SPECTRADYNAMICS, INC

HROG-10
FREQUENCY AND PHASE OFFSET GENERATOR
OPERATING MANUAL

SPECTRADYNAMICS, INC • 1849 Cherry St. Unit 2 • Louisville, CO 80027
Phone: (303) 665-1852 • Fax: (303) 604-6088
www.spectradynamics.com

Contents

1.0 Introduction

The HROG-10 is a high-resolution phase and frequency offset generator. The phase and frequency of the output signals are adjustable with respect to a 10 MHz user supplied reference. The output phase resolution of the generator is $2\pi/2^{32}$ radians or an output time step resolution of 0.024 fs. The output frequency resolution is 5×10^{-19}. Both phase and frequency steps are phase continuous.

The instrument provides two sine wave outputs and two 1PPS (one pulse-per-second) outputs. The sine wave outputs are buffered to provide greater than 80 dB of port-to-port and reverse isolation. The outputs are at a level of +13 ±1 dBm. The pulse outputs are derived from the sine wave outputs by dividing by a factor of 1×10^{7}. The pulse outputs can be synchronized to an external reference pulse to within 100 ns.

All instrument functions are displayed and controlled via the front panel LCD touch screen. Remote control of the instrument is possible through RS-232 communications. The HROG-10 comes in a stand-alone 2U rack mount enclosure.

The LN (low noise) option HROG-10 has an ultra-low noise oscillator that allows the PM noise performance at 1 Hz offset to be lower than -125 dBc/Hz and noise at 10 Hz offset to be lower than -135 dBc/Hz. The wideband PM noise is less than -167 dBc/Hz.

HROG Options:

Part Number	Low Noise Option	AC Operation	DC Operation	DC (-48V) Operation
HROG-5		√		
HROG-5-DC		√	√	
HROG-5-DC (-48V)		√		√
HROG-5-LN	√	√		
HROG-5-DC-LN	√	√	√	
HROG-5-DC(-48V)-LN	√	√		√
HROG-10		√		
HROG-10-DC		√	√	
HROG-10-DC (-48V)		√		√
HROG-10-LN	√	√		
HROG-10-DC-LN	√	√	√	
HROG-10-DC (-48V)-LN	√	√		√

2.0 Safety and Preparation for Use

The HROG-10 was designed for indoor use only and is not intended for operation outdoors or in a wet environment. The instrument may be mounted in a standard 19-inch instrumentation rack or may be used on a laboratory bench. Inspect the instrument and power cords for damage before first use.

2.1 Electrical safety and preparation for use

Voltages capable of causing injury or death are present in this instrument. Use extreme caution whenever the instrument cover is removed.

Line Voltage

This instrument can be setup to operate on 100-120 or 220-240 VAC and a line frequency of 50 to 60 Hz. For conversion to a different line voltage please contact SDI.

Fuse

A 5.0 Ampere 250V slow-blow fuse is used for 100-120 and 220-240 VAC operation.
A 4.0 Ampere 250V slow-blow fuse is used for the DC power protection.
Only replace fuse with the same type and specifications.

AC Power

The instrument has a detachable three wire power cord for connection to a grounded AC power source. The enclosure of the unit is directly connected to the outlet ground to protect against electrical shock. Always use an outlet with a protective ground and do not disable this safety mechanism.

DC Power Option

For units that have the DC power option installed, the following specifications should be used to ensure the optimum performance of the instrument:
DC Supply voltage +20 to +33 VDC, 2 Amps
Line regulation +/- 0.05% for a 10% line change
Load regulation +/- 0.05% for a 50% load change
Output ripple < 100mV peak-to-peak

DC (-48V) Power Option

For units that have the DC (-48V) power option installed, the following specifications should be used to ensure the optimum performance of the instrument:
DC Supply voltage –36 to –75 VDC, 2 Amps
Line regulation +/- 0.05% for a 10% line change
Load regulation +/- 0.05% for a 50% load change
Output ripple < 100mV peak-to-peak

2.0 Safety and Preparation for Use

DC Cable Connector

The instrument has a PT02E-10-6P DC connector on the back panel with the following configuration:

Pin Number	DC	DC (-48V)
PIN 1	+20 to +33VDC	VDC RETURN
PIN 2	+20 to +33VDC	VDC RETURN
PIN 3	VDC RETURN	–36 to –75 VDC
PIN 4	VDC RETURN	–36 to –75 VDC
PIN 5	Chassis GND /Earth GND	Chassis GND /Earth GND
PIN 6	Chassis GND /Earth GND	Chassis GND /Earth GND

Verify that the DC cable connector from your DC power supply has the pin configuration mentioned above. Do not apply AC voltage to the DC power connector. Failure to follow these directions may cause injury or death to personnel, cause irreparable damage to the instrument and voids all warranties. Please note that the power return (pin 3, 4) is NOT connected to the instrument case ground internally, however case ground connections (pin 5, 6) are available at the DC power connector and may be connected to VDC RETURN at this point.

2.2 Instrument safety and preparation for use

The HROG-10 is a frequency and phase offset generator, therefore an external reference is required for proper operation. The external reference provided should be at a frequency of 10 MHz +/-0.1Hz with a level of +7 to +15 dBm.

Input signals must be kept below +20 dBm as greater power levels will damage the unit and void all warranties.

Absolute Maximum Ratings

Input RF Power	+20 dBm Maximum
Reverse RF Power	+20 dBm Maximum
Voltage at the RF Input	50 V Maximum
Voltage at the RF Output	50 V Maximum

3.0 Front Panel

ON
The LED is on, when power is applied to unit.

DATA
The LED is on when data is being sent or received via the RS-232 port.

STATUS
The LED is on, when an error has occurred. View the instrument status via the PLL screen. The LED will turn off once the error condition is corrected or no longer present and the PLL status has been checked. If the HROG-10 is under RS-232 control, use the *SRE command to determine the error condition and the *CLS command to clear the status register and turn off the STATUS LED.

RS-232
DB-9 connector for serial communications. This is a dumb terminal RS-232 port. A null modem adapter is not required.

DISPLAY
The LCD touch screen is used to control the HROG-10 in local control mode.

10 MHz In
SMA input for the external 10 MHz reference. This input port has an impedance of 50 ohms. The external reference provided should be at 10 MHz +/- 0.1 Hz with a level of +7 to +15 dBm.

Signal LED
The 10 MHz signal LED will turn on when a 10 MHz reference is present with a level of +7 to +15 dBm.

PLL LED
The PLL lock LED will turn on when the HROG-10 is phase locked to an external reference.

3.0 Front Panel

1 PPS In
SMA input for an external one pulse per second signal (1 PPS) for synchronization. This input port has an impedance of 50 Ω. The 1 PPS signal should conform to TTL specifications and must not exceed +5.5 VDC. The voltage at this input must never be negative or the synthesizer will be damaged and warranty voided.

1 PPS LED
The 1 PPS indicator LED will flash when an external 1 PPS signal is present.

10 MHz Out 1
SMA output number one providing the frequency and phase offset 10 MHz signal. This output signal has a nominal level of +13 dBm.

Signal LED The 10 MHz signal LED will turn on when the 10 MHz outputs are present.

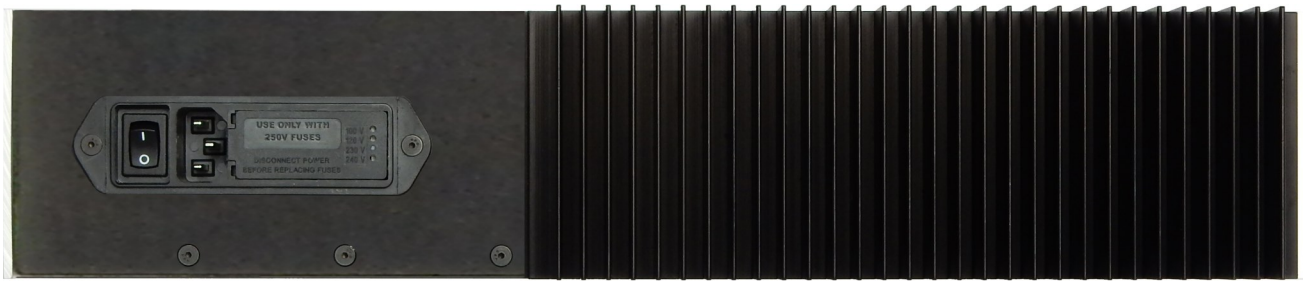
10 MHz Out 2
SMA output number two providing the frequency and phase offset 10 MHz signal. This output signal has a nominal level of +13 dBm.

1 PPS Out 1
SMA output number one providing the frequency and phase offset 1 PPS signal. This output signal conforms to TTL levels.

1 PPS LED
The 1 PPS LED will blink when the 1 PPS output is present.

1 PPS Out 2
SMA output number two providing the frequency and phase offset 1 PPS signal. This output signal conforms to TTL levels.

4.0 Back Panel



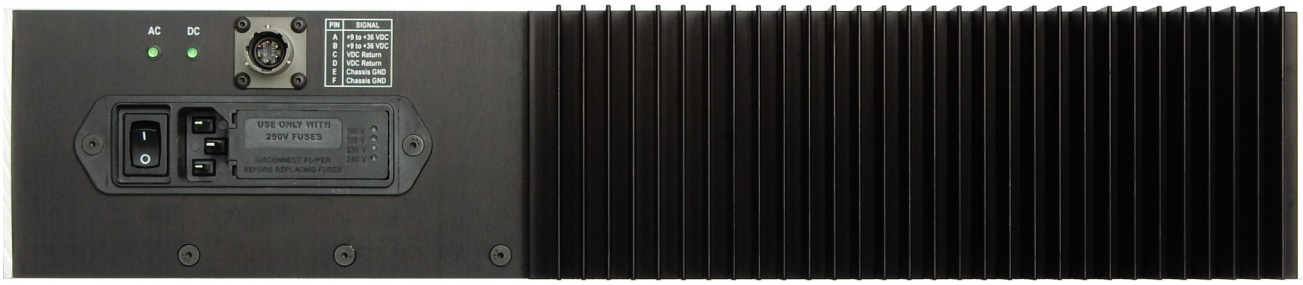
AC Power

The HROG-10 is configured to operate on 100-120 VAC or 220-240 VAC. If the unit has the DC power option, a green LED labeled AC will turn on.

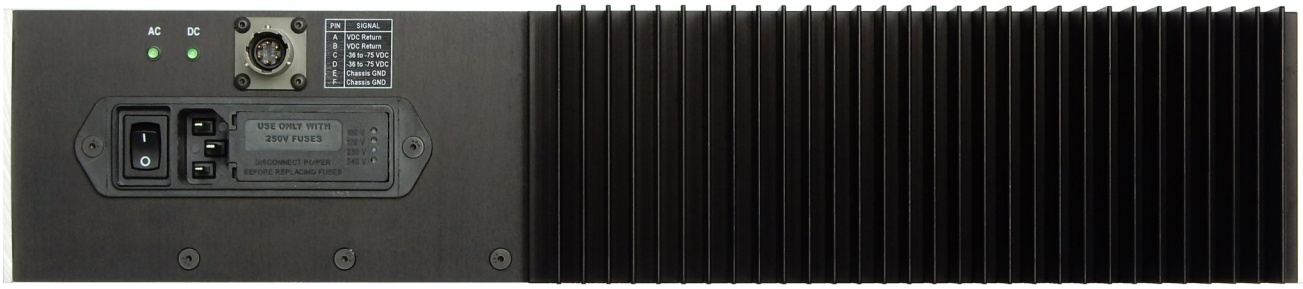
DC Power and DC (-48V)

If the instrument was ordered with the DC option or DC (-48V), it may also operate on DC power as the main power supply. When the HROG-10 is set up to operate with both AC and DC power sources at the same time, the DC power is used as backup power in case of AC power outages. The regulated DC backup voltage and the regulated and rectified AC voltage are internally monitored and the levels may be viewed using the PLL Screen or via the **PWR** RS-232 command.

HROG-10-DC, HROG-10-DC-LN



HROG-10-DC(-48V), HROG-10-DC(-48V)-LN



5.0 Installation

1. Unpack the HROG-10 and attach the rack-mounting handles. The handles should be attached even if the unit is not installed in an instrumentation rack so that it is easier to handle and move around. Once the rack mounting handles are attached mount the instrument in the instrumentation rack or move to the location where it will be in operation.

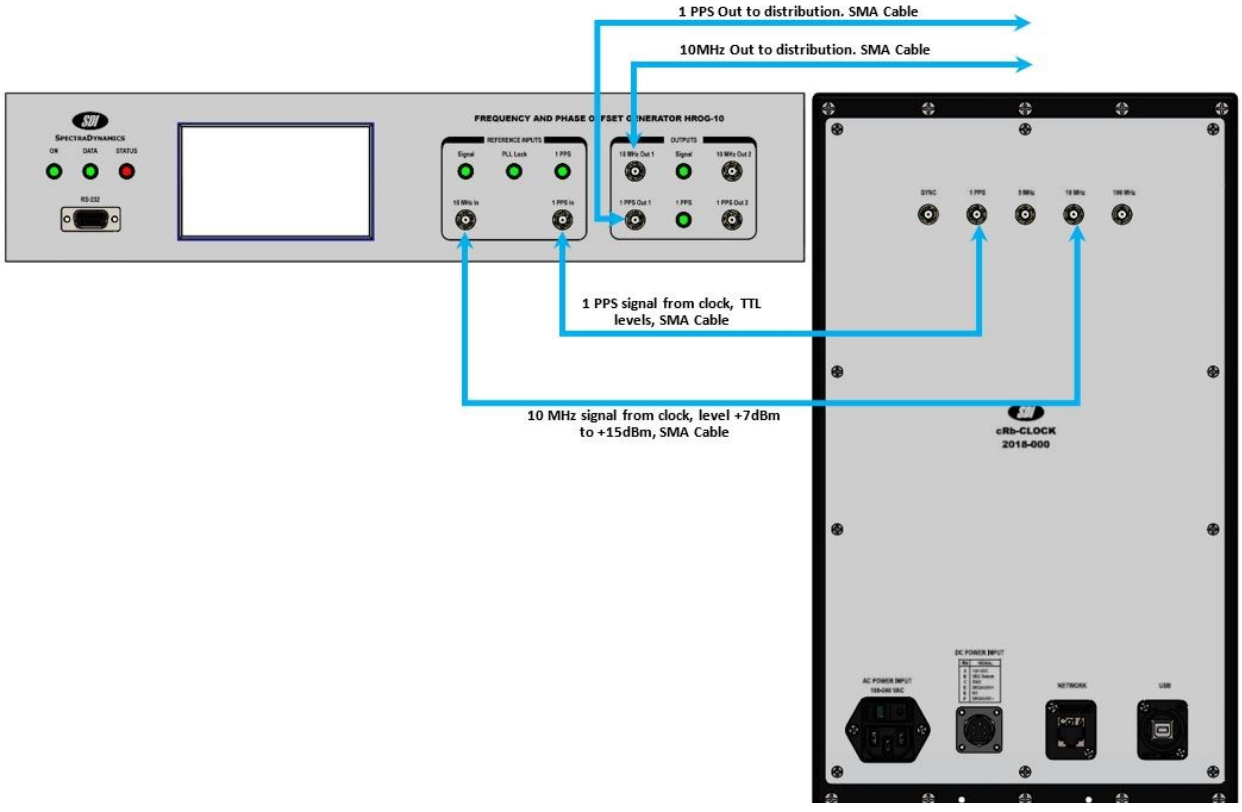
2. Connect the power cord to the IEC socket on the rear panel and verify the voltage settings on the AC power entry module are correct for your locale.

3. Plug in the power cord to an AC power source.

4. Turn the power switch located on the rear panel of the instrument to the ON position. The front screen will show the model information as the unit turns on.

5. The HROG-10 should be allowed to warm up for about 30 minutes.

6. Connect the HROG-10 to a frequency or time reference using SMA cables as shown in the diagram below.



5.0 Installation

The HROG-10 is a frequency and phase offset generator, therefore an external reference is required for proper operation. Connect the 10 MHz external reference to the SMA connector labeled 10 MHz In. The Signal LED on the front panel should light up to indicate that the 10 MHz reference is present and has a signal level between +7 and +15 dBm. Once the instrument has warmed up, the PLL LED should light up to indicate that the HROG-10 is locked to the 10 MHz external reference.

Two buffered 10 MHz sine wave outputs are available at the connectors labeled 10 MHz OUT 1 and 10 MHz OUT 2 located on the front panel. In addition, 2 1PPS (Pulse per Second) TTL outputs are also available at the SMA connectors labeled 1PPS OUT 1 and 1PPS OUT 2.

The front panel touch screen can now be used to adjust the frequency or phase of the output signals. All functions may also be accessed through the RS-232 port located on the front panel. A standard serial cable with a DB-9 connector can be used to interface to the HROG-10. The user can input commands using a simple dumb terminal program on a remote computer or more sophisticated control can be used with software such as LabView.

On the front panel above the RS-232 connector there are three LEDs. The second LED labeled DATA will light up only when data is being received or sent on the RS-232 port. This LED can be used to verify that the unit is communicating. The third LED is labeled status and is a hardware representation of the internal status flag. The status LED is on whenever an error has occurred. The user must query the unit to determine the source of error and then clear the error flag. When the error flag is cleared the LED will turn off.

5.0 Installation

Port Settings

On power-up the RS-232 port settings are:
Baudrate 9600 8 Bits 1 Stop Bit No Parity.

Hardware handshaking is not used. The DB-9 connector pinout is described below.

Pin	Function
1	NC
2	Data out
3	Data in
4	NC
5	GND
6	NC
7	NC
8	NC
9	NC

6.0 Operation: Main Screen

The main screen displays the current frequency and phase offset of the HROG-10. The soft keys at the bottom of the screen display the five main functions that are available.

DISPLAYS:

FREQUENCY OFFSET

The frequency offset may be displayed in units of Hertz (Hz) or as a fractional number that is normalized to the reference frequency of 10.0 MHz. The frequency units may be changed by the following key sequence:
SET, UNITS, FREQ.

PHASE OFFSET

The phase offset may be displayed in units of degrees (deg) or as a time offset in units of nanoseconds (ns). The phase units may be changed by the following key sequence:
SET, UNITS, PHASE.

STATUS

The status indicator is located in the upper right corner of the screen. Green indicates normal operation and red indicates an error condition.

On units with the DC Power option, the AC and DC power supply indicators are located in the upper left corner of the screen. If AC or DC is unplugged the corresponding status will change to red.

SOFT KEYS:

FREQ

Change frequency command. The FREQ key will bring up the Frequency Screen.

PHASE

Change phase command. The PHASE key will bring up the Phase Screen.

TIME

Change time and date command. The TIME key will bring up the Time Screen.

SET

Change instrument settings. The SET key will bring up the Settings Screen.

HELP

Displays the Help Screen.

6.1 Operation: Number Entry Screen

The number entry screen is used to make numeric entries.

DISPLAYS

The current setting will be displayed across the top of the screen. The new entry is displayed in a number entry box.

SPECIAL KEYS

Hz	Enter number in Hertz.
uHz	Enter number in microHertz.
deg	Enter number in degrees.
mdeg	Enter number in millidegrees.
ns	Enter number in nanoseconds.
ps	Enter number in picoseconds.
BK	Backspace.
ENTER	Enter new number and exit number menu.
ESC	Exit number menu discarding changes.
0-9	Numbers zero through nine.
.	Decimal point.
-	Negative sign
+	Positive sign.
EXP	Exponential

6.2 Operation: Frequency Screen

The frequency screen displays the current frequency offset of the HROG-10. The soft keys at the bottom of the screen are used to set a new frequency offset.

DISPLAYS

FREQUENCY OFFSET

The frequency offset may be displayed in units of Hertz (Hz) or as a fractional number that is normalized to the reference frequency of 10.0 MHz. The frequency units may be changed by the following key sequence:
SET, UNITS, FREQ.

MENU

SET

Enter new frequency offset. The SET key will bring up the Number Entry Screen. The maximum frequency offset is +/- 2.0 Hz or 2.0E-7. The frequency offset resolution is 5.0E-19.

STEP

Enter a frequency step size. The STEP key will bring up the Number Entry Screen. The maximum step size is 2.0E-7. Frequency step resolution is 5.0E-19.

UP

Increase the frequency offset by the frequency step size.

DOWN

Decrease the frequency offset by the frequency step size.

BACK

Return to previous menu.

6.3 Operation: Phase Screen

The phase screen displays the current phase offset of the HROG-10. The soft keys at the bottom of the screen are used to set a new phase offset.

DISPLAYS

PHASE OFFSET

The phase offset may be displayed in units of degrees (deg) or as a time offset in units of nanoseconds (ns). The phase units may be changed by the following key sequence:

SET, UNITS, PHASE.

MENU

SET

Enter new phase offset. The SET key will bring up the Number Entry Screen. The difference between the new phase offset and the current phase offset must be less than 3600 degrees or 1000 ns. The phase slew rate is 144 degrees/second or 40 ns/second. The phase resolution is 8.4E-8 degrees or 0.024 fs.

STEP

Enter a phase step size. The STEP key will bring up the Number Entry Screen. The phase offset step size is limited to 3600 degrees or 1000 ns. The phase step resolution is 8.4E-8 degrees or 0.024 fs.

UP

Increase the phase offset by the phase step size.

DOWN

Decrease the phase offset by the phase step size.

BACK

Return to previous menu.

6.4 Operation: Settings Screen

The settings menu is used to access, view, and edit instrument options.

MENU

UNITS

Change phase or frequency units.

PHASE

Press the PHASE key to toggle phase units. Options are:
Phase units in degrees
Time units in nanoseconds

FREQ

Press the FREQ key to toggle frequency units. Options are:
Frequency units in Hertz
Fractional frequency with reference to 10.0 MHz

COMM

RS-232 options and control. The COMM key will bring up the Communications Screen.

PPS

1 Pulse per second output options and control. The PPS key will bring up the 1 PPS Screen.

INST

Instrument setup and information. The INST key will bring up the Instrument Screen.

BACK

Return to previous menu.

6.5 Operation: Communications Screen

The communications screen displays the current RS-232 serial port settings. The soft keys at the bottom of the screen are used to set new RS-232 settings, initiate RS-232 control of the instrument or test the serial port connection. The RS-232 port is setup to be controlled by a dumb terminal. A null modem adapter is not needed and should not be used. Hardware handshaking is not used. For additional pin-out information please refer to the RS232 port section on page 9 of this manual.

DISPLAYS

Current baudrate and MODE settings.

MENU

REM Enter remote RS-232 control mode.

MODE Toggle through boot up communication options.
Boot NORMAL Echo OFF: Normal start up*
Boot NORMAL Echo ON: Normal start up**
Boot RS-232 Echo OFF: Starts up in remote RS-232 control mode*
Boot RS-232 Echo ON: Starts up in remote RS-232 control mode**
Boot Concurrent Echo OFF: RS-232/Front-panel control mode *^
Boot Concurrent Echo ON: RS-232/Front-panel control mode**^
* Echo OFF: Does not echo back characters through RS-232 port.
** Echo ON: Sends back received characters through RS-232 port.
^ The instrument can be controlled by the front panel and through the RS-232 port concurrently.

BAUD Toggle through available baudrates.
9600, 19200, 38400, 57600, 115200, 14400, 28800

TEST Used to test the RS-232 connection. Sends the following string through the serial port:
“Testing Serial Port”
“Hit Enter to Continue”

LOCAL Return to local control and terminate remote RS-232 control session. (This button appears only in remote RS-232 control mode).

BACK Return to previous menu.

6.6 Operation: 1PPS Screen

The 1 PPS screen displays the current 1 PPS generator settings. The soft keys at the bottom of the screen are used to change the 1 PPS settings and synchronize to an external 1 PPS source.

DISPLAYS

PW
The pulse width of the one pulse per second output signal.

MENU

RST
Reset the 1 PPS counter, used for diagnostics only.

SYNC
Synchronize the output 1 PPS to an external 1 PPS signal. The time difference between the output 1 PPS and external 1 PPS will be less than 50 ns for a successful synchronization. A timeout error will occur if no external 1 PPS signal is present.

SPW
Toggle through the available pulse width settings of the 1 PPS signal.
Pulse width options:
0.4 us, 1.6 us, 6.4 us, 25.6 us, 51.2 us, 102.4 us, 204.8 us, 409.6 us

BACK
Return to previous menu.

6.7 Operation: Instrument Screen

The instrument screen is used to view or change the instrument configuration settings.

MENU

REG
View center frequency and the frequency registers, reset the phase counter, and view reference frequency.

RPHS
Reset the phase offset counter to zero.

NVAL
View the frequency registers.

REF
(Factory setting) View the frequency that is used as the external reference. The external reference frequency is not user selectable and must not be changed.

DISP Change the contrast of the LCD display.

UP
Increase the value.

DOWN
Decrease the value.

PLL
View phase-lock-loop control voltages and levels. The PLL key brings up the PLL window.

BACK
Return to previous menu.

6.8 Operation: PLL Screen

The PLL Screen is used to view the current PLL voltages and RF power levels. Use this function to clear the status register and turn off the status LED. Note that the status LED will turn off only if the error condition has been resolved.

DISPLAYS

OSC The power level of the internal oscillator. This level should be +13 dBm ± 2 dB.

REF The power level of the external reference. This level should be between +7 dBm and +15 dBm for proper operation.

LOCK The lock indicator voltage. A voltage greater than 0.2 V indicates that the HROG-10 is phase locked to the external reference.

PLL The tuning port voltage on the HROG-10 internal oscillator. For proper operation, the tuning port voltage is ± 5.0 V. If the voltage displayed is within 0.5 V of these limits the internal oscillator may need to be mechanically tuned. Please refer to the mechanical tuning section on page 46 of this manual for more information.

AC & DC The internal regulated voltages of the AC and DC power supplies will only be displayed when the unit has the DC power option installed. The regulated DC voltage must be greater than 14.1 VDC. The AC regulated voltage must be greater than +14.5 VDC.

TEMP The internal instrument temperature in degrees Celsius.

STATUS The status indicator is located in the upper right corner of the screen. Green indicates normal operation and red indicates an error condition. If the unit has the DC power option installed, the AC and DC power supply indicators are located in the upper left corner of the screen. If AC or DC is unplugged the corresponding status will change to red.

MENU

CLR View and clear the device error status.

BACK Return to previous menu.

6.9 Operation: Clear Status Screen

The Clear Status Screen displays the device error status value, and allows for clearing the status value and LED. The device status is displayed as a decimal value and is equal to the sum of individual error condition codes. A device status value of zero indicates there are no errors.
Use the CLR button to clear the status. The status LED will turn off and the status value will return to zero if all the error conditions have been resolved.

Error condition codes

External reference error	**1**
Internal oscillator error	**2**
PLL Lock error	**4**
Tuning voltage error	**8**
Invalid parameter	**16**
Invalid command	**32**
DC Backup Loss	**64**
AC Power Loss	**128**
Serial Command Dropped	**256**

DISPLAYS

Error Status The device error status value.

MENU

CLR Clear the error status value.

BACK Return to previous menu.

7.0 ASCII Command Set

The HROG-10 command set is used to control all synthesizer functions. The characters sent to the HROG-10 must be upper case ASCII characters.

7.1 BAUD, BAUD?

BAUD changes the baudrate of the synthesizer.

BAUD [baud]<cr>

BAUD has one parameter and is executed following the carriage return <cr>

baud: baudrate valid values are:

9600 19200 38400 57600 115200 14400 28800

Example: BAUD 9600<cr>

Sets the baudrate of the synthesizer to 9600. <cr> is a carriage return.

BAUD? Queries the synthesizer baudrate.

BAUD?<cr>

BAUD? is executed following the carriage return <cr>

The results of the query are in the following format. <lf> is a linefeed character.

BAUD? [baud]<cr><lf>

Example: BAUD?<cr>

Queries the baudrate setting of the synthesizer. <cr> is a carriage return.

The function will return:

BAUD? 9600<cr><lf>

7.2 DATE, DATE?

DATE changes the date setting of the instrument.

DATE [month/day/year]<cr>

DATE has three parameters and is executed following the carriage return <cr>

mo	**month valid values are 1 - 12.**
day	**day valid values are 1 - 31.**
year	**year valid values are 1971 – 2100.**

Example: DATE 02/02/2015<cr>

Sets the date of the instrument to February 2, 2015. <cr> is a carriage return.

DATE? queries the instrument date setting.

DATE?<cr>

DATE? is executed following a carriage return.

The results of the query are in the following format. <lf> is a linefeed character.

DATE? [mo/day/year]<cr><lf>

Example: DATE?<cr>

Queries the date setting of the instrument. <cr> is a carriage return.

The function will return:

DATE? 02/02/2015<cr><lf>

7.3 FFOF, FFOF?

FFOF is used to make a fractional frequency offset. The HROG-10 output is offset in frequency from the external reference by the amount (frac_freq). To convert to a frequency offset in units of (Hz) use the following equation.

Frequency Offset (Hz) = Frac_Freq × Reference Frequency (Hz)

FFOF [frac_freq] <cr>

FFOF has one parameter and is executed following the carriage return <cr>

frac_freq range ± (0 to 2.0E-7) resolution is 5.0 E-19.

Example: FFOF 2.1E-10<cr>

The output of the HROG-10 will be offset from the reference by 2.1 E-10 or 0.0021 Hz for a 10 MHz reference. <cr> is a carriage return.

FFOF? queries the instrument fractional frequency offset.

FFOF?<cr>

FFOF? is executed following a carriage return.

The results of the query are in the following format. <lf> is a linefeed character.

FFOF? [frac_freq]<cr><lf>

Example: FFOF?<cr>

Queries the fractional frequency offset of the instrument. <cr> is a carriage return.

The function will return:

FFOF? 2.1E-10<cr><lf>

7.4 FREQ, FREQ?

FREQ is used to make a frequency offset. The HROG-10 output is offset in frequency from the external reference by the amount (freq).

FREQ [freq] <cr>

FREQ has one parameter and is executed following the carriage return <cr>

freq **range ± (0 to 2.0 Hz) resolution is 5 E-12 Hz.**

Example: **FREQ 0.001<cr>**

The output of the HROG-10 will be offset from the reference by 1 mHz. <cr> is a carriage return.

FREQ? queries the instrument frequency offset.

FREQ?<cr>

FREQ? is executed following a carriage return.

The results of the query are in the following format. <lf> is a linefeed character.

FREQ? [freq]<cr><lf>

Example: **FREQ?<cr>**

Queries the frequency offset of the instrument. <cr> is a carriage return.

The function will return:

FREQ? 0.001 Hz<cr><lf>

7.5 HELP, ID?

HELP is used to display basic help on the ASCII command set.

HELP<cr>

HELP is executed following the carriage return <cr>

Example: HELP<cr>

ID is used to display the model, firmware version and serial number of the HROG-10.

ID<cr>

ID is executed following the carriage return <cr>

The results of the query are in the following format. <lf> is a linefeed character.

ID [model] [version] [serial number]<cr><lf>

Example: ID<cr>

Queries the description of the instrument. <cr> is a carriage return.

The function will return:

ID HROG-10 Version 5.1.2 SN-XXXXXX<cr><lf>

7.6 LOCL

LOCL turns off the RS-232 communications and returns control to the LCD touch screen.

LOCL<cr>

LOCL is executed following the carriage return <cr>

7.7 MODE, MODE?

MODE is used to change the RS-232 communication startup options.

MODE [option] <cr>

MODE has one parameter and is executed following the carriage return <cr>

option **valid values 0 – 5**

value	Boot up mode
0	Boot NORMAL with Echo OFF
1	Boot NORMAL with Echo ON
2	Boot RS-232 with Echo OFF
3	Boot RS-232 with Echo ON
4	Boot Concurrent Operation Echo OFF
5	Boot Concurrent Operation Echo ON

Example: MODE 3<cr>

The unit will boot up in RS-232 remote control mode and it will echo commands back through RS-232 port. <cr> is a carriage return.

MODE? queries the current setting of the startup mode.

MODE? <cr>

MODE? is executed following a carriage return <cr>.

The results of the query are in the following format. <lf> is a linefeed character.

MODE? [option] <cr><lf>

Example: MODE? <cr>

Queries the current startup mode setting. <cr> is a carriage return.

The function will return: **MODE? 3 <cr><lf>**

7.8 PHAS, PHAS?

PHAS changes the phase of the HROG-10 with respect to the reference.

PHAS [phase]<cr>

PHAS has one parameter and is executed following the carriage return <cr>

phase **value is in degrees, the resolution is 8.4E-8 deg.**

The phase parameter keeps track of all phase changes that are implemented on the HROG-10. Issuing a PHAS command will cause the HROG-10 to offset the phase of the output signal relative to the 10 MHz reference signal to reach the new phase value. The power-on value of phase is zero and phase can be reset to zero without affecting the output phase by issuing the RPHS command.

Example: PHAS 360<cr>

Sets the output phase of the HROG-10 to +360 degrees from the phase = 0 condition. Note that if phase = 360 deg and we issue a PHAS 360<cr> command the output phase will not change because the synthesizer output is already at 360 deg.

PHAS? queries the instrument phase offset.

PHAS?<cr>

PHAS? is executed following a carriage return.

The results of the query are in the following format. <lf> is a linefeed character.

PHAS? [phase]<cr><lf>

Example: PHAS?<cr>

Queries the phase offset of the instrument. <cr> is a carriage return.

The function will return:

PHAS? 360 deg<cr><lf>

7.9 PPSW, PPSW?

PPSW is used to change the pulse width of the 1 PPS signal.

PPSW [pwidth] <cr>

PPSW has one parameter and is executed following the carriage return <cr>

pwidth **valid values 0 – 7**

value	pulse width (µs)
0	0.4
1	1.6
2	6.4
3	25.6
4	51.2
5	102.4
6	204.8
7	409.6

Example: PPSW 4<cr>

The 1 PPS output signal pulse width changes to 51.2 µs. <cr> is a carriage return.

PPSW? queries the 1 PPS output signal pulse width setting.

PPSW? <cr>

PPSW? is executed following a carriage return.

The results of the query are in the following format. <lf> is a linefeed character.

PPSW? [pwidth] [width in µs]<cr><lf>

Example: PPSW?<cr>

Queries the 1 PPS pulse width value. <cr> is a carriage return.

The function will return:

PPSW? 4 51.2us<cr><lf>

7.10 PLL?, PWR

PLL? queries the critical levels and voltages in the main instrument control loop.

PLL?<cr>

PLL? is executed following the carriage return <cr>

OSC Power level of the internal oscillator. Valid range +11 to +15 dBm.

REF Power level of external reference signal. Valid range +7 to +15 dBm.

LOCK Voltage of the lock detector. Valid range is 0.2 to 0.35 V.

PLL Tuning port voltage on the oscillator. Valid range is +/- 5 V.

Note that if the tuning port voltage exceeds +/- 5 V the instrument will lose phase-lock to the external reference. This voltage can also be monitored and used to decide when the internal oscillator must be mechanically tuned to adjust for aging.

Example: PLL?<cr>

Queries the critical levels and voltages in the HROG-10 control loop. <cr> is a carriage return. <lf> is a linefeed character.

The function returns:

PLL? Osc: 12.0 dBm Ref: 15.0 dBm Lock: 0.3 V PLL: -0.2 V<cr><lf>

PWR queries the AC and DC power supplies internally regulated voltages. This function is only available on units with the DC power option installed.

PWR<cr>

PWR is executed following a carriage return <cr>.

Example: PWR<cr>

Returns:

PWR DC: 14.50 V AC: 14.89 V <cr><lf>

7.11 SAVF

SAVF is used to enable or disable the storing of the frequency offset setting for the instrument in non-volatile memory. When the frequency offset is stored in non-volatile memory this value will be used upon power up of the instrument following a loss of power whether or not this power loss was intentional.

SAVF [state]<cr>

SAVF has one parameter and is executed following the carriage return <cr>

state **state valid values are 0 or 1**

0 – saving of the frequency offset setting to non-volatile memory is disabled. The instrument will power on to a frequency offset of 0 Hz.

1 – saving of the frequency offset to non-volatile memory is enabled. The instrument will power on to the last frequency offset setting received by the instrument.

Example: SAVF 1<cr>

The HROG-10 is set to save the last frequency offset value into non-volatile memory. This frequency offset value will be automatically loaded on startup or power up. <cr> is a carriage return.

7.12 SEDG

SEDG is used to select the 1PPS output rising edge alignment with the internal 10 MHz reference clock.

SEDG [edge]<cr>

SEDGE has one parameter and is executed following the carriage return <cr>

edge **edge valid values are 0 or 1**

0 - 1PPS rising edge is aligned with the positive slope zero-crossing of the 10 MHz sine wave

1 - 1PPS rising edge is aligned with the negative slope zero-crossing of the 10 MHz sine wave.

Example: SEDG 1<cr>

The HROG-10 1PPS output 1 PPS rising edge will now be aligned with the negative slope zero-crossing of the output 10 MHz signal. <cr> is a carriage return.

7.13 SFFOF, SFFOF?

SFFOF is used to make a fractional frequency step. The HROG-10 output frequency is changed by the amount specified by ffstep.

SFFOF [ffstep] <cr>

SFFOF has one parameter and is executed following the carriage return <cr>

ffstep range ± (0 to 2.0 E-7) resolution is 5.0 E-19.

Example: SFFOF 1.0E-14<cr>

The output of the HROG-10 will change in frequency by 1.0 E-14. <cr> is a carriage return.

SFFOF? queries the last fractional frequency step.

SFFOF? <cr>

SFFOF? executed following a carriage return.

The query returns the last frequency step made by the instrument. It does not return the frequency offset between the HROG-10 and the reference input. To query the frequency offset use the FFOF? or FREQ? commands.

The results of the query are in the following format. <lf> is a linefeed character.

SFFOF? [ffstep]<cr><lf>

Example: SFFOF?<cr>

Queries the last frequency step. <cr> is a carriage return.

The function will return:

SFFOF? 1E-14<cr><lf>

7.14 SFREQ, SFREQ?

SFREQ is used to make a frequency step. The HROG-10 output frequency is changed by the amount specified by fstep.

SFREQ [fstep] <cr>

SFREQ has one parameter and is executed following the carriage return <cr>

fstep **range ± (0 Hz to 2.0 Hz) resolution is 5 E-12 Hz.**

Example: SFREQ 0.001<cr>

The output of the HROG-10 will change in frequency by 0.001 Hz. <cr> is a carriage return.

SFREQ? queries the last frequency step.

SFREQ? <cr>

SFREQ? executed following a carriage return.

The query returns the last frequency step made by the instrument. It does not return the frequency offset between the HROG-10 and the reference input. To query the frequency offset use the FFOF? or FREQ? commands.

The results of the query are in the following format. <lf> is a linefeed character.

SFREQ? [fstep] Hz<cr><lf>

Example: SFREQ?<cr>

Queries the last frequency step. <cr> is a carriage return.

The function will return:

SFREQ? 0.001 Hz<cr><lf>

7.15 SPHAS, SPHAS?

SPHAS changes the phase of the HROG-10 output by the amount specified by pstep.

SPHAS [pstep]<cr>

SPHAS has one parameter and is executed following the carriage return <cr>

pstep **valid range is ± (0 to 3600 deg) resolution is 8.4E-8 deg.**

The output of the HROG-10 will change in phase by the amount of pstep. The phase slew rate is approximately 144 deg/s, therefore it takes 2.5 s to execute a 360 degree phase step.

Example: **SPHAS 10<cr>**

Steps the output phase of the HROG-10 by +10 degrees.

SPHAS? queries the last phase step executed by the instrument.

SPHAS?<cr>

SPHAS? is executed following a carriage return.

The results of the query are in the following format. <lf> is a linefeed character.

SPHAS? [pstep] deg<cr><lf>

Example: **SPHAS?<cr>**

Queries the last phase step executed by the instrument. <cr> is a carriage **return.**

The function will return:

SPHAS? 9.99999999069 deg<cr><lf>

7.16 STOFFS, STOFFS?

STOFFS changes the time offset of the HROG-10 output by the amount specified by tstep.

STOFFS [tstep]<cr>

STOFFS has one parameter and is executed following the carriage return <cr>

tstep **valid range is ± (0 to 1000ns) resolution is 2.4E-5 ns.**

The output of the HROG-10 will change in time offset by the amount of tstep. The phase slew rate is approximately 40 ns/s, therefore it takes about 2.5 s to execute a 100 ns time step.

Example: STOFFS 10.0<cr>

Steps the output time offset of the HROG-10 by +10 ns.

STOFFS? queries the instrument for the last time step.

STOFFS? <cr>

STOFFS? is executed following a carriage return.

The results of the query are in the following format. <lf> is a linefeed character.

STOFFS? [tstep] ns<cr><lf>

Example: STOFFS?<cr>

Queries the unit for the last time step. <cr> is a carriage return.

The function will return:

STOFFS? 9.99999996275 ns<cr><lf>

7.17 SYNC, SYNC?

SYNC synchronizes the output 1 PPS signal to an external 1 PPS signal to within +/- 50 ns. If the external 1 PPS signal is not present the synchronization procedure will abort. Anytime this command is executed the 1 PPS time tag is lost and the phase counter should be reset because the phase relation between the reference and internal oscillator is also lost. The following procedures should be executed following a SYNC command.

TIME Sets the time of day and also time tags the 1 PPS signal.

***RPHS** Resets the phase counter to 0.

SYNC<cr>

SYNC is executed following the carriage return <cr>.

Example: SYNC<cr>

SYNC? queries the synchronization result.

Function will return:

SYNC? 0 TIMEOUT<cr><lf>	Synchronization did not occur.
SYNC? 1 OK<cr><lf>	Synchronization successful.

Example: SYNC?<cr>

SYNC? 1 OK<cr><lf>

Synchronization was successful.

7.18 TEMP?

TEMP? Queries the system temperature.

TEMP?<cr>

TEMP? is executed following a carriage return.

Example: TEMP?<cr>

Returns

TEMP? 40.1 C<cr><lf>

<lf> is a linefeed character.

7.19 TIME, TIME?

TIME changes the time of day of the instrument.

TIME [hr:min:sec] <cr>

TIME has 3 parameters and is executed following the carriage return <cr>

hr **Hour valid range 0 – 23**

min **Minutes valid range 0 – 59**

sec **Seconds valid range 0 – 59**

Example: TIME 12:01:00<cr>

Sets the time of day to 12 hours, 1 minute and 0 seconds. <cr> is a carriage return.

TIME? Queries the system time of day.

TIME?<cr><lf>

TIME? is executed following a carriage return,

Example: TIME?<cr>

Returns

TIME? 12:01:31<cr><lf>

<lf> is a linefeed character.

7.20 TOFFS, TOFFS?

TOFFS changes the time offset of the HROG-10 output to achieve the total time offset specified by toffset.

TOFFS [toffset]<cr>

TOFFS has one parameter and is executed following the carriage return <cr>

toffset **time offset in ns, the resolution is 2.4E-5 ns.**

The time offset parameter keeps track of all time offset changes that are implemented on the HROG-10. Issuing a TOFFS command will cause the HROG-10 to change the time offset of the output signal relative to the 10 MHz reference signal to reach the new TOFFS value. The power-on value of TOFFS is zero and TOFFS can be reset to zero without affecting the time offset of the output signal by issuing the RPHS command.

Example: **TOFFS 100.0<cr>**

Sets the output time offset of the HROG-10 to +100 ns from the time offset = 0 condition. Note that if TOFFS = 100 ns and we issue a TOFFS 100.0<cr> command the output time offset will not change because the synthesizer output is already at 100ns offset.

TOFFS? queries the instrument for the last time step.

TOFFS? <cr>

TOFFS? is executed following a carriage return.

The results of the query are in the following format. <lf> is a linefeed character.

TOFFS? [toffset] ns<cr><lf>

Example: **TOFFS?<cr>**

Queries the unit for the time offset relative to the reference. <cr> is a carriage return.

The function will return:

TOFFS? 100.0 ns<cr><lf>

7.21 UPTIME

UPTIME Queries the device uptime

UPTIME<cr>

UPTIME is executed following a carriage return.

Example: UPTIME<cr>

Returns

UPTIME 1 days 12:00:00<cr><lf>

The device has been up for 1 day and 12 hours

7.21 *RPHS

***RPHS** sets the phase counter and time offset counter to zero. This function does not change the HROG-10 output signal.

***RPHS<cr>**

*RPHS is executed following the carriage return <cr>

Example: *RPHS<cr>

Sets the phase and time offset counters = 0. <cr> is a carriage return.

7.22 *SRE, *CLS

***SRE** queries the synthesizers for the value of the status register.

***SRE<cr>**

*SRE is executed following a carriage return.

The results of the query are in the following format.

SRE [status]<cr><lf>

status is an 9-bit decimal value that contains the sum of the error conditions. status is 0 when there are no errors.

External reference error	**1**
Internal oscillator error	**2**
PLL Lock error	**4**
Tuning voltage error	**8**
Invalid parameter	**16**
Invalid command	**32**
DC Backup Loss	**64**
AC Power Loss	**128**
Serial Command Dropped	**256**

Example: *SRE<cr>

The results of the status query are:

***SRE 10<cr><lf>** the return value is the sum of 8 and 2 which indicates a tuning voltage error and an internal oscillator error. <lf> is a linefeed character.

***CLS** clears the status register and turns off the status LED.

***CLS<cr>**

*CLS is executed following a carriage return.

8.0 Troubleshooting

The HROG-10 needs up to 30 minutes to warmup after power is applied to the unit. After this warmup period, the power on LED and the 10 MHz output signal LED should be on. The 1 PPS LED should be blinking at a 1 Hz rate. The external 10 MHz reference with a level of +7 dBm to +15 dBm should be connected to the instruments 10 MHz SMA input. Once the external reference is applied, the external reference signal LED will turn on and the HROG-10 will automatically lock to this external reference. Once the PLL is locked, the PLL lock LED will turn on. The status LED will remain on until the PLL Screen is invoked and the PLL status is viewed. The external 1 PPS LED should blink when an external 1 PPS signal is present.

PROBLEMS:

Unit does not turn on.
Check power cord, fuses and make sure on/off switch is in on position.

Unit does not respond to keypad
Make sure unit is in local control mode and not in RS-232 mode.

External reference signal LED is off
Check that the external 10 MHz signal is present and that the level is between +7 and +15 dBm.

PLL Lock LED is off or blinking
Check that the external 10 MHz signal is present. Check that the frequency of the external reference is 10.0 MHz +/- 0.1Hz and that the level is between +7 and +15 dBm.

Check that the HROG-10 output is present.

Check PLL status using the PLL Screen function.

OSC level should read +13 dBm +/- 2 dBm
REF level should be between +7 dBm and +15 dBm.
LOCK voltage should be greater than 0.2 V
PLL voltage should be between +4.5V and –4.5V
The unit temperature should not exceed +50°C.

If the unit remains unlocked the oscillator may require mechanical tuning. Refer to the Mechanical Tuning section on page 44.

8.0 Troubleshooting

10 MHz output signal LED is not on
Send unit to SpectraDynamics, Inc. for repair.

STATUS LED is on
Activate the PLL Screen and check the PLL status and make sure that the external reference is adequate. If the RS-232 control mode is being used use the *SRE command to read the status register and the *CLS command to clear the status register. If the DC power option is installed, check and make sure that both the DC Backup power is connected and the AC Line power is present. The status LED will turn on if either the internal regulated DC voltage drops below 14.1 VDC or if the internal regulated and rectified voltage derived from the AC power line drops below +14.5 VDC.

RS-232 communications failed
Check that the correct RS-232 cable is being used.
Do not use a null modem adapter.
Check baudrate of the HROG-10 and set the controller to the same baudrate.
Use the TEST function to test the serial connection.
The DATA LED should flash when data is being received by the HROG-10.
Make sure that the HROG-10 is in remote control mode and not in local control mode.

If any error condition persists please contact technical support.

SpectraDynamics, Inc.
1849 Cherry Street Unit 2.
Louisville, CO 80027
USA

Tel: (303) 665-1852
Fax: (303) 604-6088
support@spectradynamics.com
www.spectradynamics.com

9.0 Mechanical Tuning

Mechanical frequency tuning is available to adjust the frequency of the internal HROG-10 oscillator. Only fully qualified service personnel should perform this procedure. Frequency adjustments should be made with the unit having been powered on for at least 2 hours. Caution must be taken to avoid shorting or accidentally touching a line voltage point.

1. To adjust the frequency of the oscillator, remove the top cover of the HROG-10. The oscillator module is located at the right side of the instrument. The tuning access for the 10 MHz oscillator is located on the top side of the oscillator enclosure. A hermetic cover screw must be removed with a screwdriver to gain access to the tuning screw. A small flat blade-tuning tool is needed to make the adjustment.

2. Connect the external 10 MHz reference to the input labeled 10 MHz In. Make sure that the reference signal level is between +7dBm and +15 dBm. Program the HROG-10 to the nominal frequency offset that you want to use. For most applications you may enter 0 Hz for the frequency offset.

3. Enter the PLL screen to view the RF power levels and control voltages. The internal oscillator power level should be 13 ± 2 dBm. The reference signal power level should be between +7 dBm and +15 dBm. If the HROG-10 is phase locked to the external reference the LOCK voltage will be greater than 0.2 V. Adjust the mechanical tuning screw to achieve a lock condition. Continue adjusting the mechanical tuning screw until the PLL voltage displayed is at 0 volts. At this point the internal lock indicator LED should be on, the LOCK voltage should be greater than 0.2 V and the PLL voltage should be at 0.0 ±0.2 V.

4. Replace all hermetic covers when done adjusting the frequency of the oscillators. Replace the top cover of the HROG-10.

Note: The HROG-10 should be turned on for 2 hours prior to any mechanical frequency adjustment.

10.0 Specifications

Specifications for Part Numbers HROG-10, HROG-10-DC

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Phase Resolution		-	$2\pi / 2^{32}$	-	radians
Phase offset range		-	infinite	-	-
Time offset resolution	10 MHz External Reference	-	0.024	-	fs
Frequency Resolution		-	5 E-19	-	-
Frequency Tuning Range		-	+/- 2 E-7	-	-
Mech. Tuning Range		-	+/-1 E-6	-	-
Int. Oscillator Aging	After 30 days of operation	-	5 E-10	-	Per day
10 MHz Output Level	50 Ohm Load	+10	+13	+15	dBm
1 PPS Output Level	50 Ohm Load	3.7	4.2	5.0	V
1 PPS Rise Time	50 Ohm Load	-	1.4	2	ns
1 PPS Fall Time	50 Ohm Load	-	1.0	2	ns
Output Isolation	Channel to channel Reverse	- -	80 80	- -	dB
Phase Noise $\mathcal{L}(f)$	1 Hz 10 Hz 100 Hz 1 kHz >10 kHz	- - - - -	- -135 -155 -165 -165	- -130 -152 -162 -163	dBc/Hz
Allan Deviation $\sigma_y(\tau)$	Δf = 1.0 E-12 1 s 10 s 100 s	 - - -	 4 E-14 5 E-15 2 E-15	 5 E-14 7 E-15 3 E-15	
Allan Deviation $\sigma_y(\tau)$	Δf = 0 1 s 10 s 100 s 1000 s	 - - - -	 4 E-14 5 E-15 6 E-16 1 E-16	 5 E-14 7 E-15 8 E-16 2 E-16	
Spurious		-	-110	-100	dBc
Harmonics		-	-45	-40	dBc

External Reference	10.0 MHz ± 2.0E-8	+7 dBm to +15 dBm
External 1 PPS	400 ns min. pulse width	TTL Compatible Levels
AC Power	100–120 / 220–240 VAC 60W	see page 2.
DC Power	+20 to +33 VDC 30W	see page 2.
Size	3.5” X 19” X 17”	
Operating Environment	0-50 ºC	
Humidity	5% to 95% Non-Condensing	
Weight	23 lbs	

10.0 Specifications

Specifications for Part Numbers HROG-10-LN and HROG-10-LN-DC

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Phase Resolution		-	$2\pi / 2^{32}$	-	radians
Phase offset range		-	infinite	-	-
Time offset resolution	10 MHz External Reference	-	0.024	-	fs
Frequency Resolution		-	5 E-19	-	-
Frequency Tuning Range		-	+/- 2 E-7	-	-
Mech. Tuning Range		-	+/-1 E-6	-	-
Int. Oscillator Aging	After 30 days of operation	-	2 E-10	-	Per day
10 MHz Output Level	50 Ohm Load	+10	+13	+15	dBm
1 PPS Output Level	50 Ohm Load	3.7	4.2	5.0	V
1 PPS Rise Time	50 Ohm Load	-	1.4	2	ns
1 PPS Fall Time	50 Ohm Load	-	1.0	2	ns
Output Isolation	Channel to channel Reverse	- -	80 80	- -	dB
Phase Noise $\mathcal{L}(f)$	1 Hz 10 Hz 100 Hz 1 kHz >10 kHz	- - - - -	-131 -140 -160 -168 -168	-127 -137 -158 -167 -167	dBc/Hz
Allan Deviation $s_y(t)$	Df = 1.0 E-12 1 s 10 s 100 s	 - - -	 4 E-14 5 E-15 2 E-15	 5 E-14 7 E-15 3 E-15	
Allan Deviation $s_y(t)$	Df = 0 1 s 10 s 100 s 1000 s	 - - - -	 4 E-14 5 E-15 6 E-16 1 E-16	 5 E-14 7 E-15 8 E-16 2 E-16	
Spurious		-	-110	-100	dBc
Harmonics		-	-45	-40	dBc

Other specifications for all models

Rackmount chassis	2U H, 19“ W, 14” D, 88.9 X 482.6 X 406.4 mm
Unit weight	20 lbs, 9 kg
AC Input Voltage Range	110-120 / 220-240 VAC, 47-63 Hz, 50 W / 70 W
Option DC Input Voltage Range	+20 to +33 VDC
Option DC (-48V) Input Voltage Range	-36 to -75 VDC
Storage temperature	-10 to +55 ºC
Operation environment	+5 to +40 ºC

11.0 Warranty and Service

The HROG-10 is warranted to be free of defects under normal operating conditions, as specified, for one year from date of original shipment from SpectraDynamics, Inc. (SDI). SDI's obligation and liability under this warranty is expressly limited to repairing or replacing, at SDI's option, any product not meeting the said specifications. This warranty shall be in effect for one (1) year from the date a HROG-10 is sold by SDI. SDI makes no other warranty, express or implied, and makes no warranty of the fitness for any particular purpose. SDI's obligation under this warranty shall not include any transportation charges or costs of installation or any liability for direct, indirect, or consequential damages or delay. Any improper use, operation beyond capacity, substitution of parts not approved by SDI, or any alteration or repair by others in such manner as in SDI's reasonable judgement affects the product materially and adversely shall void this warranty. No employee or representative of SDI is authorized to change this warranty in any way or grant any other warranty.

Service

Do not attempt to service or adjust the instrument unless another person, capable of providing first aid or resuscitation, is present. Please remember that any alteration or repair may void the warranty. Contact SDI with any questions or to request an RMA if a repair is needed.

SpectraDynamics, Inc.
1849 Cherry Street Unit 2.
Louisville, CO 80027
USA

Tel: (303) 665-1852
Fax: (303) 604-6088
support@spectradynamics.com
www.spectradynamics.com

CE

SPECTRADYNAMICS, INC

EU Declaration of Conformity

In accordance with EN ISO/IEC 17050-1:2010

This declaration is issued under the sole responsibility of the manufacturer.

Manufacturers Name:	**SpectraDynamics Inc**
Manufacturers Address:	1849 Cherry St Unit 2 Louisville, Co U.S.A. https://www. spectradynamics.com/
Product:	**High Resolution Frequency and Phase Offset Generator**
Model:	**HROG-5 & HROG-10 including options: Low Noise (LN), DC operation.**

The object of the declaration described above is in conformity with the relevant Union harmonization Legislation:

Application of Council Directives:

EMC	2014/30/EU

Standards:

EMC	BS EN IEC 61326-1:2021 – Basic environment BS EN IEC 55011:2016+A2:2021 – Emissions

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directives and Standards.

Location: Louisville, Colorado

Signature:

Full Name: Franklin Ascarrunz,
President Date: March 10, 2023