SPECTRADYNAMICS, INC.

FREQUENCY REFERENCE
FEL-10A
OPERATING MANUAL

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FEL-10 Description

The FEL-10 is a high performance 10 MHz distributed frequency reference. It contains a 10 MHz SC cut ovenized oscillator and a high performance distribution amplifier module (model HPDA-5). The 10 MHz signal is distributed by the HPDA-5 to provide five 10 MHz outputs. Typical cross channel isolation is 110 dB and reverse isolation is typically greater than 125 dB. The phase noise of the distribution modules is exceptionally low, typically –150 dBc/Hz @ Fourier frequency of 1 Hz and –173 dBc/Hz @ Fourier frequency greater than 10 kHz. The distribution module does not degrade the phase noise performance of the oscillator that is typically –110 dBc/Hz @ Fourier frequency of 10 Hz and –165 dBc/Hz @ Fourier frequency greater than 10 kHz. The FEL-10 outputs are matched to 50 ohms to obtain better than 25 dB return loss. All outputs are AC coupled and the grounds are DC isolated to reduce the effect of ground loops. The FEL-10 can be phase locked via an electrical tuning port or by providing an external 10 MHz reference.

Theory of operation

The FEL-10 contains a 10 MHz SC cut, ovenized oscillator. The output of the oscillator is distributed with a high performance distribution amplifier. Five 10 MHz outputs are provided on the front panel. A buffered 10 MHz signal is used internally to phase lock the oscillator to an external 10 MHz input.

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Safety and Preparation for Use

CAUTION!
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 has been setup to operate on 220 to 240 VAC and a line frequency of 50 to 60 Hz. The unit can be converted to operate on a line voltage of 100 to 120 VAC. **Locate the power entry module and disconnect the power cord.** The voltage of operation is displayed on the power entry module. If it reads **115** the unit is setup for 100 to 120 VAC operation. If **230** is displayed the unit is setup for 220 to 240 VAC operation. To change the line voltage of operation, use a flat-blade screwdriver to carefully remove the plastic cover of the power entry connector. The cover should swing down towards the IEC power socket. Note you cannot change the voltage setting with the power cord still attached to the unit. Remove the red fuse holder and rotate to select the desired line voltage. The appropriate fuse must be replaced to ensure safe operation. See below for the appropriate fuse selection. Insert the fuse holder and replace the plastic cover. The selected line voltage setting will be displayed on the power entry module

Fuse
A 0.75 Ampere 250 V slow-blow fuse is used for 100 to 120 VAC operation.
A 0.375 Ampere 250 V slow-blow fuse is used for 220 to 240 VAC operation.
Only replace fuses with the same type and specifications.

Line Cord
The instrument has a detachable, three wire power cord for connection to a grounded 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.

Service
Do not attempt to service or adjust the instrument unless another person, capable of providing first aid or resuscitation, is present. Contact SDI for any questions or repairs.

Operation
To operate the unit, locate the AC power entry connector on the rear panel and connect the power cable. When power is applied to the unit, a red led located on the front panel, labeled “on”, should light up.

The Front Panel

Power

The LED is on when power is applied to unit and the unit is operating properly.

External Reference

Tuning	SMA input jack used to supply a 10 MHz reference to the instrument or a +/- 5VDC tuning voltage.
Signal	The LED is on when a 10 MHz reference is applied to the tuning port and the reference select switch is in the 10 MHz position.
DC/10 MHz	Tuning mode select switch used to change from DC tuning mode to 10 MHz external PLL mode.

10 MHz Status

Signal	The LED is on when the internal oscillator is operating properly.
Locked	The LED is on when the internal 10 MHz oscillator is phase-locked to the external 10 MHz reference. This LED is always off when the instrument is operating in DC tuning mode.

10 MHz Outputs

J1 – J5	SMA output jacks providing the 10 MHz output signals. The 5 outputs of the instrument are DC isolated from the chassis ground to prevent ground loops. Make sure that the amplifier ground does not float to a potential greater than 50 V from the chassis ground. **An output ground potential greater than 50 VDC will damage the amplifier and could cause injury or death to personnel.**

The Back Panel

AC POWER ENTRY MODULE

The FEL-10 is factory configured to operate on 220 to 240 VAC.

Operation

To operate the unit, locate the power entry module on the rear of the enclosure and connect the power cord. Plug the unit into an appropriate power outlet and turn the unit on. A red LED on the front panel labeled “Power” will turn on.

The 10 MHz oscillator requires a 1 hour warm up period for the output frequency to stabilize. The frequency of the 10 MHz oscillator can be adjusted through the tuning port on the front panel. The tuning port has two modes of operation, DC tuning and automatic frequency locking. The mode of operation is selected with the tuning select switch. In the DC position a +/- 5VDC signal can be used to adjust the frequency of the FEL-10. The tuning port sensitivity is 0.5 Hz/Volt and the frequency modulation bandwidth is approximately 1 kHz. In the 10 MHz position the FEL-10 will phase-lock to a 10 MHz signal provided at the tuning port. The external reference signal level must be between +7 dBm and +15 dBm for proper operation. The PLL bandwidth has been set to 2 Hz at the factory. For different PLL bandwidth requirements please contact SDI.

Mechanical Tuning

Mechanical frequency tuning is available to adjust the frequency of the oscillators. **Only fully qualified service personnel should perform this procedure.** Frequency adjustments should be made with the unit having been powered on for at least 1 hour. **Caution must be used to avoid shorting or accidentally touching a line voltage point.**

Before you begin the mechanical tuning adjustment disconnect any signal going to the front panel tuning port. Connect one of the outputs to a frequency counter and make sure that the counter has an accurate frequency reference. The top cover of the FEL-10 must be removed to perform the mechanical tuning. Locate the 10 MHz oscillator. On the right side panel there is an access hole so that a small flat blade screwdriver can be inserted. Guide the screwdriver from the top and remove the hermetic cover screw to gain access to the tuning screw. Using a tuning tool or small screwdriver adjust the frequency of the 10 MHz oscillator to the desired frequency with the tuning select switch set to the DC position and not having any DC or AC signals on the tuning port. Replace all hermetic covers when done adjusting the frequency of the oscillators. Replace the top cover of the FEL-10.

Note: The FEL-10 should be turned on for 1 hour prior to any mechanical frequency adjustment.

Specifications

FEL-10 Specifications

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Output Level	50 ohm load	10	12	15	dBm
Output Impedance	Return Loss @ 10 MHz		-25		dB
Distortion	50 ohm load		-43	-38	dBc
Isolation	output to output	110	115		dB
Temperature Stability	0 - 50 ºC		+/- $2x10^{-8}$		
Mechanical Tuning			+/- $1x10^{-6}$		
Electrical Tuning	+/-5VDC		+/- $2x10^{-7}$		
Aging			0.4 PPM/Year		
Stability	Allan Variance τ=1s		1E-11		
Phase Noise	10 Hz 100 Hz 1 kHz 10 kHz		-125 -155 -164 -165	-122 -152 -161 -162	dBc/Hz

Absolute Maximum Ratings

RF power on tuning port	+20dBm Maximum
DC Voltage on tuning port	+/-10 VDC Maximum
RF Power on outputs	+20dBm Maximum
DC Voltage on outputs	50 VDC Maximum
Storage Temperature	-10 to +75 ºC
Operation Environment	0 to +50 ºC

Chassis 2U H, 19 " W, 14" D

Warranty

The FEL-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 an FEL-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.

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