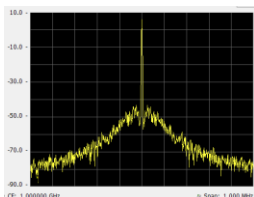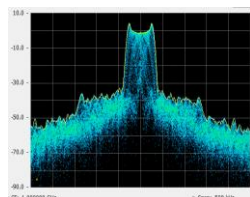# Triarchy®VSG6G1/VSG2G1/TSG4G1
USB Vector RF Signal Generator
Operating Manual

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**
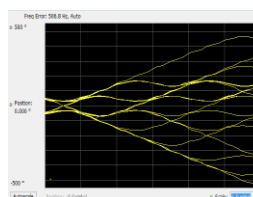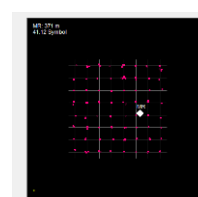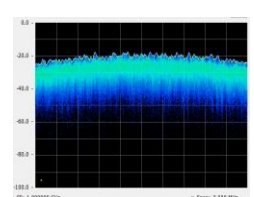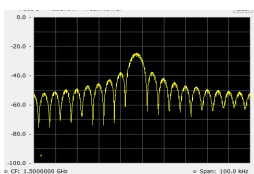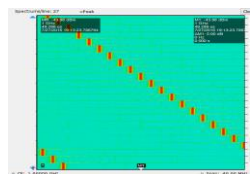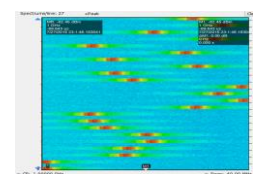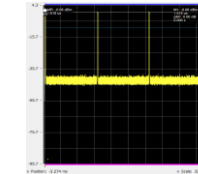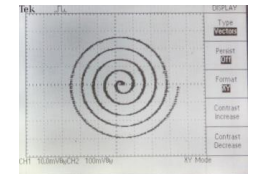
USB Vector RF Spectrum Analyzer Operating Manual

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Initial Version August 2015

Documentation version 1.0

Technical Support

For technical support, please call 1-604-637-2167, send email to info@triarchytech.com, or visit our website at http://www.triarchytech.com

Contents

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 30MHz 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
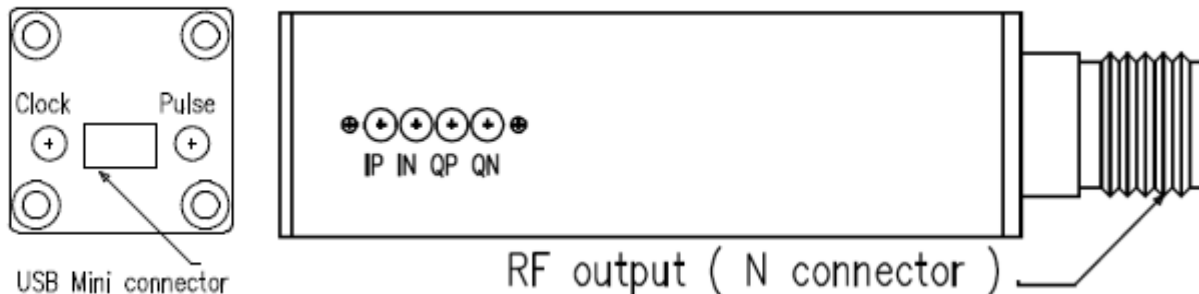
RF output	N connector (female)	RF signal output
USB connector	Mini-B USB connector	interface with PC
IP	MMCX connector	I port positive Output/Input
IN	MMCX connector	I port negative Output/Input
QP	MMCX connector	Q port positive Output/Input
QP	MMCX connector	Q port negative Output/Input
Clock	MMCX connector	Clock Output/Input
Pulse	MMCX connector	Pulse signal Output

1.3 TSG PC Application Overview
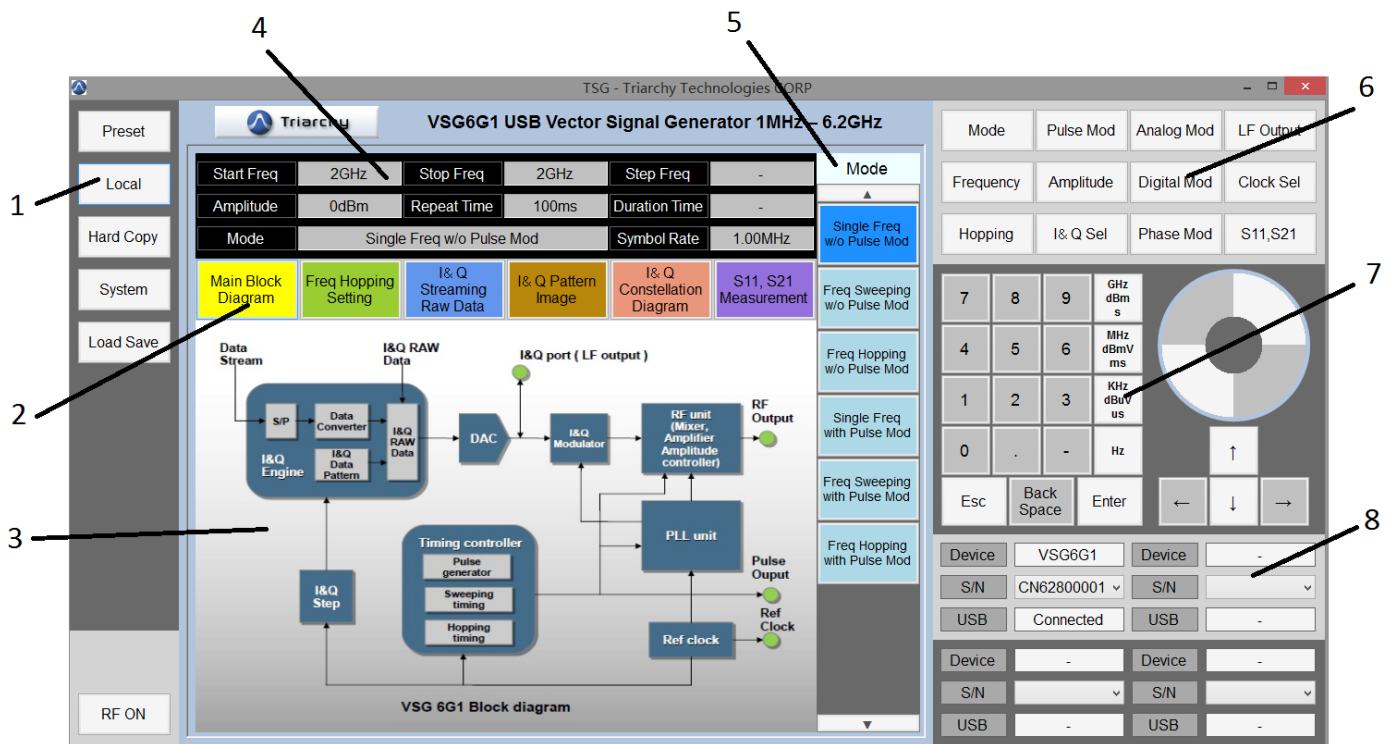
1: **utility keys**

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.

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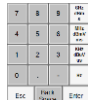
      Then operate keypad , navigation keys and Knob to change the input value.

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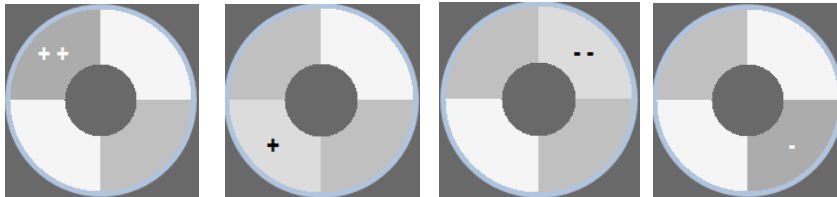
      After input digital, it need to input unit to finish all setting.

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.

![Triarchy Technologies Corp. logo]

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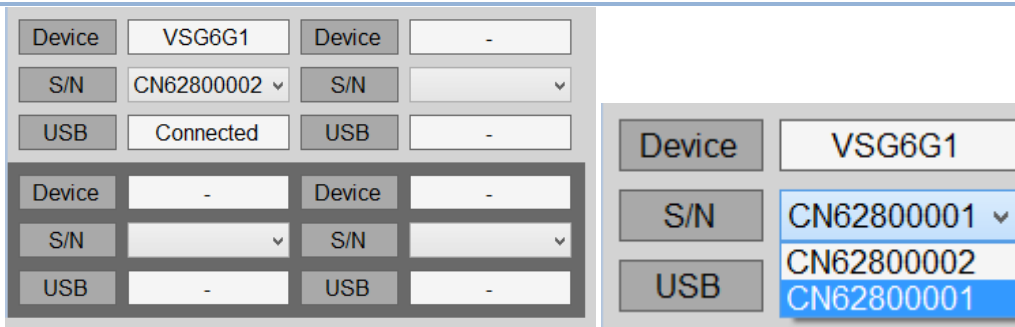
One PC can connect multiple VSG6G1/VSG2G1/TSG4G1 device. Select S/N item to choose which device will is used. When multiple TSG application are opened, each TSG can connected to each hardware device by choice proper the S/N.

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 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 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

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.

| Document | 8/9/2015 9:24 PM |
| setup.exe | 8/9/2015 4:48 PM |

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
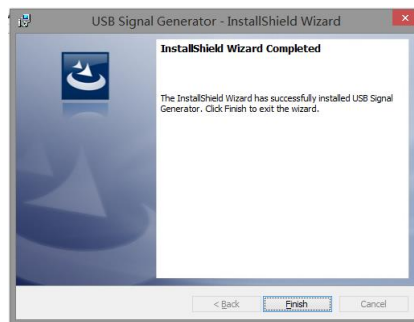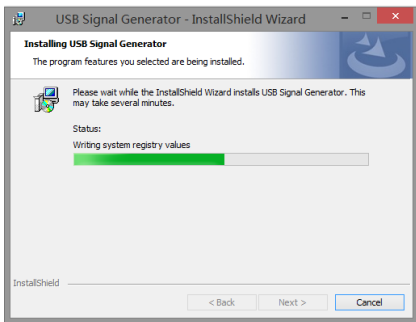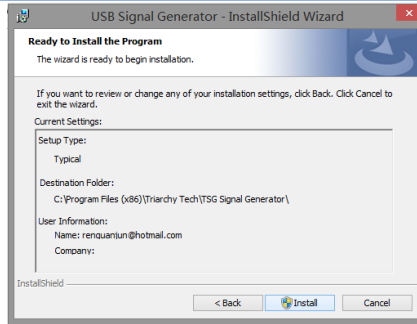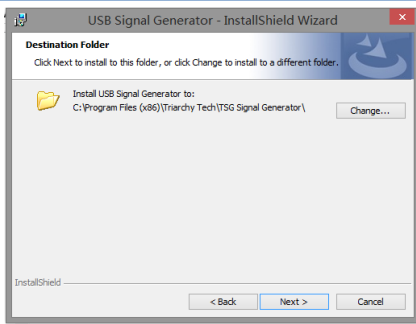
After installation, the program file will be installed at program file folder.

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.

Calibration	8/8/2015 12:22 …
Hardcopy	8/9/2015 10:53 …
Hopping	8/9/2015 10:53 …
IQ Modulation	7/31/2015 2:39 …
Setting	8/9/2015 10:53 …

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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Uninstall TSG

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.

Device	VSG6G1
S/N	CN62800002 ⌄
USB	Connected
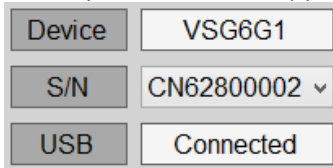
Connect device output to Spectrum analyzer. Then click RF off RF OFF ,   RF output will be on. RF ON
Spectrum analyzer will shows the signal waveform:
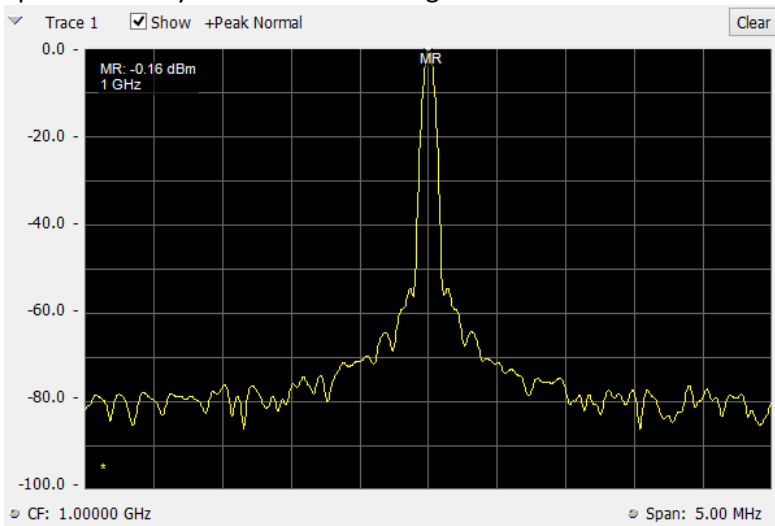
2.4 TSG Utility keys setting

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.

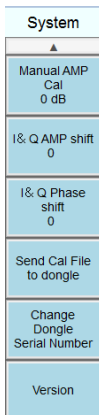Preset x can be setup at **Load Save** key

Local

Reserve to Remote function.

Hardcopy

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

System

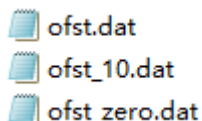When clicking the System key, the second function key will shown：

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.

ofst.dat

ofst_10.dat

ofst_zero.dat

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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.
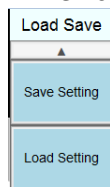
Change the dongle series number:

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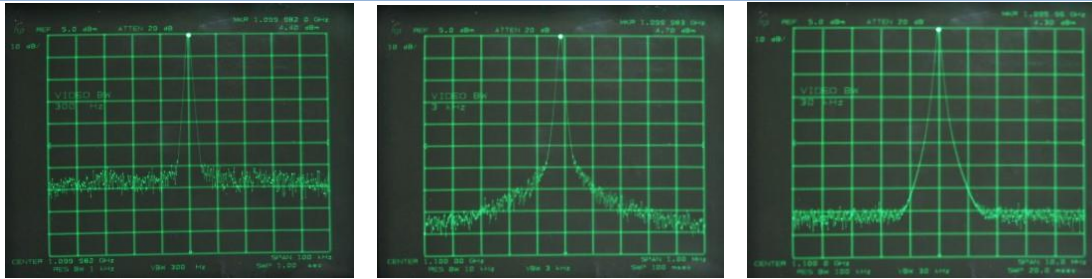
Spectrum from HP8566A
RBW=1KHz, phase noise is -90dBc/Hz @10KHz
RBW=10KHz, phase noise is -108dBc/Hz @100KHz
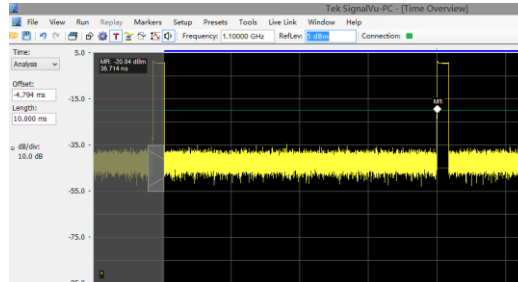RBW=100KHz, phase noise is -120dBc/Hz @1MHz

3.2 Pulse modulation Signal Output

1: [Mode] in function keys, [Single Freq with 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, 2dBm [Output Level 2 dBm] in second function keys.

4: [Pulse Mod] in function keys, 5ms [Pulse Period 5 ms], 200us [Pulse Width 200 us] in second function keys.

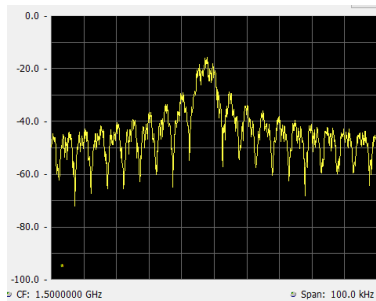After all setting [Send to dongle], commands will send to dongle.
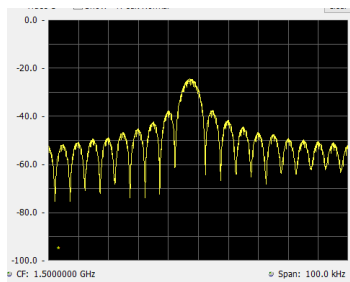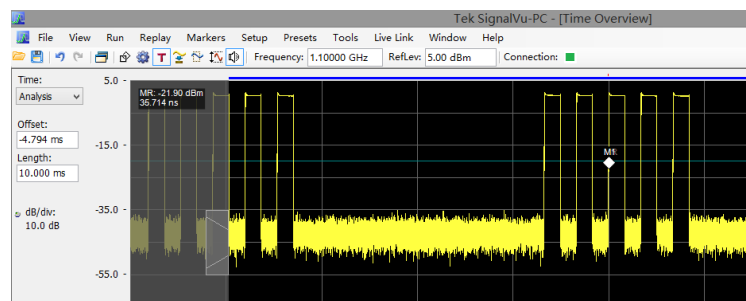

Spectrum from RSA306   RF Time waveform from RSA306

5: The multiple pulse can be setup [Multiple Pulse OFF] [Multiple Pulse ON], 200us [Pulse Delay 200 us], 5 [Pulse Number 5] in second function keys.

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

Spectrum from RSA306   RF time waveform from RSA306

3.3 AM Signal Output

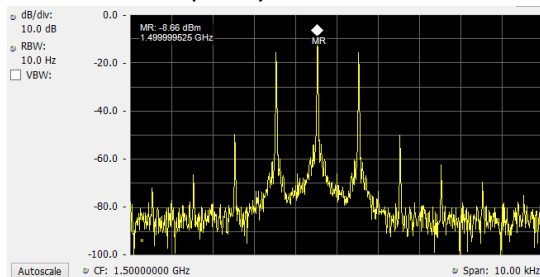1: [Mode] in function keys, [Single Freq w/o Pulse Mod] in second function keys.

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 AM` in second function keys.

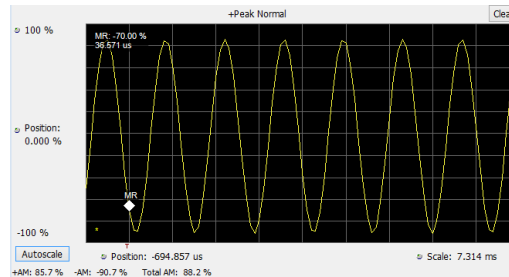3: 👆 `Analog Mod` in function keys, 👆2000 `I& Q Step Count 2000|` in second function keys.

Status block will be:

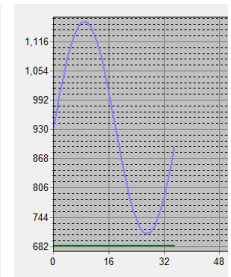| Start Freq	1.5GHz	Stop Freq	1.5GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	10ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	1.00KHz

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

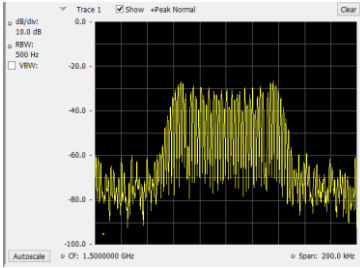| Spectrum from RSA306	Demod waveform from RSA306	I&Q raw data from TSG

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 Count 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
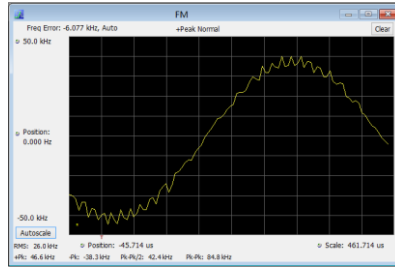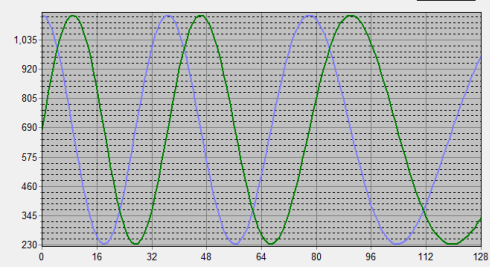
| Spectrum from RSA306 | Demodulation waveform from RSA306 | I&Q raw data from TSG |

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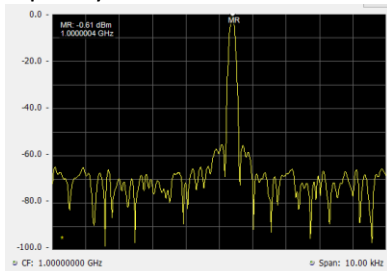
Following example is narrow band RF noise signal. I&Q will be random noise data, I&Q clock will be 2MHz, so that 2MHz bandwidth noise will at 1GHz.

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.

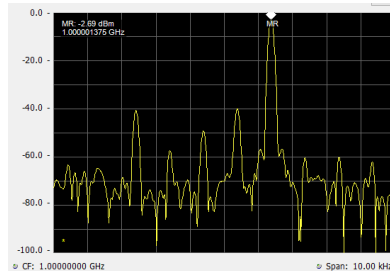6: **Analog Mod** in function keys, 100 **I & Q Step Count 100** in second function keys.

Status block will be:

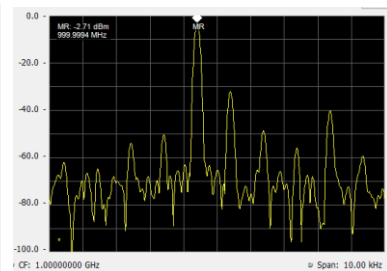| Start Freq	1GHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	1s	Duration Time	-
Mode	Single Freq w/o Pulse Mod		Symbol Rate	1.00KHz

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.

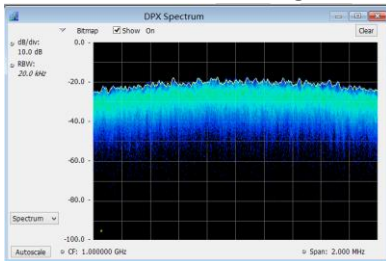6: From pop window to select PN4000.txt file in PN folder.
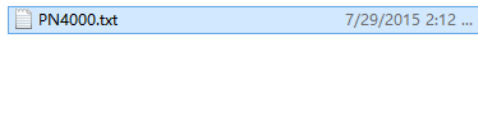
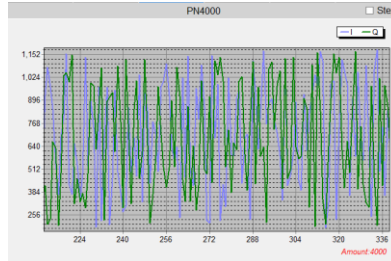3: 👆 Analog Mod in function keys, 👆 36 I& Q Step Count 36 in second function keys.

Status block will be:

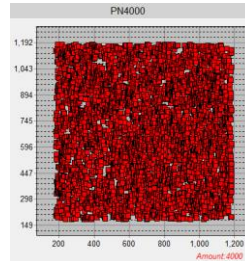| Start Freq	1000MHz	Stop Freq	1GHz	Step Freq	-
Amplitude	0dBm	Repeat Time	500ms	Duration Time	-
Mode	Single Freq w/o Pulse Mod			Symbol Rate	500.00Hz

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.