



SPECTRADYNAMICS, INC.



9.192 GHz CESIUM FREQUENCY SYNTHESIZER CS-1 OPERATING MANUAL

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

Table of Contents



Description.....	2
Safety and Preparation for Use.....	3
DC Module.....	4
Synthesizer Module: Front Panel.....	5
Synthesizer Module: Rear Panel.....	7
CS-1 Synthesizer Module Specifications.....	8
RS-232 Port.....	9
Basic Operation.....	10
Menu Diagram.....	13
Main Screen.....	15
Number Entry Screen.....	16
Frequency Screen.....	17
Phase Screen.....	18
Amplitude Screen.....	19
Settings Screen.....	20
Modulation Screen.....	21
Frequency Sweep Screen.....	22
Frequency Shift Keying Screen.....	24
Phase Modulation Screen.....	25
Amplitude Modulation Screen.....	26
State Machine Trigger Screen.....	27
Instrument Screen.....	29
Communication Screen.....	30
Time Screen.....	31
PLL Screen.....	32
Warranty.....	34

Description



The 9.192 GHz Synthesizer CS-1 is made up of two separate units: the Synthesizer Module and the DC Module.

The Synthesizer Module is a high stability and high resolution signal source designed to be used in the implementation of a Cesium atomic clock. The unit is provided in a 2U, 19 inch rack-mount enclosure. All synthesizer functions are accessed from the front panel or a RS232 interface. An external trigger input may be used to synchronize programmable events such as frequency sweeps, phase modulation and amplitude modulation with external events.

The synthesizer is implemented with a flexible modular topology. Two ultra-low noise quartz oscillators are part of the multiplication chain from 5 MHz to 100 MHz. Buffered outputs are provided at the front panel for 5 MHz, 10 MHz and 100 MHz. The 100 MHz signal is the highest frequency in the low frequency section of the synthesizer. This 100 MHz signal is distributed using a 1 input, four output isolation amplifier. One of these 100 MHz signal is used as the reference for a 9.2 GHz DRO. The output of the 9.2 GHz DRO is buffered and used to drive the LO port of a single-sideband mixer. The second 100 MHz signal is used to clock a DDS synthesizer module. The DDS synthesizer generates a 7.xx MHz signal with 48 bit resolution and complete modulation capabilities. The DDS synthesizer output drives the IF port of the single-sideband mixer. The lower sideband of the mixer is selected as the output generating the 9.192 GHz output signal. The amplitude of the 9.192 GHz output is controlled with 12 bits of resolution and an internal relay may be used to turn off the RF signal.

The DC Module, also in a 2U, 19-inch rack-mount enclosure, provides the DC power to the Synthesizer Module through DC cable.

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 DC Module for this instrument can be setup to operate on 110-120 or 220-240 VAC and a line frequency of 50 to 60 Hz. **The setup voltage for this DC Module is specified on page 4.** For conversion to a different line voltage please contact SDI.

Fuse

A 2.0 Ampere 250V slow-blow fuse is used for 100-120 VAC operation

A 1.0 Ampere 250V slow-blow fuse is used for 220-240 VAC operation.

Only replace fuses with the same type and specifications.

Line Cord

The CS-1 DC Module 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.

Operation

To operate the CS-1 unit, locate the AC power entry connector on the rear panel of the CS-1 DC Module and connect the AC power cable. When power is applied to the CS-1 DC Module, LEDs located on the front panel, labeled "ON", should light up. **Make sure that the CS-1 Synthesizer Module has the STANDBY switch in OFF position.** Using the DC cables provided, connect the DC connectors located on the rear panel of the DC Module to the DC connectors located on the rear panel of the CS-1 Synthesizer Module. Once all AC and DC cables are connected you can put the STANDBY switch in the ON position.

DC Module



FRONT PANEL

5V, 12V, 15V, 24V The LEDs are on when power is applied to the unit and the unit is operating properly.

REAR PANEL

AC POWER ENTRY MODULE

The CS-1 DC Module is configured to operate on:

100-120 VAC

220-240 VAC

DC OUTPUTS Connectors for the DC power to be supplied to the Synthesizer Module

ENCLOSURE Size: 3U X 19" X 16" Weight: 22 lbs

Synthesizer Module: Front Panel



ON	The LED is on, when power is applied to unit and the unit is operating properly.
DATA	The LED is on when data is being sent or received via the RS-232 port.
STATUS	This LED is a hardware representation of the system status flag. The LED is turned on when an error has occurred. The LED will stay ON even if the error condition has been automatically corrected for or is no longer present. The user must go to the PLL Status Menu to clear the status flag with the soft key CLR.
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 display and touch screen is used to control the CS-1 in local control mode.
REFERENCE INPUTS	
Signal	The Signal LED will turn on when the external reference is present at the Ext Ref port.
PLL	The PLL LED will turn on when the CS-1 internal PLLs are operating properly.
Ext Ref	SMA input for the 5 MHz external reference signal (+/-0.1 Hz, level +7 to +15 dBm. This input port has an impedance of 50 ohms when an external reference is provided and an impedance of 10 kOhm when routed to the tuning port of the internal 5 MHz crystal. (See Alternative Reference Configurations p.11)
Mod In	SMA input for the external modulation signal.
Trig In	SMA input for the state machine trigger signal.
RF On	The RF On LED will turn on when the 9.192 GHz output signal is activated.



OUTPUTS

- 5 MHz** SMA output providing a buffered copy of the 5 MHz reference signal. This output signal has a level of +15 dBm \pm 1 dB.
- 10 MHz** SMA output providing a buffered copy of the 5 MHz reference signal multiplied by 2. This output signal has a level of +14 dBm \pm 1 dB.
- 100 MHz** SMA output providing a buffered copy of the internally generated 100 MHz signal. This output signal has a level of +14 dBm \pm 1 dB.
- 7 MHz** SMA output providing a buffered copy of the internal DDS (Direct Digital Synthesizer) output, phase locked to the 100 MHz reference signal. This output signal has a level of -12 dBm \pm 1 dB.
- 9.2 GHz** SMA output providing a buffered copy of the internal DRO (Dielectric Resonator Oscillator) output, phase locked to the reference signal. This output signal has a level of +2 dBm \pm 1 dB.
- 9.192 GHz** SMA buffered output providing the frequency/phase modulated 9.192 GHz signal, phase locked to the reference signal. This output signal has a level between -10 dBm and +15 dBm and the default value is 0 dBm. An internal relay is used to turn off the RF signal.

Synthesizer Module: Rear Panel



DC INPUT Connectors for the DC power provided to the Synthesizer Module by the DC Module.

STANDBY Standby Switch turns off the synthesizer but keeps all oscillators powered on.

CS-1 Synthesizer Module Specifications



PARAMETER	CONDITIONS	TYP	UNITS
Frequency Stability $\sigma_y(\tau)$ Ref. 5 MHz, +13 dBm Pair measurement	Averaging time		
	1 s	$1 \cdot 10^{-13}$	-
	10 s	$1 \cdot 10^{-14}$	
	100 s	$1 \cdot 10^{-15}$	
	1000 s	$2 \cdot 10^{-16}$	
	100000 s 1000000 s	$2 \cdot 10^{-17}$ $2 \cdot 10^{-17}$	
Phase Noise $\mathcal{L}(f)$ * Carrier 9.192 GHz Pair measurement (locked 6Hz BW)	Offset frequency		
	1 Hz	-69	dBc/Hz
	10 Hz	-80	
	100 Hz	-93	
	1 kHz	-107	
Phase Noise $\mathcal{L}(f)$ Carrier 100 MHz	Offset frequency		
	10 Hz	-120	dBc/Hz
	100 Hz	-133	
	1 kHz	-155	
	>10 kHz	-175	
Phase Noise $\mathcal{L}(f)$ Carrier 10 MHz	Offset frequency		
	1 Hz	-114	dBc/Hz
	10 Hz	-142	
	100Hz	-160	
	>1 kHz	-168	
Phase Noise $\mathcal{L}(f)$ Carrier 5 MHz	Offset frequency		
	1 Hz	-118	dBc/Hz
	10 Hz	-150	
	100Hz	-167	
	>1 kHz	-173	
Temperature coefficient @ 9.192 GHz		0.5	ps/K

*Note: The PM Noise at 1 Hz for Carrier 9.192 GHz Pair measurement (locked 0.5Hz BW) -49dBc/Hz.

External Reference $5.0 \text{ MHz} \pm 2.0 \cdot 10^{-8}$ +7 dBm to +15 dBm

Rack-mount Enclosure
Size: 3U" X 19" X 16"
Weight: 20 lbs

RS-232 Port



RS-232 Communication Port

The CS-1 Synthesizer Module functions are 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 unit. 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 the LED labeled DATA will light up when data is being received or sent on the RS-232 port and can be used to verify that the unit is communicating.

Port Settings

On power-up the RS-232 port settings are:

Baud rate 9600 8 Bits 1 Stop Bit No Parity.

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

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



Upon connection of the DC Module to the AC power outlet and the DC connectors on the Rear Panel of both Modules, the Synthesizer Module has the ON LED lit up indicating that CS-1 is turned on.

The DATA LED is turned off indicating that the unit is not communicating through the RS-232 port and it is ready to receive commands from the LCD touch screen on the front panel.

The STATUS LED is turned on during the time necessary to warm-up the internal crystal oscillators. The crystal may take up to 2 hours to warm up and up to 24 hours to stabilize. Check the PLL Status Screen to know when the oscillators have warmed up and all internal loops are locked.

Reference Configuration

Upon power-up, the machine is set to work in its Internal Reference configuration that is using its internal 5 MHz crystal oscillator as the reference signal.

To set the CS-1 to work in External Reference configuration use the following sequence:

SET INST PLL EXT

then apply to the Ext Ref port a 5 MHz signal with power level between +10 and +15 dBm. Both PLLs will be properly locked as indicated by the illuminated PLL LED. Press the soft key **EXIT** three times to return to the Main Menu.

It is possible to use CS-1 in its Internal Reference configuration. To do so, go to the PLL Menu and select **INT**. The Ext Ref port is then routed to the tuning port of the internal low-noise 5 MHz reference crystal, which is now the main reference for the synthesizer. The Ext Ref port is DC coupled and has 10 kOhm impedance. The crystal has a tuning coefficient of 0.3 ± 0.1 Hz/V that allows the steering of the crystal frequency over a bandwidth of +/- 2.5 Hz. The PLL LED will be turned on indicating the use of the internal PLL operating at 100 MHz.

Menu: **PLL Status**



Output

Upon power up, the internal relay at the 9.192 GHz output port is in the OFF position and the RF ON LED is turned off.

To turn the RF output on, press the soft key **RFOFF** in the Main Screen. When the RF is turned on, the signal level at the 9.192 GHz port is 0 dBm with a preset frequency of 9.192631770 GHz. The 9.2 GHz port has a signal with level +2 dBm \pm 1 dB. The 7 MHz port has a signal with preset frequency 7.368230 MHz and level -12 dBm \pm 1dB.

Menu: **MAIN**

Frequency Control

The carrier frequency of the 9.192GHz output signal is controllable using the LCD touch screen on the front panel or through the RS-232 Communication Port. The frequency can range from 9.189631770 GHz to 9.195631770 GHz (\pm 3 MHz with respect to the preset value) with a resolution of 10^{-6} Hz.

Menu: **FREQ**

Amplitude control

The signal amplitude at the 9.192 GHz port is controllable through the RS-232 Communication Port or using the LCD touch screen on the front panel. The amplitude can range from -10 dBm to +15 dBm with a resolution of 0.1 dB.

Menu: **AMPL**

Signal Modulation

Four types of signal modulation are available to the user. The first one is linear Frequency Modulation (FM) and allows to sweep the RF carrier frequency between two values (F1 and F2) chosen by the user.



The second one is Frequency Shift Keying (FSK) Modulation and allows sideline interrogation of the Cesium resonance. The modulation is obtained by alternating between two frequency values (F1 and F2) for the 9.192 GHz output signal. The two frequency values can range from 9.189631770 GHz to 9.195631770 GHz (± 3 MHz with respect to the preset value) with a resolution of 10^{-6} Hz.

The third possibility is Phase Shift Keying (PSK) Modulation obtained by alternating between two specified amounts of phase (PHS1 and PHS2) of the 9.192 GHz output signal. The phase amounts can range between 0 and 360 degrees with resolution 0.022 degrees.

The last one is Amplitude Shift Keying Modulation (ASK), obtained by turning on and off the amplitude of the 9.192 GHz output signal. The time used by the RF signal to go from on to off (and vice versa) can range from $164 \cdot 10^{-6}$ (square-wave) to $10485 \cdot 10^{-6}$.

The modulation parameters can be programmed through the RS-232 or entered using the front panel LCD touch screen.

Menu: **MOD**

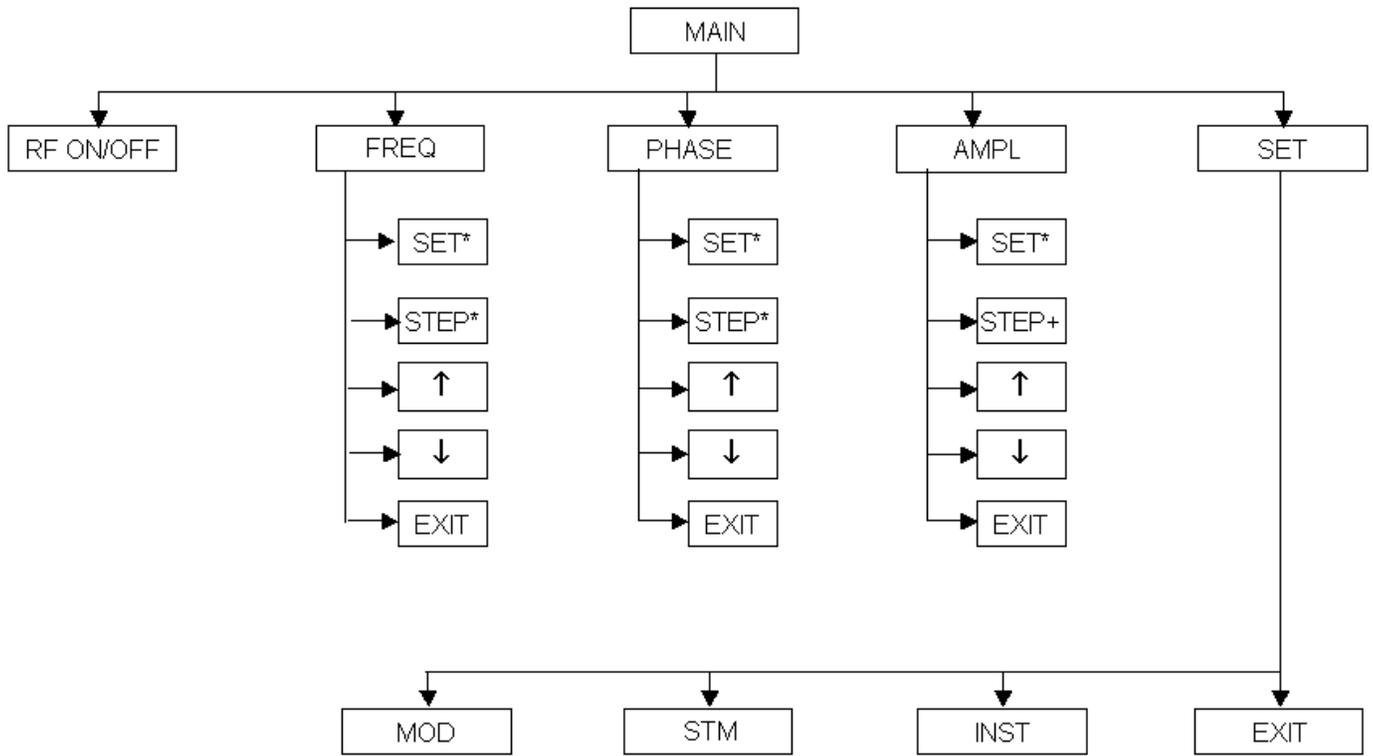
The Trigger Menu offers the possibility of synchronizing the modulation events with an external trigger provided at the Trigger In Port, setting the CS-1 to operate as a state machine. The operation as a state machine includes up to 10 states, each one incremented on every rising edge of the hardware trigger. When the state number 10 is reached the next hardware trigger resets the machine to state 1 and the cycle can continue indefinitely. The number of states or events in a sequence is programmed to be 1 through 10. Each state is defined by four parameters: frequency, phase, amplitude of the 9.192 GHz signal and the state of the RF relay (on or off).

Note: *it is not recommended to switch the RF relay with every trigger event because will significantly limit the RF relay lifetime, which is specified by a finite number of switching cycles. MTBF typically 5 million cycles.*

Menu: **TRIG**

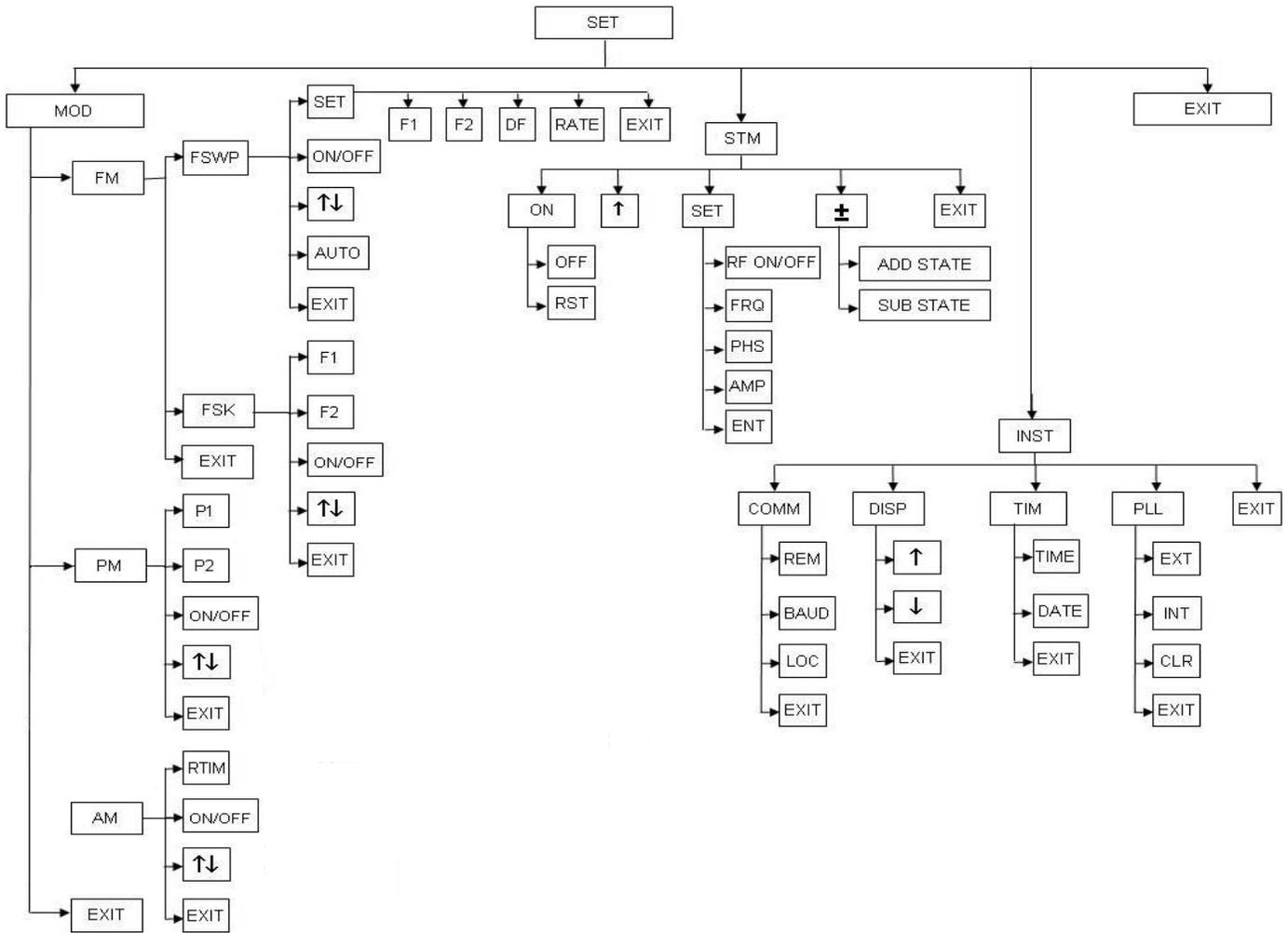
The Trigger Menu and the Modulation Menu are mutually exclusive: when the modulation parameters are entered using one of them, then the other is automatically ignored.

Menu Diagram



* This softkey gives access to the Number Menu (NUM) to make a numeric entry.

Menu Diagram





Main Screen The main screen displays the current frequency and phase and amplitude of the CS-1 Synthesizer. The soft keys at the bottom of the screen display the five main functions that are available.

DISPLAYS

Frequency Frequency of the 9.1926xx GHz output carrier expressed in Hz.

Phase Amount of phase added by the user to the 9.1926xx GHz output carrier, expressed in degrees (deg). 360 is equal to 0.

Amplitude Amplitude of the 9.1926xx GHz output carrier expressed in dBm.

MENU

RF ON/OFF Turns ON the 9.1926xx GHz output port by use of an internal relay controlled by the internal processor.

FREQ Allows changing of the carrier frequency. The FREQ soft key will bring up the Frequency Menu.

PHASE Allows changing the phase of the RF carrier signal. The PHASE soft key will bring up the Phase Menu.

AMPL Allows changing of the carrier RF amplitude. The AMPL soft key will bring up the Amplitude Menu.

SET Allows access to the instrument settings. The SET soft key will bring up the Settings Menu.

Number Entry Screen



Number 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.
kHz	Enter number in kiloHertz.
MHz	Enter number in MegaHertz.
deg	Enter number in degrees.
dBm	Enter number in dBm.
Vrms	Enter number in Volts RMS.
Vpp	Enter number in Volts peak-to-peak.
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.

Frequency Screen



Frequency Screen The frequency screen allows the changing of the 9.192 GHz carrier frequency using the soft keys at the bottom of the screen as described below.

DISPLAYS

Frequency Current frequency of the 9.1926xx GHz output carrier expressed in Hz.

MENU

SET Allows entering the new carrier frequency using the Frequency Entry Menu. The preset value is 9.192631770 GHz. The new frequency can be specified in Hz, kHz or MHz and can range from 9.189631770 GHz to 9.195631770 GHz (± 3 MHz with respect to the preset value). The frequency resolution is 10^{-6} Hz.

STEP Allows entering the frequency step size (in Hz, kHz or MHz) using the Frequency Entry Menu. The maximum frequency step size is 6 MHz and the frequency step resolution is 10^{-6} Hz.

UP Increases the carrier frequency by the frequency step size.

DOWN Decreases the carrier frequency by the frequency step size.

EXIT Exit to previous menu

Phase Screen



Phase Screen The phase screen allows the changing of the 9.192 GHz carrier phase using the soft keys at the bottom of the screen as described below.

DISPLAYS

Phase Current phase added to the 9.1926xx GHz output carrier, expressed in degrees (deg).

MENU

SET Allows entering the phase to be added to the 9.1926xx GHz signal using the Phase Entry Menu. The new phase is specified in degrees (deg) and must be with the interval -360 deg to 360 deg. The phase resolution is 0.022 deg.

STEP Allows entering the phase step size (in degrees) using the Phase Entry Menu. The maximum step size is 360 deg. The phase step resolution is 0.022 deg.

UP Increases the carrier phase by the phase step size.

DOWN Decreases the carrier phase by the phase step size.

EXIT Exit to previous menu

Amplitude Screen



Amplitude Screen The amplitude screen allows the changing of the 9.1926xx GHz signal amplitude using the soft keys at the bottom of the screen as described below.

DISPLAYS

Amplitude Current amplitude of the 9.1926xx GHz output carrier, expressed in dBm.

MENU

SET Allows entering the new amplitude of the 9.1926xx GHz carrier using the Amplitude Entry Menu. The amplitude can be expressed in dBm, Vrms or Vpp, always referring to 50 Ohm characteristic impedance. The amplitude can range from -10 dBm to +15dBm.

STEP Allows entering a step size in dBm using the Number Menu (NUM). The smallest step size is 0.1 dB.

UP Increases the carrier amplitude by the step size.

DOWN Decreases the carrier amplitude by the step size.

EXIT Exit to previous menu.

Settings Screen



Settings Screen The settings screen is used to access, view and edit instrument options.

MENU

- MOD** Setup Modulation options.
- FM** Setup Frequency Modulation.
- PM** Setup Phase Modulation.
- AM** Setup Amplitude Modulation.
- STM** State Machine Trigger setup and information. The STM key will bring up the State Machine Trigger Screen.
- INST** Instrument setup and information. The INST key will bring up the Instrument Screen.
- EXIT** Exit to previous screen.

Modulation Screen



Modulation Screen The modulation screen allows setting of the modulation parameters using the soft keys described below, according to the possibilities described in Basic Operation section.

MENU

FM allows two options for the frequency modulation (FM) of the 9.1926xx GHz output signal: a Frequency Sweep and Frequency Shift Keying (FSK) modulation. This soft key gives access to the two FM menus:

FSWP allows access to the Frequency Sweep Menu.

FSK allows access to the Frequency Shift Keying Menu.

EXIT returns to the Modulation Menu.

PM allows Phase Shift Keying (PSK) modulation of the 9.1926xx GHz output signal.

AM allows Amplitude Shift Keying (ASK) modulation of the 9.1926xx GHz output signal.

EXIT Returns to previous menu.

Frequency Sweep Screen



FSWP Screen The frequency sweep screen allows setting of the parameters of the linear frequency modulation. When FSWP is enabled a * **character** will appear before the frequency display in the Main Screen.

DISPLAYS

F1	Sweep start frequency in Hz.
F2	Sweep stop frequency in Hz.
DF	Step size in Hz.
RATE	The frequency step rate in Hz.

Use with External Modulation Input.

The first rising edge of a TTL level signal on the external modulation input starts a sweep with increasing frequency and subsequent pulses will change direction of the frequency sweep. **To turn off the frequency sweep, toggle the ON/OFF soft key.**

Frequency Sweep Screen



MENU

- SET** Allows entering the frequency sweep parameters. Each one of the soft keys described below will bring up the Frequency Entry Menu, to enter the numeric quantities, expressing them in Hz, kHz or MHz.
- F1** Sweep start frequency in Hz. Valid range of values is from 9.189631770 GHz to 9.195631770 GHz (± 3 MHz with respect to the preset value). The resolution is 10^{-6} Hz.
- F2** Sweep stop frequency in Hz. The stop frequency must be greater than the start frequency and within the range specified above.
- DF** Step size in Hz. The step size must be smaller than the difference in frequency between the start and stop frequency. The smallest step size is 10^{-6} Hz.
- RATE** The frequency step rate in Hz. The frequency step rate must be between 48 Hz and 25 MHz.
- EXIT** Returns to the previous menu.
- ON/OFF** Toggles frequency sweep on or off.
- UP/DOWN** Toggles between sweep upward or downward in frequency.
- AUTO** Turn on automatic sweep function allowing for continuous up/downward sweep.
- EXIT** Exit to previous menu.

Frequency Shift Keying Screen



FSK Screen The frequency shift keying screen is used to access, view and edit frequency shift keying modulation options. When FSK is enabled a * **character** will appear before the frequency display in the Main Screen.

DISPLAYS

- F1** First frequency setting in Hz.
- F2** Second frequency setting in Hz.

MENU

- F1** Allows entering the *first* frequency value using the Frequency Entry Menu. The valid range is from 9.189631770 GHz to 9.195631770 GHz (± 3 MHz with respect to the preset value). The frequency resolution is 10^{-6} Hz.
- F2** Allows entering the *second* frequency value using the Frequency Entry Menu. F2 needs to be larger than F1 and within the range specified above.
- ON/OFF** Toggles FSK modulation of or off.
- UP/DOWN** Toggle between frequency 1 and frequency 2.
- EXIT** Exit to previous menu.

Use with External Modulation Input.

Each rising edge of a TTL level signal on the external trigger input will trigger a frequency shift of the carrier between F1 and F2. **To turn off the modulation, toggle the ON/OFF soft key.**

Phase Modulation Screen



PM Screen The phase modulation screen is used to access, view and edit phase shift keying modulation options. When PM is enabled a * **character** will appear before the phase display in the Main Screen.

DISPLAYS

Phase 1 First phase setting in degrees.

Phase 2 Second phase setting in degrees.

MENU

PHAS1 Allows entering the *first* phase value using the Phase Entry Menu. The phase is specified in degrees (deg) and must be within the interval -360 deg to 360 deg. The resolution is 0.022 deg.

PHAS2 Allows entering the *second* phase value using the Phase Entry Menu according to the specifications above.

ON/OFF Toggle phase modulation on or off.

UP/DOWN Toggle between phase 1 and phase 2.

EXIT Exit to previous menu.

Use with External Modulation Input.

Phase shift between phase 1 and phase 2 of the synthesizer occurs on each rising edge of a TTL level signal on the external modulation input. **To turn off the modulation, toggle the ON/OFF soft key.**

Amplitude Modulation Screen



AM Screen The amplitude modulation screen is used to access, view and edit amplitude shift keying modulation options. When AM is enabled a * **character** will appear before the phase display in the Main Screen.

DISPLAYS

RTIM The ramp time, the time in microseconds that it takes for the output amplitude to go from off to on.

MENU

RTIM Allows entering the time used by the RF signal to go from on to off and vice versa (ramp time). The ramp time can range from $164 \cdot 10^{-6}$ (square-wave) to $10485 \cdot 10^{-6}$.

ON/OFF Toggle modulation on or off.

UP/DOWN Toggle between amplitude off to amplitude on.

EXIT Exit to previous menu.

Uses External Modulation Input.

The amplitude change from off state to on state of the synthesizer occurs on each rising edge of a TTL level signal on the external modulation input. **To turn off the modulation toggle the ON/OFF button.**

State Machine Trigger Screen



SMT Screen The state machine trigger screen allows synchronization of the modulation events with an externally provided hardware trigger (see Synthesizer Module Front Panel), setting the CS-1 to operate as a state machine. The operation as a state machine includes up to 10 states, each one incremented on every rising edge of the hardware trigger. When the state number 10 is reached the next hardware trigger resets the machine to state 1 and the cycle can continue indefinitely. The number of states or events in a sequence is programmed to be 1 through 10. Each state is identified by four parameters: frequency, phase and amplitude of the RF carrier and the state of the RF relay (on or off).

Note: *it is not recommended to switch the RF relay with every trigger event because will significantly limit the RF relay lifetime, which is specified by a finite number of switching cycles. MTBF is typically 5 million cycles.*

DISPLAYS

- State n/m** Indicates which state is being edited (n) and the total number of states that have been programmed (m).
- RF ON/OFF** Current position of the RF relay at the 9.1926xx GHz output port.
- Frequency** Current frequency of the 9.1926xx GHz output carrier expressed in Hz.
- Phase** Current phase of the 9.1926xx GHz output carrier expressed in degrees.
- Amplitude** Current amplitude of the 9.1926xx GHz output carrier expressed in dBm.

MENU

- ON** Enables, disables and resets the operation of CS-1 as a state machine
- OFF** Disables the state machine operation.
- RST** Resets the state machine cycle, forcing the next executable state to be state 1.

State Machine Trigger Screen



- NEXT** Allows access to the next state of the state machine.
- SET** Allows the setting of the four parameters describing each state of the CS-1.
- RF ON/OFF** Sets the RF relay to be on or off for this state.
- FREQ** Allows entering the carrier frequency for this state, using the Frequency Entry Menu. The frequency can be specified in Hz, kHz or MHz and can range from 9.189631770 GHz to 9.195631770 GHz (± 3 MHz with respect to the preset value 9.192631770 GHz). The frequency resolution is 10^{-6} Hz.
- PHAS** Allows entering the phase to be added to the RF carrier signal for this state, using the Phase Entry Menu. The phase is specified in degrees (deg) and must be with the interval -360 deg to 360 deg. The resolution is 0.022 deg.
- AMPL** Allows entering the amplitude of the RF carrier for this state, using the Amplitude Entry Menu. The amplitude can be expressed in dBm, Vrms or Vpp, always referring to 50 Ohm characteristic impedance. The amplitude can range from -10 dBm to +15dBm.
- EXIT** Enters the new state.
- +/-** Allows adding (subtract) a state to (from) the programmed sequence:
- ADD** Adds a new state, *always at the end of the existing sequence*. By default the new state is a copy of the last state of the sequence before the addition.
- DEL** Eliminates the *last state* of the sequence.
- EXIT** Return to previous menu.



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

MENU

COMM Set serial communications options and RS-232 remote control configuration.

DISP Change the brightness of the LCD display.

UP Increase the value.

DOWN Decrease the value.

EXIT Exit to previous screen.

TIME Set the instrument date and time.

PLL Allows access to the PLL Menu to change the reference configuration of CS-1.

EXIT Exit to previous menu.



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 RS-232 port section on page 9 of this manual.

DISPLAYS

Current baud rate setting.

MENU

REM/LOCL Allows entering remote control mode: CS-1 is now waiting for commands through the RS-232 serial port. The RS-232 port is set as 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 RS-232 Port Communication section of the manual. To restore local control and terminate remote control session use the soft key LOCAL.

BAUD Toggle through available baud rates.

9600, 19200, 38400, 57600, 115200, 14400, 28800

TEST Test Serial port.

EXIT Exit to previous screen.

Time Screen



Time Screen The time screen allows changing time and date of CS-1, according to the soft keys described below.

DISPLAYS

Time current time in the form *hh:mm:ss*.

Date current date in the form *mm/dd/yy*.

MENU

TIME Allows entering new time using the Time Entry Menu in the form *hh:mm:ss*.

DATE Allows entering new time using the Date Entry Menu in the form *mm/dd/yy*.

UP Increments the current time by one second.

DOWN Decrements the current time by one second.

EXIT Return to previous menu.



PLL Screen The PLL Menu is used to choose the Reference Configuration and to view the current PLL voltages and RF power levels. All voltages and levels that are in the normal operating range will be displayed in green. All voltages and levels that are outside the normal operating range and indicate an error condition will be displayed in red. The CLR soft key can be used to clear the status register and turn off the status LED.

Note: The CLR function will turn off the status LED only if the error condition has been resolved.

DISPLAYS

5 MHz: power level of the internal 5 MHz signal. It should be about +12 dBm.

Ref power level of the 5 MHz external reference signal. It should be between +7 and +15 dBm.

100 MHz: power level of the 100 MHz signal. It should be at least +11 dBm.

LVn: indicates the locking voltage for the three PLLs of the CS-1. $n=1$ is the 5 MHz PLL, while $n=2$ is the 100 MHz PLL. They are locked when the displayed value is between 0.2 and 0.3. $n=3$ is the PLL for the DRO and it is locked when the displayed value is 2.5.

TVn: indicates the tuning voltage for the internal 5 MHz and 100 MHz oscillators. It should be within ± 5 .

DC tuning enabled indicates that the Internal Reference configuration is enabled. *This is displayed in place of Ref, LV1 and TV1 because the 5 MHz PLL is disabled.*



MENU

- EXT** Enables the External Reference configuration. The Ext Ref port is now set to receive a 5 MHz signal with level between +10 to +15 dBm.

- INT** Enables the Internal Reference configuration. The Ext Ref port is now routed to the tuning port of the internal 5 MHz oscillator and is set to receive a DC-coupled tuning signal. The DC voltage should be less than +/-5VDC.

- CLR** Allows the clearing of the status register, turning off the status LED, if the error condition that caused it has been resolved.

- EXIT** Exit to previous menu.

Warranty



The CS-1 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 CS-1 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 judgment 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.

