MICROWAVE FREQUENCY SYNTHESIZER QP-FSPLL-0040-01

USER MANUAL

Description

The QP-FSPLL-0040-01 is a low-phase noise wideband synthesizer operating from 50 MHz to 40 GHz with a nominal output power of +15 dBm.

The synthesizer has a very stable internal reference and accepts 10MHz/100MHz external reference (auto-selectable), it includes a Jitter Attenuator.

In addition to the RF output, it provides 2 programmable outputs, one in single-ended mode (LVCMOS) and one in differential or single-ended modes. Reference differential output is voltage programmable (1.8, 2.5 and 3.3 V) and reference single-ended output is also voltage programmable (1.8, 2.5, 3.3, and 5 V).

The synthesizer has two operation modes. The "Fast Mode" provides a very fast switching frequency (as low as 30 μs). The standard mode provides very accurate frequency (0.05Hz). The frequency change can be controlled optionally using external Latch In (logic level triggered). Latch Out will change when frequency is ready to be changed (pulse).

Its supply voltage is +7 V with typical consumption of 15 W and it can be configured and operated using USB 2.0, Ethernet (10BaseT), SPI and RS232.

The wide temperature operating range from -20 ºC to 70 ºC, the IP67 sealing and the ruggedized connections make it suitable for both laboratory and harsh environments.

Features

RF OUTPUT:

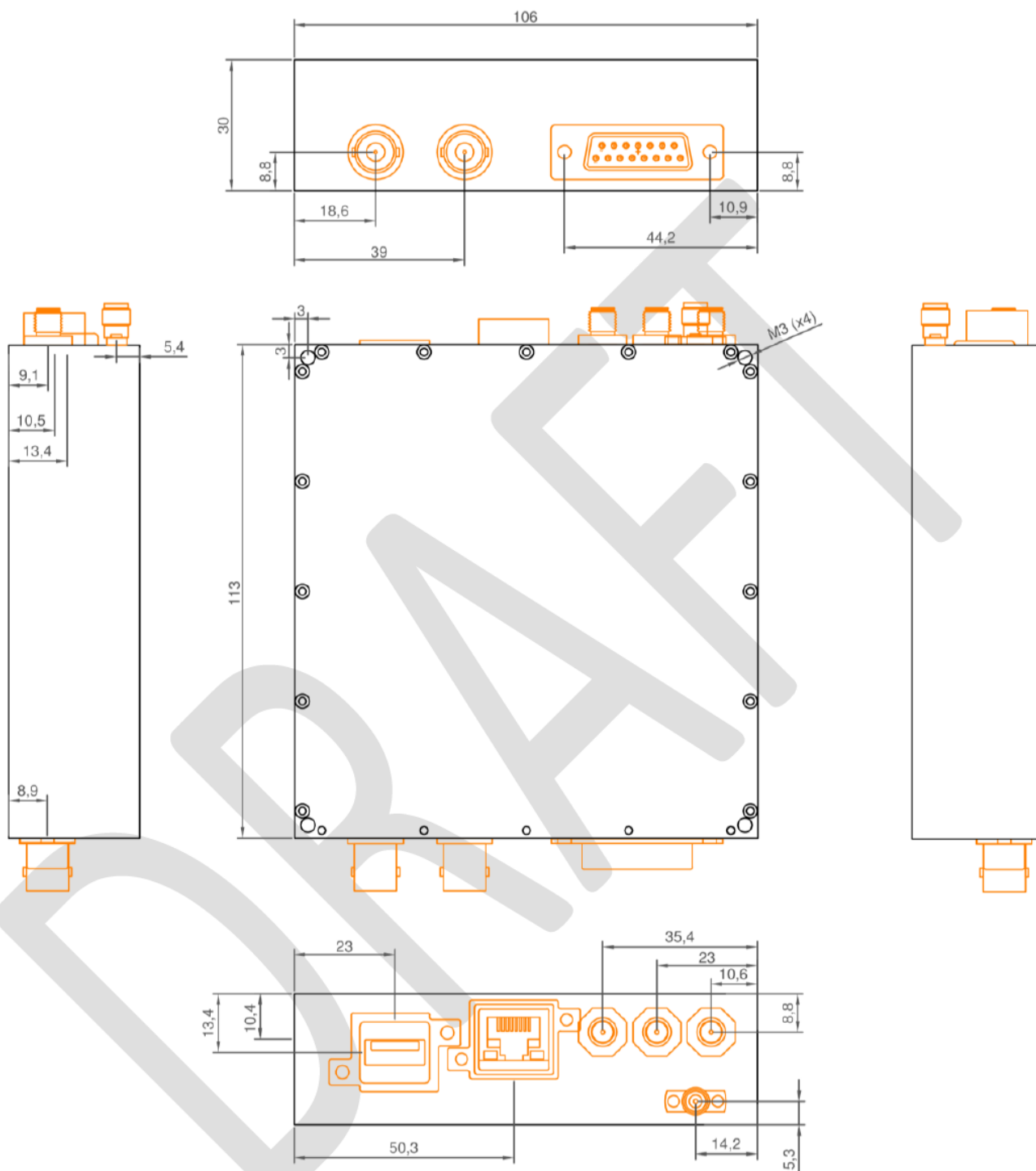|	
FREQUENCY RANGE	50 MHz - 40 GHz
FREQ. STEP @ Fout<3 GHz	0.05 Hz (STANDARD MODE) or 3 Hz (FAST MODE)
SWITCHING TIME	80 μs (STANDARD MODE) or 30 μs (FAST MODE)
OUTPUT POWER	+15 dBm
OUTPUT RETURN LOSS	14 dB
HARMONIC LEVEL	-25 dBc
SUBHARMONIC LEVEL	-50 dBc
SPURIOUS LEVEL	-60 dBc

DIGITAL OUTPUT:

FREQUENCY RANGE	300 kHz - 700 MHz
REF OUT_1	SINGLE-ENDED: LVCMOS
REF OUT_2	DIFFERENTIAL: LVPECL, LVDS, HCSL 2x SINGLE-ENDED: LVCMOS

ENVIROMENTAL RATING

TEMPERATURE RANGE	-20ºC TO 70ºC
IP RATING	IP67

PHASE NOISE*:

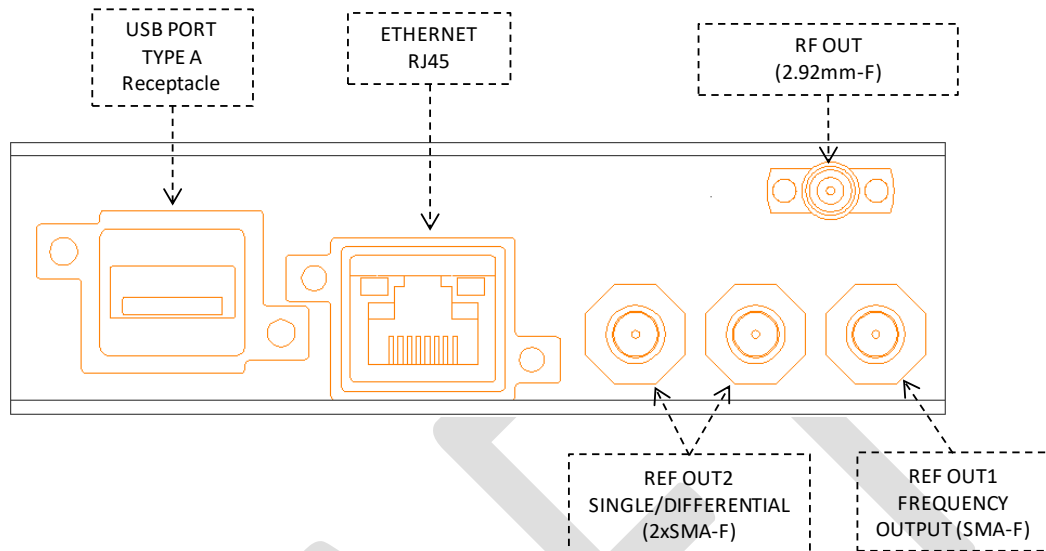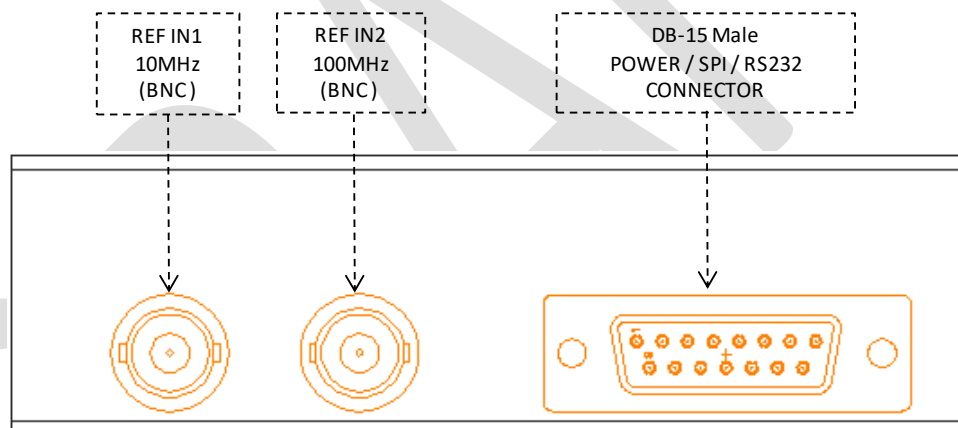|	@1 GHz	@3 GHz	@10 GHz	@20 GHz	@40 GHz
1KHz	-114 dBc/Hz	-102 dBc/Hz	-89 dBc/Hz	-83 dBc/Hz	-77 dBc/Hz
10KHz	-120 dBc/Hz	-103 dBc/Hz	-91 dBc/Hz	-85 dBc/Hz	-79 dBc/Hz
100KHz	-118 dBc/Hz	-109 dBc/Hz	-97 dBc/Hz	-91 dBc/Hz	-85 dBc/Hz
1MHz	-136 dBc/Hz	-131 dBc/Hz	-119 dBc/Hz	-113 dBc/Hz	-107 dBc/Hz
10MHz	-165 dBc/Hz	-139 dBc/Hz	-127 dBc/Hz	-121 dBc/Hz	-115 dBc/Hz

* Typical values

Dimensions

Note: Specifications and ordering information are subject to change without notice.

Connection Specifications

Front view:


USB PORT TYPE A Receptacle

ETHERNET RJ45

RF OUT (2.92mm-F)

REF OUT2 SINGLE/DIFFERENTIAL (2xSMA-F)

REF OUT1 FREQUENCY OUTPUT (SMA-F)

Rear view:

REF IN1 10MHz (BNC)

REF IN2 100MHz (BNC)

DB-15 Male POWER / SPI / RS232 CONNECTOR

Connectors:

REF IN1	BNC External Reference Input for 10 MHz (+5 ± 10 dBm)[1]
REF IN2	BNC External Reference Input for 100 MHz (+5 ± 10 dBm)[2]
RF OUT	2.92mm-F connector. Frequency Output, connector for Synthesizer Frequency Output. Range from 50 MHz to 40 GHz
REF OUT1	SMA (F) connector programmable Output reference single-ended LVCMOS. Range from 300 KHz to 700 MHz. +5 ±2dBm. Voltage programmable (1.8, 2.5, 3.3, and 5 V) (Default: 100Mhz)
REF OUT2	Two 2 SMA (F) connectors for a full programmable differential output. Voltage programmable (1.8, 2.5 and 3.3 V) and format programmable (LVPECL, LVDS, HCLS, LVCMOS). Range from 300 KHz to 700 MHz. +5 ±2 dBm. (Default: 100 MHz)
USB PORT	USB Type A receptacle (USB 2.0) for communicate Synthesizer with PC application
ETHERNET	Ethernet connector (10BaseT, RJ45). For communicate Synthesizer with PC application using LAN infrastructure. If you need to use more than one synthesizer at the same time, use this protocol. Assign different IP address to each one and connect (in the same LAN)
EXT CONNECTOR	DB-15 Male connector for power supply, SPI, RS232, lock detect, latch in and latch out.

[1,2] The reference is selected automatically when connected in the order of priority: 1) REF IN2, 2) REF IN, 3) Internal Reference.

External connector pinout:

PIN	NAME	PIN	NAME
1	PWR	9	PWR
2	PWR	10	GND
3	LOCK	11	Latch_Out
4	Latch_In	12	GND
5	SSE	13	SCK
6	MISO	14	MOSI
7	GND	15	RX
8	TX		
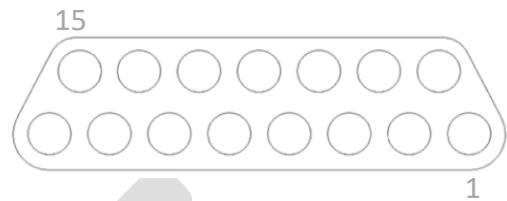
General Power Supply

PWR	Power supply: 7 V, 15 W
GND	Common ground

SPI™ Port[3]

MOSI (In)	Master Output Slave Input. Data is read on rising edge of SCK
MISO (Out)	Master Input Slave Output. Data output is valid on the falling edge of SCK
SCK (In)	SPI Clock (Max. 4 MHz clock speed)
SSE (In)	Slave Select Enable. Active-Low Slave Select
GND	SPI port common ground

[3]The maximum operating voltage admitted in SPI port is 5 V. It also accepts 3.3 V levels.

RS232 Serial Port[4]

TX	Transmit
RX	Receive
GND	RS232 common ground
Communication Parameters	Baud=115200, Data size=8 bit, Parity=None, Stop Bits=1. No handshake

[4]Port has RS232 voltage levels (not TTL).

Latch

Latch_In	Trigger input for frequency change. The frequency change is made when there is logic level zero in this entry (or NC). If the input is logic one, no frequency change will occur
Latch_Out	Output frequency change. When frequency command is received this output generates a positive pulse when synthesizer is ready to change the frequency. Only then Latch_In should be triggered.

Lock

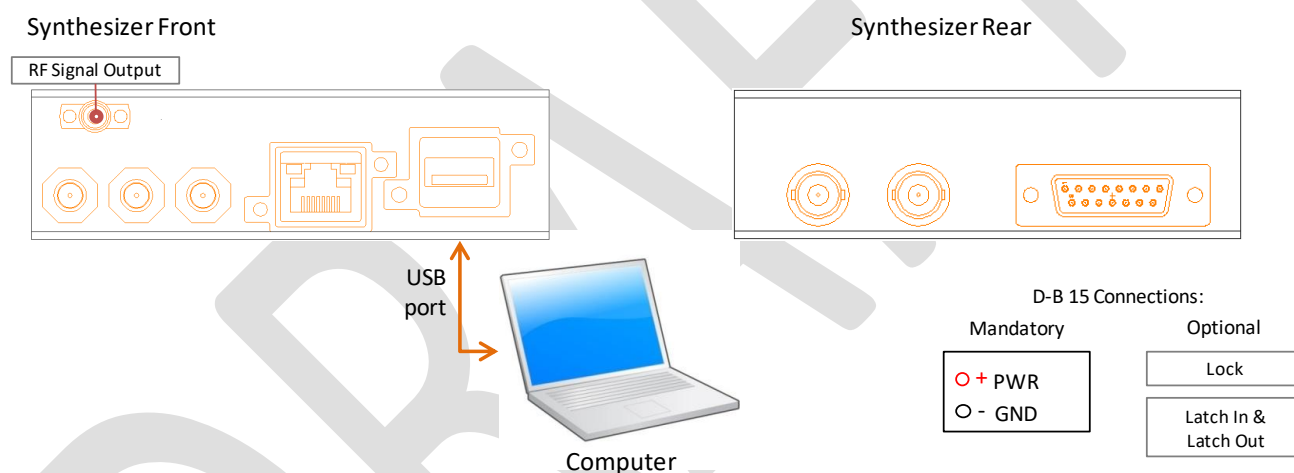|	
LOCK (out)	Logic level equal to one while PLL is locked, zero in other case. During SPI transmission between microcontroller and PLL the state can vary due to shared pin

Synthesizer Installation

USB port

Steps:

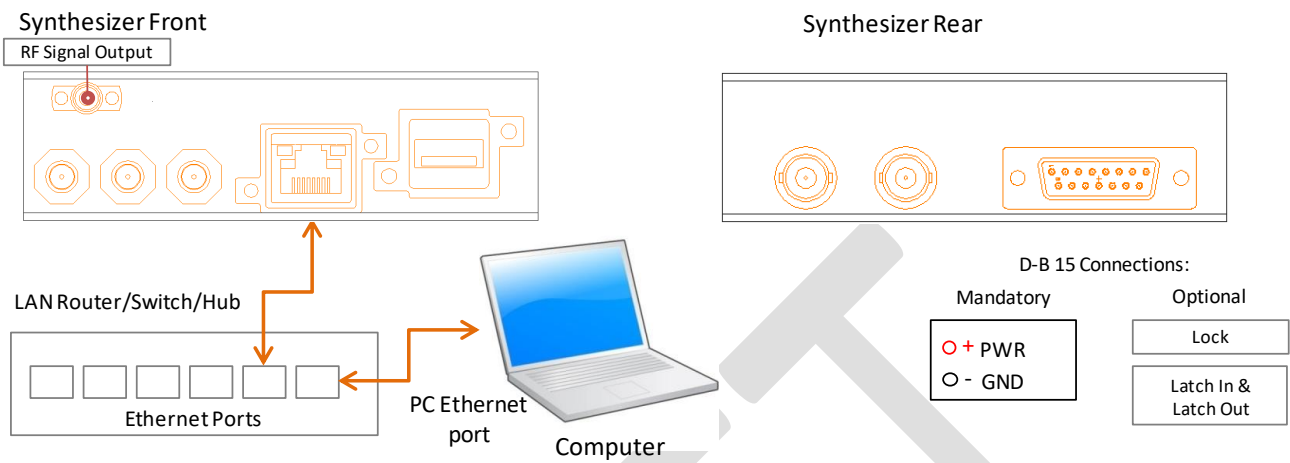|	
Step 1	Connect the synthesizer to PC using USB port. See Image USB Connection below
Step 2	Run the application "Synthesizer.exe"
Step 3	Select the desired options in Settings Tab (see Settings Tab example)
Step 4	Click on "Configure" button. Configuration will not be lost after turn off the synthesizer
Step 5	Click on USB Tab to define desired frequency of operation and other parameters (see USB Tab example)

USB Connection:

Synthesizer Front

RF Signal Output

Synthesizer Rear

USB port

Computer

D-B 15 Connections:

Mandatory

Optional

O + PWR

O - GND

Lock

Latch In & Latch Out

ETHERNET port

Steps:

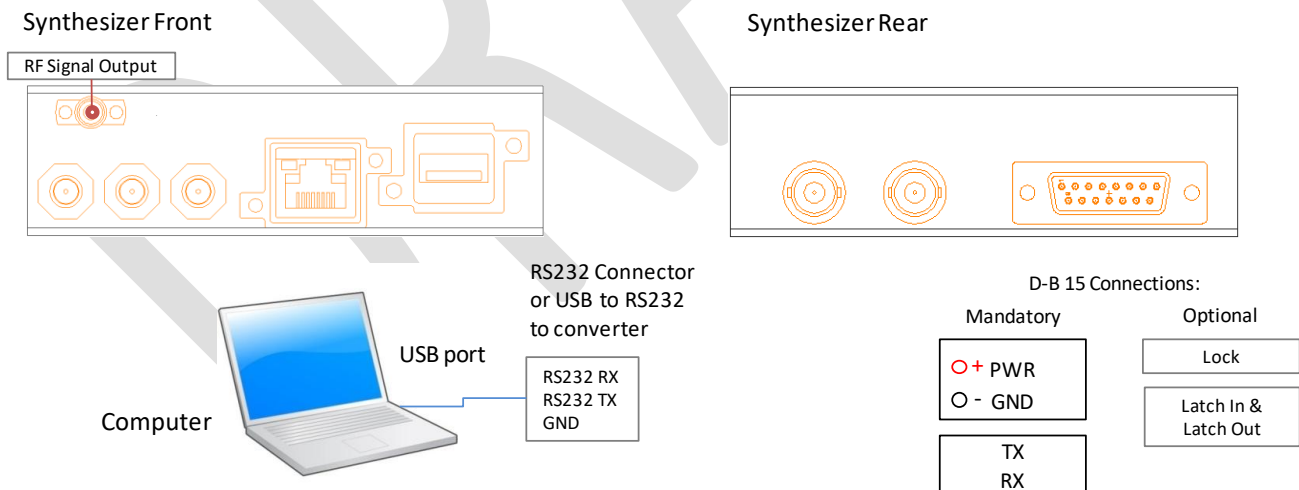|	
Step 1	Connect the synthesizer to PC using USB port
Step 2	Run the application "Synthesizer.exe"
Step 3	Select the desired options in Settings Tab (see Settings Tab example)
Step 4	Enter the Local IP (this is the IP assigned to PC Ethernet or Wireless interface)
Step 5	Enter the Synthesizer IP (should be an unused IP), the network mask, and default gateway. The synthesizer does not support DHCP protocol
Step 6	Click on "Configure" button. Configuration will not be lost after turn off the synthesizer
Step 7	Disconnect Synthesizer from PC USB port and connect Ethernet cable.
Step 8	Click on Ethernet Tab to define desired frequency of operation and other parameters (see Ethernet Tab example)

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Ethernet Connections:

Synthesizer Front

RF Signal Output

Synthesizer Rear

LAN Router/Switch/Hub

Ethernet Ports

PC Ethernet port

Computer

D-B 15 Connections:

Mandatory

Optional

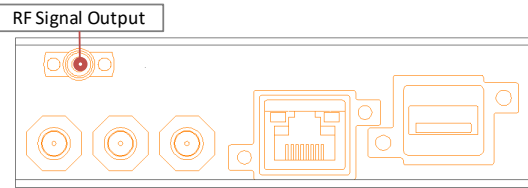| + PWR |
| - GND |

Lock

Latch In & Latch Out

External connector (SPI, RS32 ports):

Step 1	Connect the synthesizer to the PC (or another system) trough selected protocol. (SPI @ 3.3 or 5 V, RS232 @ ±12 V)
Step 2	Send the desired frequency or command (as described in "Operation Commands" section)

RS232 Connections:

Synthesizer Front

RF Signal Output

Synthesizer Rear

USB port

Computer

RS232 Connector or USB to RS232 to converter

RS232 RX
RS232 TX
GND

D-B 15 Connections:

Mandatory

Optional

| + PWR |
| - GND |

Lock

Latch In & Latch Out

| TX |
| RX |

SPI Connections:

Synthesizer Front

RF Signal Output

Synthesizer Rear

SPI Master
Controller

| MOSI |
| MISO |
| SCK |
| SSE |
| GND |

D-B 15 Connections:

Mandatory

Optional

○ + PWR
○ - GND
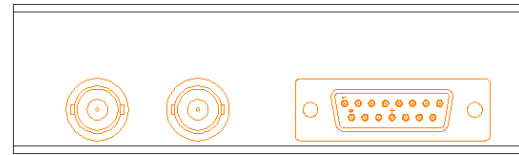
Lock

MOSI	SSE
MISO	GND
SCK	

Latch In &
Latch Out

PC Application

The PC application does not need to be installed. It can run from any path or directory. Execute "Synthesizer.exe".
Settings tab is always opened by default. Following is a review of the different tabs of the application:

Settings Tab

Description	This tab has different options. It can be selected the function mode of the synthesizer (Standard or Fast) and set the network configuration data. The differential output can enabled or disabled and the frequency can be configured, in addition to format, voltage and impedance. Information about the different outputs can be seen clicking the button `Output info` . The `CONFIGURE` button send all the previous parameters configured in this tab to the synthesizer through USB. The `Reset to Default Values` button will restore the parameters of the synthesizer to default state and all data previously stored in the synthesizer will be lost.

Settings Tab example:

Mode	Standard
Differential Output (REF OUT2)	Enabled, Frequency: 1 MHz Voltage: 3.3 V Impedance: 22 Ω
Local IP	192.168.1.122
Synthesizer Network Config	IP: 192.168.1.199 Subnet Mask: 255.255.0 Gateway: 192.168.1.1

The attached image shows the configuration in the Settings tab.

1	Insert all the configuration data properly and select the desired options
2	Ensure synthesizer is connected through USB (USB cable with green check symbol at top right)
3	Finally click on CONFIGURE button to send the data

Calibration

|	
Description	Use this section to calibrate the frequency of the synthesizer. This section is password protected. The Change Password button allows to change the password. See Change Password example below. Default factory password is "1234". The frequency offset can be restarted with the Reset Offset button. Tha maximum positive frequency offset value is 3428027 Hz and the minimum negative frequency offset is -3428028 Hz.

Calibration example:

|	
Frequency Offset	Set a frequency offset of 242.71 Hz

Steps:

1	Insert a valid password and click on [Accept]
2	Click the button [SEND] to set a frequency of 1500MHz.
3	Measure the frequency offset with a high precision frequency meter.
4	Introduce the offset necessary to adjust the frequency in the Frequency Offset Adjust (+/-) box. –10534.79Hz is introduced in this example.
5	Click on [CALIBRATE] button.
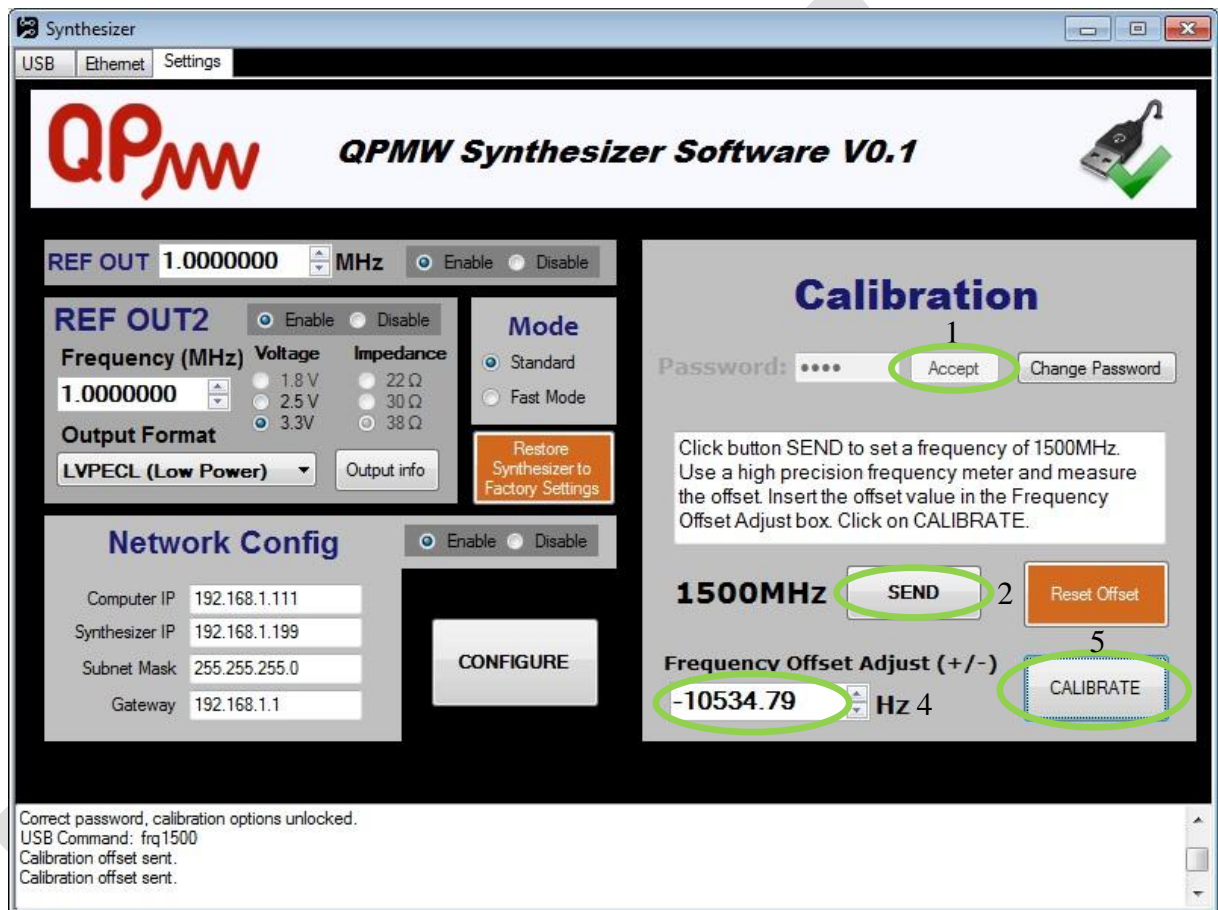
Password	Change the password using the [Change Password] button.

Steps:

1	Introduce a valid old password, introduce a new password and repeat it. Click on [Accept]
2	Click the button [Change Password] to change the password
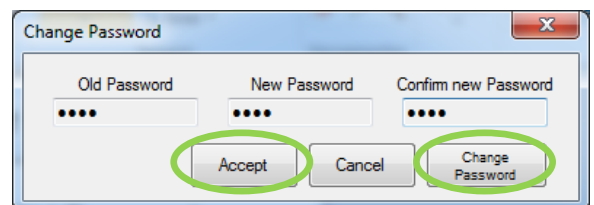
Note: If you lose the password you can download the application again with the default factory password.

Note 2: The maximum password size is 8 chars.

USB Tab

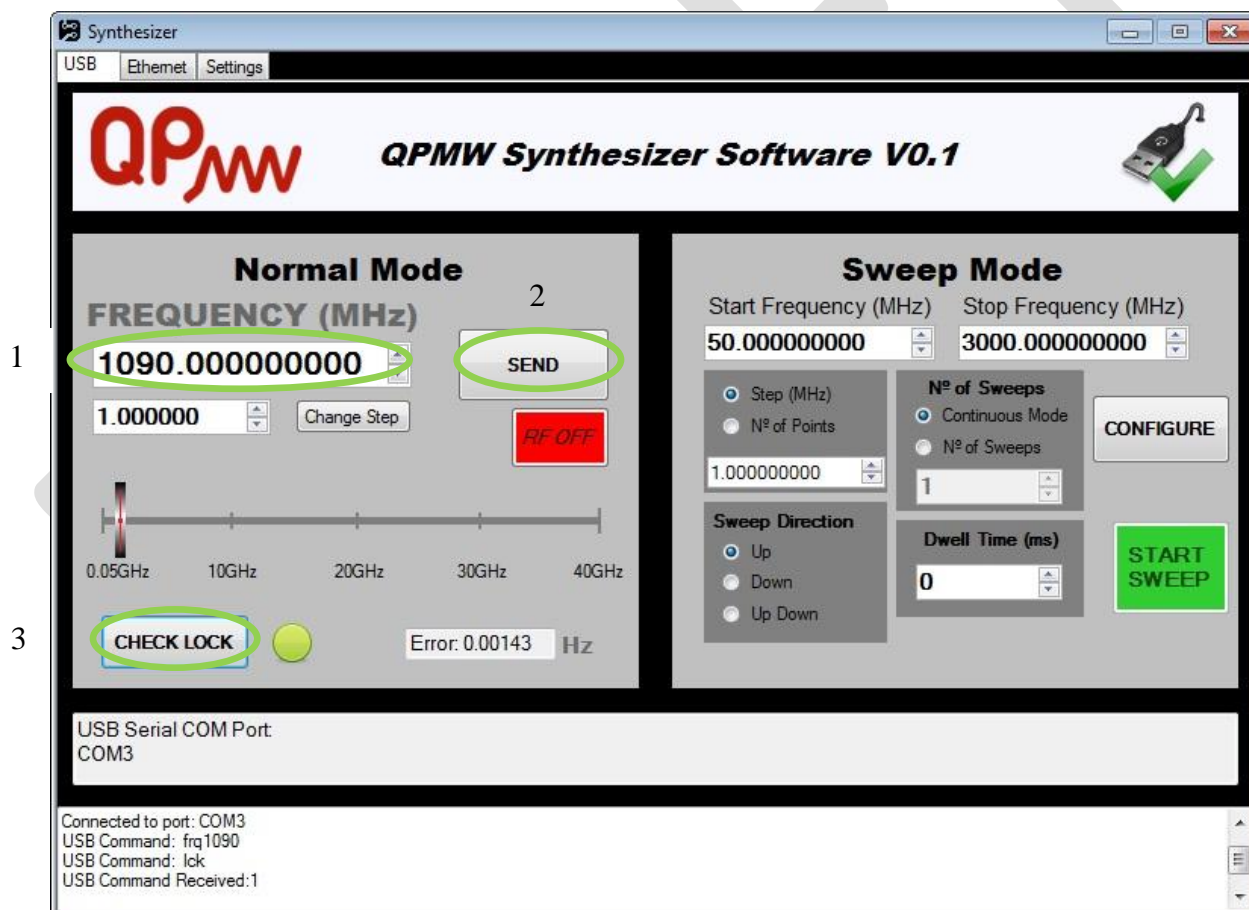| Description	Use this tab to manage the synthesizer from USB port. In this tab, the RF OUT frequency can be configured. The lock state can also be checked. The frequency can be introduced in the FREQUENCY box, it can also be changed with the arrows or using the mouse wheel. The `Change Step` button set the frequency change step, value can be introduced in the box, changed with the arrows or the mouse wheel.

USB Tab example, Normal Mode:

Frequency	Set frequency of RF OUT to 2501.5 MHz.

Steps:

1	Introduce the frequency in the FREQUENCY box.
2	Click the button `SEND`
3	After step 2, the Lock state of the PLL can be checked clicking on the button `CHECK LOCK`. If the PLL is locked, the circle turns green. If not, it turns red. Grey means lock state is not checked.

USB Tab example, Sweep Mode:

Sweep	Sweep Mode settings: frequency out from 1GHz to 40GHz with a step of 500MHz, 2 sweeps, Up Down mode and dwell time of 10ms.

Steps:

1	Introduce the sweep configuration.
2	Click the button CONFIGURE .
3	After step 2, the config is loaded in Synthesizer so now the button START SWEEP can be clicked to initiate the sweep.
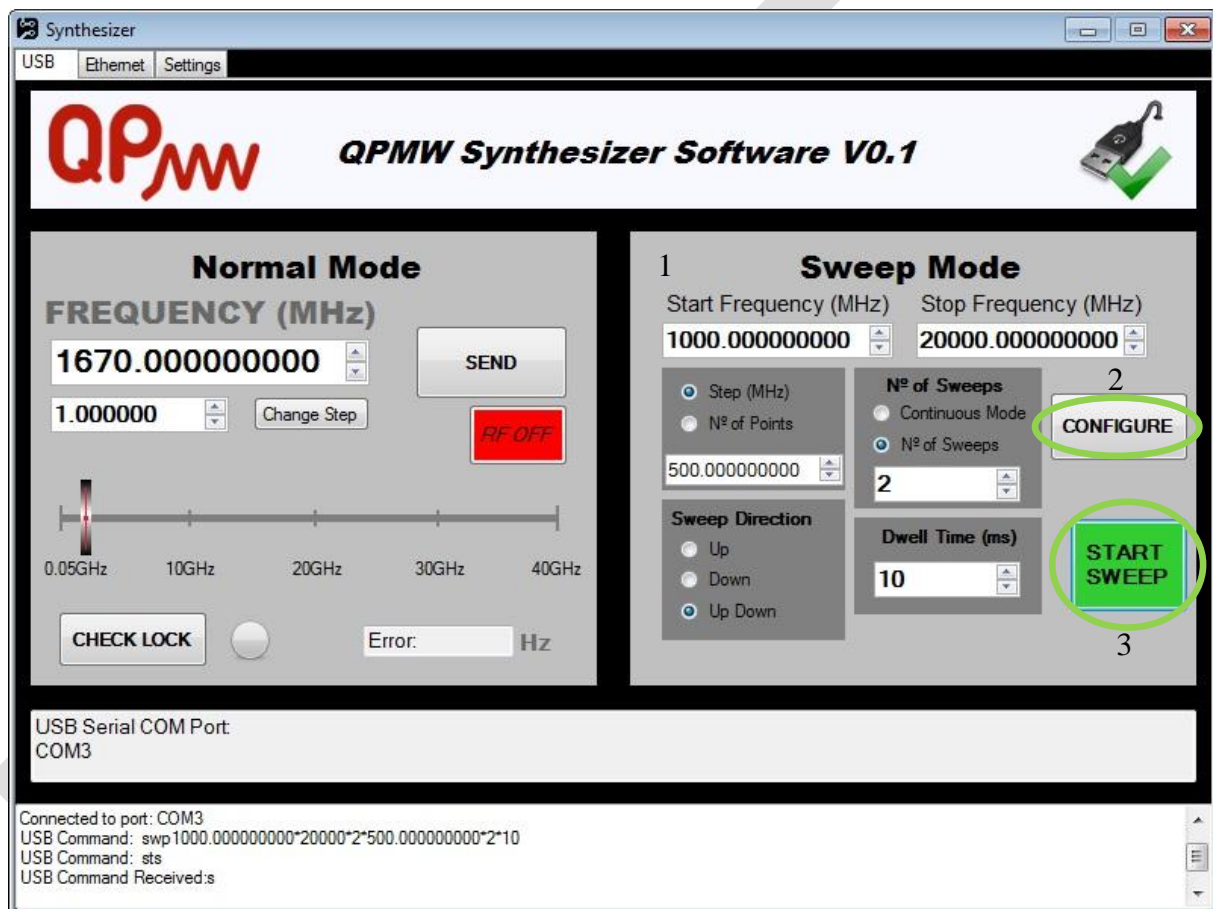
Note: The external Latch can be used to latch the sweep after step 3.

Ethernet Tab

Description	Use this tab to manage the synthesizer from Ethernet (LAN) port. In this tab, the RF OUT frequency can be set. The lock state can also be checked. The frequency can be introduced in the FREQUENCY box, it can also be changed with the arrows or using the mouse wheel. The `Change Step` button set the frequency change step, value can be introduced in the box, changed with the arrows or the mouse wheel.

Ethernet Tab example, Normal Mode:

Frequency	Set frequency of RF OUT to 2501.5 MHz.

Steps:

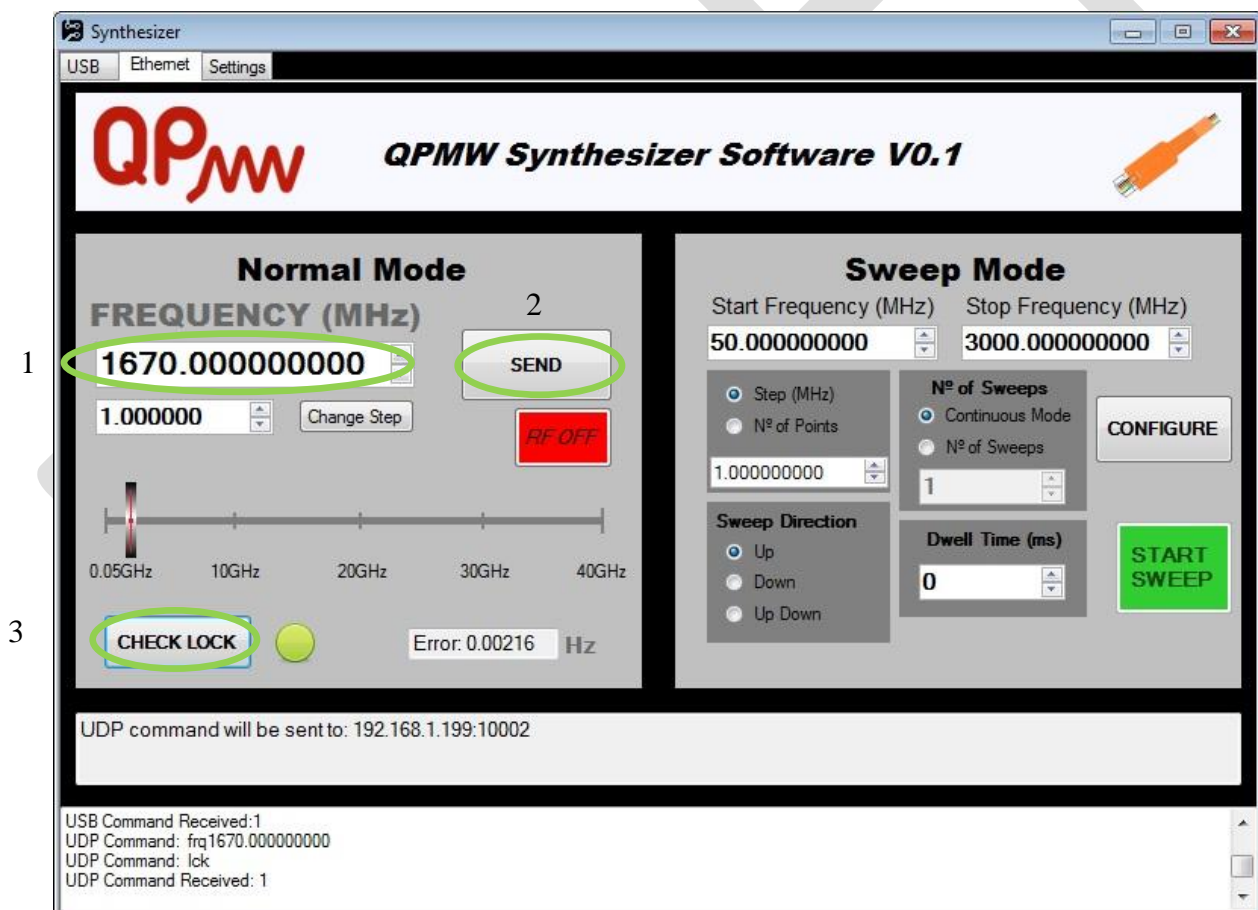| 1	Introduce the frequency in the FREQUENCY box.
2	Click the button **SEND**
3	After step 2, the Lock state of the PLL can be checked clicking on the button `CHECK LOCK` If the PLL is locked, the circle turns green. If not, it turns red. Grey means lock state is not checked.

UDP Tab example, Sweep Mode:

Sweep	Sweep frequency settings are: frequency out from 1GHz to 20GHz in 2000 points, continuous sweep mode,Up Down mode, and dwell time of 100ms.

Steps:

1	Introduce the sweep configuration.
2	Click the button **CONFIGURE**.
3	After step 2, the config is loaded in Synthesizer so now the button **START SWEEP** can be clicked to initiate the sweep.
4	Click on **STOP SWEEP** to terminate the sweep.
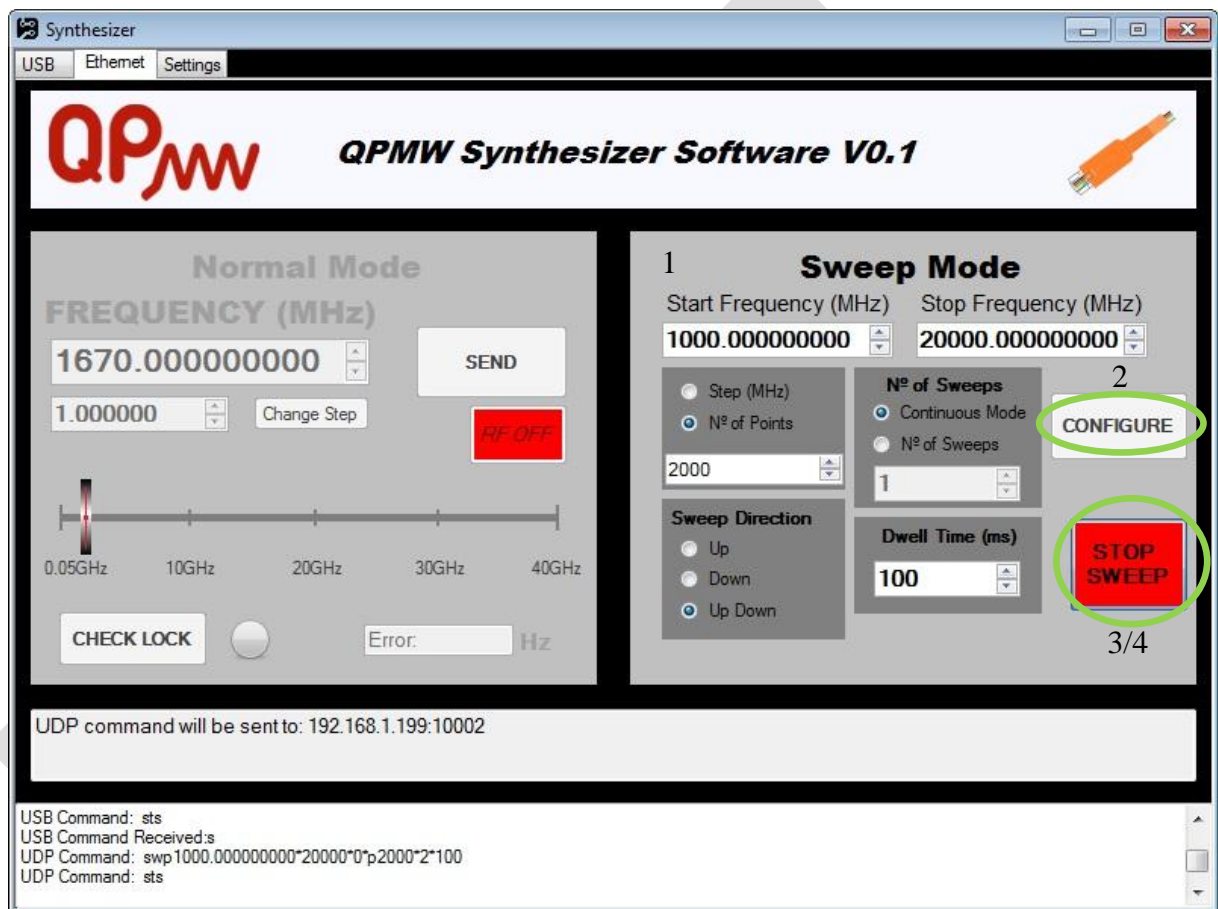
Note: The external Latch can be used to latch the sweep after step 3.

Communication Specifications

NOTE: It is recommended to use only one protocol to control the synthesizer at the same time. Mixing protocols (e.g.: Ethernet and RS232) can produce unknown effects.
NOTE 2: A delay of 2ms should be between commands.

RS232

Command syntax	The syntax of the commands is "Command name" + "Optional Parameters" (if required) + 'Carriage Return' char. ASCII code is used

List of operation commands:

Frequency Change

Command description	Send "frq" string followed by frequency value (in MHz) and followed by the 'Carriage Return' char (Hex: 0x0D). ASCII code
Example	frq1500.123456<CR> (To set 1500.123456MHz)

System Reset

Command description	Send "rst" string followed by the 'Carriage Return' char (Hex: 0x0D). (ASCII code)
Example	rst<CR>

IP PC Remote

Command description	Send "ipl" followed by IP from PC that will be used to communicate with the device. The IP must be in hexadecimal value, not in ASCII. 4 bytes must be sent with values from 0 to 255 each one. Finally send the 'Carriage Return' char. ASCII code + bytes
Example	ipl C0 A8 01 78 <CR> (To set 192.168.1.120)

IP Synthesizer

Command description	Send "ips" followed by the IP used for communications with the device. The IP must be in hexadecimal value, not in ASCII. 4 bytes must be sent with values from 0 to 255 each one. Finally send the 'Carriage Return' char. ASCII code + bytes
Example	ips C0 A8 01 C7 <CR> (To set 192.168.1.199)

Subnet Mask

Command description	Send "msk" followed by the Subnet Mask used in the network and. The IP must be in hexadecimal value, not in ASCII. 4 bytes must be sent with values from 0 to 255 each one. Finally send the 'Carriage Return' char. ASCII code + bytes
Example	msk FF FF FF 00 <CR> (To set 255.255.255.0)

Gateway

Command description	Send "gtw" followed by the Gateway used in the network. The IP must be in hexadecimal value, not in ASCII. 4 bytes must be sent with values from 0 to 255 each one. Finally send the 'Carriage Return' char. ASCII code
Example	gtw C0 A8 01 01 <CR> (To set 192.168.1.1)

Lock

Command description	Send "lck" followed by a 'Carriage Return' char to receive the Lock state of the PLL. ASCII code
Example	lck<CR>

Mode Standard

Command description	Send "mst" followed by a 'Carriage Return' char to configure the synthesizer in Standard Mode. ASCII code
Example	mst<CR>

Mode Fast

Command description	Send "mfs" followed by a 'Carriage Return' char to configure the Synthesizer in Standard Mode. ASCII code
Example	mfs<CR>

Disable Differential Output

Command description	Send "cg99" followed by a 'Carriage Return' char to disable the Differential Output. ASCII code
Example	cg99<CR>

Enable Differential Output

Command description	Send "cg00" followed by a 'Carriage Return' char to disable the Differential Output. ASCII code
Example	cg00<CR>

Frequency Out REF OUT2

Command description	Send "foc" string followed by the frequency value (in MHz) and followed by the 'Carriage Return' char (Hex: 0x0D). ASCII code
Example	foc100.54714<CR> (to set 100.54714 MHz)

Differential Output Format

Command description	Send "cg" string followed by the number of the configuration desired (see next table) and the 'Carriage Return' char (Hex: 0x0D). ASCII code
Example	cg11<CR> (to set LVCMOS 3,3 V, 22 Ω (Phase))

Number	Output Format
1	LVPECL
2	LVPECL 2.5 V (Low Power)
3	LVDS 1,8 V
4	LVDS 2,5 V
5	LVDS 3,3 V
6	LVDS 1.8 V (Low Power)
7	LVDS 2.5 V (Low Power)
8	LVDS 3.3 V (Low Power)
9	HCSL 1.8 V
10	HCSL 2.5 V or 3.3 V
11	LVCMOS (In Phase): 1,8 V, 31 Ω / 2,5 V, 24 Ω /3,3 V, 22 Ω
12	LVCMOS (In Phase): 2,5 V, 43 Ω / 3,3 V, 38 Ω
13	LVCMOS (In Phase): 2,5 V, 35 Ω / LVCMOS 3,3 V, 30 Ω
14	LVCMOS (Complementary): 1,8 V, 31 Ω / 2,5 V, 24 Ω 3,3 V, 22 Ω
15	LVCMOS (Complementary): 2,5 V, 43 Ω / 3,3 V, 38 Ω
16	LVCMOS (Complementary): 2,5 V, 35 Ω / 3,3 V, 30 Ω

Differential Output Voltage 1.8 V

Command description	Send "vo1" followed by a 'Carriage Return' char to set Differential Output with 1.8 V. ASCII code
Example	vo1<CR>

Differential Output Voltage 2.5 V

Command description	Send "vo2" followed by a 'Carriage Return' char to set Differential Output with 2.5 V. ASCII code
Example	vo2<CR>

Differential Output Voltage 3.3 V

Command description	Send "vo3" followed by a 'Carriage Return' char to set Differential Output with 3.3 V. ASCII code
Example	vo3<CR>

Sweep Mode Configuration

Command description	Send "swp" followed by the desired options. Use the table to set the command. All the variables are mandatory. The command is swpINITIAL_FREQ_*FINAL _FREQ *REPETITTIONS*POINTS_STEP*MODE*

Option	Description
INITIAL_FREQ	Any valid frequency from 50MHz to 40000 (MHz) It should be smaller than FINAL_FREQ
FINAL _FREQ	Any valid frequency from 50MHz to 40000 (MHz) It should be greater than INITIALL_FREQ
REPETITTIONS	0 for continuous mode, a number between 1 and 32768 to choose the repetitions.
POINTS_STEP	A number to choose the step frequency in MHz (Max 5000MHz) or 'p' followed by the number of points desired between the INITIAL_FREQ and the FINAL_FREQ.
MODE	'0' UP Mode, '1' DOWN Mode, '2' UP DOWN Mode
DWELL_TIME	Dwell time in ms,0 for minimum dwell time, maximum dwell time is 65535ms.

Example 1	swp1000*35000*0*p2000*2*100<CR> (to set a sweep from 1GHz to 35GHz, continuous mode, 2000 points, Up Down mode and Dwell time 100ms
Example 2	swp50*3000*10*50*0*0 (to set a sweep from 50MHz to 3GHz, 10 repetitions, step of 50MHz, Up mode and minimum Dwell time.

Start Sweep

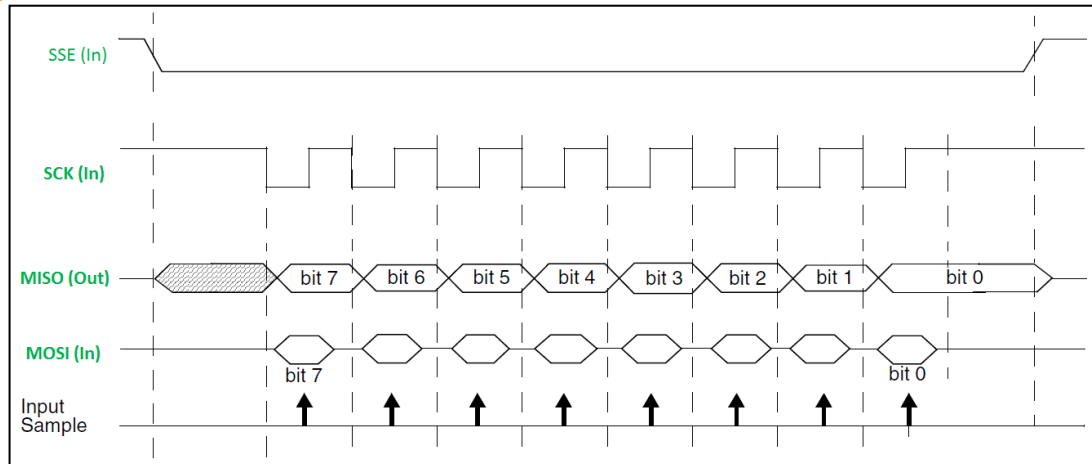| Command description	Send "sts" followed by a 'Carriage Return' char to start the sweep previously configured. ASCII code
Example	sts<CR>

Stop Sweep

Command description	Send "sps" followed by a 'Carriage Return' char to stop an ongoing sweep. ASCII code
Example	sps<CR>

SPI

Command syntax	Same commands as RS232. Hexadecimal ASCII values of commands must be sent

SPI Timing:

Operation command examples:

Frequency Change

Command description	Send hexadecimal values of "frq" string followed by hexadecimal values of frequency (in MHz) and a 'Carriage Return' char in hexadecimal (0x0D). Hexadecimal values are equivalent to chars in ASCII code
Example	66 72 71 31 35 30 30 2E 31 32 33 34 35 36 0D (to set 1500.123456 MHz)

System Reset

Command description	Send string "rst" followed by 'Carriage Return' (0x0D) in hexadecimal ASCII equivalent
Example	72 73 74 0D

IP PC Remote

Command description	Send hexadecimal values of "ipl" string followed by IP from PC that will be used to communicate with the device. The IP must be in hexadecimal value, not in ASCII. 4 bytes must be sent with values from 0 to 255 each one. Finally send the 'Carriage Return' char.
Example	69 70 6C C0 A8 01 78 0D (to send "ipl192.168.1.120<CR>")

Note: Do not send SPI commands until Synthesizer is powered on during 5 seconds.

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