the Rb 87 atom (6,834,682,614 Hz) is used as a reference against which an OCXO output is compared. The OCXO output is multiplied to the resonance frequency and is used to drive the microwave cavity where the atomic transition is detected by Electro-optical means. The detector is used to lock the OCXO output ensuring its medium and long-term stability.

The first realised Rubidium frequency reference arose out of the work of Carpenter (Carpenter et al 1960) and Arditi (Arditi 1960). It was a few years until the first commercial devices came onto the market and this was primarily due to the work of Packard and Schwartz who had been strongly influenced by the work of Arditi a few years before on Alkali atoms (of which Rb 87 is one). Unlike much of the research done into frequency references at that time, practical realization of a Rubidium maser was high on the researchers' agenda. This was mainly due to an understanding that such a device would have extremely good short-term stability relative to size and price. In 1964, Davidovits brought such research to fruition, with the first operational Rubidium frequency reference.

The Rubidium frequency reference, like its more expensive cousin, the Hydrogen maser, may be operated either as a passive or as an active device. The passive Rubidium frequency standard has proved the most useful, as it may be reduced to the smallest size whilst retaining excellent frequency stability. The applications for such a device abound in the communication, space and navigation fields.

The Rubidium frequency reference may be thought of as consisting of a cell containing the Rubidium in its vapour state, placed into a microwave cavity resonant at the hyperfine frequency of the ground state. Optical pumping ensures state selection. The cell contains a buffer gas primarily to inhibit wall relaxation and Doppler broadening. The Rubidium frequency reference essentially consists of a voltage controlled crystal oscillator, which is locked to a highly stable atomic transition in the ground state of the Rb 87 atom.

There are several reasons why Rubidium has an important role to play as a frequency reference. Perhaps more important is its accuracy and stability. Accuracy is comparable with that of the standard Caesium with an operating life approximately 5 times that of Caesium. Moreover the stability of a Rubidium frequency reference over short time-scales - 100s of seconds- betters that of Caesium (Caesium is more stable over longer time periods, in the regions of hours to years).

There are, however, a few drawbacks to the use of Rubidium as a frequency reference. In the past, these included the limited life of the Rubidium lamp (since improved to >10 years), The Caesium is affected to a greater degree than this, whilst the Hydrogen Maser operates differently and is not affected. The thermal stability of Rubidium is inferior to that of Caesium or Hydrogen Masers, and the Rubidium previously required frequency access to a primary reference signal or synchronization source to maintain long-term Caesium level accuracy.

The cost of a Rubidium frequency reference is significantly cheaper than a Caesium, with a much reduced size and weight. Due to its small size, low weight and environmental tolerance the Rubidium frequency reference is ideal for mobile applications. Indeed, Rubidium atomic clocks are beginning to be implemented into the new generation of GPS satellites. This is in part due to the extended life of the Rubidium physics package compared to that of Caesium. The Rubidium is also extremely quick to reach operational performance, within 10 minutes reaching 5 parts in 10^{-11}.

3 Operating Procedure

3.1 Introduction

The basic E10-Y8 unit contains three principal internal units:

1) A Rubidium Atomic Frequency Standard.
2) An Oven Controlled Crystal Oscillator used to provide a clean low noise output.
3) An 8 way distribution amplifier.
4) The Associated External Power Supply.

Additionally 2 indicators are available on the front panel to monitor the status of the instrument. These are: Rubidium Unlocked and Power.

3.2 Getting Started

Check that the appropriate supply voltage is being used. Connect the external supply to the unit (at the rear) and switch on.

Switch on the unit via the front panel switch, the 'ON' indicator LED will come on and it will remain on. The 'UNLOCKED' indicator will initially come on.

The 10 MHz output is available from the appropriately labelled SMA sockets on the rear of the unit.

The units' warm time is approximately 5 minutes. Frequency stabilization time is up to 15 minutes depending on the detailed specification of the particular Rubidium fitted. Once the rubidium has locked the 'UNLOCKED' indicator LED will turn off and will remain off as long as the instrument is performing correctly.

4 Specification

1. Output Characteristics:		
	a. Frequency	10MHz Sine
	b. Impedance:	50 Ω nominal
	c. Level:	+10 dBm ±3 dBm
	d. Connector:	SMA
	e. Number	8
2. Harmonics		
	a. Second harmonic	<-30dBc
3. Spurious Outputs:		
		< -80 dBc
4. Accuracy		
	a. At shipment @ 25°C	$\pm 5x10^{-11}$
5. Short Term Stability:		
	a. 1s	$5x10^{-12}$
	b. 10s	$5x10^{-12}$
	c. 100s	$8x10^{-12}$
6. Drift		
	a. 1 day	$5x10^{-12}$
	b. 1 month	$5x10^{-11}$
7. Phase Noise		
	a. 1Hz	110dBc
	b. 10Hz	140dBc
	c. 100Hz	145dBc
	d. 1kHz	155dBc
8. Input Voltage		
		+12Vdc to +18Vdc
9. Input Power		
		9W @ 12Vdc, 25°C Max 1.7A
10. Universal Power Adaptor		
	a. Class II power (no earth)	
	b. Protection	Over voltage, short circuit & over temperature
	c. Approvals	GS, UL/cUL & CE
	d. Voltage	100 to 240V AC
	e. Frequency	50 to 60Hz
	f. Power characteristics	600mA Max
	g. Output Voltage	15V DC 1.7A
11. Warm Time		
	a. @ 25°C	5 Minutes to lock
12. Retrace		
		$\leq\pm 2x10^{-11}$
13. Magnetic Field Sensitivity		
		$<\pm 2x10^{-11}$
14. Mechanical		
	a. Size	107 x 58 x 145 mm
	b. Weight	500g
15. Warranty		
		24 months
16. Temperature		
	a. Operating	-20°C to +50°C
	b. Storage	-20°C to +80°C

17. Temperature Coefficient

a. Ambient	$2x10^{-10}$

18. MTBF

100,000 hours

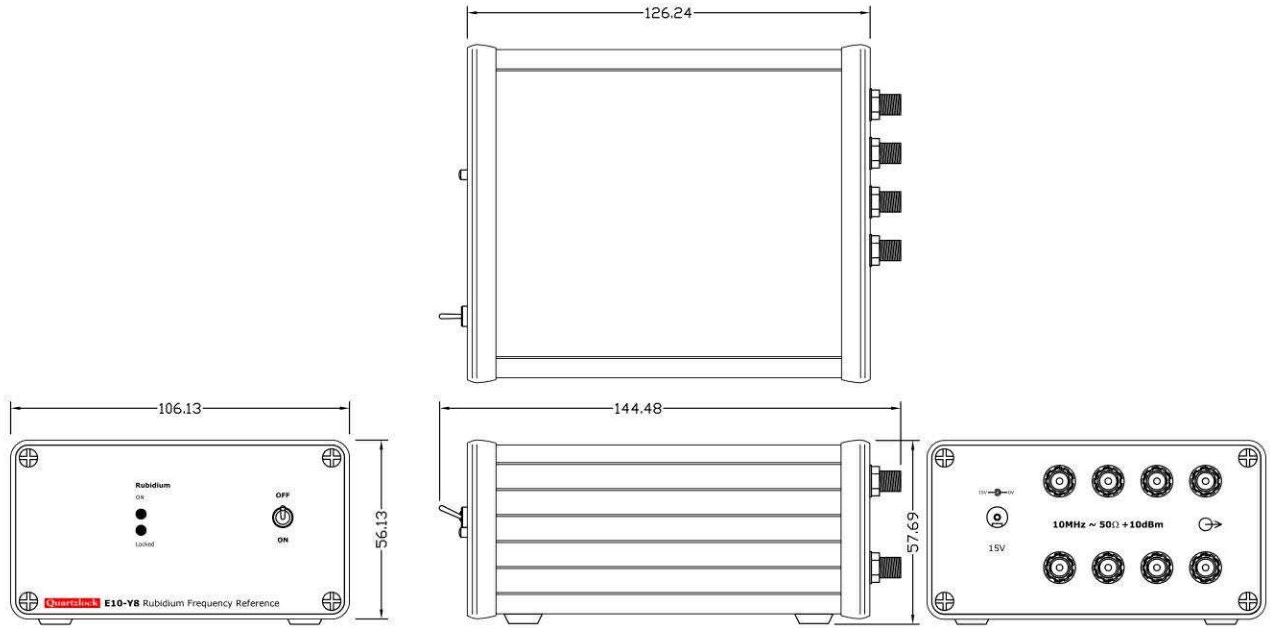
19. Environmental

RoHS

20. EMI

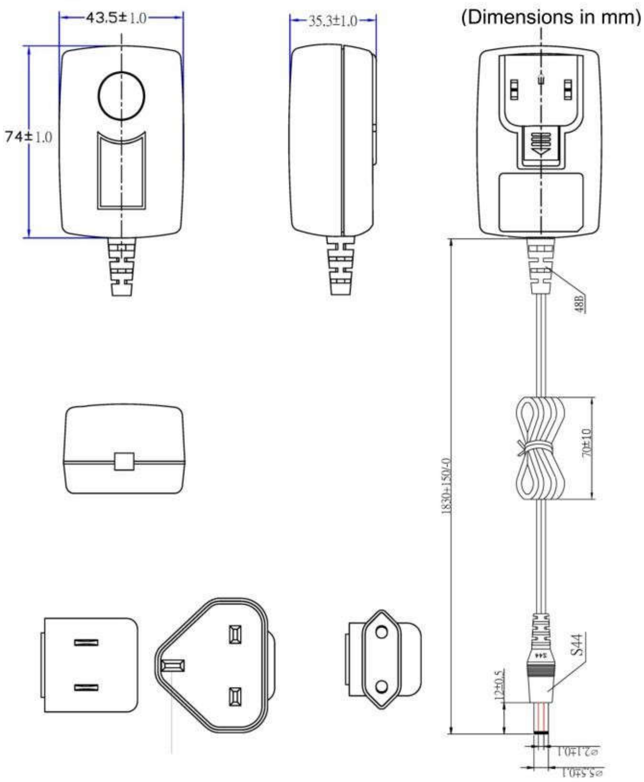
a. Compliant to	FCC Part 15 Class B

5 Unit Outline



6 Accessories

6.1 Plug Top Supply



7 Service

7.1 Introduction

The board test uses special test routines that are a permanent part of the operating software. General purpose test equipment is used to make manual measurements.

7.2 Equipment required

1. Source1 10MHz fixed frequency accuracy ±1E-6 level 1V RMS (EMF) adjustable.
2. Source2 10MHz variable ± 100Hz in 1Hz steps. Level adjustable 100mV RMS to 2V RMS (EMF).
3. DVM Digital voltmeter with 5 digitresolution.
4. Scope 2 Channel digital.
5. Counter With external reference locked to Source2.
6. RF Power Meter 50Ω

7.3 Initial tests

7.3.1 Preliminary

A new board should be configured as follows: -

1. OCXO not fitted
2. Rubidium not fitted
3. Links JP8 and JP5 both removed.

Procedure:

Power up the board from a regulated supply set to 14V. Check supply current is about 100mA.

Supply LED (LED1a green) should light.

7.3.2 Programming

Connect the programmer to JP7 and load the latest version firmware. Board power must be on. In case of problems, check the Vdd supply at C27 (5V± 0.15V)

Replace link JP8.

7.3.3 Power Supplies

Check: -

1. +10V ±0.3V at C39
2. Vdd 5V ±0.15V at C27
3. +5V ±0.1V at C24
4. +12V ±0.3V at C47
5. 5V ref ±5mV at JP8
6. 2.5V ref ±50mV at C43

7.4 Board Functional Tests

Connect source 1 to TP9 (OCXO Pin4) and set to 10MHz, 1VRMS (EMF) The processor should now be clocked from this source.

Procedure:

LED1b (red) should be continuously on. If it is flashing, the processor is not getting an external clock check U6 and U18.

Operation of the interface must first be checked. Connect a PC with RS232 to JP6. Only pins 4 (TXD) pin 5 (RXD) and pin 6 (GND) need to be connected. Start a general terminal program, set the interface to 9600 baud, 1 start bit, no parity, and check that the microcontroller responds to commands by sending "OS?"

All commands are case sensitive and must be sent in uppercase.

The special board test software is started by entering state7. The following command is used:

OSL07

The reply should be "BOARD TEST 0"

In this state all the normal interface commands are locked out except the keys "I" (increment) and "D" (decrement). In some tests the keys "H" (high) and "L" (low) can also be used.

I and D may be freely used to step from one test to another. The tests may be performed in any order. Test F will roll over to test 0 when incremented.

7.4.1 Test 0 Input buffer, phase detector I and input ADC

This test checks the phase detector I offset, Input Buffer and ADC.

Procedure:

Connect source 2 to Rubidium pin 3, and set to 10.000050MHz, 100mV RMS.

Check link JP5 is removed.

Connect oscilloscope to TP2.

A stepped sine wave of amplitude 0.8VPP should be observed. Increase source 2 amplitude to 2V RMS. The sine wave will initially clip, but the AGC should reduce the gain until an undistorted sine wave is again present. Reduce source 2 amplitude to 100mV RMS.

SOT resistors R34/R33 are used to adjust the offset of the "I" phase detector. Adjust the oscilloscope so the offset is at a voltage of 2.5V DC. The stepped sine wave should be symmetrical about this voltage. If it is not, try the effect of fixed resistors of value 47K to 220k at R34/R33 positions. A resistor at R33 will lower the mean voltage of the sine wave; a resistor at R34 will raise the voltage. Only 1 resistor at either R33 or R34 is required. When a suitable value has been found, remove board power and solder a 0603 surface mount resistor into place.

Note the offset is most apparent at high frequencies, low amplitude. This test is therefore performed at 10MHz phase detector frequency with 100mV input.

7.4.2 Test 1 Input buffer, phase detector Q and input ADC

This test checks the phase detector Q offset, Input Buffer and ADC.

Procedure:

Connect source 2 to TP8 (Rubidium Pin 3), and set to 10.000050MHz, 100mV RMS.

Check link JP5 is removed.

Connect oscilloscope to TP2.

A stepped sine wave of amplitude 0.8VPP should be observed. Increase source 2 amplitude to 2VRMS. The sine wave will initially clip, but the AGC should reduce the gain until an undistorted sine wave is again present. Reduce source 2 amplitude to 100mV RMS.

SOT resistors R35/R36 are used to adjust the offset of the "Q" phase detector. Adjust the oscilloscope so the offset is at a voltage of 2.5V DC. The stepped sine wave should be symmetrical about this voltage. If it is not, try the effect of fixed resistors of value 47K to 220k at R35/R36 positions. A resistor at R36 will lower the mean voltage of the sine wave; a resistor at R35 will raise the voltage. Only 1 resistor at either R35 or R36 is required. When a suitable value has been found, remove board power and solder a 0603 surface mount resistor intoplace.

7.4.3 Test 2 2.5V ADC reference check

This tests checks the 2.5V ADC reference

Procedure:

Connect the DC voltmeter to TP2 and ground and check the DC voltage is 2.5V ± 50mV.

7.4.4 Test 3 Quadrature delay check.

This test checks that the quadrature delay is functioning correctly.

Procedure:

Set source 2 to 10.000001MHz 1VRMS.

Observe the waveform at TP2. This will be a 1Hz stepped saw tooth. This is the output from the narrow range phase detector. Using the H and L keys, step the quadrature delay in steps of 02h. Check that the relative step interval on the saw tooth changes.

When the quadrature setting is correct, the steps will be of equal amplitude.

If a digital oscilloscope is not available, this check may be done with a dual trace oscilloscope.

Connect the two traces to TP4 and TP7.

Set source 2 to 10.000050MHz.

Two 50Hz sine waves should be observed. Check that the H and L key varies the phase between the two sine waves.

7.4.5 Test 4 Course tune DAC

The course tune DAC is stepped through its entire range to ensure correct functionality. The fine tune DAC is set to 0V.

Procedure:

Replace link JP5

Connect the DC voltmeter between TP1 and ground. By using the H and L keys, check that the voltage can be stepped between 0V and about 4.7V with Link1 open or 7.6V with Link1 closed.

7.4.6 Test 5 Fine tune DAC

The fine tune DAC is stepped through its entire range to ensure correct functionality. The course tune DAC is set to mid range.

Procedure:

Connect the DC voltmeter between TP1 and ground. By using the H and L keys, check that the voltage may be stepped over a total range of about 21mV with Link1 open or 30mV with link1 closed

7.4.7 Test 6 Reference tune span

This is not used on this product; test is only here to maintain compatibility with other Quartzlock products.

7.4.8 Test 7 DDS tuning

This is not used on this product; test is only here to maintain compatibility with other Quartzlock products.

7.4.9 Test 8 OCXO current monitor

In this test the OCXO current is continuously displayed. The current monitor can be checked by connecting a known resistor from the OCXO supply pin to ground.

The OCXO current is displayed as a 2 byte hex number. Full scale is about 500mA. With no resistor, i.e. an OCXO current of zero, the maximum offset should be 0600h.

Procedure:

Connect a 120ohm, 1W resistor from the OCXO supply pin 3 (C47) to ground. The current monitor has a long time constant so at least 30 seconds should be allowed for the reading to stabilise. Note the reading, convert to decimal, divide by 65536 and multiply by 500. This should be the current in mA. A typical reading of 33CCh is a current of 101mA. The expected accuracy is only about 10%.

7.4.10 Output Distribution Amplifier

This tests the 8 output amplifier stage for correct operation.

Procedure:

Ensure source 1 is connected to the TP9 (OCXO pin 4). Set to 1V RMS (EMF)

Connect oscilloscope with 50ohm input impedance or RF power meter to one of the 8 output connectors Board 1 JP1 ... JP4 and Board 2 JP1 ... JP4.

Check that the output power can be set to 13dBm using VR1. Check that the second and third harmonic are about –30dBc. Check all 8 outputs for correct levels and harmonics.

7.5 Post Functional Test

This concludes the E10-Y8 board test. The OCXO, Rubidium, ensure JP5 and JP8 are fitted. Once the OCXO and Rubidium have been fitted the following tests should be completed.

7.5.1 Power supplies

Check: -

1. +10V ±0.3V at C39
2. Vdd 5V ±0.15V at C27
3. +5V ±0.1V at C24
4. +12V ±0.3V at C47
5. 5V ref ±5mV at JP8
6. 2.5V ref ±50mV at c43

7.5.2 PLL Locks

Ensure that the “UNLOCKED” indicator goes off within the allocated lock time.

7.5.3 Output Distribution Amplifier

Connect oscilloscope with 50ohm input impedance or RF power meter to one of the 8 output connectors.

Set the output power to 10dBm using VR1. Check that the second and third harmonic are about –30dBc. Check all 8 outputs for correct levels and harmonics.

7.6 Connector, Jumper and Link References

J1
15Vdc Input

JP1
RF Output

JP2
RF Output

JP3
RF Output

JP4
RF Output

JP5
Normally closed (Opened to disconnect the fine tune DAC from the tuning voltage)

JP6
Pin 1 – Lock
Pin 2 – Ground
Pin 3 – Ground
Pin 4 – RS232 TX
Pin 5 – RS232 RX
Pin 6 – Ground

JP7
Eeprom programming connection

JP8
Normally closed (Opened to program eeprom)

JP9
Connection to 4 way expansion board

Link1
Link for 8V tune

Link2
Link for electronic frequency control tuning of rubidium module

TP1
OCXO tuning control voltage output

TP2
Test Out

TP3
OCXO tuning control voltage output

TP4
External Reference Oscillator Lock Input (High +5Vdc = Not Locked. Low 0Vdc = Locked)

TP5
Quadrature Oscillator Tuning

TP6
Factory use only

TP7
Quadrature Oscillator Tuning

TP8
External 10MHz rubidium reference frequency input

TP9k
External 10MHz OCXO frequency input

TP10
0Vdc

7.7 Result Sheet

Test No.	Description	Upper Limit	Lower Limit	Nom	Unit	Result
1	**Preliminary**					
1.1	Supply Current			100	mA	
1.2	Supply LED (LED1a Green) Illuminated					Sat/Unsat
2	**Programming**					
2.1	Program downloaded					Sat/Unsat
3	**Power Supplies**					
3.1	10V at C39	10.30	9.70	10.00	Vdc	
3.2	Vdd 5V at C27	5.15	4.85	5.00	Vdc	
3.3	5V at C24	5.10	4.90	5.00	Vdc	
3.4	12V at C47	12.30	11.70	12.00	Vdc	
3.5	5V Ref at JP8	5.005	4.995	5.00	Vdc	
3.6	2.5V Ref at C43	2.55	2.45	2.50	Vdc	
4	**Board Functional Tests**					
4.1	LED1b Status Continuously on					Sat/Unsat
4.2	Test 0 Input buffer, phase detector I and input ADC					Sat/Unsat
4.3	Test 1 Input buffer, phase detector Q and input ADC					Sat/Unsat
4.4	Test 2 2.5V ADC reference check	2.55	2.45	2.50	Vdc	
OO4.5	Test 3 Quadrature delay check					Sat/Unsat
4.6	Test 4 Course tune DAC					Sat/Unsat
4.7	Test 5 Fine tune DAC					Sat/Unsat
4.8	Test 6 Reference tune span					Sat/Unsat
4.9	Test 8 OCXO current monitor					Sat/Unsat
5	**OCXO Distribution Amplifier**					
5.1	Output level adjustment +13dBm					Sat/Unsat
5.2	Harmonics			-30.00	dBc	
6	**Rubidium and OCXO Fitted**					
6.1	10V at C39	10.30	9.70	10.00	Vdc	
6.2	Vdd 5V at C27	5.15	4.85	5.00	Vdc	
6.3	5V at C24	5.10	4.90	5.00	Vdc	
6.4	12V at C47	12.30	11.70	12.00	Vdc	
6.5	5V Ref at JP8	5.005	4.995	5.00	Vdc	
6.6	2.5V Ref at C43	2.05	2.45	5.00	Vdc	
6.7	Output level adjustment +13dBm					Sat/Unsat
6.8	Output level Output 1	11.00	9.00	10.00	dBm	
6.9	Harmonics Output 1	-30.00			dBc	
6.11	Output level Output 2	11.00	9.00	10.00	dBm	
6.12	Harmonics Output 2	-30.00			dBc	
6.13	Output level Output 3	11.00	9.00	10.00	dBm	
6.14	Harmonics Output 3	-30.00			dBc	
6.15	Output level Output 4	11.00	9.00	10.00	dBm	
6.16	Harmonics Output 4	-30.00			dBc	
6.17	Output level Output 5	11.00	9.00	10.00	dBm	
6.18	Harmonics Output 5	-30.00			dBc	
6.19	Output level Output 6	11.00	9.00	10.00	dBm	
6.20	Harmonics Output 6	-30.00			dBc	
6.21	Output level Output 7	11.00	9.00	10.00	dBm	
6.22	Harmonics Output 7	-30.00			dBc	
6.23	Output level Output 8	11.00	9.00	10.00	dBm	
6.24	Harmonics Output 8	-30.00			dBc	
6.25	Instrument Locks					Sat/Unsat

7.8 RS232 Control Codes

RS232 control codes (all values following command or returned from the microcontroller are hexadecimal)

* = backed up in EEPROM

UA User adjust

	UA?	returns user parameters			
		aa bbbb			
	aa	*is bandwidth control: bits set:*		*bit0,1, 2:*	*bandwidth (0 to 7)*
				bit3 to 6:	*not used*
				bit 7:	*controlled oscillator negative slope*
*	*bbbb*	*is clock registers 3 and 4 (elapsed time)*			
	UABaa	write new bandwidth control byte			

OS Overall Status

	OS?	returns overall status bytes:			
		aa bb cccc dd ee ff gg hhhh			
*	*aa*	*is test status byte:*	*bits set::*	*bit0,1,2:*	*bits 0 to 2 DAC output select*
				bit3:	*no integrator update*
				bit4:	*no proportional term*
				bit5:	*AGC off*
				bit6:	*not used*
				bit7:	*inhibit state control*
		bits 2,1,0:	*000*	*no test output, fine tune DAC used for tuning*	
			001	*sub sampled I*	
			010	*sub sampled Q*	
			011	*PLL Integrator upper 16 bits*	
			100	*Phase result*	
			101	*I sample (filtered)*	
			110	*Q sample (filtered)*	
			111	*reference CH6 (filtered)*	
	bb	*is lock status byte:*	*bits set*	*bit0 to 2:*	*State control, states 0 to 7*
				bit3:	*set to normalise tuning DACs (cleared automatically)*
				bit4:	*OCXO warmed up*
				bit5:	*Loop locked*
				bit6:	*narrow range phase detector in use*
				bit7:	*set to inhibit auto load of PLL gain parameters*
	cccc	*is PLL control:*	*bits set*	*bit0,1,2,3*	*subsample rate*
				bit4, 5, 6, 7	*exp filter order*
				bit8, 9, 10, 11	*integrator gain*
				bit12, 13, 14, 15	*proportional gain*
*	*dd*	*is quadrature delay line setting*			
*	*ee*	*is tune voltage span (FFh min,00h max) 0 to 5.8V (FFh), and 0 to 10V (00h):*			
	ff	*is Q amp AGC setting*			
	gg	*is I amp AGC setting*			
	hhhh	*is OCXO current*			
	OSTaa	write new test status byte			
	OSLbb	write new lock status byte			
	OSGcccc	Write new PLL control			
	OSDdd	Write new quadrature setting			
	OSSee	Write new tuning span			

	OSQff	Write new Q amp AGC byte
	OSIgg	Write new I amp AGC byte
PL	**Phase lock loop**	
	PL?	returns current status of PLL
	aaaa bbbb cccccccc dddd eeee	
	aaaa	*last value of I sample(filtered) , 2s complement, 16 bit*
	bbbb	*last value of Q sample(filtered), 2s complement 16 bit*
*	*cccccccc*	*last value of PLL integrator (32 bit integer)*
	dddd	*Coarse tune DAC 16 bit integer*
	eeee	*Fine tune DAC 16 bit integer*
	PLIcccccccc	write new PLL integrator
	PLCdddd	write new coarse tune DAC
	PLFeeee	write new fine tune DAC
	PL+	enter command PL? into repeat stack
PD	**Phase detector**	
	PD?	returns phase detector parameters
	aaaa bbbb cccc dddd eeee	
	aaaa	*Last phase result, 2s complement*
	bbbb	*Last mod[I] +mod[Q]*
	cccc	*2.5V reference (filtered)*
	dddd	*mod (phase result) (filtered) lsb=0.763ps*
	eeee	*mod(freq offset) (filtered) lsb = 5.82E-15*
	PD+	write PD? to command repeat stack
EU	**EEPROM update (backed up values)**	
SR	**Software Reset**	
ER	**EEPROM read**	
	ERCaabb	returns bb bytes from starting address aa as ASCII characters
	ERNaabb	returns bb bytes from starting address aa ashexadecimal numbers (character pairs)
EW	**EEPROM write**	
	EWCaabbccccc------c	
		writes bb characters to starting address aa. Correct number of characters must be included in string
	EWNaabbcccc------c	
		Writes bb bytes to starting address aa. Character pairs cc etc are interpreted as hexadecimal numbers.
RI	**Repeat Interval**	
	RI?	returns command repeat interval
	aa	
	aa	*8 bit command repeat interval multiplier. Range 1 to 255. Command repeat interval is 50ms x aa*
	RI0aa	write new command repeat interval
	RID	cancel command repeat and clear command repeat stack

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