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Vincit Omnia Veritas

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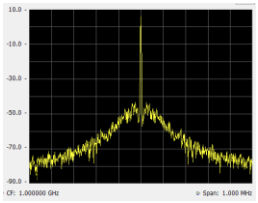
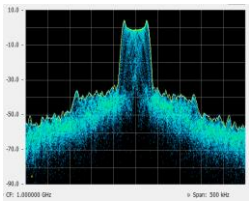
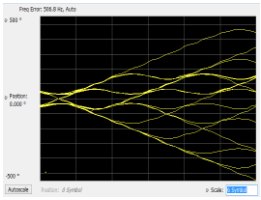
Triarchy®VSG6G1/VSG2G1/TSG4G1

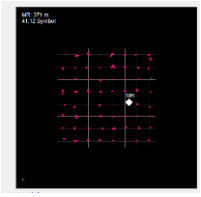
USB Vector RF Signal Generator

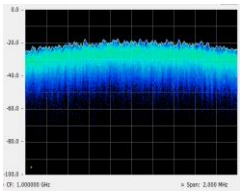
Operating Manual

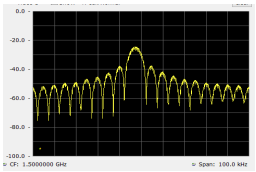

CW signal

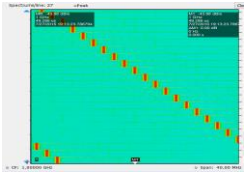

Analog modulation

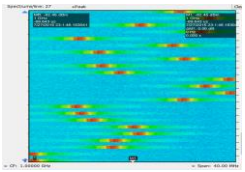

GMSK modulation

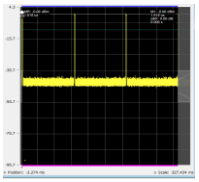

64 QAM

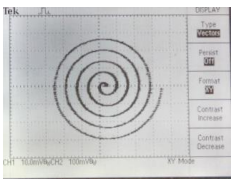

NB RF noise generator


Pulse modulation


Frequency sweeping


Hopping with data Mod


GSM signal


arbitrary signal generator

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USB Vector RF Spectrum Analyzer Operating Manual

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Technical Support

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1 Introduction

VSG6G1/VSG2G1/TSG4G1 is a USB RF signal generator that plugs on PC and works using PC or tablet application.
For VSG6G1: the RF frequency range is from 1MHz to 6.2GHz, amplitude output range will be -60dBm~10dBm.
For VSG2G1: the RF frequency range is from 1MHz to 2.2GHz, amplitude output range will be -60dBm~10dBm.
For TSG4G1: frequency range is from 35MHz to 4.4GHz, and amplitude is from -60dBm to 0dBm.

VSG6G1 /VSG2G1/TSG4G1 will be very easy to use. The application's user interface is designed to be just like the front panel of normal desktop signal generators, allowing signal generator users to easily pick up and use the application intuitively without a high learning curve. If your PC or tablet support touch screen, the user experience will be even more realistic to a desktop signal generator.

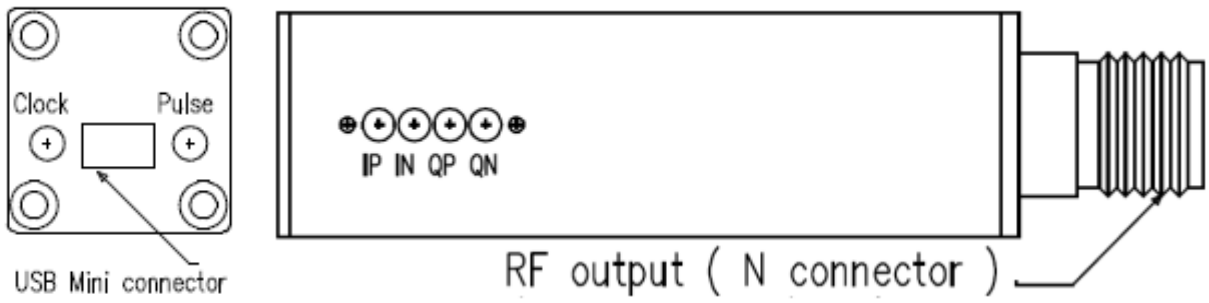
VSG6G1 have additional functions: such as the generation of modulation signal with I&Q engine and Pulse modulation so that it can simulate a lot of wireless systems.

1.1 Product Package Overview

VSG6G1/VSG2G1/TSG4G1 product package will be:

1: USB signal generator device (25x25x100mm)	one piece
2: mini USB cable	one piece
3: SMA to MMCX cable	one piece
4: N to SMA adapter	one piece
5: 30 dB attenuator	one piece
6: CD with PC application program and document	one piece
7: 160x110x40mm product case	one piece

1.2 USB Device Overview



RF output	N connector (female)	RF signal output
USB connector	Mini-B USB connector	interface with PC
IP	MMCX connector	I port positive Output/Input
IN	MMCX connector	I port negative Output/Input
QP	MMCX connector	Q port positive Output/Input
QP	MMCX connector	Q port negative Output/Input
Clock	MMCX connector	Clock Output/Input
Pulse	MMCX connector	Pulse signal Output

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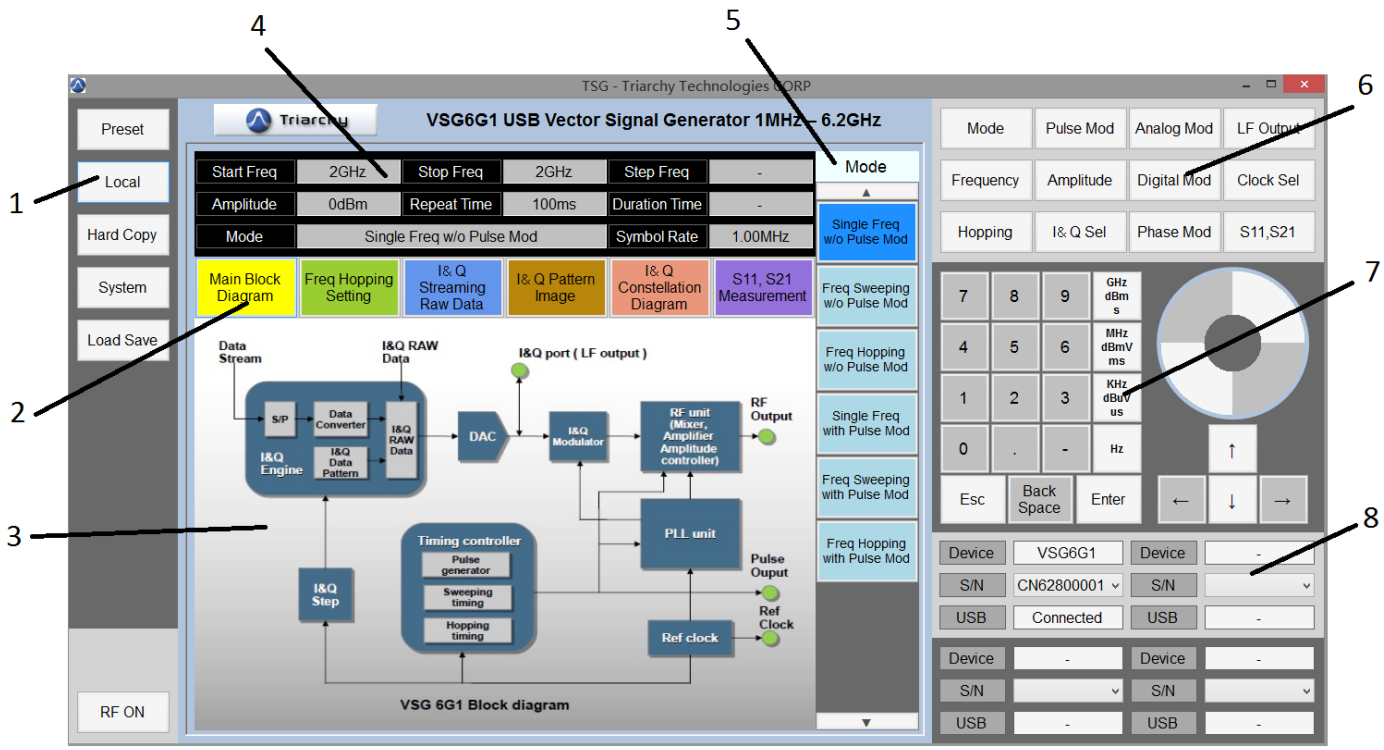
1.3 TSG PC Application Overview



1: **utility keys**

Allows user to access the system level function. Function detail will be shown on second function keys

2: **Message selection keys**

Click the Message selection key, the Message display area will change according to selection.

3: **Message display area**

Message display area shows detailed information about output signal.

Main Block Diagram illustrates how the RF vector signal generator working, how the signal is output.

Freq Hopping setting shows a table of hopping frequency points.

I&Q Streaming Raw Data is waveform of I&Q raw data, it will be same as real waveform signal from I&Q port.

I&Q pattern image shows I&Q pattern if I&Q raw data is generated based on the I&Q pattern.

I&Q constellation diagram is shown, it will be selected depending on Raw data or I&Q pattern.

S11, S21 Measurement shows the waveform of S11 and S21 test result.

4: **Status block**

Status block shows the main parameter of output signal: such as frequency, amplitude, repeat time, duration, symbol rate and working mode.

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5: **Second functions keys**

Second function keys will extend secondary functions relative to the primary function keys and utility key. It is similar to soft key in most of equipment which is location on side of screen.

6: **Function keys**

Most of major the equipment settings are done by the **Function keys**. General setting for signal generator will be: Select mode: such as frequency selection for single, sweeping and hopping and pulse modulation selection.

Input frequency: such as setting for signal frequency, frequency sweeping and frequency hopping

Input amplitude: such as level setting, external attenuator selection and setting.

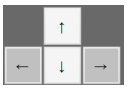
Input timing: for pulse modulation.

Adding I&Q modulation: to setup a lot of different kind of modulation to meet each application requirements.

7: **Digital input keys**

Digital input keys will input digital and units for frequency, amplitude and timing. This standalone input key is similar to desktop equipment

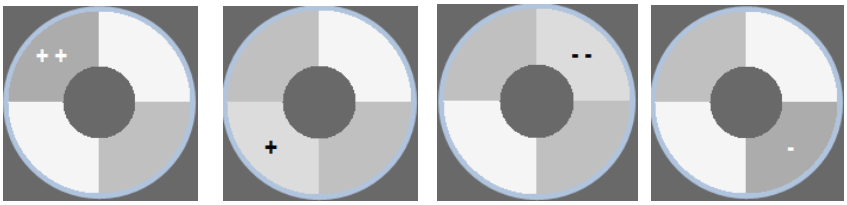
Frist select the digital at second function, frequency, amplitude and timing.

Then operate keypad  , navigation keys  and Knob  to change the input value.

Knob Operation

When the mouser cursor hovers over each of the four buttons on the knob: ++, +, --, - icon will display. Click and hold on each icon to increase or decrease value:

++	fast increase
+	slowly increase
--	fast decrease
-	Slowly decrease



After input digital, it need to input unit to finish all setting.

8: USB connection area

When VSG6G1/VSG2G2/TSG4G1 is plugged in the PC, USB connection area will display the product model name, S/N and connection status. A device is properly connected to and recognized by the application program when Model number, S/N and connected status are all displayed.

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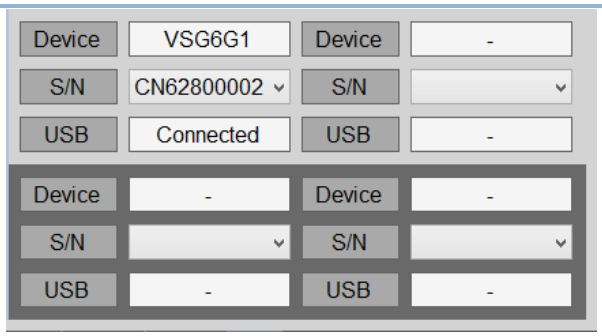

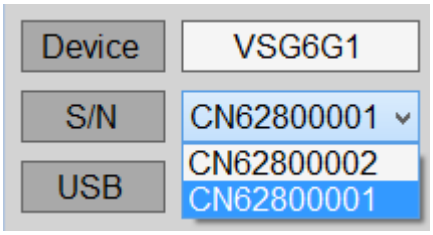

One PC can connect multiple VSG6G1/VSG2G1/TSG4G1 device. Select S/N item to choose which device will is used. When multiple TSG application are opened, each TSG can connected to each hardware device by choice proper the S/N.

1.4 Electrical Requirements

1.41 Specification for Frequency

Frequency range for VSG6G1:

Band 0: 1MHz ~30MHz
Band 1: 30MHz ~2200MHz
Band 2: 2200MHz ~6200MHz

Frequency range for VSG2G1:

Band 0: 1MHz ~30MHz
Band 1: 30MHz ~2200MHz

Frequency range for TSG4G1:

Band 1: 35MHz ~4400MHz

Frequency resolution: 1 KHz with PLL setting
Frequency offset: +/-2Hz to +/-1KHz with I&Q Freq Shift +/- setting
* frequency offset can only be setup at single frequency mode without any modulation (not working at TSG4G1)
Frequency stability: +/-2.5PPM over temperature -20~+60 degree
Frequency aging per year: +/-1PPM
Frequency reference output: 12MHz
Frequency reference input: 10MHz/5dBm

1.4.2 Specification for power

Output level range for VSG6G1 :

Band 0: -21dBm~10dBm
Band 1: -21dBm~10dBm
Band 2: -31dBm~0dBm

Output level range for VSG2G1 :

Band 0: -21dBm~10dBm
Band 1: -21dBm~10dBm

Output level range for TSG4G1 :

Band 1: -31dBm~0dBm

Output level resolution: 1dB
Output level error: <3dB
Phase noise:

-90dBc/Hz offset 10 KHz at 1GHz
-105dBc/Hz offset 100 KHz at 1GHz
-120dBc/Hz offset 1MHz at 1GHz

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1.4.3 Specification for Pulse modulation

Pulse repeat time:	400uS to 20s
Pulse duration time:	10us to 5S
Multiple pulse number:	2~250
Multiple pulse delay:	100us~5s (last pulse cannot be overlay with first pulse)
On/off ratio:	>90dB

1.4.4 Specification for Frequency sweeping with/ without pulse modulation

Span range:	1 KHz to full span
Scan points range:	2 to 50000
Frequency step range:	1 KHz to 1GHz
Pulse period (set at Pulse Mod):	repeat time 400uS to 20s
Pulse width (set at Pulse Mod):	duration time 10us to 10s

* If it is in “Freq sweeping w/o Pulse mod”, this parameter is no function

1.4.5 Specification for Frequency hopping with/ without pulse modulation

Frequency hopping range:	1MHz to 6.2GHz (30MHz to 2.2GHz for VSG2G1/ 35MHz to 4.4GHz for TSG4G1)
Frequency hopping number:	2~4000
hopping times(Pulse period):	2500 hop/s to 0.05 hop/s (or repeat time 400uS to 20s)
Pulse width (set at Pulse Mod):	duration time 10us to 10s

* If it is in “Freq hopping w/o pulse mod”, this parameter is no function

1.4.6 Specification for I&Q unit for analog modulation (not suit for TSG4G1)

FM modulation in Demo key: Modulation frequency range: 1.5Hz to 3.3KHz; Modulation index 20

FM modulation by defined the file, load different file:

Modulation frequency range: 1.5Hz to 33KHz

Modulation index 0.5 to 20

AM modulation in Demo key: Modulation frequency range: 30.7Hz to 66.7KHz; Modulation index 90%

AM modulation by defined the file, load different file:

Modulation frequency range: 1.5Hz to 66.7KHz

Modulation index 10%to90%

PM modulation in Demo key: Modulation frequency range: 30.7Hz to 66.7 KHz; Modulation index 180 degrees

PM modulation by defined the file, load different file:

Modulation frequency range: 30.7Hz to 66.7KHz

Modulation index 36 degree to 288 degree

*Define the I&Q RAW data file, any kind of analog modulation can be achieved. Such as RF narrow band noise generator.

1.4.7 Specification for I&Q unit for Digital modulation (not suit for TSG4G1)

MSK modulation in Demo key:	Data rate rage: 110b/s to 240Kb/s; Data depth: 400 bit
GMSK modulation in Demo key:	Data rate rage: 110b/s to 240Kb/s; Data depth: 400 bit; BT=0.3
FSK modulation in Demo key:	Data rate rage: 27.7b/s to 60Kb/s; Data depth: 25 bit

* Define the I&Q data file, study different I&Q pattern, internal I&Q engine will generate the most of digital modulation; Such as SFSK.

1.4.8 Specification for I&Q unit for phase modulation (not suit for TSG4G1)

QPSK modulation in Demo key:	Data rate rage: 2.2kb/s to 4.8Mb/s; Data depth: 4000 bit
8PSK modulation in Demo key:	Data rate rage: 3.3kb/s to 7.2Mb/s; Data depth: 4000 bit

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16QAM modulation in Demo key: Data rate rage: 4.4kb/s to 9.6Mb/s; Data depth: 4000 bit
* Define the I&Q data file, study different I&Q pattern, internal I&Q engine will generate the most of digital modulation; Such as 64QAM.

1.4.9 Specification for I&Q external modulation (not suit for TSG4G1)

Baseband signal bandwidth:	500MHz
I&Q signal level:	1Vpp
I&Q port impedance:	200 ohm

* any kind of modulation will be depended on the input of I&Q signal

1.4.10 Specification for LF output

SIN Waveform in Demo:	Waveform pattern length: 72 point.
	Frequency range: 15.4Hz to 33.3 KHz
	Signal level: 1VPP
Triangle Waveform in Demo:	Waveform pattern length: 36 point
	Frequency range: 30.8Hz to 66.6 KHz
	Signal level: 1VPP
Spiral waveform in Demo:	Waveform pattern length: 720 point
	Frequency range: 1.5Hz to 3.3 KHz
	Signal level 1VPP
Total I&Q raw data length:	4Kb
I&Q points range:	30 to 65000

*Define the I&Q data file, study different pattern. internal I&Q engine will generate most of the signal waveform.

1.4.11 Specification for Pulse signal output

Pulse output level:	3.3V
Pulse repeat time:	400uS to 20s
Pulse duration time:	10us to 5S
Multiple pulse number:	2~250
Multiple pulse delay:	100us~5s (last pulse cannot be overlaid with first pulse)

2 Getting Started

2.1 Install PC Application

Open the CD, go into the SW file folder, you can find setup.exe and Document folder.

If you want copy the setup.exe to any PC any folder to install the program, please make sure that Document folder shall be copied and located at same folder as setup.exe file.
When you finished the installation, the TSG ICON will be shown on the desk

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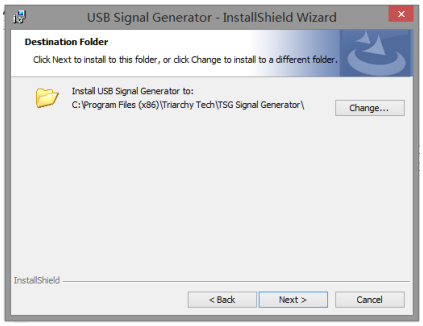

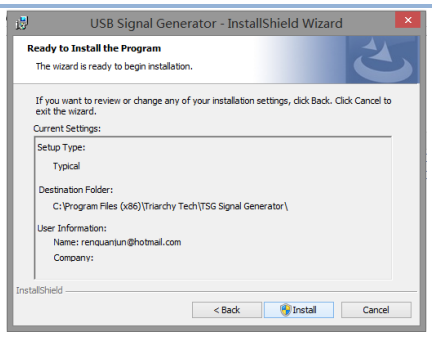

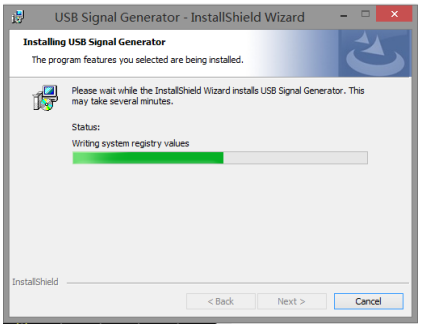

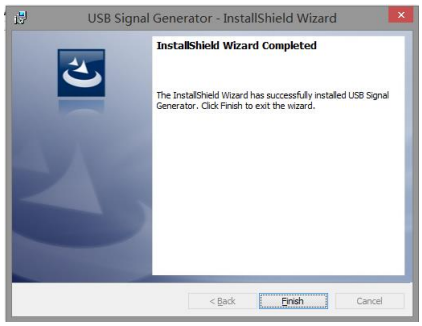

After installation, the program file will be installed at program file folder.
C:\Program Files (x86)\Triarchy Tech\USB Vector Signal Generator
The application data will be generated at Document folder:
C:\Users\Username\Documents\Triarchy Tech\TSG Signal Generator

Customer need to check the application data at document folder.
Calibration folder stores the calibration file. There multiple calibration files in the folder. You can generate new calibration file and stored in same folder.
Hardcopy folder: stores the image file which generated by hardcopy key.
Hopping folder: stores the hopping files.
IQ Modulation folder: stores all the modulation file.
Setting folder: save file, preset, and specific setting are stored in it, then using load key to resumed the previous setting.

You can add more files into document folder, so that more modulation signal can be generated.

2.2 Uninstall PC Application

Uninstall TSG ICON, click it to uninstall.

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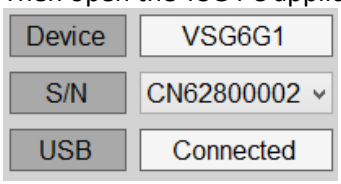
You also can use control panel to uninstall the TSG program.

2.3 First Working Example

During the first time using VSG6G1 product: turn off the TSG PC application first, then connect VSG6G1 to PC via USB cable, PC will install the USB device hardware configuration.

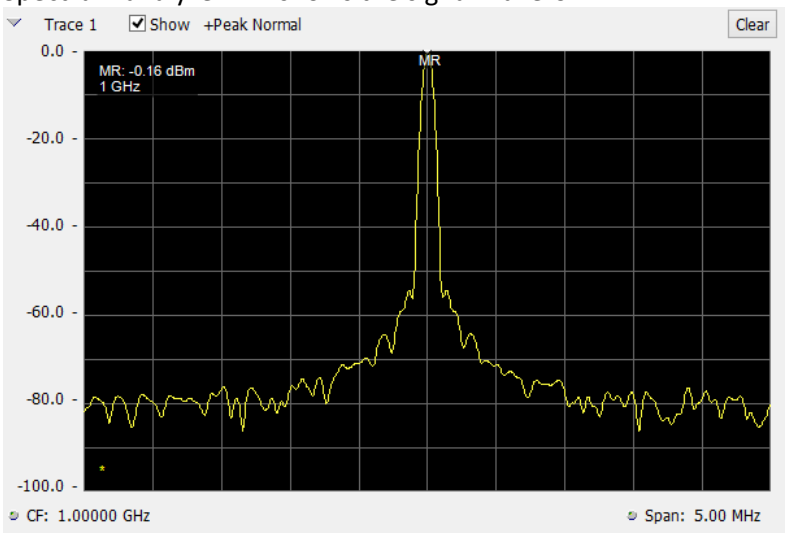
Then open the TSG PC application, the USB connection area will show the device model, S/N and connection status.



Connect device output to Spectrum analyzer. Then click RF off 

, RF output will be on. 

Spectrum analyzer will shows the signal waveform:



2.4 TSG Utility keys setting

Preset

When clicking the Preset key, the second function key will be shown:

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Last setting key select to ON, when TSG program turn on or USB device plug off and on, all system setting will go to last setting.
Last setting key select to OFF, when TSG program turn on or USB device plug off and on, all system setting will go to preset 1 status.
Preset x (x=1~6) can be clicked, then system setting will go into the preset x status.
Preset x can be setup at **Load Save** key

Local

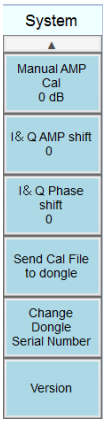
Reserve to Remote function.

Hardcopy

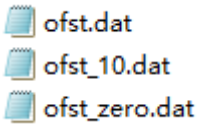
Click hard copy, the image of setting will be save at document folder:

System

When clicking the System key, the second function key will shown：



Manual AMP Cal:
The value can be input, when output terminal attach the attenuator or cable path loss.
I&Q AMP shift and **I&Q Phase shift**:
This function is used for compensation of I&Q error in RF path to improve the EVM performance. Application note will discuss this item in more detail.
Send Cal File to Dongle:
Three calibration file can be selected in the calibration folder.



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ofst.dat is calibration file. It is the default setup in the dongle, if you want setup another calibration, you need to setup this calibration file again to resume the calibration condition.
ofst._zero.dat is un calibration, open this file. The output level will be maximum, such as you can get 15dBm output at 1GHz
ofst_10.dat is calibration with 10dB level decrease. EVM performance can be improved when using this file.

Change the dongle series number:

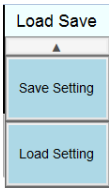
It need passwords to change the series number. This function is reserved for manufacture use.

Version:

Show the current TSG version number

Load Save:

`When clicking the System key, the second function key will shown：



Save Setting:

To save the current setting status into file, it can be resume setting by **Load setting**.
If saving the file into preset folder, and name as Presetx_mode.txt, the preset set can be updated by **save setting** key.

Load Setting:

To recall the setting file by **Load setting**, the old setting status will be represent into current setting.

Flash ON/OFF

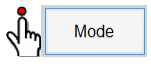
This is selection key, when select **Flash ON,** all the command and setting will be stored at flash memory, when TSG program turn off, then device plug off PC and plug on 5V power adapter, the device will be working on the previous setting. So that Device can standalone work without PC, when select **Flash off,** all the command and setting will stored at RAM, it is normal working mode, please select Flash off, if you don't want to work as standalone mode.

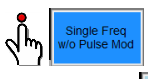
RF ON/OFF

This is selection key, the Preset 1 will set this key to RF OFF, after you connect RF output terminal with UUT, then you can set this key to RF ON. Please note, don't turn on the RF output when RF output terminal is open.

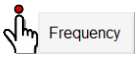
3 Operations

3.1 CW Signal Output

1: 

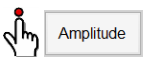
in function keys, 

in second function keys.

2: 

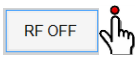
in function keys, 1.1GHz 

in second function keys.

3: 

in function keys, 5dBm 

in second function keys.

4: 

in utility keys, measure the RF output by Spectrum analyzer.

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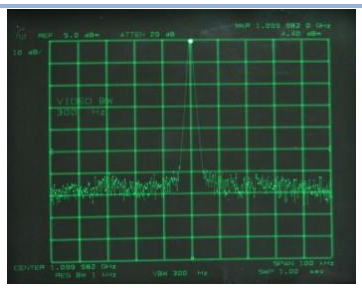
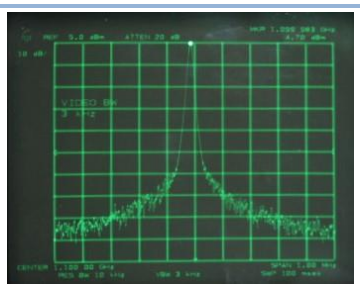
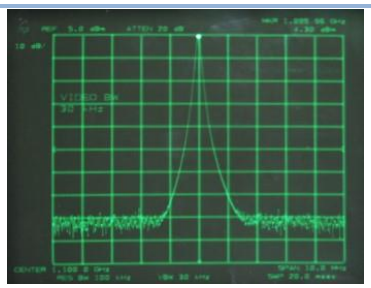
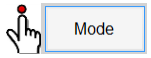




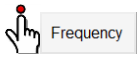
Spectrum from HP8566A
RBW=1KHz, phase noise is -90dBc/Hz @10KHz
RBW=10KHz, phase noise is -108dBc/Hz @100KHz
RBW=100KHz, phase noise is -120dBc/Hz @1MHz

3.2 Pulse modulation Signal Output

1: 

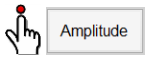
in function keys, 

in second function keys.

2: 

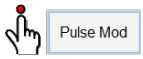
in function keys, 1.5GHz 

in second function keys.

3: 

in function keys, 2dBm 

in second function keys.

4: 

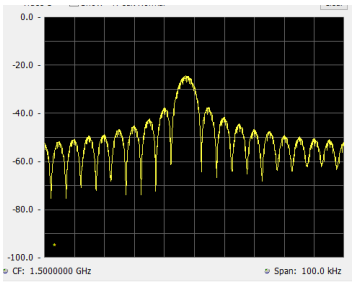
in function keys, 5ms 

, 200us 

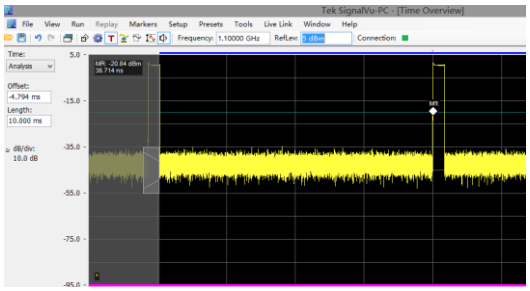
in second function keys.

After all setting 

,commands will send to dongle.



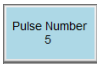
Spectrum from RSA306



RF Time waveform from RSA306

5: The multiple pulse can be setup 

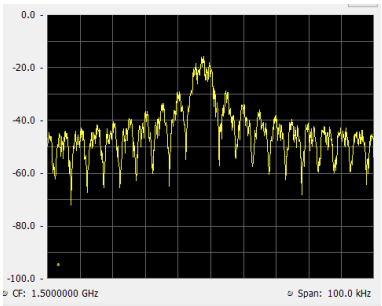
, 200us 

, 5 

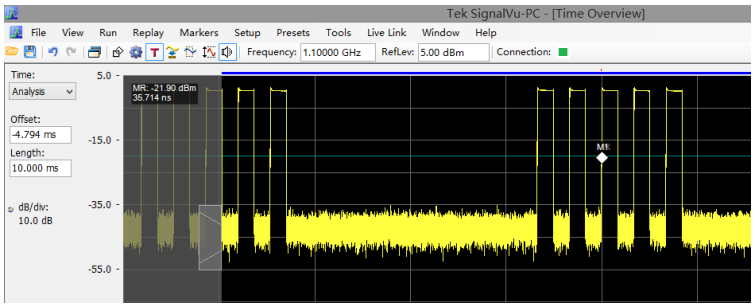
in second function keys.

After all setting 

,commands will send to dongle.

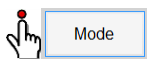


Spectrum from RSA306



RF time waveform from RSA306

3.3 AM Signal Output

1: 

in function keys, 

in second function keys.

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2: Frequency in function keys, 1.5GHz Start Freq 1.5 GHz in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: I& Q Sel in function keys, Internal in second function keys.

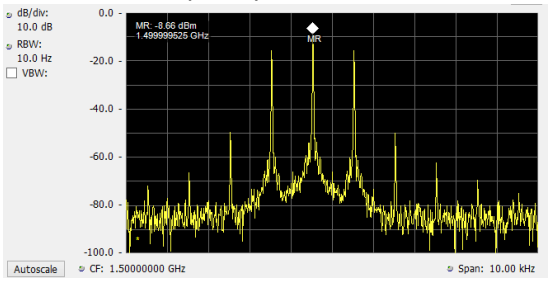
3: Analog Mod in function keys, Demo AM in second function keys.

3: Analog Mod in function keys, 2000 I& Q Step 2000 in second function keys.

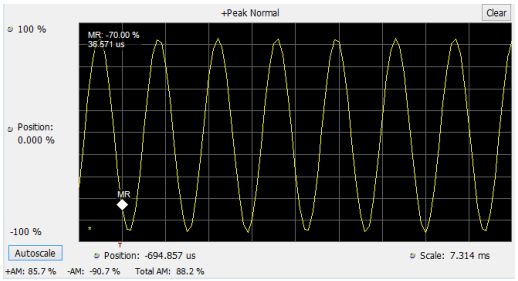
Status block will be:

Start Freq	1.5GHz	Stop Freq	1.5GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	1.00KHz

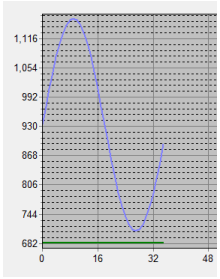
AM modulation frequency will be 1KHz, modulation index is 90%, changing I&Q step count will change AM modulation frequency



Spectrum from RSA306



Demod waveform from RSA306



I&Q raw data from TSG

3.4 FM Signal Output

1: Mode in function keys, Single Freq w/o Pulse Mod in second function keys.

2: Frequency in function keys, 1.5GHz Start Freq 1.5 GHz in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: I& Q Sel in function keys, Internal in second function keys.

3: Analog Mod in function keys, Demo FM in second function keys.

3: Analog Mod in function keys, 50 I& Q Step 50 in second function keys.

Status block will be:

Start Freq	1.5GHz	Stop Freq	1.5GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	2.00KHz

FM modulation frequency will be 2KHz, modulation index is 20, the deviation frequency will be +/-40KHz, changing I&Q step count will change FM modulation frequency

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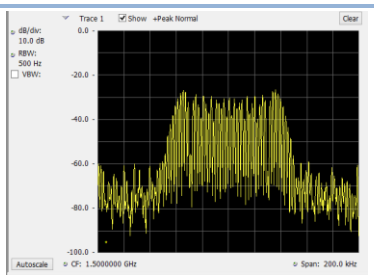
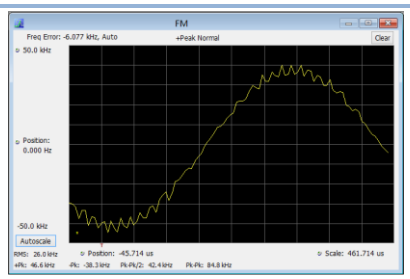
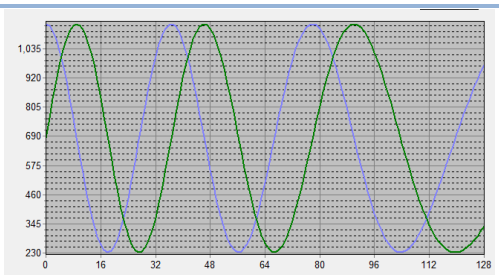


Spectrum from RSA306



Demodulation waveform from RSA306



I&Q raw data from TSG

3.5 Frequency shift

Analog modulation is using I&Q raw data file, AM/FM/PM modulation index can be changed by using this raw data file, signal modulation repeat frequency can depended on the I&Q step count and I&Q data amount. It also can generate a lot of modulation signal by defining the raw data file.

Following example is narrow band RF noise signal. I&Q will be random noise data, I&Q clock will be 2MHz, so that 2MHz bandwidth noise will at 1GHz.

1: Mode in function keys, Single Freq with Pulse Mod in second function keys.

2: Frequency in function keys, 1GHz Start Freq 1 GHz in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: I& Q Sel in function keys, Internal in second function keys.

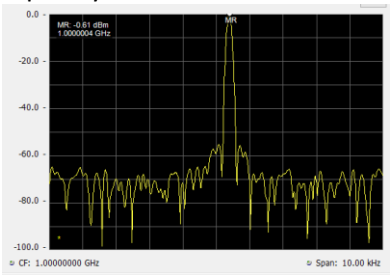
5: Analog Mod in function keys, Freq Shift + in second function keys.

6: Analog Mod in function keys, 100 I& Q Step Count 100 in second function keys.

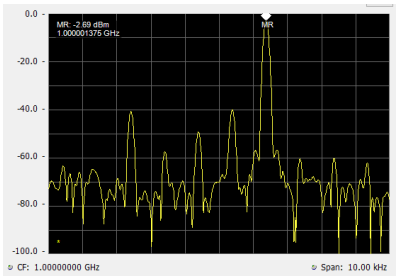
Status block will be:

Start Freq	1GHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	1s	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	1.00KHz

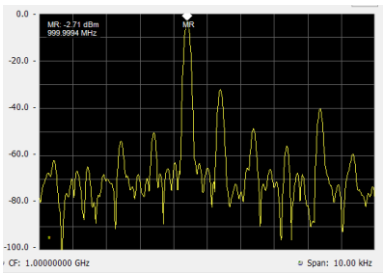
Frequency shift at 1GHz.



No shift in Frequency



Shift +1KHz in frequency



Shift -1KHz in frequency

Setup I&Q step count to 1000, the shift will be 100Hz,
I&Q step count to 10000, the shift will be 10Hz,

3.6 Analog Modulation with I&Q raw data file

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Analog modulation is using I&Q raw data file, AM/FM/PM modulation index can be changed by using this raw data file, signal modulation repeat frequency can depended on the I&Q step count and I&Q data amount. It can also generate a lot of modulation signal by defining the raw data file.
Following example is narrow band RF noise signal. I&Q will be rand noise data, I&Q clock will be 2MHz, so that 2MHz bandwidth noise will be at 1GHz.

1: Mode in function keys, Single Freq with Pulse Mod in second function keys.

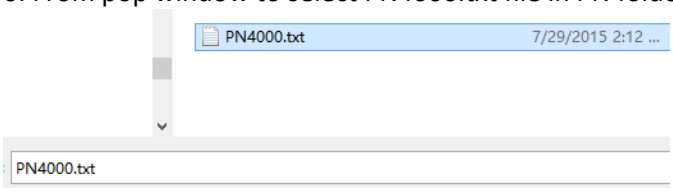
2: Frequency in function keys, 1GHz Start Freq 1 GHz in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: I& Q Sel in function keys, Internal in second function keys.

5: Analog Mod in function keys, Load File in second function keys.

6: From pop window to select PN4000.txt file in PN folder.

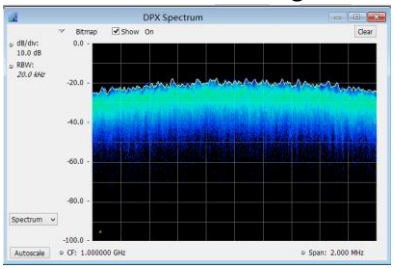


3: Analog Mod in function keys, 36 I& Q Step Count 36 in second function keys.

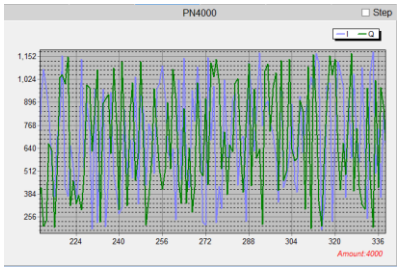
Status block will be:

Start Freq	1000MHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	500ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	500.00Hz

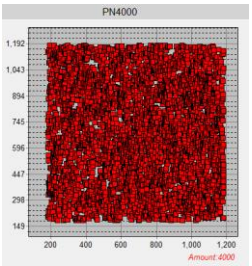
RF narrow band noise is generated at 1GHz.



Spectrum from RSA306



I&Q Raw data from TSG



I&Q constellation from TSG

3.7 GMSK signal Output

1: Mode in function keys, Single Freq w/o Pulse Mod in second function keys.

2: Frequency in function keys, 1.5GHz Start Freq 1.5 GHz in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: I& Q Sel in function keys, Internal in second function keys.

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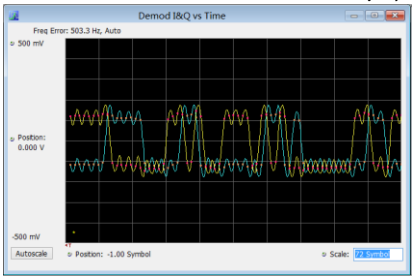
3: Digital Mod in function keys, Demo GMSK in second function keys.

3: Digital Mod in function keys, 72 I& Q Step Count 72 in second function keys.

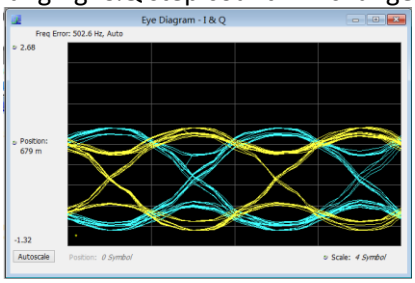
Status block will be:

Start Freq	1.5GHz	Stop Freq	1.5GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	100.00KHz

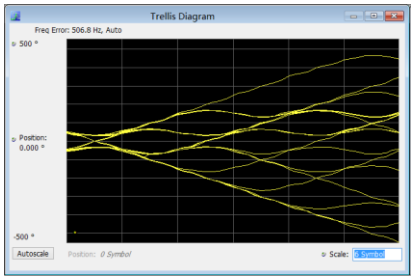
GMSK data rate will be 100KHz/b, changing I&Q step count will change GMSK data rate.



Demod I&Q vs Time from RSA306



Eye Diagram from RSA306



Trellis Diagram from RSA306

3.8 FSK signal Output

1: Mode in function keys, Single Freq w/o Pulse Mod in second function keys.

2: Frequency in function keys, 1GHz Start Freq 1 GHz in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: I& Q Sel in function keys, Internal in second function keys.

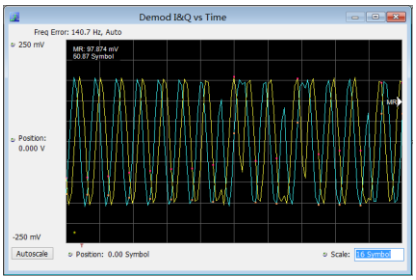
5: Digital Mod in function keys, Demo FSK in second function keys.

6: Digital Mod in function keys, 50 I& Q Step Count 50 in second function keys.

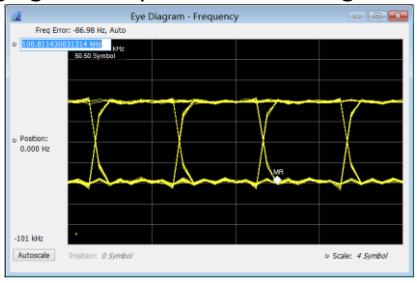
Status block will be:

Start Freq	1GHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	40.00KHz

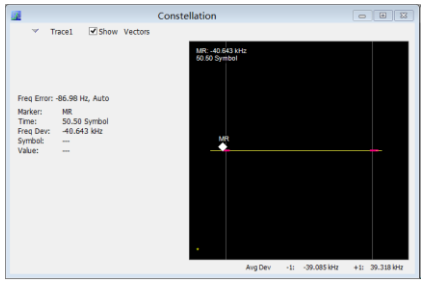
FSK data rate will be 40KHz/b, changing I&Q step count will change FSK data rate.



Demod I&Q vs Time from RSA306



Eye Diagram from RSA306



Constellation Diagram from RSA306

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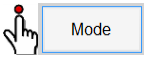
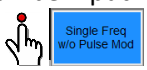
3.9 Digital Modulation with I&Q Engine

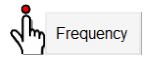
Working on I&Q file， most of all digital modulation can be generated, save the I&Q file into Digital modulation sub folder, click the 

， I&Q file can be input. The 4FSK file is example in following section.

1: 

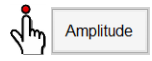
in function keys, 

in second function keys.

2: 

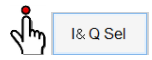
in function keys, 1GHz 

in second function keys.

3: 

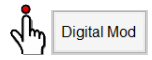
in function keys, 0dBm 

in second function keys.

4: 

in function keys, 

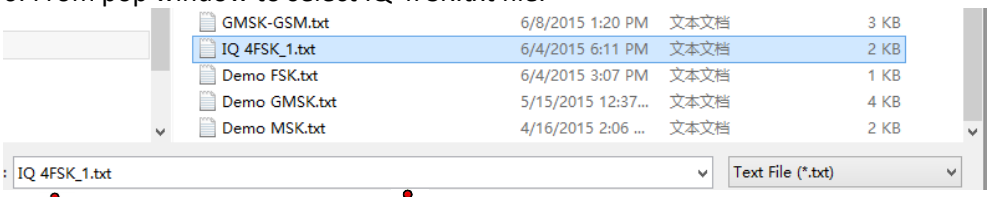
in second function keys.

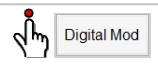
5: 

in function keys, 

in second function keys.

6: From pop window to select IQ 4FSK.txt file.



7: 

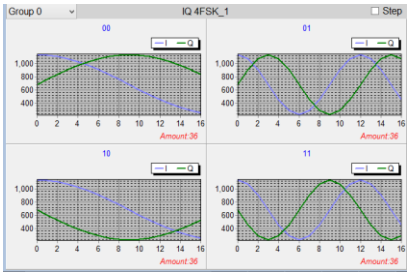
in function keys, 50 

in second function keys.

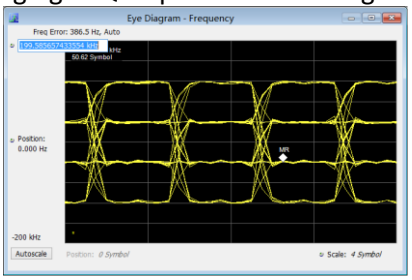
Status block will be:

Start Freq	1GHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	40.00KHz

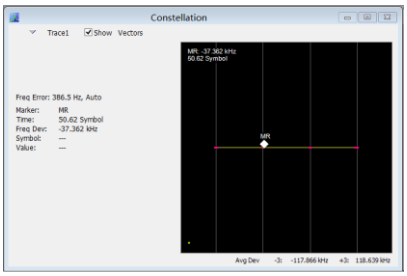
4FSK data rate will be 40KHz/b, changing I&Q step count will change 4FSK data rate.



I&Q pattern from TSG

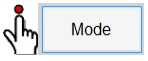


Eye Diagram from RSA306



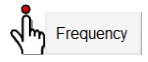
Constellation Diagram from RSA306

3.10 QPSK Signal output

1: 

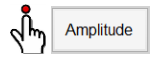
in function keys, 

in second function keys.

2: 

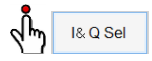
in function keys, 1GHz 

in second function keys.

3: 

in function keys, 0dBm 

in second function keys.

4: 

in function keys, 

in second function keys.

5: 

in function keys, 

in second function keys.

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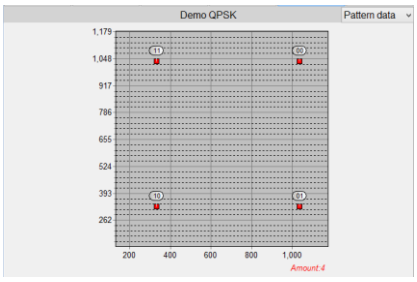
6: Phase Mod in function keys, 72 I& Q Step Count 72 in second function keys.

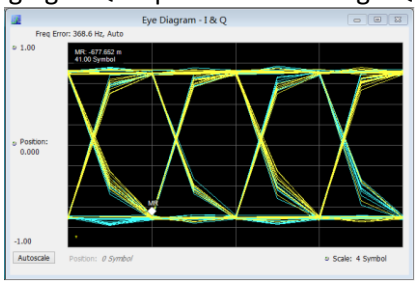
Status block will be:

Start Freq	1GHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	1.00MHz

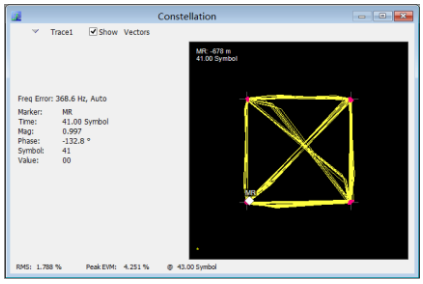
QPSK data rate will be 4MHz/b, changing I&Q step count will change QPSK data rate.



Constellation Diagram from TSG



Eye Diagram from RSA306



Constellation Diagram from RSA306

3.11 8PSK Signal output

1: Mode in function keys, Single Freq w/o Pulse Mod in second function keys.

2: Frequency in function keys, 1GHz Start Freq 1 GHz in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: I& Q Sel in function keys, Internal in second function keys.

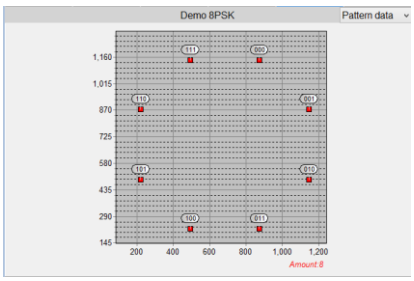
5: Phase Mod in function keys, Demo 8PSK in second function keys.

6: Phase Mod in function keys, 72 I& Q Step Count 72 in second function keys.

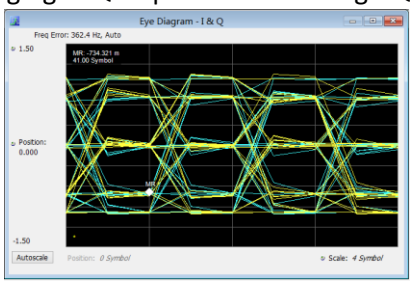
Status block will be:

Start Freq	1GHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	1.00MHz

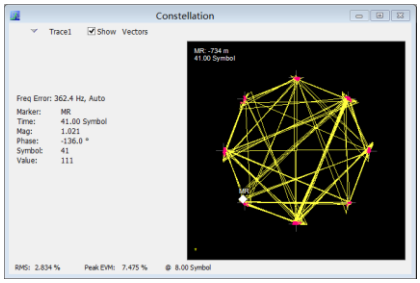
8PSK data rate will be 8MHz/b, changing I&Q step count will change QPSK data rate.



Constellation Diagram from TSG



Eye Diagram from RSA306



Constellation Diagram from RSA306

3.12 16QAM Signal output

1: Mode in function keys, Single Freq w/o Pulse Mod in second function keys.

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2: Frequency in function keys, 1GHz (Start Freq 1 GHz) in second function keys.

3: Amplitude in function keys, 0dBm (Output Level 0 dBm) in second function keys.

4: I& Q Sel in function keys, (Internal) in second function keys.

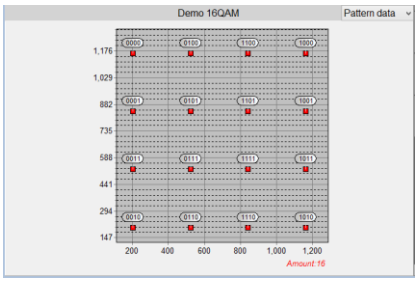
5: Phase Mod in function keys, (Demo 16QAM) in second function keys.

6: Phase Mod in function keys, 72 (I& Q Step Count 72) in second function keys.

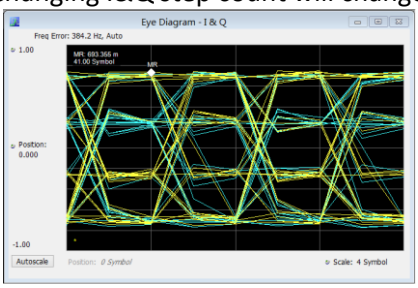
Status block will be:

Start Freq	1GHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	1.00MHz

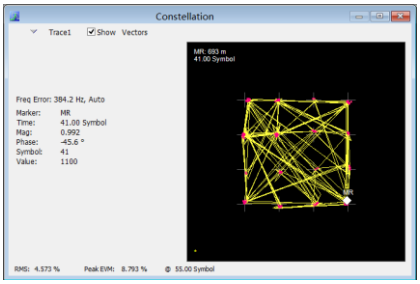
16QAM data rate will be 16MHz/b, changing I&Q step count will change QPSK data rate.



Constellation Diagram from TSG



Eye Diagram from RSA306



Constellation Diagram from RSA306

3.13 Phase Modulation with I&Q Engine

Working on I&Q file， most of all phase modulation can be generated, save the I&Q file into phase modulation sub folder, click the (Load File)， I&Q file can be input. The 64QAM file is example in following section.

1: Mode in function keys, (Single Freq w/o Pulse Mod) in second function keys.

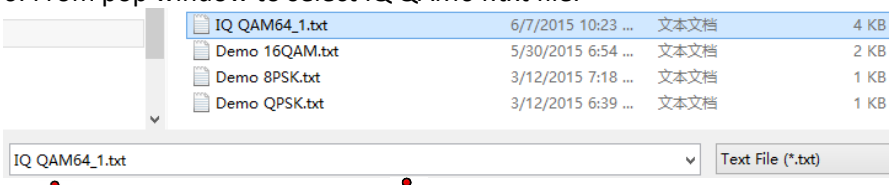
2: Frequency in function keys, 1GHz (Start Freq 1 GHz) in second function keys.

3: Amplitude in function keys, 0dBm (Output Level 0 dBm) in second function keys.

4: I& Q Sel in function keys, (Internal) in second function keys.

5: Phase Mod in function keys, (Load File) in second function keys.

6: From pop window to select IQ QAM64.txt file.



6: Phase Mod in function keys, 72 (I& Q Step Count 72) in second function keys.

Status block will be:

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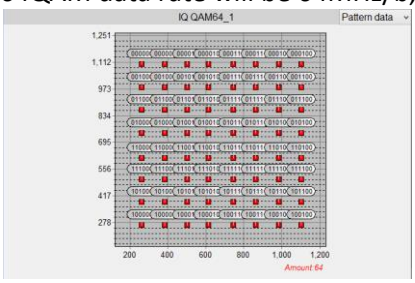
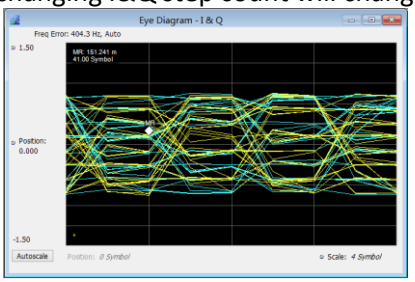
Start Freq	1GHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	1.00MHz

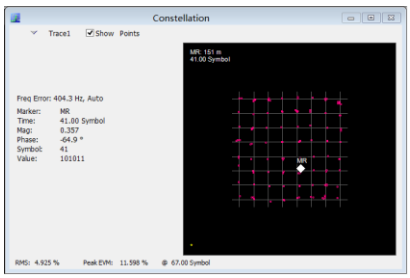
64QAM data rate will be 64MHz/b, changing I&Q step count will change QPSK data rate.



Constellation Diagram from TSG



Eye Diagram from RSA306



Constellation Diagram from RSA306

3.14 Frequency Sweeping without Pulse Modulation

1: Mode in function keys, Freq Sweeping w/o Pulse Mod in second function keys.

2: Frequency in function keys, 0.98GHz Start Freq 0.98 GHz, 1.02GHz Stop Freq 1.02 GHz, 1MHz Step Freq 1 MHz

1MHz Scan Poins 41, Send to dongle in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: Pulse Mod in function keys, 100ms Pulse Period 100 ms, Send to dongle, commands will send to dongle.

If sweeping signal need to add I&Q modulation, go into the next step.

4: I& Q Sel in function keys, Internal in second function keys.

5: Phase Mod in function keys, Demo 16QAM in second function keys.

6: Phase Mod in function keys, 72 I& Q Step Count 72 in second function keys.

Status block will be:

Start Freq	0.98GHz	Stop Freq	1.02GHz	Step Freq	1MHz
Amplitude	0dBm	Repeat Time	100ms	Duration Time	-
Mode	Freq Sweeping w/o Pulse Mod			Symbol Rate	1.00MHz

Following image will be shown the sweeping signal without Pulse modulation.

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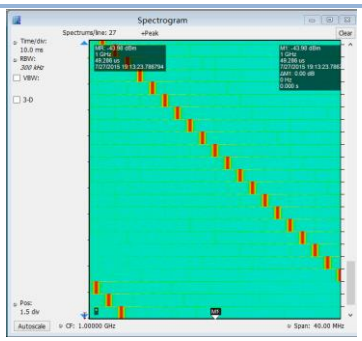
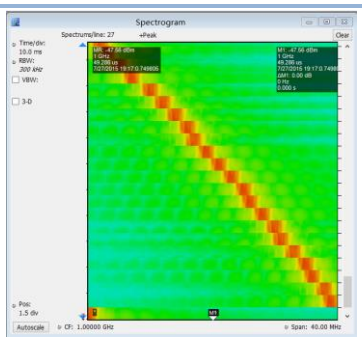
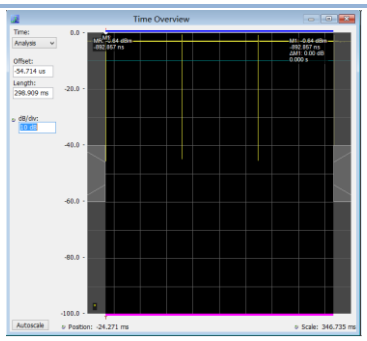


Sweeping signal without I@Q Mod



Sweeping signal with I@Q Mod



Sweeping timing from RSA306

3.15 Frequency Sweeping with Pulse Modulation

1: Mode in function keys, Freq Sweeping with Pulse Mod in second function keys.

2: Frequency in function keys, 0.98GHz Start Freq 0.98 GHz, 1.02GHz Stop Freq 1.02 GHz, 1MHz Step Freq 1 MHz 1MHz Scan Poins 41, Send to dongle in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: Pulse Mod in function keys, 100ms Pulse Period 100 ms, 2ms Pulse Width 2 ms in second function keys.

After all setting, Send to dongle ,commands will send to dongle.

If sweeping signal need to add I&Q modulation, go into the next step.

5: I& Q Sel in function keys, Internal in second function keys.

6: Phase Mod in function keys, Demo 16QAM in second function keys.

7: Phase Mod in function keys, 72 I& Q Step Count 72 in second function keys.

Status block will be:

Start Freq	0.98GHz	Stop Freq	1.02GHz	Step Freq	1MHz
Amplitude	0dBm	Repeat Time	100ms	Duration Time	2ms
Mode	Freq Sweeping with Pulse Mod			Symbol Rate	1.00MHz

Following image will be shown the sweeping signal with Pulse modulation

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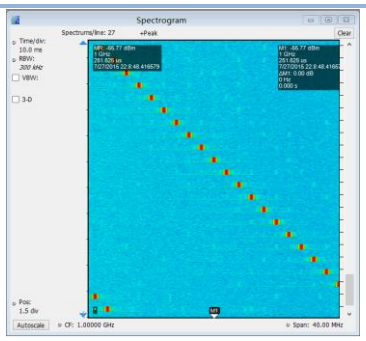
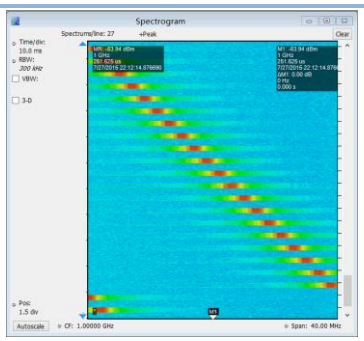
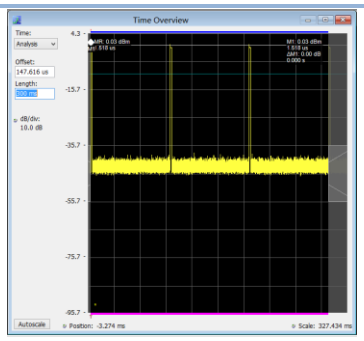


Sweeping signal without I@Q Mod

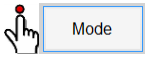


Sweeping signal with I@Q Mod



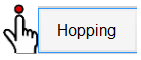
Sweeping timing from RSA306

3.16 Frequency hopping without Pulse Modulation

1: 

in function keys, 

in second function keys.

2: 

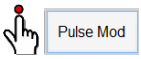
in function keys, 

in second function keys.

3: 

in function keys, 0dBm 

in second function keys.

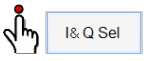
4: 

in function keys, 100ms 

, 

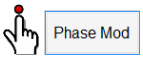
,commands will send to dongle.

If sweeping signal need to add I&Q modulation, go into the next step.

4: 

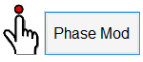
in function keys, 

in second function keys.

5: 

in function keys, 

in second function keys.

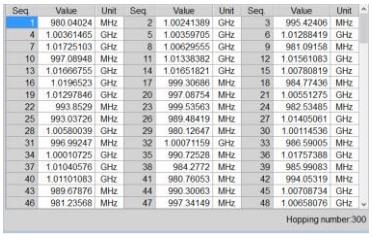
6: 

in function keys, 72 

in second function keys.

Status block and hopping table will be:

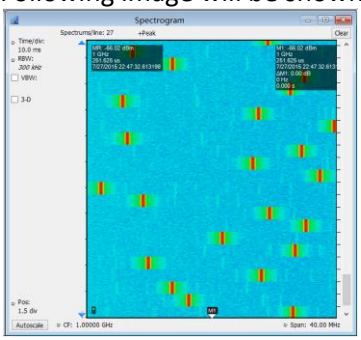
Start Freq	-	Stop Freq	-	Step Freq	-
Amplitude	0dBm	Repeat Time	100ms	Duration Time	-
Mode	Freq Hopping w/o Pulse Mod			Symbol Rate	1.00MHz



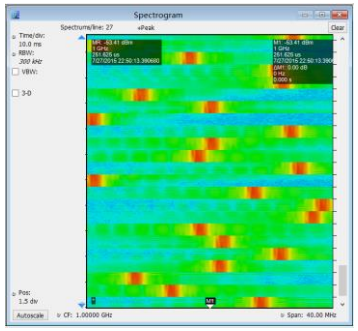
Seq	Value	Unit	Seq	Value	Unit	Seq	Value	Unit
1	980.04024	MHz	2	1.00241389	GHz	3	995.42406	MHz
4	1.00361465	GHz	5	1.00359705	GHz	6	1.01288419	GHz
7	1.01725103	GHz	8	1.00629555	GHz	9	981.09158	MHz
10	997.08948	MHz	11	1.01338382	GHz	12	1.01561083	GHz
13	1.01666755	GHz	14	1.01651821	GHz	15	1.00780819	GHz
16	1.0196523	GHz	17	999.30686	MHz	18	984.77436	MHz
19	1.01297846	GHz	20	997.08754	MHz	21	1.00551275	GHz
22	993.8529	MHz	23	999.53563	MHz	24	982.53485	MHz
25	993.03726	MHz	26	989.48419	MHz	27	1.01405061	GHz
28	1.00580039	GHz	29	980.12647	MHz	30	1.00114536	GHz
31	996.99247	MHz	32	1.00071159	GHz	33	986.59005	MHz
34	1.00010725	GHz	35	990.72528	MHz	36	1.01757388	GHz
37	1.01040576	GHz	38	984.2772	MHz	39	985.99083	MHz
40	1.01101083	GHz	41	980.76053	MHz	42	994.05319	MHz
43	989.67876	MHz	44	990.30063	MHz	45	1.00708734	GHz
46	981.23568	MHz	47	997.34149	MHz	48	1.00658076	GHz

Hopping number:300

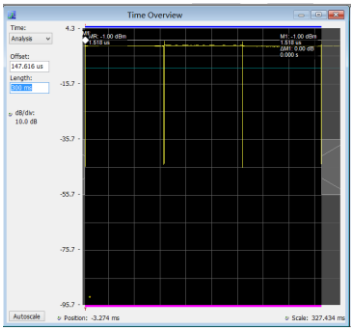
Following image will be shown the hopping signal without Pulse modulation



Hopping signal without I@Q Mod



Hopping signal with I@Q Mod



Hopping timing from RSA306

3.17 Frequency Hopping with Pulse Modulation

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1: Mode in function keys, Freq Hopping with Pulse Mod in second function keys.

2: Hopping in function keys, Demo 1 in second function keys.

3: Amplitude in function keys, 0dBm Output Level 0 dBm in second function keys.

4: Pulse Mod in function keys, 100ms Pulse Period 100 ms, 2ms Pulse Width 2 ms in second function keys.

After all setting, Send to dongle, commands will send to dongle.

If sweeping signal need to add I&Q modulation, go into the next step.

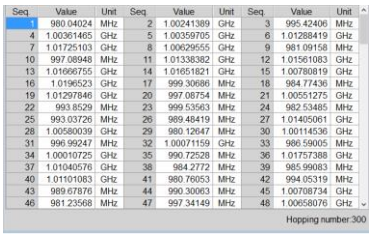
5: I& Q Sel in function keys, Internal in second function keys.

6: Phase Mod in function keys, Demo 16QAM in second function keys.

7: Phase Mod in function keys, 72 I& Q Step Count 72 in second function keys.

Status block and hopping table will be:

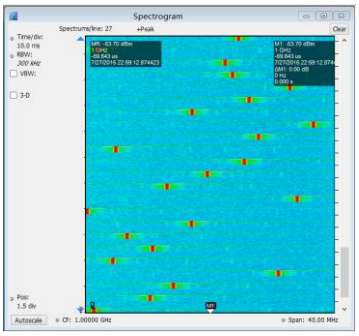
Start Freq	-	Stop Freq	-	Step Freq	-
Amplitude	0dBm	Repeat Time	100ms	Duration Time	2ms
Mode	Freq Hopping with Pulse Mod			Symbol Rate	1.00MHz



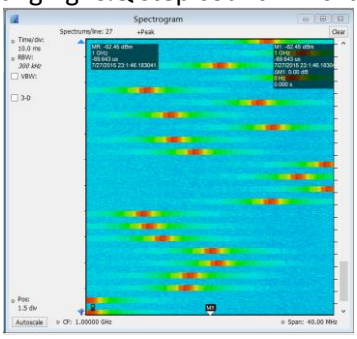
Seq	Value	Unit	Seq	Value	Unit	Seq	Value	Unit
1	980.04024	MHz	2	1.00241389	GHz	3	995.42406	MHz
4	1.00361465	GHz	5	1.00359705	GHz	6	1.01288419	GHz
7	1.01725103	GHz	8	1.00629555	GHz	9	981.09158	MHz
10	997.08948	MHz	11	1.01338382	GHz	12	1.01561083	GHz
13	1.01666755	GHz	14	1.01651821	GHz	15	1.00780819	GHz
16	1.0196523	GHz	17	999.30686	MHz	18	984.77436	MHz
19	1.01297846	GHz	20	997.08754	MHz	21	1.00551275	GHz
22	993.8529	MHz	23	999.53563	MHz	24	982.53485	MHz
25	993.03726	MHz	26	989.48419	MHz	27	1.01405061	GHz
28	1.00580039	GHz	29	980.12647	MHz	30	1.00114536	GHz
31	996.99247	MHz	32	1.00071159	GHz	33	986.59005	MHz
34	1.00010725	GHz	35	990.72528	MHz	36	1.01757388	GHz
37	1.01040576	GHz	38	984.2772	MHz	39	985.99083	MHz
40	1.01101083	GHz	41	980.76053	MHz	42	994.05319	MHz
43	989.67876	MHz	44	990.30063	MHz	45	1.00708734	GHz
46	981.23568	MHz	47	997.34149	MHz	48	1.00658076	GHz

Hopping number:300

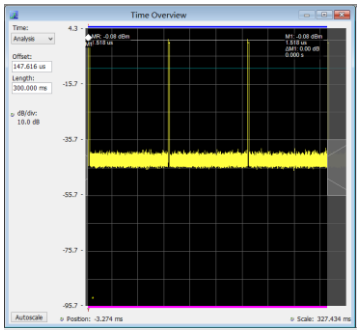
16QAM data rate will be 16MHz/b, changing I&Q step count will change QPSK data rate.



Hopping signal without I@Q Mod



Hopping signal with I@Q Mod



Hopping timing from RSA306

3.18 S11/S21 measurement with spectrum analyzer

The S11/S21 key is reserved for multi device measurement, it is not ready now. Such as working with RF power meter or spectrum analyzer. But it need to setup synchronize with spectrum analyzer when it is scanning.

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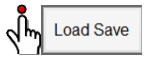
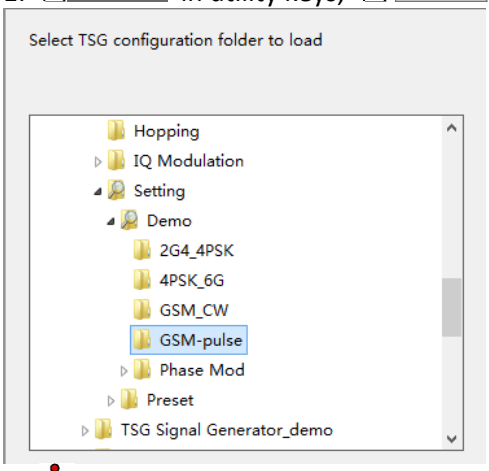
3.19 Example for GSM signal output

1: 

in utility keys, 

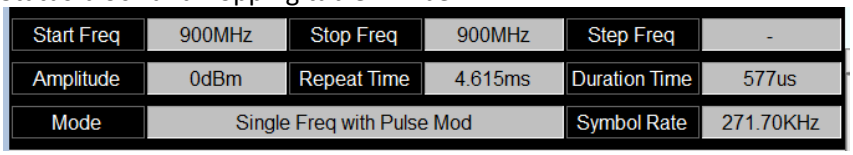
in second function keys.



2: 

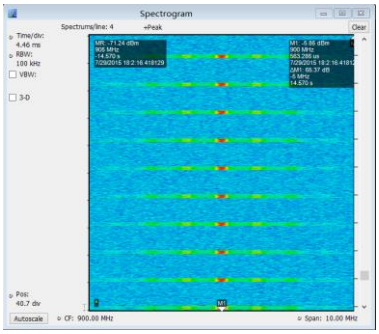
in TSG configuration folder and open this file.

Status block and hopping table will be:

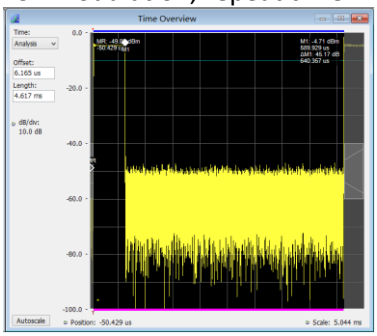


Start Freq	900MHz	Stop Freq	900MHz	Step Freq	-
Amplitude	0dBm	Repeat Time	4.615ms	Duration Time	577us
Mode	Single Freq with Pulse Mod			Symbol Rate	271.70KHz

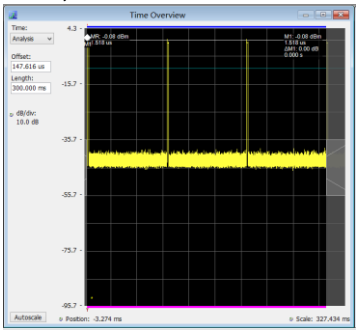
GSM data rate will be 271Kb with GMSK modulation, repeat time will be 4.6ms, duration time will be 577us.



GSM signal with I@Q Mod



One slot of GSM signal



three pulse of GSM signal

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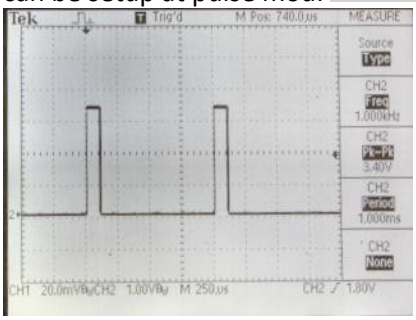
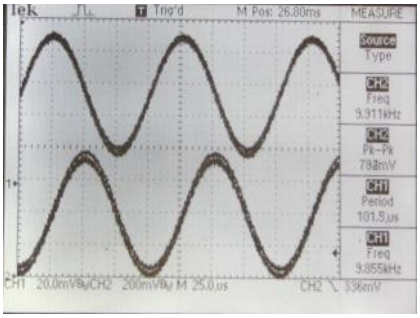
3.20 Pulse modulation signal output

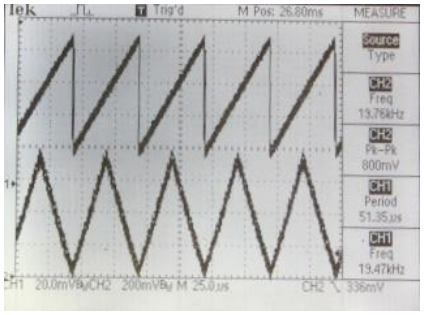
The Pulse signal output port can generate pulse signal, when mode setup to xxx with pulse mod. The parameter of pulse can be setup at pulse mod. Pulse Mod, following will be pulse signal output measured by scope.

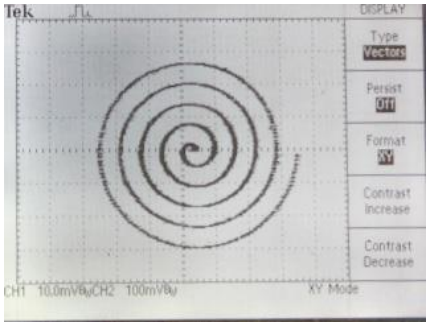


3.21 SIN/Triangle/Spiral waveform signal output

VSG6G1/VSG2G1/TSG4G1 also can output low frequency signal, using I&Q raw data file, I&Q port can output any kind of low frequency signal, the demo setting will be sin waveform, triangle waveform, and spiral waveform, output waveform will be shown at following:







You can output a lot different waveform by define I&Q raw data file, it is more like arbitrary signal generator.
The frequency can be setup I*Q step count to fine turn. The total sampling length are also impact with output frequency.
The frequency=72MHz/(step count*sampling length).

3.22 Clock selection

Internal clock reference will be 12MHz, and Main processor will be working at 72MHz, maximum the I&Q symbol rate will be 2.4MHz (when I*Q step count set at 30).
When clock select at internal, it is also the default setting, clock port will be output 12MHz reference clock.
When clock select at external, it needs to input 10MHz reference clock at clock port, the clock level need to be larger than 5dBm.
Internal clock reference will be 12MHz, and Main processor will be work at 72MHz, maximum the I&Q symbol rate will be 2.4MHz (when I*Q step count set at 30).
When clock select at internal, it is also default setting, clock port will output 12MHz reference clock.
When clock select at external, it need input 10MHz reference clock at clock port, the clock level need to be larger than 5dBm.

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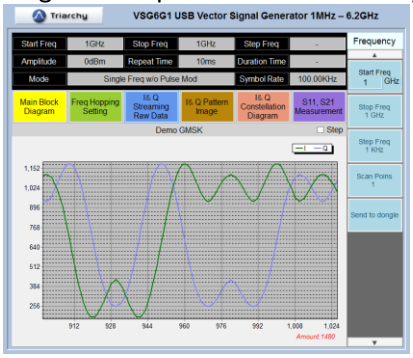
3.23 I&Q Selection

I&Q port selection will have three choice:
1: None: it will turn off any I&Q modulation, only CW signal will be output.
2: Internal: internal I&Q waveform will connect to modulation IC.
3: External/Fast: External setup will need I&Q signal input from I&Q port, it can generate very fast modulation, the signal bandwidth can be setup to 500MHz. Fast setup will be reserved for high speed I&Q data generator option. It is an accessory of VSG6G1, it can generate up to 100MHz data rate modulation signal.

3.24 Hardcopy Operation

Click the hardcopy, the image of setup can be store within jpg file. File can be found at document folder.



4 I&Q Engine

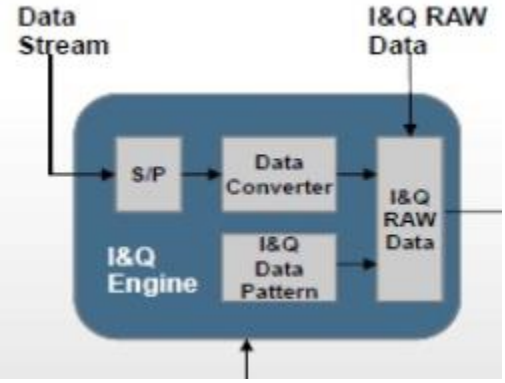
4.1 I&Q Engine principle

What is I&Q engine?

I&Q engine is to generate I&Q raw data based on input data stream and modulation. I&Q raw data will send to DAC to generate I&Q waveform which will be needed for I&Q modulator.

So that data stream will be input, and I&Q raw data will be output conditional upon the type of modulation.

The block diagram of I&Q engine will be follow:



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First, data stream will be go into S/P block, which is series to parallel section, most of modulation need this S/P section to setup I&Q mapping.

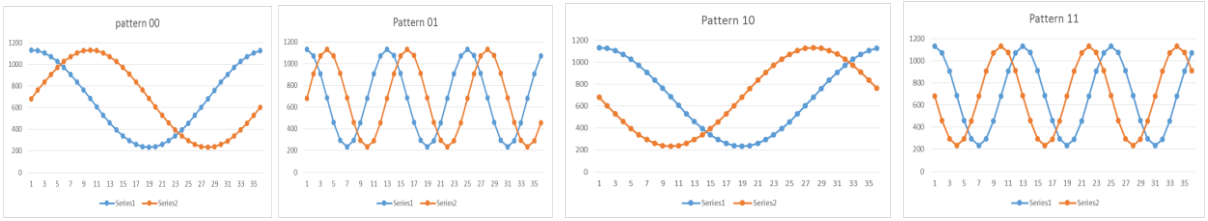
After S/P section, the parallel data may be need to do certain types of process, such as Gray code conversion, this section will be Data converter.

The parallel data will be mapping with I&Q data pattern to generate I&Q raw data. The mapping pattern is depend on the modulation, a lot of text book will discuss I&Q data pattern. Studying the data pattern can be generated a lot of different kind of modulation.

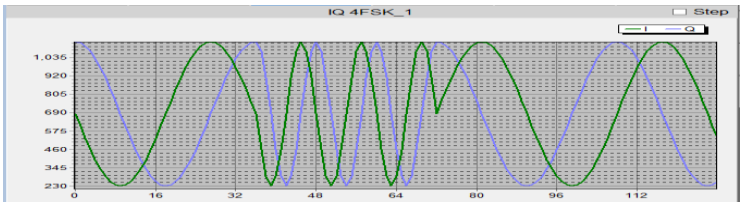
For example, 4FSK generator:

1: convert series data into 2 bits parallel data,

2: generate 4 I&Q pattern with 36 samples, which related to F1, F2, F3, F4.



3: mapping the I&Q pattern based on the input data stream, then generate the raw I&Q data.



4.2 I&Q file configuration

There are two kind of I&Q file which can be used by TSG program:
1: I&Q raw data file, which is only two rows of I&Q raw data. I&Q raw data will sent to DAC to generate I&Q waveform.
2: Data stream file, which will input to I&Q engine to generate I&Q raw data file.

4.21 I&Q raw data file

I&Q raw data file format is very simple, only two row of data with comma in txt file, first data is Q data, second data is I data.
I&Q data will be DAC input, the DAC will be 12 bit with 3.3V range, and DAC setup range will be 0~1.1V, reference bias will be 0.55V.
So that DAC input range will be 0~1365 (4095/3), the reference bias of DAC will be 683.
Following data shows the PM file and data waveform:

684,233
494,275

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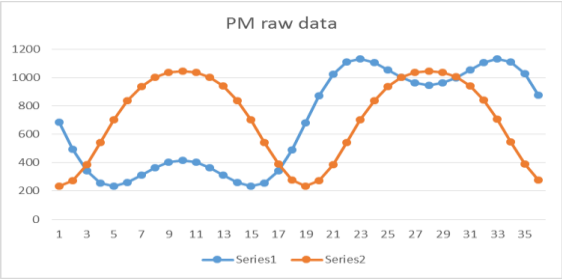
343,388
255,543
233,702
260,838
312,938
365,1002
404,1036
417,1046
404,1036
366,1002
313,939
261,839
233,703
255,544
342,390
492,276
682,233
872,275
1023,388
1111,543
1133,702
1105,838
1053,938
1000,1002
961,1037
947,1047
961,1037
999,1004
1052,941



The modulation frequency will be 72MHz/(step count*I&Q sample amount)
If step count=200, and I&Q sample amount=36, modulation frequency will be 10MHz.

Any analog modulation and low frequency signal can be generated by I&Q raw data file. Define the I&Q raw data by math formula. you can generate any kind of waveform, the working method of I&Q raw data file is same as Arbitrary Signal Generator, it have two channels to generate signal.

I&Q raw data will also can be generated by I&Q engine with or without I&Q channel shift.

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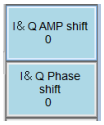
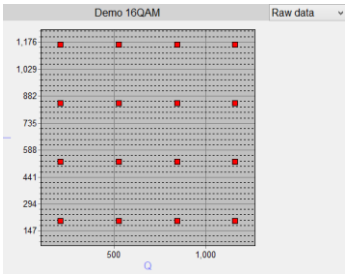
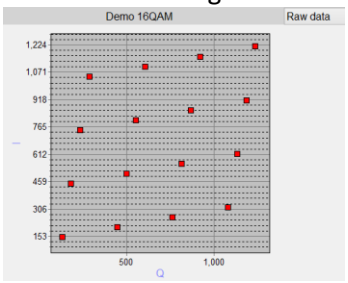
Click the system in the utility keys, you will find I&Q AMP shift and I&Q Phase shift in the second function keys.



The default value for shift is 0. If you use default value, I&Q raw data file generated from I&Q engine will be not shift. For example, input data stream file of Demo 16QAM.txt 5/30/2015 6:54 ... into the I&Q engine, output will be raw data file Demo 16QAM_rawdata.txt 8/17/2015 3:17 ... . The constellation image will be:



If change I&Q AMP shift to 5 and I&Q Phase shift to 10, output will be raw data file Demo 16QAM_rawdata_A5_P10.txt 8/17/2015 3:17 ... . The constellation image will be:



The I&Q amp and phase shift will be used for compensation of I&Q unbalance. When VSG6G1 is working on the band 2, I&Q channel will generate unbalance due to the Mixer stage. You have to use function of I&Q amp and phase shift to improve the EVM parameter.

I&Q AMP shift will be amplitude shift of I&Q channel with unit in percentage.
I&Q Phase shift will be phase shift of I&Q channel with unit in degree.

4.22 Data stream file

Data stream file will be include input data, I&Q pattern and some settings.
When you open the data stream file, you will find four section:
1: Data input
2: S/P setting
3: converter setting
4: I&Q pattern data
the file format will be shown at following:

```
Binary_IN, 1, 0001101111010100000110111101010011111111100000000010100101C
S/P_mode, 4, 3
Code_converter, 1
PatternI_000, 683, 762, 838, 910, 977, 1037, 1088, 1129, 1159, 1177
PatternQ_000, 1183, 1177, 1158, 1128, 1087, 1036, 977, 910, 837, 761
PatternI_001, 183, 189, 208, 238, 279, 330, 390, 456, 529, 605
PatternQ_001, 684, 762, 838, 911, 977, 1037, 1088, 1129, 1159, 1177
PatternI_010, 682, 604, 527, 455, 388, 329, 278, 237, 207, 189
PatternQ_010, 183, 189, 208, 238, 279, 330, 390, 457, 529, 606
PatternI_011, 1183, 1177, 1158, 1128, 1087, 1036, 976, 909, 836, 760
PatternQ_011, 681, 603, 527, 455, 388, 328, 278, 237, 207, 189
PatternI_100, 682, 760, 836, 909, 976, 1036, 1087, 1128, 1158, 1177
PatternQ_100, 183, 189, 207, 237, 278, 328, 388, 455, 527, 603
PatternI_101, 1183, 1177, 1159, 1129, 1088, 1037, 977, 910, 838, 762
PatternQ_101, 683, 761, 837, 910, 977, 1036, 1087, 1128, 1158, 1177
```

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Data input:
One parameter (M), one data stream will be setup in following format:
Binary_IN, M, binary data stream
M is one bit, it is FSK mode.
M=1, it is MSK/GMSK , modulation index is 0.5
M=2~15, it will be FSK/GFSK mode, modulation index is 0.5*M
Total I&Q buffer will be 4Kb, so that the Maximum length of data will be 4Kb/M
When binary data will total length of binary input. P will be parallel length of modulation.

S/P setting:
Two parameter (X,Y) will be setup in following format:
S/P_mode,X,Y
Y will be length of parallel data in bit.
X will be setup S/P mode.
X=1, Bypass mode, for all kind of binary modulation such as FSK, PSK and ASK.
X=2, Group mode, series to parallel conversion with group mode.
If input data is : 1100101011101000,

Y=4, date in parallel will be 1100 1010 1110 1000

I,Q data in parallel will be: 1100

1010

1110

1000

X=3, interleave mode, series to parallel conversion with interleave mode.
If input data is : 1100101011101000,

Y=4, date in parallel will be 1(11) 1(21) 0(31) 0(41) 1(12) 0 (22) 1(32) 0(42) 1(13) 1(23) 1(33) 0(43)

1(14) 0(24)0(34) 0(44)

I,Q data in parallel will be: 1111

1010

0110

0000

X=4, MSK mode. It is special setup for MSK, GMSK, FSK, GFSK, OQPSK, SFSK..

Converter setting:

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One parameter (**Z**) will be setup in following format:
Code convertor, **Z**
Z will be setup converter mode.

Z=1, Bypass mode, it means converter will do nothing, just pass through.

Z=2, Gray code mode, do gray code calculation: **G(N) = (B(n)/2) XOR B(n)**

Z=3, GMSK filter, if you want to generate GMSK modulation, select it.

I&Q pattern data:

The I&Q pattern data format will be:

PatternI_number,dataI1, dataI2, dataI3, dataI4, dataI5, dataI6, dataI7, dataI8, dataI9, dataI10

PatternQ_number,dataQ1, dataQ2, dataQ3, dataQ4, dataQ5, dataQ6, dataQ7, dataQ8, dataQ9, dataQ10will

Number length will be parameter X, parallel data length. If X=4, total I&Q pattern will be 16 set.

DataIn and DataQn, will be pattern data, n will be pattern amount in length.

I&Q pattern will be defined by modulation, analyze the modulation, then you can get I&Q pattern.

The following will be partial of I&Q pattern:

PatternI_00000,683,762,838,910,977,1037,1088,1129,1159,1177

PatternQ_00000,1183,1177,1158,1128,1087,1036,977,910,837,761

PatternI_00001,183,189,208,238,279,330,390,457,529,606

PatternQ_00001,684,762,838,911,977,1037,1088,1129,1159,1177

PatternI_00010,682,604,527,455,388,329,278,237,207,189

PatternQ_00010,183,189,208,238,279,330,390,456,529,605

PatternI_00011,1183,1177,1158,1128,1087,1036,976,909,836,760

PatternQ_00011,681,603,527,455,388,328,278,237,207,189