5009 Dual Frequency Synthesizer Module

Operations Manual

Version 1.36

August 02, 2019

1　Introduction

1.1　Overview

The Valon Technology 5009 Dual Frequency Synthesizer Module is a versatile, low-cost dual channel, PLL-synthesized RF signal source programmable from 23.5MHz to 6GHz , with output level control from approximately +15dBm to -15 dBm in 0.5dB steps. Both sources are locked to a common internal TCXO reference or to an external frequency reference.   The synthesizers are fully shielded by machined aluminum, RF-tight, housing and use low noise circuit techniques to ensure high signal purity.

The 5009 can be controlled using simple, human-readable, commands either through the micro-USB port or the direct TTL-User port.   Alternatively, the 5009 can be configured using the V5009CM.exe downloadable MS-Windows based graphical user interface. The 5009 settings can all be saved to non-volatile flash memory for automatic recall on power up.

1.2　Detailed Description
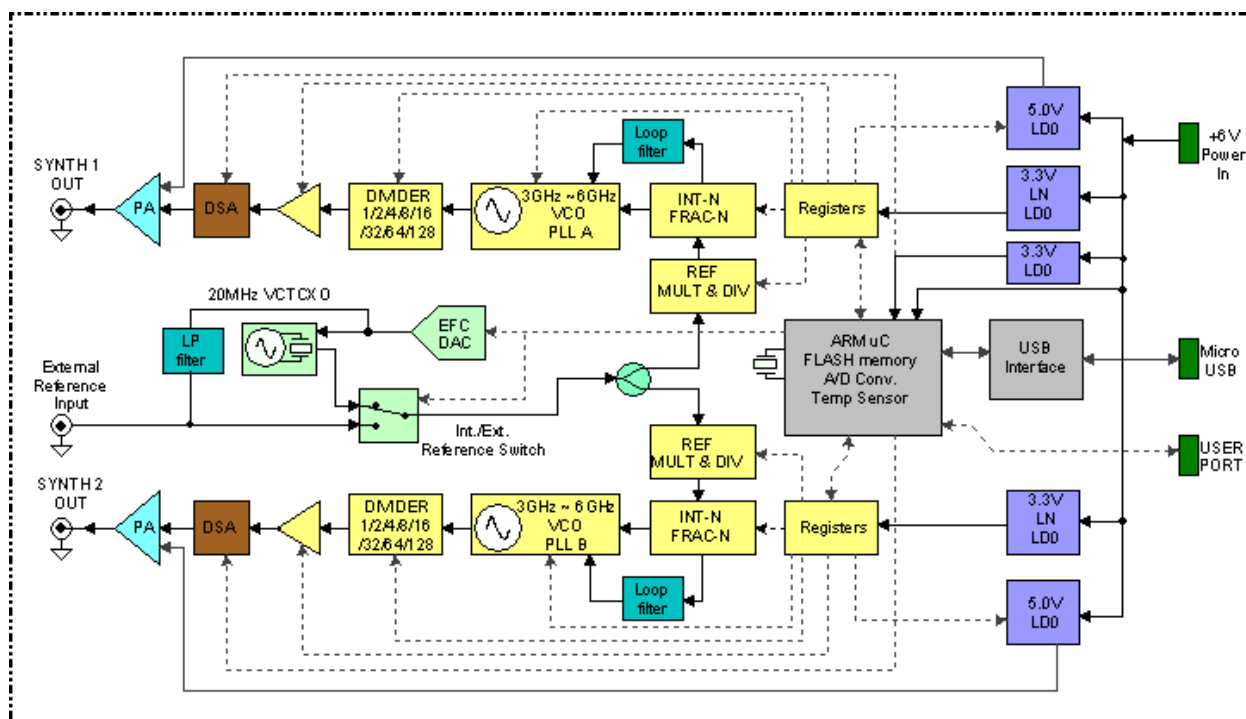

Figure 1 Block Diagram

Figure 1 shows a block diagram of the 5009 system topology. The 32-bit ARM processor controls the operation of the synthesizer as well as storing user settings in non-volatile flash memory. Simple, human readable, commands can be sent through either the micro-USB serial port or to the 3.3V TTL USER port to control the operation of the 5009 synthesizers.

When the processor receives a command, it then calculates the register values required for each synthesizer and any other hardware. The ARM processor can make these calculation very quickly which allows for fast sweep operation by simply setting the start and stop frequencies.

The actual synthesizers are integrated VCO/PLL ICs. The basic synthesizer VCO frequency is 3000MHz to 6000MHz. Subsequent lower frequencies are created by dividing the VCO output by cascaded digital dividers. Since these dividers are digital, the output frequency will not be a sign wave and will have high harmonic content.

The output of the divider is amplified by a pre-amplifier that has 4-level of gain control. This, together with the following digital step attenuator (DSA) provides just over 30dB of level control in 0.5dB steps.   The PA provides additional flat gain to give an output of typically +15dBm over the full frequency range with a typical return loss of 14dB. The pre-amplifier can be turned off which drops the output level by approximately 50dB providing a low level output at around -65dBm.

Both synthesizer are locked to a 40MHz internal high-stability, low phase noise, precision analog compensated VCTCXO.   The initial accuracy is better than 2ppm and the stability over temperature and time is better than 2ppm. Typical initial frequency error is less than 1ppm while the stability over the -30deg. C. to +70deg. C is less than 0.5ppm. For even better stability the user can select an external reference in the range of 10MHz to 200MHz. The VCTCXO allows the user to correct any frequency error to within about 0.010ppm using the   Also, the VCTCXO option allows for electronic frequency control (EFC) by applying a dc tune voltage to the external reference input.

The 5009 uses a total of five, low-noise, low dropout voltage regulators. Having multiple separate regulators maximizes the isolation between each synthesizer output and helps improve close-in phase noise performance. Ultra low noise LDOs are used to power the integrated PLL/VCO ICs while a 5V LDO is used to power the output power amplifier. The ARM processor and USB interface have a separate 3V LDOs which isolate digital processor noise from the synthesizers. The VCTCXO is powered by the synthesizer 1's 3V ultra low noise LDO.

The synthesizer is designed to run from an external 6Vdc power supply capable of supplying the maximum current draw (see specifications).   No special power supply is required and most switching power supplies will work without degrading the noise performance of the synthesizers. The maximum input voltage is 8Vdc. Above 9.8V, the synthesizer will shut down. When using the synthesizer at power supply voltage higher than 6V, it may be necessary to provide additional heat sinking or cooling depending upon the operating environment maximum temperature expected. The absolute non-operational maximum input is ± 16V, reverse polarity protection is provided. The **5009 cannot be powered from the USB port**.

Raising the input voltage to >10V for more than 10sec will reset all of the synthesizers stored settings to the factory default values.

The 5009 is equipped with a USER PORT which can be use to provide a direct TTL-serial interface at a default baud rate of 115200. The USER PORT is also used in LIST mode to allow remote

switches to select preset frequencies. In SWEEP mode the USER PORT has sweep trigger and sweep enable signals preset.

1.3 Electrical Specifications

Note: The 5009 is **NOT** USB powered See Valon **PS6V-1** power supply kit.

DC Input

Input Voltage Range	
Absolute Max	+16V to -16V (reverse protected)
Operational Max	+8v
Operational Min	**+6V Recommended Operation Voltage**
Reduced performance	+4.8 to 5.8V (output power reduced)
Min non-operational	+3.5V (synthesizer remains locked and serial port ok)
	>10V for >10sec resets the synthesizer to factory default settings
Input Current	
Source 1 and Source 2 on	560mA Output Enabled
	330m Output disabled
Source 1 or Source 2 on	190mA Output disabled
	270mA Output enable
Source and Source 2 off	30mA both disabled
DC Input Connector	Hirose DF3A-2P-2DS
	Mates with Hirose DF3-2S-2C plug and pre-crimped wire H2BXT-10112-R4 (red) and H2BXT-10112-B4 (black). 20" dc cables supplied with synthesizer, additional cables available.

Full performance is obtained when the dc input voltage is in the operational range. If the input voltage is increased above the operational range, the output will be disabled and the synthesizer will be in standby mode.   The synthesizer may be operated with reduced RF output power in the reduced performance voltage range. If the dc voltage is in the Min non-operational range, the output will be disabled but all user setting will be retained. Input voltages below the minimum non-operational range will cause a reset condition.

RF Synthesizer Specifications (Unless otherwise noted, all specifications apply equally to both synthesizers.)

Frequency Range		
Max	6000MHz	
Min	23.5MHz	
Frequency Increment (Fractional-N Mode)	20MHz reference	20MHz reference
Frequency Range (MHz)	Reference Doubler ON	Reference Doubler OFF
3000~6000	10 kHz	5 kHz
1500~3000	5 kHz	2.5 kHz
750~1500	2.5 kHz	1.25 kHz
375~750	1.25 kHz	1 kHz
187.5~375	1 kHz	500 Hz
93.75~187.5	500 Hz	250 Hz
46.875~93.75	250 Hz	100 Hz
23.4375~46.875	100 Hz	50 Hz
	(minimum step size)	(minimum step size)

Frequency Lock Time	<100uS Lock time is from the time the frequency command is sent, or a frequency step in sweep mode, or input from User Port in List mode to a sable Lock Detector output							
Frequency Increment (Integer-N Mode)	20MHz reference				20MHz reference			
Frequency Range (MHz)	Reference Doubler ON				Reference Doubler OFF			
3000~6000	40 MHz				20 MHz			
1500~3000	20 MHz				10 MHz			
750~1500	10 MHz				5 MHz			
375~750	5 MHz				2.5 MHz			
187.5~375	2.5 MHz				1.25 MHz			
93.75~187.5	1.25 MHz				625 kHz			
46.875~93.75	625 kHz				312.5 kHz			
23.4375~46.875	312.5 kHz				156.25kHz			
Sweep rate	0.1ms to 1sec in 0.1ms steps							
Phase Noise	Typical phase noise as measured with Berkeley Nucleonics 7300 Signal Source Analyzer							
	10Hz	**100Hz**	**1kHz**	**10kHz**	**100kHz**	**1MHz**	**10MHz**	
6GHz	-54	-59	-85	-90	-94	-126	-147	dBc/Hz
5GHz	-57	-61	-86	-93	-94	-127	-149	dBc/Hz
4GHz	-76	-82	-89	-98	-95	-129	-150	dBc/Hz
3GHz	-60	-65	-93	-101	-100	-134	-150	dBc/Hz
2GHz	-64	-69	-96	-104	-100	-130	-152	dBc/Hz
1GHz	-70	-99	-99	-107	-106	-140	-152	dBc/Hz
500MHz	-76	-81	-105	-113	-112	-124	-152	dBc/Hz
200MHz	-83	-89	-113	-121	-124	-152	-155	dBc/Hz
40MHz	-90	-104	-126	-132	-135	-156	-157	dBc/Hz
Harmonics	The 5009 output waveform is a clipped sine wave. Harmonics are typically 12dBc. Odd harmonics are most prominent.							
Spurious	Non-Harmonic <-60dBc except boundary spurs							
Output Return loss	Min.(dB)		Typical(dB)					
25~ 100MHz	>5		8dB					
100 ~ 1000MHz	>9		15					
1000 ~ 2000MHz	>8		10					
2000 ~ 4000MHz	>6		8					
4000 ~ 6000MHz	>7		10					
Connectors	SMA Female							

Unless otherwise noted, all specifications apply equally to both synthesizers.

AM Modulation	0.5dB to 31.5dB
AM Frequency	
Range	0.5Hz to 10kHz
Accuracy	±0.5Hz
AM Waveform	50% duty cycle square wave

Output Amplitude Frequency Response (PLEV=4, ATT=0) Freq. Range (MHz)	Min dBm	Typ. dBm	Max. dBm
25~100	>12	17	<17.5
100~4000	>13	15	<17
4000~6000	>10	14	<16

Attenuator	
Relative Attenuation Range	0dB to 31.5dB
Attenuation Step Size	0.5dB
RF output On/OFF	When off power is reduced by ~30dB

Reference Frequency

Internal Reference	
Frequency	20.000MHz
Initial Accuracy	± 2ppm (23°C)
Temperature Stability	±0.5ppm -20°C to +70°C (case temp)
Reference Trim Range	± 10ppm
Reference Trim Resolution	8-bit, 10-bit after 12/2016
Internal Phase Frequency Detector (PFD)	Max 140MHz, 125MHz Fractional mode Min 1 MHz
External Reference Frequency Range Input power range	50Ω nominal impedance 10MHz to 210MHz (max PFD 140MHz integer mode, 125MHz fractional mode) -10dBm min. +13dBm max. (note, external reference as low as -50dBm with reduced phase noise performance)
External Reference Connector	SMA Female 50Ω nominal impedance Note: Ext input is ac coupled to synthesizer but dc coupled to internal VCTCXO control circuit. External reference should be disconnected when using internal reference.
External Reference Return Loss 10MHz 20MHz 50MHz 100MHz 200MHz	10dB typical 50Ω nominal impedance >24dB >20dB >14dB >6dB >5dB
EFC Electronic frequency Control at external reference input	Pulling range >±10ppm Voltage ±3V Input resistance 20kΩ Frequency response 0Hz~>5kHz

Interface

USB	**Micro-B socket**
	FTDI virtual com port
	9600, 8, N,1,N default- Automatically shift to 115200 with GUI
	See FTDI for drivers for your computer. Note: The Configuration Manager GUI will automatically configure the USB port and switch to 115200 baud rate.
USER PORT	**3.3V TTL TXD & RXD**
	(see section 5)
	115200,8,N,1,N default
	Hirose DF11-8DP-2DS
	Mates with Hirose DF11-8DS-2C plug and pre-crimped
	wireH3BXT-10112-** (DigiKey)
	LSW-1 LIST Mode switch and cable accessory is also available.
	External Trigger Input: 3.3V TTL Hi-Z input
Selectable Baud Rates	Either port: 9600, 19200, 38400, 57600,115200, 230400, 460800, 921600

Environmental

Operational full specifications:	-20°C~+70°C (case temperature)
No damage functional:	-40°C~+85°C (case temperature)
Humidity:	5%~95% minimal condensation allowed
IP rating:	50 No water protection.

1.4   User interface USB and TTL User Port

The simplest way to set frequencies and configure the 5009 synthesizer module is to use the USB port with the Valon Technology downloadable V5009CM.exe Configuration Manager (GUI). The Configuration Manager is a MS Windows compatible graphic user interface. No programming knowledge is required. The V5009CM will automatically detect a connected 5009 synthesizer and configure the USB port. Multiple 5009 synthesizers can be supported simultaneously with multiple instances of the V5009CM GUI.

Alternatively, the user can also use our 5000term.exe terminal program, Figure-2, to control and configure the synthesizer using simple text commands. 5000term.exe will support multiple 5009 synthesizers. If you have more than one 5009 connected, you can simply start a new instance of 5000term which will connect to the next 5009 synthesizer found. Alternatively, you can type 5000term -S <serial_num> where <serial_num> is the serial number of the 5009. You can find the serial number of the 5009 by using the **ID** or **STAT**us command.   There serial number will appear as shown:

```
Valon Technology, 5009, 12201623, version 1.0   Build: Jul  4 2019  13:11:04
```

Any other terminal program should also work well, however 5000term.exe will automatically detect the 5009 and configure the virtual serial port. A list of available commands appears in section 4.

```
C.S. cmd.exe - Shortcut - Copy - 5009term

Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Files\EEprojects\Valon\122019 dual 6GHz 5009\5009 FW>5009term
5009term: Serial terminal/5009 programmer V0.5 (Jun 17 2015 11:50:30).
Copyright David Paulsen Consulting  1992 - 2015.  All rights reserved.
Development version for internal use only!  CNTL-BREAK or char 3 (^C) to exit.
CNTL-R to reset processor.
CNTL-F to switch to fast baud rate.
Using 9600 BAUD

-2->help
           Source  : <1|2>  Set synth number for subsequent commands
             TRGR  : Start a sweep in manual trigger mode
             DALL  : Dump all synth parameters for both synths
             LOCK  : [1|2]? Display lock
               LK  : ...
               ID  : Device ID info
             Help  : Help
              RCL  : Recall state from flash
              RST  : Reset to default factory settings
```

Figure 2 5000term.exe terminal program provides a convenient method of direct synthesizer control using simple commands.

Links to our GUI and terminal program are shown below in the Quick Start section 2.0.

Also available is a direct 3.3V TTL serial interface at the USER PORT. This allows the same command set to be sent directly to the ARM processor from a host processor without requiring any USB connection.   This port can also be used with the optional external RS-232 to TTL serial adapter. This 3V TTL/CMOS port is also 5V tolerant. For more information on this port, see section 5.

The default baud rates are 9600 for the USB port and 115200 for the USER PORT. Either port can be set to 9600, 19200, 38400, 57600, 115200, 230400, 460800, or 921600.

1.5   Setting the Baud Rate

The USB port baud rate can be changed using the baud command as in "baud 115200" which changes the synthesizer baud rate from the default value of 9600 to 115200. However, once the baud rate has been change it will be necessary to exit the terminal program using "ctrl C" because communication will no longer be possible. To reestablish communication, restart the terminal program with the corresponding baud rate. When using 5000term.exe, the command would be "5000term -r115200. Note: If you want the baud rate to persist after power down, use the SAVe command.

1.6   Safety

The 5009 Dual Frequency Synthesizer operates on an external, user provided, low-voltage power supply. The user is responsible for ensuring the safety of the power source and any components or equipment connected to it including this one. The 5009 can be connected to any number of external components and care should be taken to fully understand the safety issues with these connections. Valon Technology is not responsible for any damage this equipment causes to any other equipment connected to or used with it in any way.

1.7 Power Connections

Power connections are made to the dc power supply using the supplied Hirose 2-pin plug and 24" pig-tail cable assembly. The optimum input voltage for full performance is 6 Volts at ~600mA maximum (less current if only using one source). The red wire is the positive input and correct polarity is required. The 5009 is reverse polarity protected and no damage will occur if reverse connected to dc power supplies of less than 15V. There is no provision for power to be supplied by USB.

1.8 RoHS (Restriction of the use of certain Hazardous Substances)

The 5009 module is manufactured using all RoHS compliant components and RoHS compliant printed circuit board processing. The case is manufactured using only aluminum with steel fasteners.

Valon Technology, LLC certifies that the 5009 is RoHS compliant and conforms with the requirements of EC directive 2002/95/EC (RoHS) by having no intentional addition of Lead (Pb), Cadmium (Cd), Mercury (Hg), Hexavalent Chromium (Cr), Polybrominated Biphenyls (PBB), Polybrominated Diphenyl Ethers (PBDE), and any trace impurities of these substances are below the threshold limits as specified by the RoHS directive, specifically Cr+6, Hg, Pb, PBB, PBDE do not exceed 1000 ppm (0.1%) and Cd does not exceed 100 ppm (0.01%).

1.9 FCC Part 15

The 5009 is considered an industrial component and is intended to be incorporated into customer supplied equipment and is therefore exempt from FCC Part 15.

1.10 Default Frequency Setting

The table in section 2 shows the default settings.

1.11 Cleans Function (Sanitize)

The Cleans function (or sanitize) completely erases all stored user entries including frequency settings, LIST settings, and Sweep Start and Stop settings and restores the default frequencies. The Cleans function can be set by selecting Cleans from the Configuration Manager drop down **Synthesizer** menu tab, or in the case where no serial interface is available, the input voltage can be raised to 10.0V for >4 seconds.

1.12 Place of Manufacture

The Valon 5009 printed circuit boards are fabricated and assembled in Northern California. All components are sourced from U.S.A. vendors and distributors. Final assembly and test is performed at Valon Technology.

2   Quick-Start Instructions

The 5009 Dual Frequency Synthesizer module has been pre-programmed to 2440MHz for the Source1 and 2480MHz for source2. Just apply 6Vdc @ ~600mA using the supplied power cable (red +, black -). Plug it in now! Within 2 seconds, the two blue LED lock lights should be illuminated (see note at end).

In order to program your desired frequencies or change any other settings you will need to download the **Configuration Manager** graphical user interface (GUI) program at: http://valontechnology.com/5009users/5009.htm.   (Please note: The 5009 does not use the same Configuration Manager as the 5007/5008 synthesizers).

Note: If you don't want to use the GUI and would prefer to use a terminal program, go to section 4.

1. From the website link, click the V5009CM.exe and save the program to your desktop or any other folder.

2. Connect the micro-USB cable to your PC and the synthesizer module. Your computer should automatically start to detect the new USB device. If it does not you may need to install the FTDI driver. http://www.ftdichip.com/Drivers/VCP.htm.

3. Launch the V5009CM GUI program by double-clicking the icon. At the start of the launch process a Windows dialog box will appear that verifies that a Valon 5009 synthesizer is connected. The serial number and virtual com port will be displayed. More than one 5009 synthesizer may be connected. This dialog box allows the selection of the desired synthesizer. To control another synthesizer, start another instance of the configuration manager.
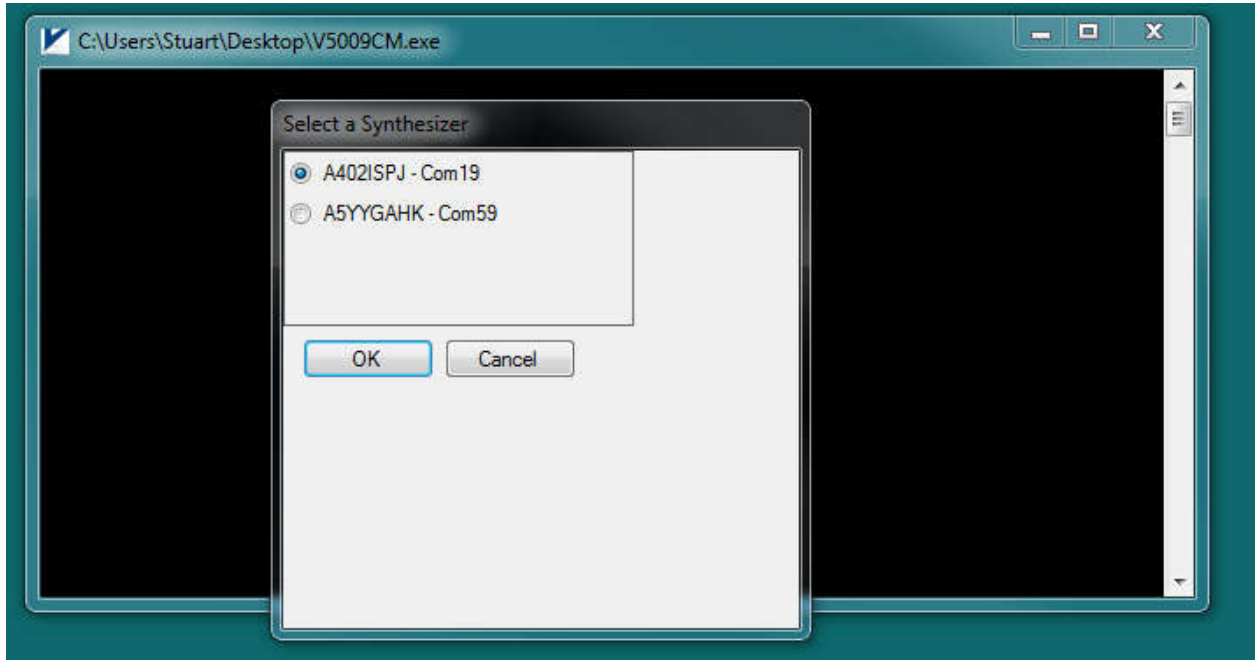
Figure 3 V5009CM dialog box at program launch. Note that two 5009 synthesizers are shown connected with the option to select either.

4. Once the connection to the synthesizer is established, it is recommended that you select **Synthesizer/Read Registers** command before you perform any other operation. That will update the Configuration Manager with all the initial register values that were programmed into your synthesizer as it was shipped. Make a note of the serial number for future reference. You may want to save these original setting by using the **File/Save Config** command. This will save your synthesizer's register setting to a disk file.

5. Now you are ready to change your frequency settings using the CM. Once you are satisfied with your settings use the **Synthesizer/ Save to Flash** command to store your settings in non-volatile flash memory.

6. Your 5009 is initialized to use the internal 20MHz reference. You can easily change to an external reference by clicking the **External** button in the **Reference Select** section of the Configuration Manager. When an external reference has been connected and selected, it may be necessary to update the synthesizer with a **File/Write Registers** command.

Note: Supply Voltage and Current 6.0V 600mA. You may experience startup and lock problems if you are using clip leads to connect the supplied leads to a power supply. The supplied leads should be connected directly to a low impedance dc power supply.

3 Configuration Manager (CM) graphical user interface (GUI)

The **Configuration Manager** can be used to quickly and easily set the 5009 dual synthesizer frequencies and mode of operation. The Configuration Manager is available as a free download from the Valon Technology Products web site. Install the V5009CM.exe in any directory or on the desktop.

3.1 Configuration Manager Menu Bar
The CM menu bar provides quick access to the 5009's various operational modes.

File: The File drop-down menu item provides.

File/Load Config; Loads all the previously saved CM configuration parameters from a .VR0 file to the active CM.

File/Save; Saves the all the current CM configuration parameters to a file.

File/Toggle LogFile; Creates a log5009.txt log file in the directory that the CM is in and captures all CM commands and responses.

File/Exit; Closes the CM.

Synthesizer:
Synthesizer/Read Registers; Read registers will fill the CM with the all the parameter data of the connected synthesizer model. Do this when first connecting to a synthesizer model.

Synthesizer/Write Registers; Write registers will transfer all CM data to the synthesizers module. Use this if you just loaded a configuration from a file and want to update the synthesizer with the new parameters. WRIT is primarily used by the GUI to send all of the GUI setting to synthesizer with just one command.

Synthesizer/Reset; Resets the synthesizer to the factory presets.

Synthesizer/Save to Flash; Saves all synthesizer setting to non-volatile flash memory. Next power up will restore these settings.

Synthesizer/Recall from Flash; Recalls synthesizer settings from flash memory.

Synthesizer/Cleanse; Completely clears all edited synthesizer setting and information including synthesizer names.

View:
View /Small Font; Smaller screen size and fonts.
View /Large Font; Larger screen size and fonts.

3.2   Configuration Manager Main Page

Clicking **Main** button on the Configuration Manger allows the user to enter the desired operating frequencies and output power attenuation levels. The Main page also has a number of useful secondary functions.

Frequency: Enter the desired operating frequency here. The up and down arrows in the Frequency window will increment or decrement the displayed frequency by the Step Frequency amount.

Step Frequency: Amount the Frequency will change with the Frequency up and down arrows.

Offset Frequency: This can be either a positive or negative number and is useful added to the Frequency value. Use an offset frequency when it's desired to automatically account for an IF frequency in a super heterodyne system. For example, if the Offset frequency is 10.7MHz (a standard FM broadcast receiver IF) and the desired 88.5MHz (KQED), the actually synthesizer frequency will be 99.2MHz (LO).

Frac/Int: Synthesizer can be operated in the Fractional-N mode or Integer-N mode. The lowest spur mode will be the Integer-N mode but that will limit the frequency resolution (see specifications above). The Fractional-N mode provides the finest frequency resolution at the expense of spurious signals. The recommend mode for most applications is the AUTO mode.

Spur Mode: Low Noise mode will provide the best phase noise at most frequencies. When operating near integer boundaries of the PLL, the Spur Mode 1 or Spur Mode 2 might provide improved spurious performance along with a slight degradation in phase noise.

VCO/Div Feedback: (Not currently implemented) the internal PLL feedback is selectable from either VCO or the internal output frequency divider. Normally, for best phase noise performance, the VCO mode should be selected.

AM Modulation: AM modulation is available by setting the AM Modulation value to any value other than 0.0dB. AM Modulation changes the RF output power at the AM frequency rate using the RF attenuator. For example: If the attenuator is set to 15dB (approximately 0dBm output) and the AM Modulation set to 10dB, the then attenuator is switched between 10dB and 20dB at the modulation rate. 0.0dB turns the modulation off.

AM Frequency: The AM frequency range is 0.5Hz to 10kHz. The frequency setting resolution is 1Hz. The AM waveform is 50% duty cycle square wave.

Attenuator: Sets the relative output power level in 0.5dB steps. The default value of 15 will typically set the output power near 0dBm. Setting the attenuator to 0dB will result in the maximum output power (~+15dBm).

RF Output: Turns the output buffer amplifier on or off. Setting to Off will drop the output power by ~30dB. Setting the attenuator to 31.5 and the output Off will set the synthesizer to minimum output power level of -45dBm to -55dBm depending on frequency.

Synth Power: Off completely disables the synthesizer and the unlocked notification will appear. Use this Off mode when no synthesizer output is desired.

Reference Source: Internal selects the internal 20MHz VCTCXO. External selects the external reference frequency.

Reference Frequency: Set to actual internal or external reference frequency. Setting this to frequency other than the actual internal or external reference frequency will cause unpredictable results.

Reference Trim: Provides ±10ppm trimming range to the internal VCTCXO with 8-bit resolution. Reference Trim is useful when it is desirable to "spot" 5009 frequency to an external frequency when an external reference source is not available. Reference trim can also be used to provide a fine frequency control. For example, with an output frequency of setting of 1GHz, the 8-bit reference trim range would be ±10kHz in 78Hz steps.

Ref Doubler: Reference Doubler multiplies the reference frequency by 2 and therefore provides the Phase Frequency Detector with a higher sample frequency which results in a lower PLL feedback division ratio. Normally the reference doubler should be enabled unless the reference frequency is higher than ~25MHz.

Ref Divider: Reference divider divides the reference input to the Phase Frequency Detector by 2. Use the Reference divider when using an external frequency that exceeds 80MHz.

PFD: Phase Detector frequency should normally be set to 40MHz. Best phase noise performance will be achieved at this setting. It may be desirable to set the PFD to something other than 40MHz when using an unusual external reference frequency. For example, if an external 70MHz reference is available the PFD should be set to 35MHz or 70MHz.

Lock: Lock indicators are shown at the bottom of the main page. Normally, the Lock indicator will be green if the synthesizer is functioning correctly. If the Lock indicator is red, then the synthesizer is malfunctioning. If an unlocked condition is detected (red Lock indicator) check for the following conditions:
1) Check that Synth Power is On.
2) Check the Reference source is set to Internal.
3) If Reference source is set to External, then check to see that external reference is connected and available.

4) Check Reference Frequency setting matches actual internal or external reference frequency in use.
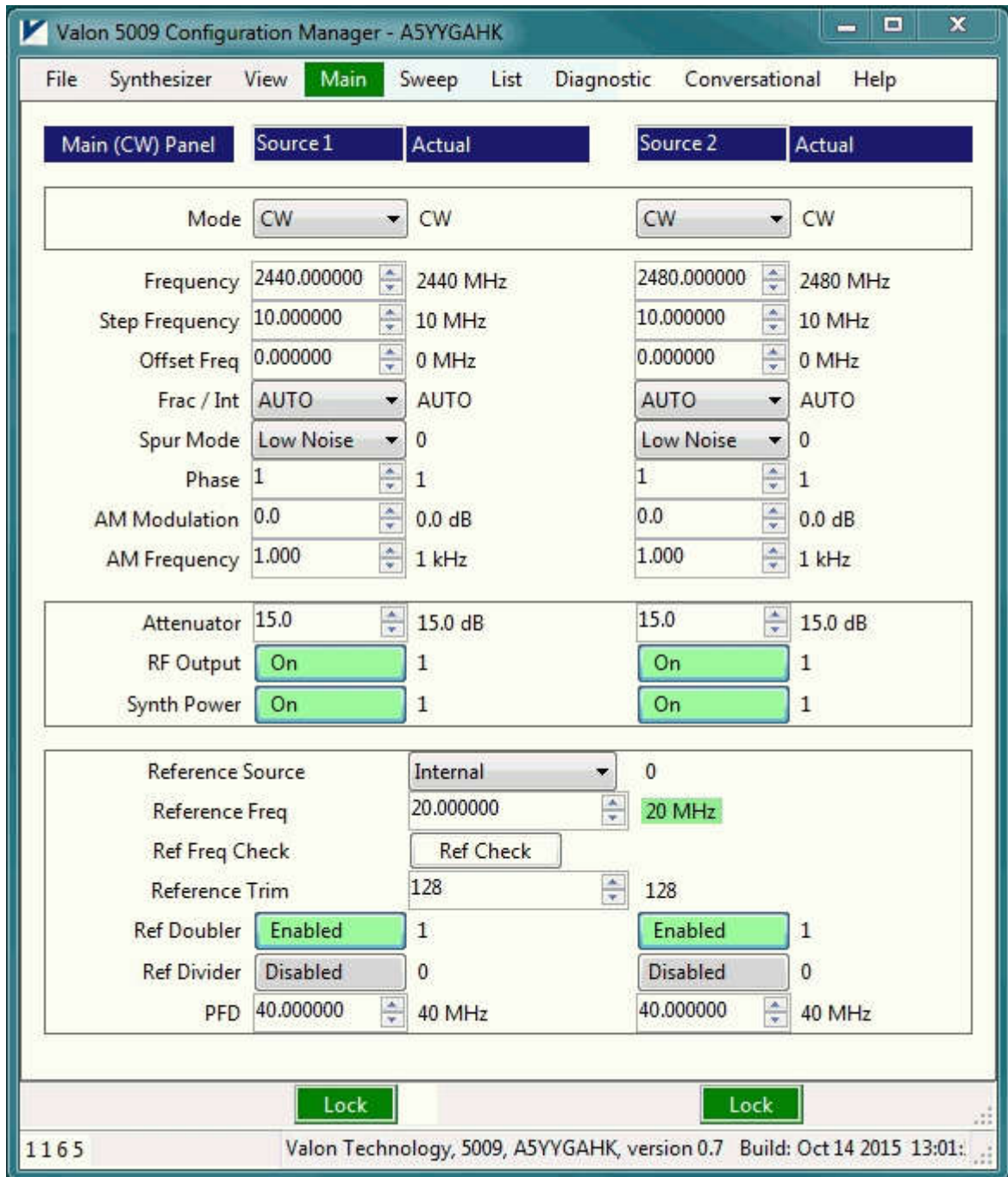
5) Check PFD frequency setting and actual PFD frequency.
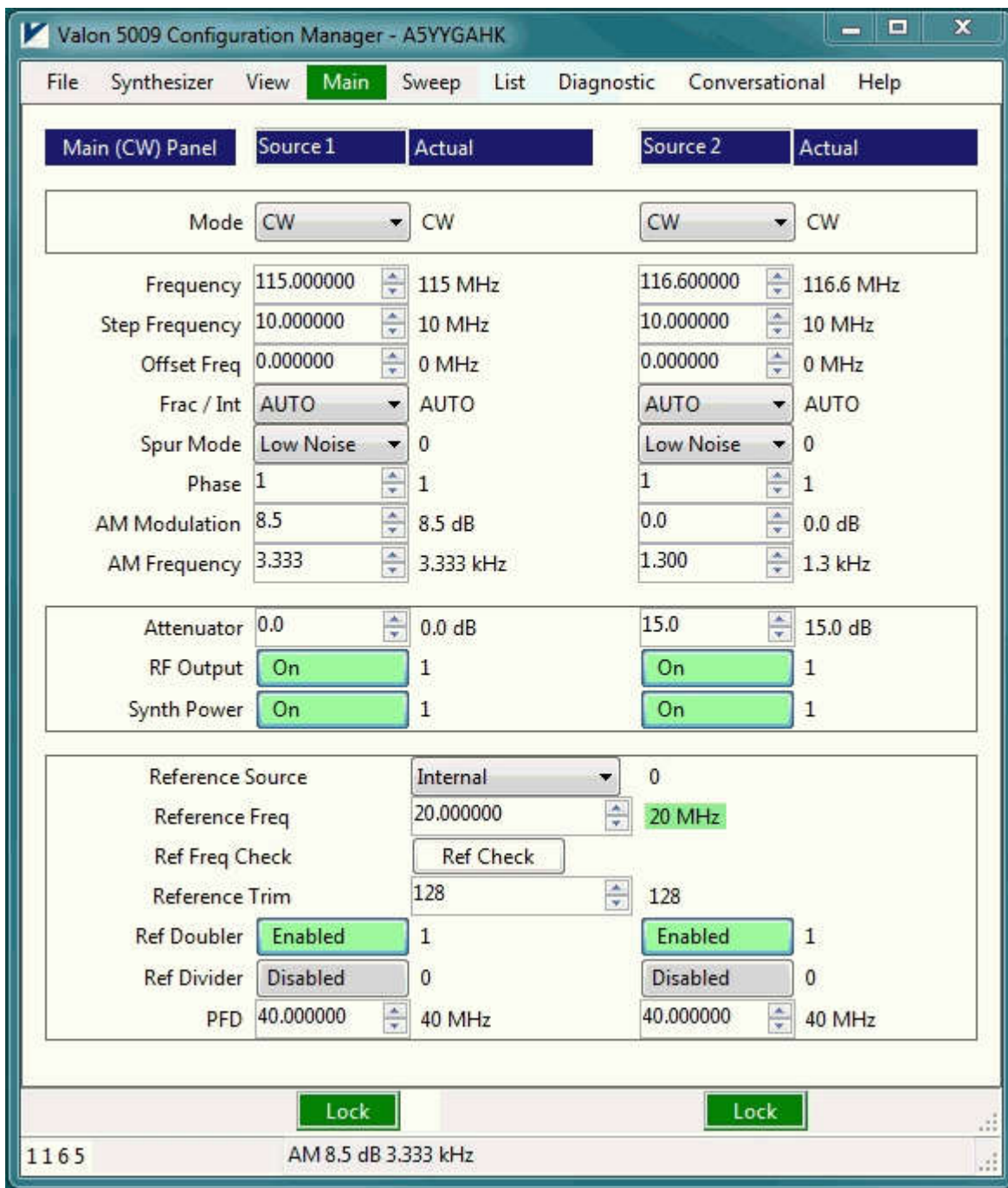

Figure 4 Default Configuration Manager Main page

Figure 5 Configuration Manager Main page after clicking Synthesizer/Read Registers . The Main page is now refreshed with the settings from the connected synthesizer module.

3.3 Configuration Manager Sweep Page

Controls for operating sweep mode are found on this page. Sweep is implemented by stepping from the Start Frequency to the Stop Frequency by an incremental Step Frequency at the sweep step Rate. The Mode has to be set to Sweep for sweep setting to take effect.
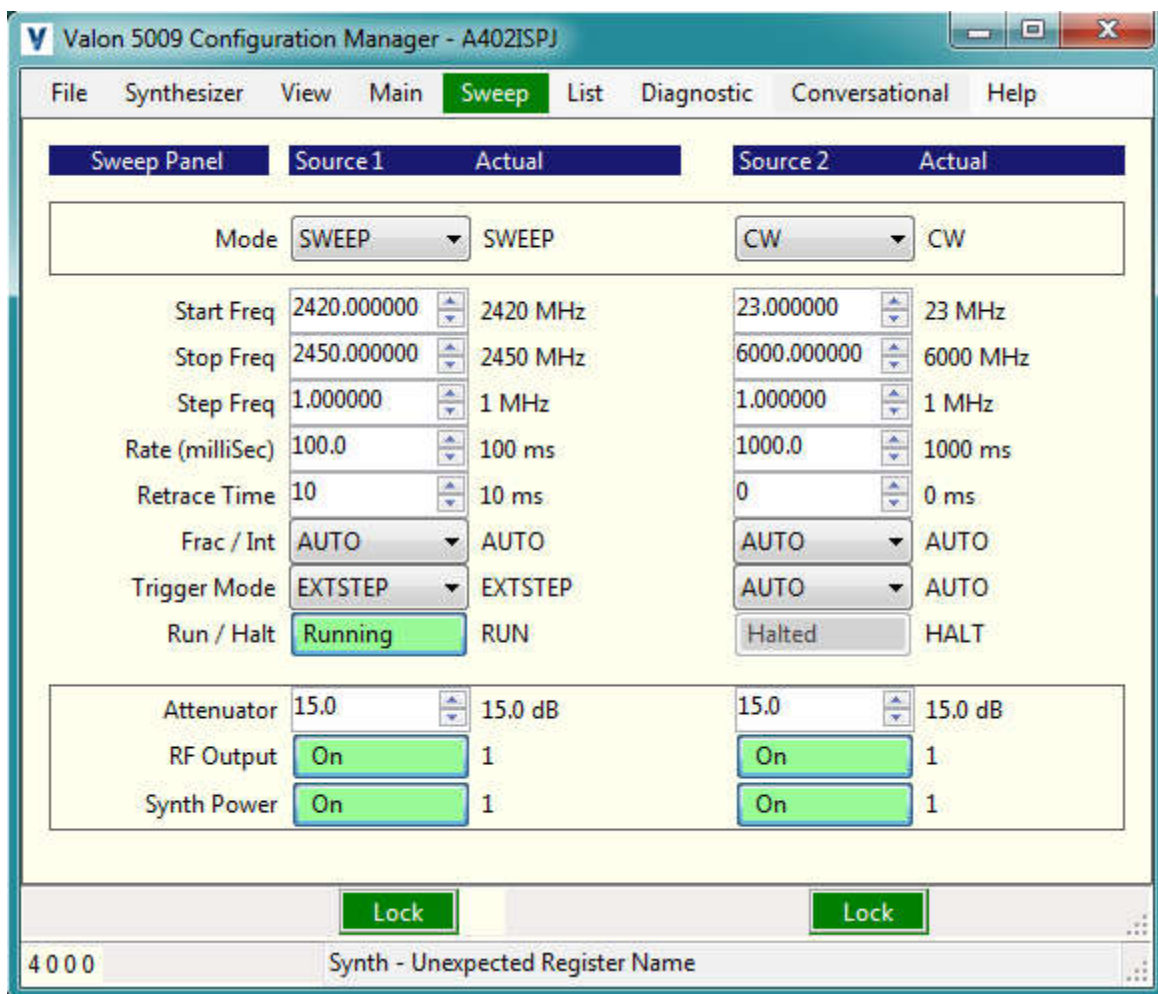

Figure 6 Sweep Page

Sweep/Mode; CW, Sweep, or List modes are selected and displayed. This bar is a global element of the CM and will be shown on the Main and List pages as well.

Sweep/Start Freq; Set sweep start frequency.

Sweep/Stop Freq; Set sweep stop frequency.

Sweep/Step Freq; Set sweep step size.

Sweep/Rate; Set sweep step rate (milliseconds).

Sweep/ Frac / Int; Set sweep mode to Fractional or Integer mode.

Sweep/Trigger Mode; Start sweep trigger modes are Auto (continuous sweep), Manual Trigger, External Trigger, and External Step(See USER PORT).

3.4 Configuration Manager LIST page

Selecting **List** in the CM menu bar presents the frequency list tables for both sources. To edit the table, click on the table entry and enter the desired frequency and attenuation.

Figure 7 List Page
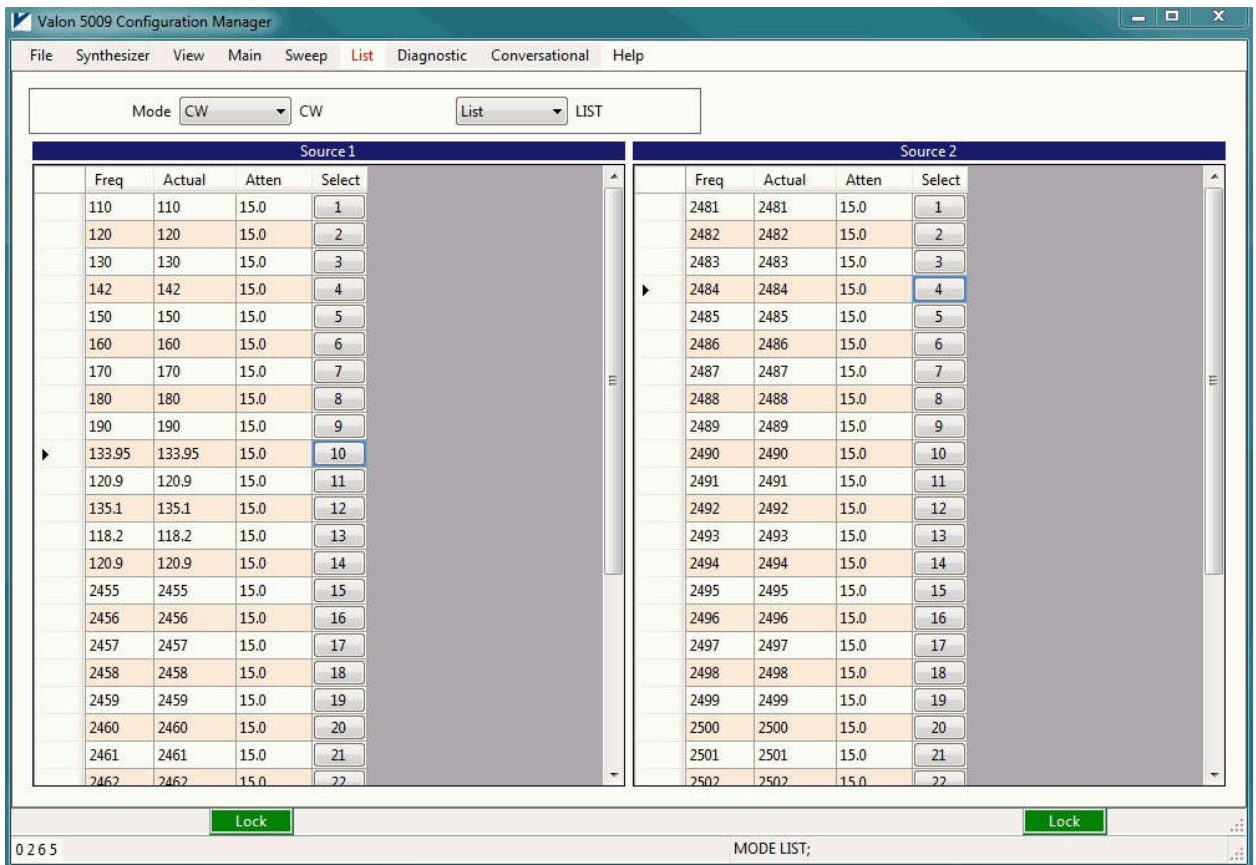
The List page provides a convenient method for quickly selecting preset frequency and attenuation setting. While in CW mode, clicking on any of the "radio" buttons in the Select column, will program the synthesizer to the preset frequency and attenuation. When the Mode is set to List, the synthesizer presets will be selected by the state of the USER PORT input (see USER PORT for more details).

3.5 Diagnostics Page

The diagnostics page is primarily intended for manufacturing test and firmware debugging. There two controls that may be useful to the user:

1. Power Level allows the user to offset the output power in approximately 3dB steps. There are four selectable power levels. This may be useful when it is desirable to offset the power level relative to the attenuator settings.

2. Chg (charge) Pump Current. This control change gain of the synthesizers internal loop filter. The default charge pump current is 3. Using other charge pump currents can change the frequency characteristics of the synthesizer's phase noise.
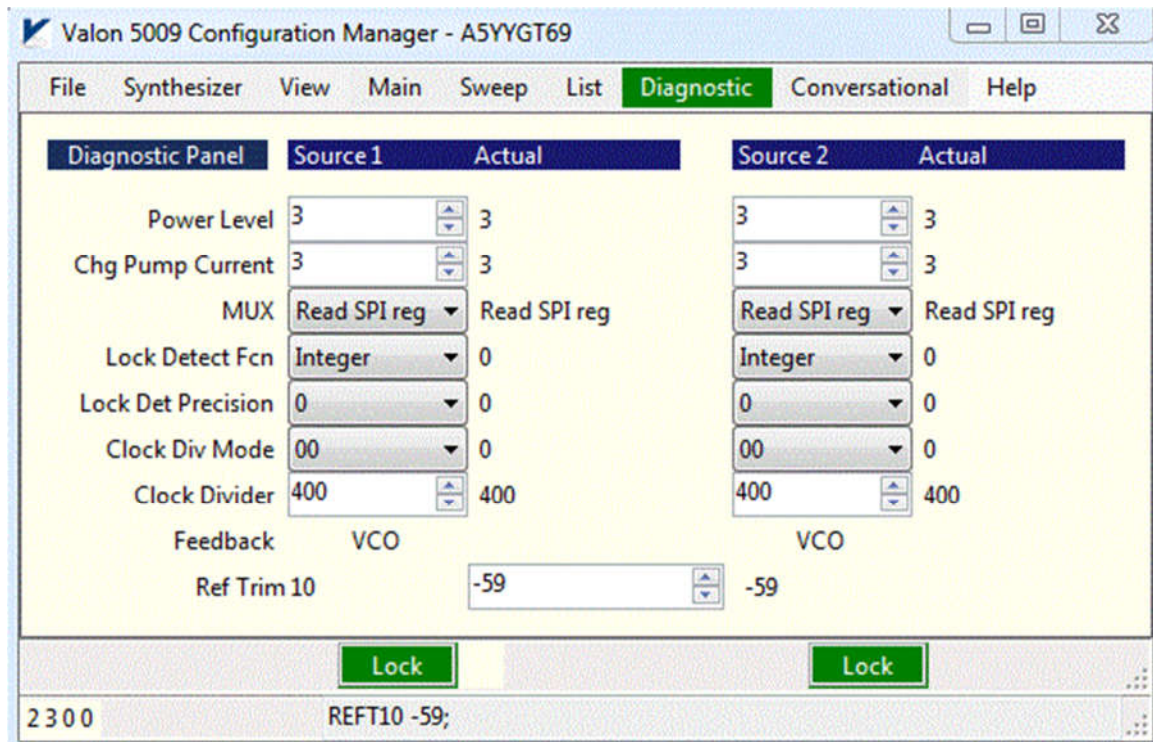

Figure 8 Configuration Manager Diagnostic page

4 Programming With a Terminal Program

In some instances the user will not want to use the MS-Windows based V5009CM GUI and will want to communicate directly with the synthesizer using simple commands. The following section describes the available commands.

4.1 Introduction to Commands

The synthesizer can be programmed using a set of simple commands accessed by the micro-USB serial interface or TTL USER Port and either a terminal emulator program such as Putty, TeraTerm or the recommended 5000term.exe. The 5000term.exe is a download available on the valontechnology.com website. A direct digital TTL interface is also available at the 8-pin User Port.

Once connection to the serial port has been established, type "help" in the teminal program for a list of the latest vailable commands.

By convention, the 5009 module is refered to as a dual frequency synthesizer. However in this context, each of the two internal synthsizers will be refered to as a source.

4.2 Syntax notes:

[ ] means optional entry may be used. SS1; f ;[CW];2550 MHz.

< > String value to be entered: SOURce; Frequency 1 ;CW <2550> <MHz>.

| Indicates one of two choices are available. SOURce<1|2>;Frequency 2550 MHz.

Upper-case lettering indicates that the upper-case portion of the command is the minimum required for the command. For example, F is the minimum required for the Frequency command. Note: The minimum required character does not have to be sent as upper case.

Lower-case lettering indicates that the lower-case portion of the command is optional; it can either be included with the minimum required upper-case portion of the command or omitted.

Commands must be separated by a semi-colon (;) and no action is taken until a carriage return is sent. If only a single command is being sent then the semicolon is not required.

Spaces between command entries are not required and are ignored.

The 5009 contains two RF synthesizers and in this document are referred to as sources. Source and synthesizer are used interchangeably throughout.

Units: When entering frequency numbers the units <U> entry is optional. You can specify M for MHz, G for Gigahertz, or K for kilohertz. You can also specify H for Hertz. If you do not specify the units, the synthesizer will make logical assumptions. For example, if you entered 2450 with no units, the synthesizer would know you meant MHz since it can't produce 2450Hz, or 2450kHz, or 2450GHz.

Parameters: Certain command inputs are binary in nature. In most cases a binary input parameter such as Enable can also be a "1" and Disable a "0". Also references to External can be a "1" while internal is a "0".

4.3   Query syntax

Query syntax is used to check the state or parameter of a command function.   If a command has a query mode, and most do, then enter the command with a "?" or enter the command with no parameters.

4.4   General Commands

4.4.1   Baud

Note: Baud has a query, the command "baud or baud?" followed by a RETURN will display //Available rates = 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600.

You may send the command "baud" followed by any of the allowable baud rates, 9600, 19200, 38400, 57600, 115200, 230400, 460800, and 921600. Once the baud rate has been changed the terminal program will no longer be able to communicate. Close the terminal program, change the terminal program baud rate to match the synthesizer's baud rate previously changed, and then reconnect at the new baud rate.

4.4.2   Source <1|2>

The 5009 contains two independent and identical signal sources. Commands are directed to a particular source by sending the s (select source) command. The select Source command is takes effect for all following commands and it is not necessary to precede any subsequent command or commands with the select source command.

4.4.3   STATus

Returns the Manufacturer's name, model, serial number, firmware version, firmware build date and time, uP clock rate, power supply voltage (VBAT), internal temperature, LM, and UID.

4.4.4   LocK?

Returns the status of the PLL lock condition from both sources. LocK1? And Lock2? Returns he status of each source separately.

4.4.5   ID

This query outputs an identifying string. The response will show the following information: Valon Technology, 5009, serial number, firmware revision. The firmware version can also inform the UI what attributes are available such as number of sources, attenuators, modulation, etc.

4.4.6 Help

Help list all the commands available for the 5009. Note: Help with commands is not available from the UI.

4.4.7 RCL

Recalls the synthesizer state from flash memory. All setting stored in flash memory will be loaded into the synthesizers. This function is useful when it is desirable to restore previously stored flash settings.

Recall is also under the File menu drop-down box in the UI.
The "reg" command can also be used to show the register values.

4.4.8 RST

This command resets both synthesizers to default factory settings. RST does not change the Reference trim value.

4.4.9 SAVe

The SAVe command writes the current synthesizer state to flash memory. This is the state the synthesizer will be in on the next power-up (except for baud rate).

4.4.10 CLEanse

This command cleanses all user saved data in flash (non-volatile) memory. Use this command to "sanitize" the synthesizer. Same as RST except it also removes any user synthesizer names.

If a terminal program or Valon Configuration Manager GUI is not available then use the following procedure to cleanse the non-volatile memory: Connect the synthesizer to a 6Vdc power supply, then increase the input voltage to 10.0V ± 1V for >4 seconds. The blue LED LOCK indicators will flash off and then back on indicating that the cleansing operation was successful.

4.5 MODe

Three mode types are available to each source. The mode settings are completely independent, for example, one source can sweep while the other is fixed. NoteCW, Sweep, and Fixed have independent attenuator settings.

The three MODe(s) are: CW, SWEep, and LIST. MODe can be sent as a single command or combined with other commands. Typically, a source will be set to a specific mode and then subsequent commands will be interpreted for that mode.

NOTE: The Source command is "sticky". That is, once Source 1 or Source 2 (s 1 or s 2) has been selected, then it is no longer necessary to include the Source command in combination with any other command.

4.5.1 Source <1|2>; MODe <CW >

Sets the selected source to the normal default CW, or single tone, mode. All subsequent commands will be assumed to be single frequency commands. See Frequency Setting Commands for more information.

4.5.2   Source <1|2>; MODe SWEep
Sets the selected source to sweep mode. A STARt frequency, STOP frequency, STEP frequency, sweep RATE will also have to be set.

4.5.3   Source <1|2>; MODe LIST
Sets the selected source to the list mode. When set to list, the synthesizer frequency is set to preset values much like radio push-buttons. The specific list value from the list is selected by the hardware bit selected by the user port.

4.6   Frequency Setting Commands (CW)
The frequency setting commands are listed below.

4.6.1   Source <1|2>; <Frequency <F> <U>
Source; Frequency is the method for setting the single tone frequency. The range of <F> is 23.5MHz to 6000MHz but can be expressed as Hz or GHz.

Follow the Source or just s command with either a 1 or 2 to select Source 1 or Source 2. If no source number is specified then the command will be set to source shown at the cursor.

Source 1; Frequency   2115 M; Sets source 1 to 2115MHz. Since no source number was specified the default source is 1.

f 2115; Defaults to the present source and sets the frequency to 2115MHz without specifying the units.

f 2115m also sets the present source to 2115MHz by default since no source was specified.

s 2; f 2445 is a method for setting source 2 to 2445MHz.

Source 2; Frequency 2000M sets source 2 to 2000MHz

Source 2; Frequency; CW 2000M sets source 2 to 2000MHz

Source 2; Frequency 2000000000 sets source 2 to 2000MHz

S 2; f 2000000k sets source 2 to 2000MHz

Various valid query forms are accepted

For example: Frequency? returns the frequency for the currently selected source.

4.6.2   Source <1|2>; OFFset <F> <U>
Stores an offset frequency that can be added to any Frequency command. This command is useful for heterodyned frequency conversion systems, i.e. systems that employ an RF mixer for example.

s 1; off 2m will set source 1 offset to +2MHz. If for example source 1 frequency was set to 200MHz, the actual output frequency would be 202MHz.
The query form is Source <1|2> ; OFFset ? <U> or

Source <1|2> ;OFFset?

Note: UI may accept offsets that result in an out of range frequency however firmware will check and report an error condition.

4.6.3   Source <1|2>; FrequencyStep <F> <U>
Sets the frequency step size in CW mode. Used with INCRement and DECRement command.

Note: Step size can be any value however it may be more practical to limit the maximum acceptable step size to 100MHz. The minimum step size is complicated by whether the synthesizer is integer mode or Fractional mode, what the output divider is setting is.

4.6.4   Source <1|2>;FrequencyINCrement <F> <U>
Increases the CW frequency by the amount set by the STEP command.

4.6.5   Source <1|2>;FrequencyDECrement <F> <U>
Decreases the CW frequency by the amount set by the STEP command.

4.7   Sweep Mode

4.7.1   Source <1|2>; SWEep
Each source can independently sweep from a Start frequency to Stop frequency by setting the mode to SWEep. Example:

Source2;MODe SWEep

Source2;[Frequency];[SWEep]; STARt 2000m

Source2;[Frequency];[SWEep] ; STOP 2400m

Source2;SWEep;STEp 1 M; Notice in this case the ;SWEep command is required in order to differentiate the sweep step size from the CW increment/decrement step size.

4.7.2   Source <1|2>; STARt <F> <U>
Sweep Start frequency. Example:

Source2; STARt 2000M

4.7.3 Source <1|2; STOP <F> <U>
Sweep Stop frequency. Example:

Source2;[Frequency]; STOP 2400M

4.7.4 Source <1|2>; STEP <F> <U>
Number of frequency points. Minimum number of steps 2 and the maximum 2001.

4.7.5 Source <1|2>; SINC <F> <U>
Sweep increment frequency step size. (not to exceed the stop ...no accumulated error)

4.7.6 Source <1|2>; RATE<ms>
Sweep step rate in milliseconds . Step rates of 10ms to 200ms are typically optimum.

4.7.7 Source <1|2>; Run [0|1|2|3]
Sweeping begins with a Run command. The RUN command followed with no parameters starts the sweep of the active source. RUN 1 starts the sweep of source 1, 2 source 2, and 3 both sources.

4.7.8 Source <1|2>; Halt
Sweeping stops with the Halt command. The HALT command followed with no parameters stops the sweep of the active source. HALT 1 stops the sweep of source 1, 2 source 2, and 3 both sources.

4.7.9 Source <1|2>; TMODe <AUT0|MANual|EXTermal|EXTstep>
Three sweep trigger mode (TMOD) options are available. Auto trigger is a continuous, free-running mode where the trigger is supplied by the internal controller. Manual trigger is a single-sweep mode occurring once with every TRG command. External trigger is provided by a positive edge on pin-6 of the USER PORT connector. EXTernal trigger will trigger one sweep for every trigger input. EXTstep increments the frequency by the value of the STEP.

Setting the MODe to CW or LIST will disable the SWEep mode.

4.7.10 TRGR
This command must be sent to start the sweep in Manual mode. One sweep will occur each time the command is sent.

4.7.11 RetraceTIME ; <ms>
Retrace time or RTIME allows the user to set a dwell interval of 0ms to over 100 seconds before the start of a new sweep.

4.8   List Mode

The List mode is useful in production or automatic test environments where it is desirable to switch between a number of preset frequencies or "markers" under hardware control. Once in list mode, a terminal or host computer is no longer required to set the output frequencies.

The List Mode allows the setting of the 32 preset frequencies. When the list mode is set using the MODe LIST command, the source output frequency is set by the list frequency settings and the 5-bit logic state of the USER PORT. Not all 32 preset entries have to be set. Unless user modified, the default list frequency settings for all 32 settings is 2445MHz for source 1 and 2465MHz for source 2.

4.8.1   List entry

Source<1|2>;List <N > <Fn> [<U>] [<ATTn>];
This mode sets the specified synthesizer frequency to the values set in the list table. The list table can have up to 32 entries. N is the list number.

An example of the list command: S1; list 5 2155m would set source 1 LIST frequency number 5 to 2155MHz.

List?, List, or LI will return the 32 list entries from current source.

Source <1|2>;LIST? will return the list from the selected source.

Source<1|2>;LIST? <N> [<U>] will return only the frequency of the **nth** entry of the selected source in the units specified.

After setting the list frequencies, remember to use the SAVE command to store the list frequencies to flash memory.

Attenuator entries may also be set with the list frequency. The method below shows how to set an attenuator value for a specific LIST entry. If the attenuator value is not specified after the LIST command, then the attenuator value set globally by the ATTenuator command will be retained.
Source<1|2>;LIST <n> <Fn> <U> <0.0|0.5|1.0|...63>
For example to set the third entry into the currently selected source, type:
LI 3 2450 12
to set entry 3 to 2450 MHz with an attenuator setting of 12.

4.8.2   List hardware Control

See Section 5 User Port for information on hardware control of the List selection. The List selection can either be done with a switch closure to ground or by TTL logic level.

4.9   Power Level, Attenuation Control, Amplitude Modulation

4.9.1   Source<1|2>; ATTenuator<0.0|0.5|1.0|...31.5>

Relative power output control from the selected source using the internal attenuator. The attenuator has a range of 0dB to 31.5dB in 0.5dB steps.

Att? returns the value of the attenuator.

4.9.2   Source <1|2>; PLEVel <0|1|2|3>

Relative power control from the selected source using the output amplifier and can also be used to adjust the output power level. Typically, the power control can be used to trim the output of synthesizer level depending on frequency of operation.

4.9.3   Source <1|2>; OEN <0|1|2 or OFF|ON>

Enables or disables the RF output buffer amplifiers while leaving the synthesizer PLL locked. This command does not completely extinguish the RF output signal level but reduces the level by approximately 50dB. This command can be used with the attenuator command to reduce the output level by 80dB. ON turn the buffer amplifiers on.   (OEN is automatically set to off if the power supply voltage rises above 8.0V. Note this function is logically AND of LOCK, so the buffer amplifier will only be enabled if LOCKed.

4.9.4   Source <1|2>; PDN <0|1>

PDN is a complete power down of the active source. The internal control register will retain the data however. PDN 0 turns the source off, PDN 1 turns the source on.

4.9.5   Source <1|2>; AMDepth<0|0.5|1.0|..31.5>

Enables 50% duty cycle square wave amplitude modulation of selected source. The default modulation rate is 1 kHz. The AM modulator uses the attenuator function so the modulation on/off ratio is determined by the setting of the attenuator. AM is accomplished by switching the attenuator from its set value to ± the AM value. For example if the RF attenuator was set to 15dB, and the AM modulation was set to 10dB, then the RF attenuator would switch from 10dB to 20dB at the modulation Rate.

AM is enabled when the AMDepth is set to any value other than 0(dB). For example; to turn on 20dB modulation at 1 kHz the command would be AMD 20.

4.9.6   Source <1|2>; AMFrequency <f>

Sets the AM modulation frequency to and value from 1Hz to 10kHz in 1 Hz increments.

4.10 Configuration Commands

Configuration commands are used to control settings that are secondary to the operation of the synthesizers or affect operation of both synthesizers together.

4.10.1 REFerence; <F> <U>

REF sets the reference frequency used by both sources. The reference frequency is the used by the PLL circuitry in both synthesizers and is the fundamental clock that determines the accuracy, stability, phase noise, and overall quality of the output signals. The default reference frequency is 20MHz. If an external reference is being used, that is not 20MHz (10MHz for example) then the reference, **REF** must be set to correspond to that frequency. Setting **REF** to something other than the actual internal or external frequency will result in indeterminate or unstable performance.

The optimum range for the reference frequency is 20MHz to 100MHz. The minimum frequency is 5MHz and the maximum frequency is 200MHz.

The query form is **REF?** [U]

4.10.2 REFTrim; <0|1|2|...255>

REFerence Trim command can be used to trim or "spot" the synthesizers' frequency when using the internal reference. Reference trim changes the voltage sent to the VCTCXO by setting the reference DAC output voltage. Reference trimming can be used to minimize the internal reference frequency error. Reference trim can also be used when a small frequency offset is desired. The trimming range is >±10ppm.

Note: The EFC circuit is connected to the external reference input through a lowpass filter networks. The EFC voltage is summed with the REFTrim DAC. Any dc path such as a termination or dc coupled source on the external reference input will shunt part of the REFTrim voltage to ground. A dc coupled external reference should be disconnected when using the internal reference.

4.10.3 REFerenceSource;

REFS sets the reference source to either internal or external. **REFS 0** set the reference to internal **REFS 1** set the reference source to external.

REFS? returns the state of the reference source.

4.10.4 Source <1|2>; PFD <F> <U>

By default, Phase/Frequency Detector (PFD) is 40MHz when the 5009 is supplied with either a 40MHz or 20MHz TCXO. The synthesizer loop filters are optimized for the lowest phase noise with a PFD frequency in the range of 20MHz ~50MHz. A block diagram of the synthesizer reference divider circuit is shown below. The permitted PFD range is 1MHz to 140MHz.
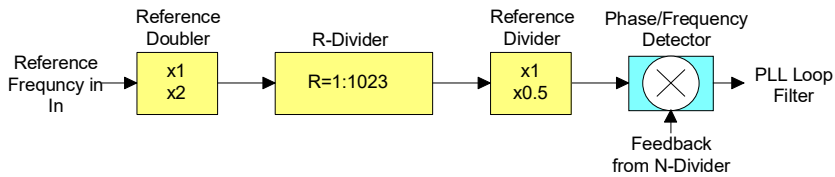
The Reference Doubler and Reference Divider can be user set to optimize the PFD frequency to 40MHz when an external reference is applied. For example, if an external reference of 10MHz is applied, the user should set the Reference Doubler to2 using the DEFDB command.

Setting the PFD frequency then allows the 5009 to determine the closest R-Divider value that will provide the selected PFD frequency based on the previously set Reference Frequency, Reference Doubler setting, and Reference Divider setting. Selected PFD frequencies should be low-valued multiples of the actual reference frequency.

Sending the "PFD?" command will return the actual PFD frequency.

Example: PFD set to 40MHz with the External Reference of 100MHz, Reference Doubler disabled(x1), and reference divider disabled (1/1). The 5009 would select an R-Divider value of 3 (providing the closest PFD in the 20MHz to 50MHz range). Sending a "PFD?" command would return PFD=33.333333MHz.

Example 2: PFD set to 25MHz with the Internal Reference of 40MHz, Reference Doubler enabled(x2), and reference divider disabled (1/1). The 5009 would select an R-Divider value of 3. Sending a "PFD?" command would return PFD=26.666667MHz.

Example 3: PFD set to 22MHz with the Internal Reference of 40MHz, Reference Doubler disabled(x1), and reference divider disabled(1/1). The 5009 would select an R-Divider value of 2. Sending a "PFD?" command would return PFD=20.000000MHz.

4.10.5 Source <1|2>; REFerenceDouBler <Enable|Disable>
REFDB enables or disables reference doubler. The referenced doubler multiplies the internal or external reference frequency by 2. With the internal 20MHz reference, the reference doubler is defaulted to off. Enable the reference doubler when the external reference is less than 20MHz. The reference doubler function precedes the PLL R divider function. The reference doubler should not be enabled when the reference divider is enabled. {r2, b25}

4.10.6 Source <1|2>; REFerenceDIVider <Enable|Disable>
or **REFDIV** enable or disable reference divider. The referenced divider divides the internal or external reference frequency by 2. With the internal 40MHz reference the reference divider is defaulted to off. The Reference Divider is not normally used and actual use is tbd. {r2, b24}.

4.10.7 Source <1|2>; ChargePump <0|1|2|…15>
CP Sets the 4-bit charge pump current. Optimum value is 7 but users can optimize this setting to optimize minimize phase noise at a particular frequency.

4.10.8 Source<1|2>; SDN<00|10|11>

Spur mitigation modes. 00=low-noise mode, 10=low-spur mode1, 11=low-spur mode2. User can enter 0 for 00, 2 for 10, and 3 for 11, either format is acceptable. (Reg2 30:29). Default is low noise mode. Use low-spur modes at integer boundaries of the PFD frequency.   Integer boundaries occur at frequencies at are integer multiples of the PFD frequency. For example, with a PFD of 20MHz, 2000MHz is an integer (100) boundary.

4.10.9   Source<1|2>; INTFRAC <0,1,2>

0= Fractional mode (Default). Fractional mode even when frequency is integer multiple of PFD frequency.

1= Integer mode. Output frequency will be set to the closest integer multiple of the PFD frequency.

2= Fractional mode and switched to integer mode automatically if frequency is a multiple of the PFD frequency.

4.10.10 Source<1|2>; NAMe <name>

Allows the user to specify an alias name of up to 48 characters long for each source. Naming the source helps identify the use of each output.

5 User Port

The user port is a 8-pin male Hirose connector located on the back edge of the synthesizer module. This port can be used as the List Mode hardware control input or an auxiliary 3V TTL serial port.

The port can be user configured to provide the access for the sweep trigger, sweep active, and sweep step signals.
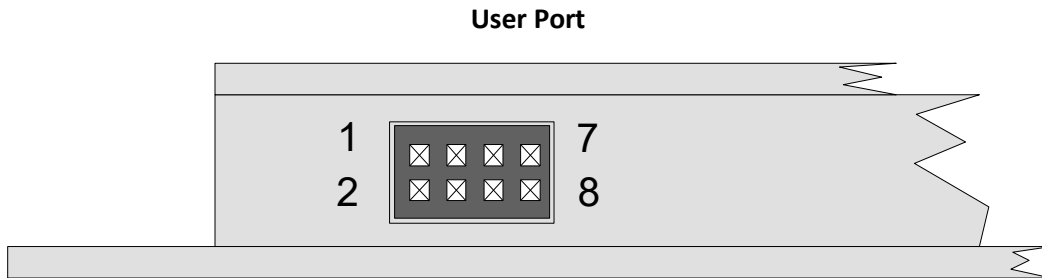
5.1.1 User Port Pin Assignments

User Port

Figure 9 USER PORT PIN ASSIGNMENT

User Port Pin Assignment Table

USER PORT Pin	Name	Description
1	L0	List bit 0
2	L1	List bit 1
3	L2	List bit 2
4	L3	List bit 3
5	L4/RXD	List bit 4 or Serial RXD,
6	TXD	Serial TXD
7	Lock Detector/Sweep Sync Output/Sweep trigger	Lock Detector output, high when both channels are locked. Input for external trigger in external trigger sweep mode. Output for sweep enabled in Auto Sweep or Manual Sweep mode
8	GND	Common ground (same as chassis)

The USER PORT mating connector is a Hirose DF11-8DS-2C with pre-terminated cables H3BBT-10112-W4. All available from Digi-Key or you can ordered the 5009 list mode selector switch (LMS-1).

5.1.2 Lock Detector/Sweep Sync/ Sweep Trigger

If both sources are in CW mode, pin-7 is the lock detector status output. If one of the source is in Sweep mode pin-7 can be used as a Sweep Sync output for Auto triggered sweep or a Sweep Trigger for externally triggered sweeps.

The Sweep Sync signal goes high at the beginning of the Start frequency and stays high for the first step. For all other steps, the Sweep Signal goes low and stays low until the Start frequency step is reached.
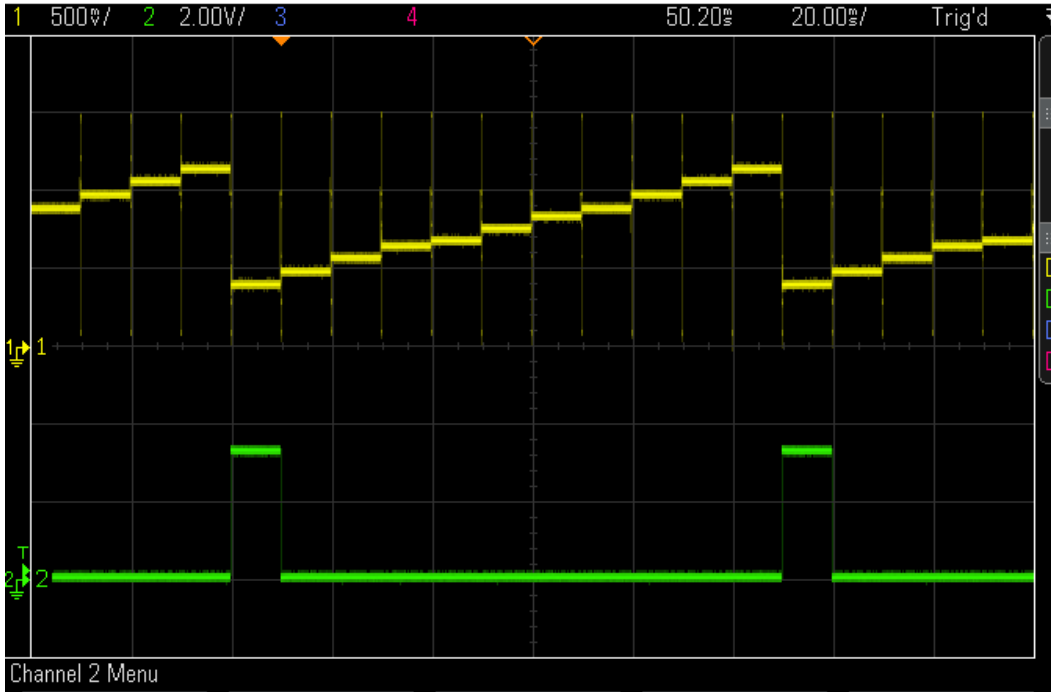
Figure 10 Green top trace is sweep frequency output from delay line discriminator vs. bottom trace Sweep Sync output for Start 1600MHz, Stop 1700MHz, Step 10MHz, Rate 10ms.

5.1.3   External Switch and cable recommendations for USER PORT

In List mode, the 32 preset frequency selection is accomplished by pulling M4:0 USER PORT pins LOW. Figure-8 below shows the schematic of the Valon LSW-1. A 7-conductor cable assembly plugs into the User port and connects to the accessory switch panel. The Phoenix connector provides screw clamping terminal post so that any external switch contact or TTL signal level can also be used if desired.
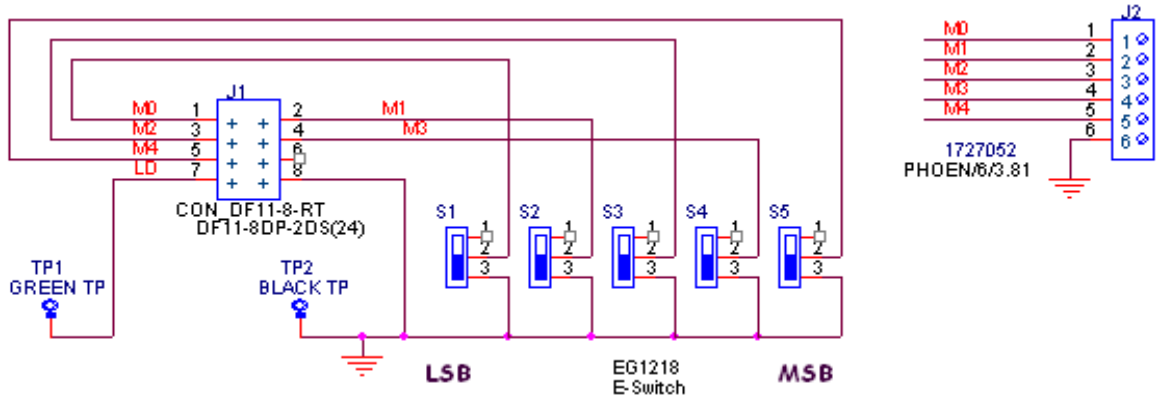

Figure 11 Schematic of LSW-1 List node accessory switch assembly

6 Mechanical Dimensions

3.625"W x 2.685"L x 0.55"H

Weight: 0.2lbs, 91g

Material: AL-6061-T6
Finish: Clear Alodine (conductive)