User Manual
Vector Signal Generator

APVSGXX(-X)

MANUFACTURER ADDRESS

AnaPico AG of Switzerland
Europa-Strasse 9
8152 Glattbrugg
Switzerland
Tel.: +41 44 440 00 50
Email: support@anapico.com
Website: www.anapico.com

WARRANTY

All AnaPico instruments are warranted against defects in material and workmanship for a period of two years from the date of shipment. AnaPico will, at its option, repair or replace products that prove to be defective during the warranty period, provided they are returned to AnaPico and provided the preventative maintenance procedures are followed. Repairs necessitated by misuse of the product are not covered by this warranty. No other warranties are expressed or implied, including but not limited to implied warranties of merchantability and fitness for a particular purpose. AnaPico is not liable for consequential damages.

IMPORTANT! PLEASE READ CAREFULLY

COPYRIGHT

Table of Contents

General Remarks

Today, digital modulation schemes are widely used in communication systems, and the increasing need for data bandwidth has pushed the signal purity and modulation bandwidth requirements for modern vector signal sources. Other applications with similar performance requirements include radio surveillance, interference analysis, radar signal analysis and electronic warfare.

Addressing these demanding requirements, AnaPico's APVSG series of vector signal generators (VSGs) provide frequency coverage to 40 GHz and are available as single output desktop units or rack-mount instruments with multiple phase-coherent outputs. The APVSG series offers a cost-effective and flexible tool for generating high-quality, complex, wideband, digitally modulated signals.

Among others, the following use cases are supported:

- Upload multiple formats of IQ Data into APVSG Memory. The APVSG internal AWG can play selected sections of the RAM upon a user trigger.
- Use APVSG to synthesize and play predefined digital modulation formats
- Use FCP interface to live stream and play digital IQ data
- Use the analog IQ inputs with up to 250 MHz IQ bandwidth
- Use FCP to instantaneously switch between pre-loaded IQ data segments
- Use FCP to control the APVSG for ultra-fast frequency hopping.

All APVSGs operate with an ultra-stable temperature compensated frequency reference (OCXO) that can be phase-locked to an external reference.

The compact unit allows for full front panel control via touch panel display, and PC GUI Software supported operation via ETHERNET, USB, FCP (fast control port) and GPIB communication ports.

Validity of this Manual

This manual is valid for the following devices and their extended versions:

- APVSGXX(-X)

Available Casing

The devices are available in the following cases:

Desktop Case (APDESK)

Figure 1: Desktop enclosure with touch display (single channel device)

Compact Portable Case (CPC)

Figure 2: Compact portable case with touch display (single channel device)

2U Case (2URM)

Figure 3: 2URM case for multi-channel devices

Data Connections

The devices may only be connected to a network or a computer by using a shielded LAN cable. Unless shorter lengths are prescribed, a maximum length of 3 m must not be exceeded for the LAN and the USB connection.

Signal Connections

In general, all connections between the signal generator and another device should be made as short as possible and must be well shielded. It is recommended to use a high-quality cable with low loss especially for frequencies above 20 GHz.

Transportation

The devices must only be transported with the packaging supplied by the manufacturer. The device can be lifted up or transported in any orientation.

Safety Information

The information in this chapter is important to prevent personal injury, loss of life or damage to the equipment. Please read them carefully. If the device is used in a manner not specified by this manual, the protection provided by the device may be impaired.

Signal Symbol

In this manual, the following symbols are used to warn the reader about risks and dangers.

DANGER denotes a hazard for personal health or life.

WARNING denotes a risk or danger, that could damage the device.

Labels on Products

These labels are on the products. Familiarize yourself with the meaning of each of the labels before using the product.

	Direct Current (DC)
	Alternating Current (AC)
	Earth (Ground)
	EU label for separate collection of electrical and electronic waste.
	Caution, general danger zone. Attend the manual and/or a notice on the device.

General Safety Considerations

FCC notice

This equipment has been tested and found to comply with the limits for a Class A device, pursuant to **Part 15 of the FCC Rules** from the Federal Communications Commission. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and**,** if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Operation of this equipment in a residential area may cause harmful interference in which case the user will be required to correct the interference at his or her expense.

If products or their components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as nickel) may be released. For this reason, the product may only be disassembled or opened by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.

Connector View

Front & Rear View

APDESK and CPC with Touch display

The front panel contains a touch display, RF output female SMA connector (up to 20 GHz), or a K connector (40 GHz devices). The touch display shows information on the current function. Information includes status indicators, frequency and amplitude settings, modulations, current connectivity status, and error messages.

Front Panel

Figure 4: APVSG front panel view

1. **Touch display** The main display shows information on the current function, such as frequency, power, reference.
2. **Rotary Button** The rotary button is used to change the value selected on the screen.
3. **RF 50Ω** This female SMA/ K connector provides the output for generator signals. The impedance is 50Ω. Please check the data sheets for more details.

Rear Panel

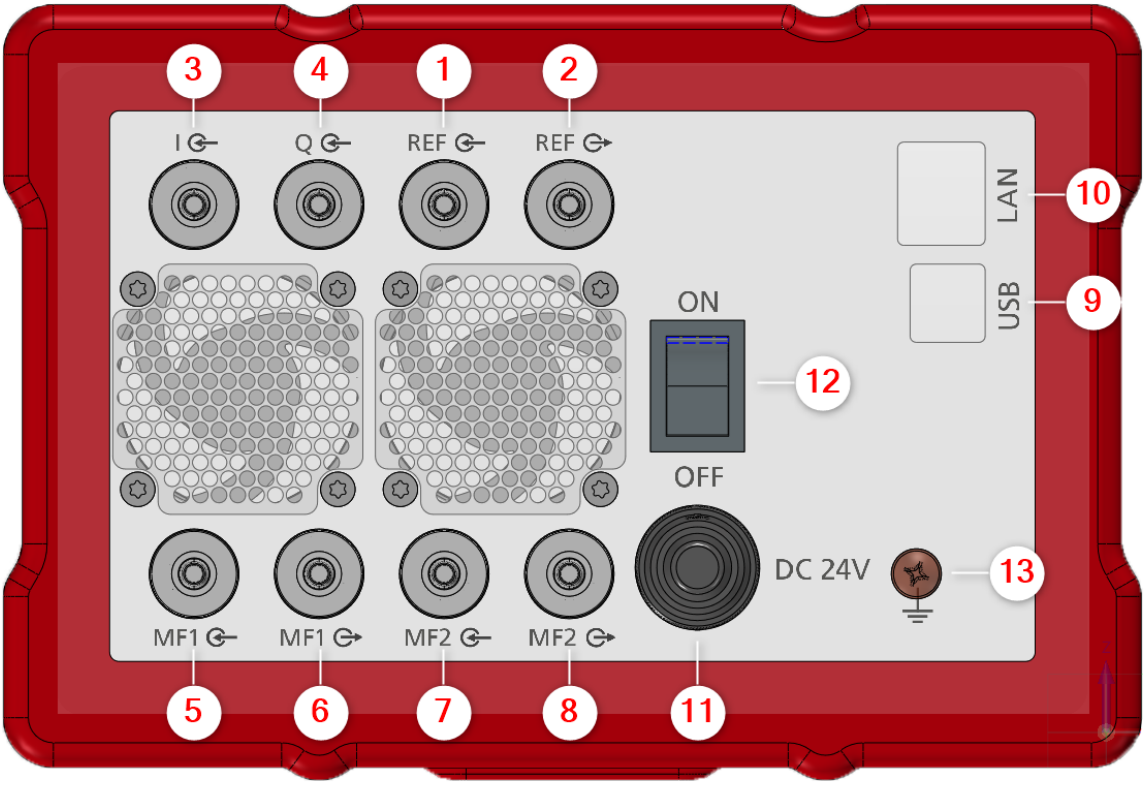


Figure 5: APVSG rear panel view

1. **REF input** This BNC female connector is the input for the reference signal.
2. **REF output** This BNC female connector is the output of the reference signal.
3. **I input** This BNC female connector is the input for analogue in-phase signals.
4. **Q input** This BNC female connector is the input for analogue quadrature signals.
5. **MF1 input** This BNC female connector is a multifunction input.
6. **MF1 output** This BNC female connector is a multifunction output.
7. **MF2 input** This BNC female connector is a multifunction input.
8. **MF2 output** This BNC female connector is a multifunction output.
9. **USB B** The USB B connector is used to connect the device to a computer.
10. **LAN** The LAN connector is used to connect the device to a network.
11. **Power Supply** Connector for the AnaPico power adaptor.
12. **ON/OFF Switch** Turns the device on or off.
13. **Ground Screw** The screw can be used to connect the device to ground reference.

2URM

Front panel

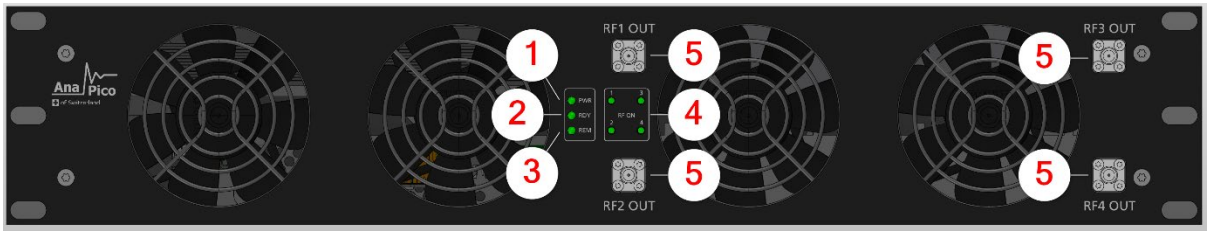


Figure 6: APVSG 2URM front panel view (model with 4 rf channels)

1. **Power LED** The power LED is indicating whether the device is on or off.
2. **Ready LED** The ready LED indicates that the boot process is completed and ready to be used.
3. **Remote LED** The remote LED is indicating whether the device connected to a computer or not.
4. **RF LED [1…4]** This LED indicates whether the RF signal on or off.
5. **RF OUT [1..4]** This female K- type/ SMA connector provides the output for generator signals. The impedance is 50Ω. Please check the data sheets for more details.

Rear Panel

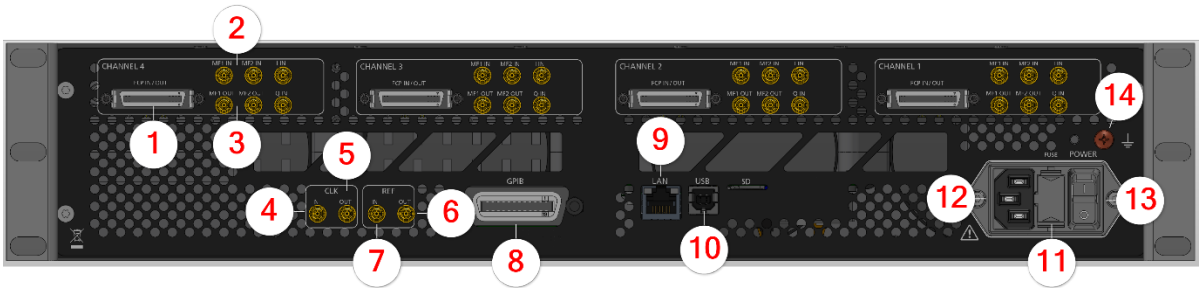


Figure 7: APVSG 2URM rear panel view

Ports available per RF channel:

1. **FCP** Fast control port, see Applications notes AN6002.
2. **MF input [1..2]** SMB jack is a multifunction input port
3. **MF output [1..2]** SMB jack is a multifunction output port

Ports belong to the instrument:

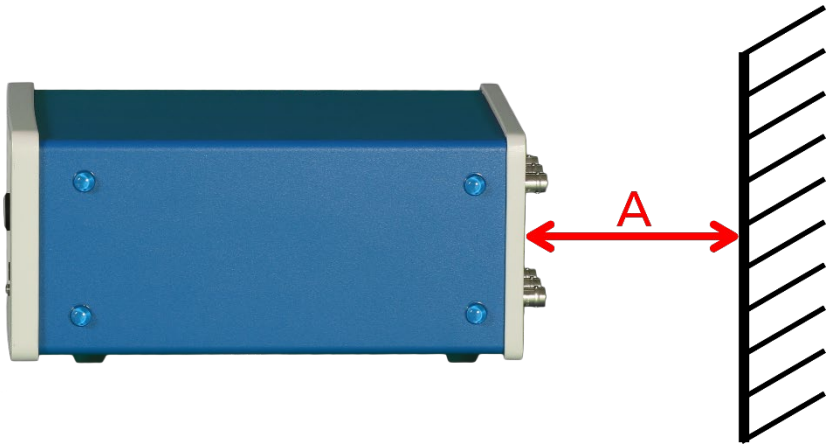
4. **CLK IN** Proprietary port for multi-device synchronization: SMB jack
5. **CLK OUT** Proprietary port for multi-device synchronization: SMB jack
6. **REF OUT** This BNC female connector is the output for the reference signal.
7. **REF IN** This BNC female connector is the input for the reference signal.
8. **GPIB Connector** If the device has the option “GPIB”, this is the position of the GPIB connector.
9. **LAN** The LAN connector is used to connect the device to a network
10. **USB B** The USB B connector is used to connect the device to a computer.
11. **FUSE Holder** This holder contains an exchangeable fuse.
12. **AC Power** Connector for AC power
13. **ON/OFF Switch** Turns the device on or off.
14. **Ground Screw** The screw can be used to connect the device to ground reference.

Minimum Distances

WARNING

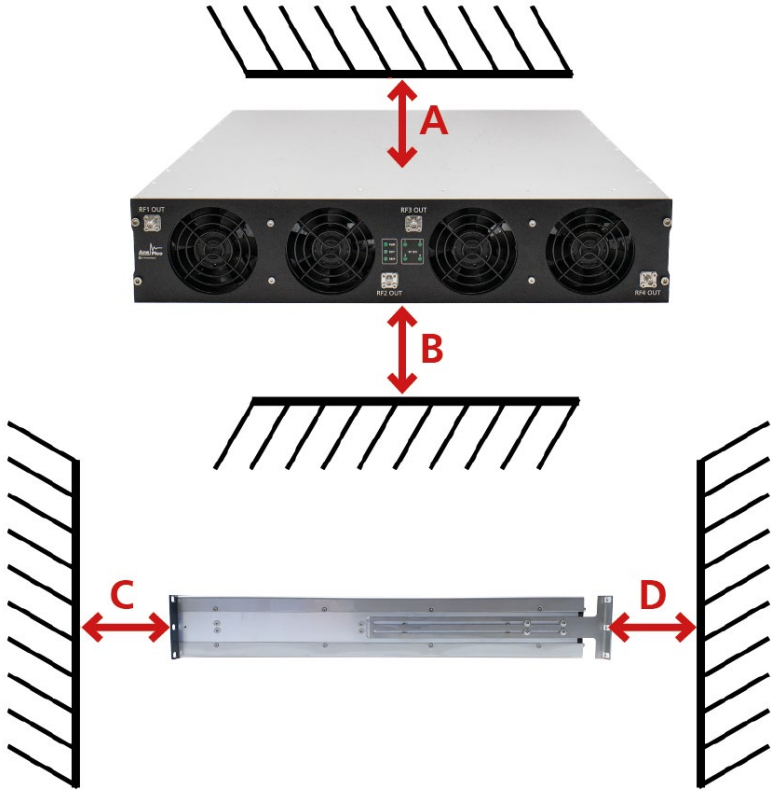
For an adequate cooling, the minimum distances between the device and another object, such as walls, rack cabinet walls or other equipment must be respected.

The minimum distances are:



Minimum distances for the CPC:

A: 150 mm



Minimum distances for the 2URM & 2URM:

A: 1mm

B: 1mm

C: 50 mm

D: 50 mm

Operating Conditions

Use only the supplied power adapter from AnaPico to supply the CPC.

If the back side of the 2URM case is not accessible during operation, it is recommended that the rack has a power switch.

Proper operation conditions

The devices are designed for use in dry and clean environments. The CPC can also be used in field as long as the operating conditions are met. Operation in an environment with high dust content, high humidity, danger of explosion or chemical vapors is prohibited.

In case of condensation 2 hours are to be allowed for drying prior to operation. Operation is only allowed from a 3-terminal mains connector with a safety ground connection and a mains plug used in your specific country. For sufficient ventilation, ensure airflow to and from ventilation holes.

Environmental Information

1. Waste electrical and electronic equipment must not be disposed of with unsorted municipal waste but must be collected separately. Contact the AnaPico customer service center for environmentally responsible disposal of the product.

2. Specially marked equipment has a battery or accumulator that must not be disposed of with unsorted municipal waste but must be collected separately. It may only be disposed of at a suitable collection point or via AnaPico service center.

Getting Started

Included Material

Your signal generator kit contains the following items:

- Signal generator
- Universal power adaptor (AC 100 – 240V) with corresponding country specific plugs
- Ethernet cable
- Memory stick with graphical user interface for Windows and documentation

System Requirements

The AnaPico graphical user interface requires at least the minimum system requirements to run one of the supported operating systems.

Operating system	Windows™ 7, 8, 10, 11
Remote	10/100/1000M Ethernet or USB 2.0 Port

Unpacking the Instrument

Remove the instrument materials from the shipping containers. Save the containers for future use. For a list of material included in the standard package, please refer to chapter **Included Material**.

Initial Inspection

Inspect the shipping container for damage. If container is damaged, retain it until contents of the shipment have been verified against the packing list and instruments have been inspected for mechanical and electrical operation.

Starting the Instrument

This section describes installation instructions and verification tests.

Applying Power

Place the instrument on the intended workbench and connect the appropriate DC power supply to the receptacle on the rear of the unit. Make sure you use the included DC power supply.

Using other supplies may lead to malfunction or damage of the instrument.

Press the line on/off switch on the rear panel. If available, the front panel (if applicable) display will illuminate. The instrument will initialize and momentarily display the model number, firmware revision and product serial number. The display will then switch to the factory default display setting, showing preset frequency and power, phase lock status (of internal reference) and instrument connectivity status (Ethernet IP or USB identifier).

Note, the instrument booting process may take up to 60 seconds (depending on configuration) to complete.

Connecting to LAN

Connect the instrument to your local area network (LAN) using the Ethernet cable. By default, the instrument is configured to accept its dynamic IP number from the DHCP server of your network. If it is configured properly, your network router will assign a dynamic IP number to the instrument which will be automatically displayed on the screen. Your instrument is now ready to receive remote commands.

Direct Connectivity to Host via Ethernet Cable (No Router)

You can connect to the instrument to your computer with the Ethernet cable without using a local area network with DHCP server. To work properly, the network controller (NIC) of your computer must be set to an IP address following the ZEROCONF standard, beginning with 169.254.xxx.xxx (excluding 169.254.1.0 and 169.254.254.255) and network mask 255.255.0.0 to match the ZEROCONF IP that the signal generator will assign itself after DHCP timeout. Any fixed address in the abovementioned range is admissible as well. The generators ZEROCONF address cannot be predicted as it is assigned dynamically, however the ZEROCONF address assignment process ensures it will not conflict with any other address used in the network.

Connection from a NIC that is configured to use DHCP is also possible. After a pre-set timeout, the NIC will assume that no DHCP is available and self-assign a fallback IP that will fall into the range 169.254.xxx.xxx.

Alternatively, you may assign the instrument a fixed IP. Please refer to a later section of this manual to learn how to do this.

Connecting through USB

Connect the (powered on) instrument to the computer using a quality USB type-A to type-B cable. If properly connected, the computer host should automatically recognize your instrument as a USBTMC device.

Note if you want to work with the AnaPico GUI, it must be installed with USB support selected. Then the GUI will detect all attached devices automatically. Open the GUI and follow the instructions given in Chapter **Start Vector Signal Generator GUI.**

Alternatively, a VISA runtime environment (NI, Keysight or comparable) must be installed.

Use VISA Write to send the *IDN? Query and use VISA Read to get the response. The USBTMC protocol supports service request, triggers and other GPIB specific operations.

Connecting through GPIB

Connect the instrument to the GPIB controller using the rear panel GPIB connector (option GPIB is required). Once connected properly, use VISA Write to send the *IDN? query and use VISA Read to get the response. The protocol supports service request, triggers and other GPIB specific operations.

Installing the AnaPico Signal Generator Remote Client

AnaPico's graphical user interface provides an intuitive control of the instruments. It runs under Windows™ operating system with minimum requirements. To install the GUI on the computer, insert the AnaPico memory stick, double click on the **setup.exe** to run the auto-installer.

The self-extracting setup provides easy installation and de-installation of the software. The setup program guides you in a few steps though the installation process.

Troubleshooting the LAN Interconnection

Software does not install properly

- Make sure your memory stick is not damaged.

Software cannot detect any instrument

- Make sure you have connected both computer and instrument to a common network.
- If a direct connection is used, you may require resetting your computer Ethernet controller (depending on the configuration). Note that in that case detection of the instrument can take a considerable amount of time if your computer is configured to work with an external DHCP server. In some cases, the detection may even fail completely. Configure your computer network controller to an appropriate fixed IP instead.
- Make sure that your software firewall enables the GUI to setup a TCP/IP connection via the LAN. Under Windows 7/10 this can be achieved with the following steps:
  Open *Control Panel* under *Settings* in your *Start* menu. Then go to *Windows Firewall*. Click on *Exceptions* and then *add Program.* If the GUI is in this list, choose it and click *OK* otherwise you have to browse for the path to GUI installation directory. Finally close all open dialogs with *OK*. Now your Windows™ Firewall will not block requests from the GUI.

Shutting Down the Signal Generator

Press the line on/off switch on the rear panel to off.

Replacing the Fuse

The 2URM case has a fuse, accessible from the outside. To change the fuse, pull out the mains plug and pull the fuse holder out. Replace the old fuse with a new one. It is forbidden to repair defect fuses or to bridge them by any means. Use only a fuse with same specifications.

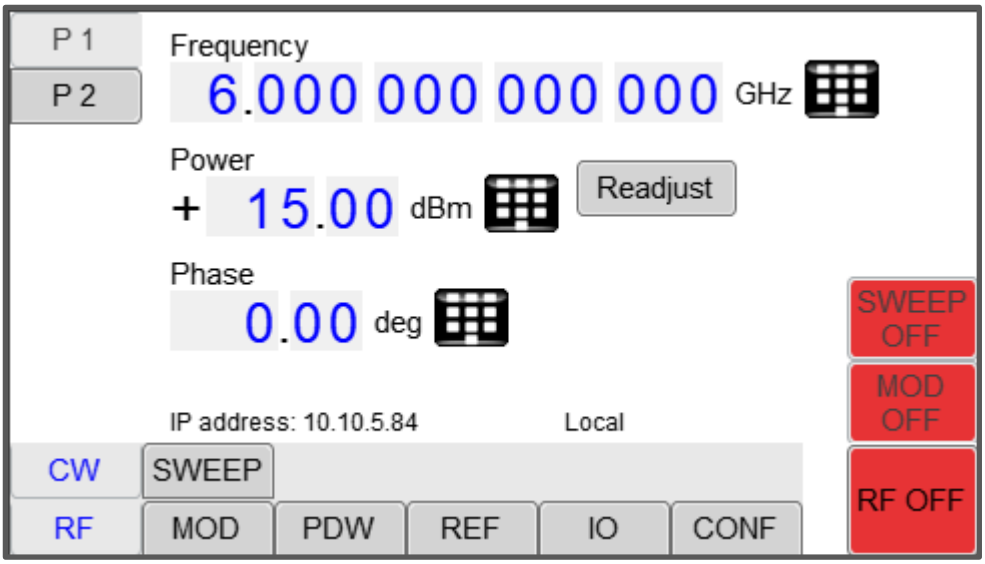
Front Panel

Figure 8: APVSG front panel

The currently active display position is shown by the cursor (underline symbol, or different background colour). The cursor does not move beyond the field of the currently selected parameter. Rotate the front panel knob or use the numpad icon to modify the value. Clockwise rotation increases the parameter and counterclockwise rotation decreases the parameter. The parameter value will continue to increase or decrease by the amount of the selected resolution until it reaches the maximum or minimum limit of the parameter.

Displayed Parameter Formats

The following sections describe the various menu and submenu options provided by the front panel.



CW RF Output

The Main or CW RF Display is shown after the instrument has successfully booted and is ready. This section contains settings related to the CW as well as the sweep functionality of the device.

Modulation

The modulation section gives access to most settings related to available modulations. The different types of modulations are grouped in submenus, which include but may not be limited to

- Arbitrary modulation
    - Waveform modulation
    - Waveforms on SD memory [device option SD]
    - Streamed modulation from the FCP interface
- Analog modulations [device option MOD]
  Including AM, FM, PM and Pulse modulation settings.
- Additive white gaussian noise modulation [device option AWGN]
- AVIO Modulations [device option AVIO]
  Including settings for VOR; ILS and DME.
- Digital Modulations [device option IVM]
- Arbitrary Trigger
  Settings to trigger arbitrary modulations.

Pulse Descriptor Word

This menu is only available with device option PDW. For configuring and utilizing the PDW feature, it is recommended to use the APVSG GUI. More information can be found in AN6008.

Reference

In the reference submenu the reference source input and the reference output signal can be set.

Input / Output

This menu includes configurations for input and output ports of the device. Submenus included here, are:

- Multifunction Output
  Select the signal to be output at each of the multifunction ports.
- Fast Control Port [device option FCP]
  Configure the FCP interface to interpret received signals appropriately.
- Analog Input [device option AIQ]
  Configure the analog input interface and set gain and offset for applied input signals.

Configuration

The configuration menu of the front panel includes different settings. The following list gives an overview of available submenus and a brief description of their content.

- Device Presets
  Setting device default presets and user defined presets.
- Communication
  Network configuration overview with LAN configuration, where IP address, subnet mask and DHCP can be configured.
- Display Configuration
- Device Information
  Includes Firmware version, installed options and similar attributes.
- Selftest
  The AnaPico support staff may prompt you to perform a Selftest of the device, which can be initiated in this submenu.

Graphical User Interface (GUI)

AnaPico's graphical user interface provides an intuitive control of the signal generator. It runs under any Windows™ operating system. Make sure the software is installed correctly and the computer's firewall is configured properly.

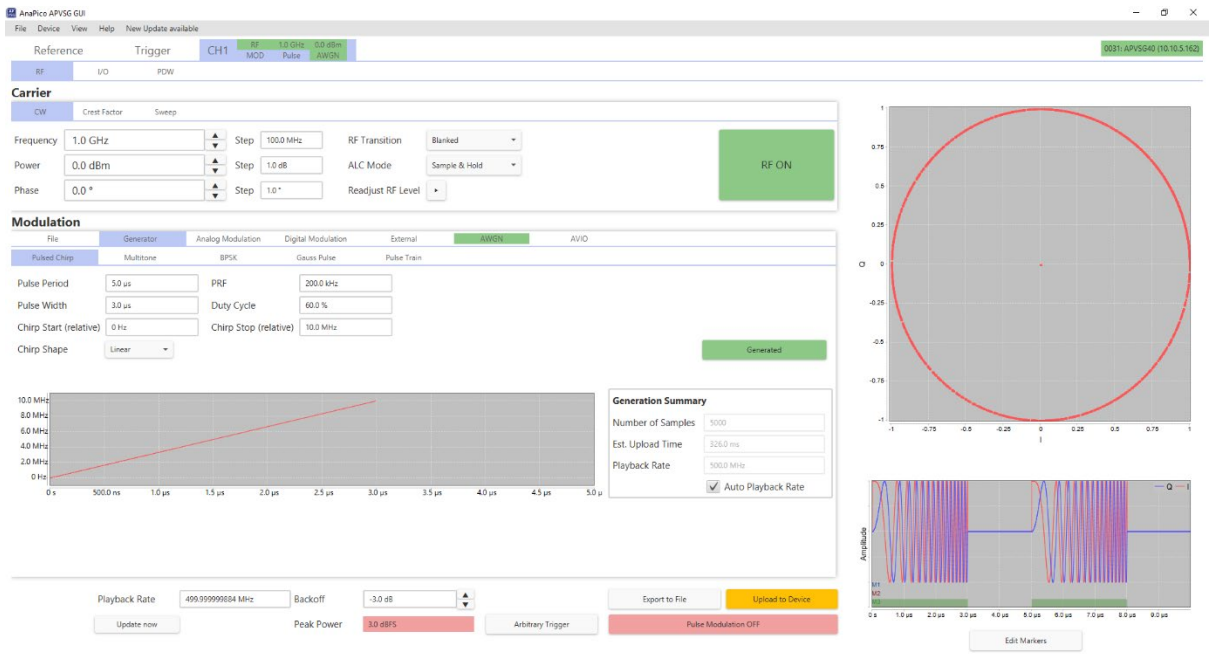


Figure 9: Vector signal generator UI

Start Vector Signal Generator GUI

After successful installation of the software double-click the software shortcut that has been created on your desktop.

After start, the GUI will automatically detect existing AnaPico instruments that are connected to the computer (network) via local area network, USB, or GPIB. In the ***CONTROL*** tab the detected instruments are listed. Clicking on one of the devices will instantly establish connection. Clicking on an alternate device will disconnect the old device and reconnect to the new device.

Simultaneously controlling Multiple Signal Generators from one PC

You can easily control multiple AnaPico instruments from a single computer, but you need to start a separate GUI for every instrument as only one instrument is controlled by a single GUI at once.

Setting Network Configuration

The **Network Configuration** button allows configuring the LAN settings as shown in Figure 8 . You may choose from three distinct network addressing modes: setting to *AUTO* will check for a DHCP server on the network but if this fails, will fall back to assigning an address automatically using zeroconf. Setting to *DHCP* will check for a DHCP server on the network with no fallback option if one doesn't exist. Setting to *MANUAL* will require the user to supply all network settings for the device manually as shown below. Additionally, the device name can be modified as desired. The unit's serial number and firmware revision are displayed at the bottom of the dialog box.

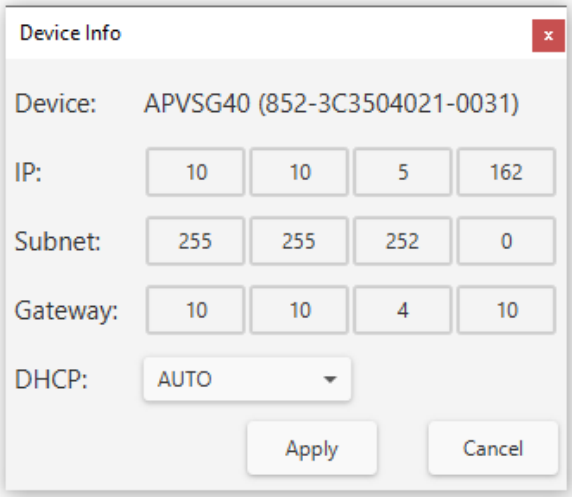


Figure 10: Network configuration submenu

Multi-Session Option

The 'Multi-Session' checkbox can be selected to enable the device to be accessed from more than one instance of the UI. This enables users on multiple computers on the network to connect to and configure the device simultaneously. It is the user's responsibility to manage access conflicts whilst this mode is enabled (i.e., 2 users changing the same option from different PCs).

Device Port Setting

The 'Port' option allows the listening TCP port to be customized for the device. The default setting for all devices is port 18. If changed, the device will no longer be accessible using this port number. Any instances of the UI (or other VISA applications connecting to the device over a network) will need to modify their destination port number to match the device to connect to.

Connecting to devices using a non-default port

There are 2 options for connecting to a device when its default listening port has been changed.

1. Specify a temporary connection port

Click the menu 'Info' -> 'Connection Settings' -> 'Specify Connection Port'. This will cause a new setting 'Custom Port' to be displayed on the 'Control' tab of the UI (see figures 6-d and 6-e). The connection port to use can then be entered (within the range of permissible TCP port numbers). Beware that this setting will overwrite the default port until it is removed. To remove, select 'Specify Connection Port' again – this will remove the 'Custom Port' setting from the UI and revert to using the current default port. Deleting the port number from the 'Custom Port' text box will also cause the UI to revert to using the default port.

2. Change the application's default port setting

The global default port to use for connections can be changed by selecting menu 'Info' -> 'Connection Settings' -> 'Change Default Port' (see figure 6-d). A default port can be entered into the dialog box which appears and set by clicking button 'Set Default' – only permissible TCP ports can be entered here. If the new default port is accepted, the '[Default=]' text above will display the new setting. Beware that the new default setting will now persist until changed again – including after restarting the UI or rebooting your system.

Setting the GPIB Address

If the instrument has the GPIB option installed, the GPIB address can be changed in the GPIB submenu in the control tab. Valid GPIB addresses range from 1 to 30.

To verify GPIB functionality, use the VISA Assistant available with the Agilent IO Library or the Getting Started Wizard available with the National Instrument IO Library. These utility programs enable you to communicate with the signal generator and verify its operation over GPIB. For information and instructions on running these programs refer to the Help menu available in each utility.

Perform Firmware Upgrade

A firmware upgrade of the instrument can be done directly via the GUI. First make sure you are connected to the right instrument and have the correct firmware binary file (.tar) ready. Then apply **Controller → Update Firmware** and select the appropriate binary file that you have received from AnaPico or downloaded from the AnaPico website. The update will take a few seconds and after completion, your instrument will reboot. Reconnect to the instruments after booting is completed and continue with the updated firmware.

Do not disconnect and power off device during firmware update.

Remotely Programming the Signal Generator

The signal generator can be remotely programmed with the use of SCPI commands. Please refer to the Programmer's Manual for details.

APVSG Operation based on the GUI

The single channel APVSG model may be operated via graphical user interface[1] (GUI) or directly from the front panel (if included). The multichannel models are operated via GUI. All APVSG models can optionally be remotely controlled with SCPI commands, as described in section **Remote Programming the Signal Generator**. In the following, basic functions of the device are explained. Examples demonstrate a selection of modulated signals that can be generated with the APVSG. In all examples the GUI is used to control the APVSG.

On the top GUI level, the user can choose between these tabs:
The “Reference” and “Trigger” tabs are found in all GUIs. In the GUI of the single channel model one “Channel 1” tab is shown whereas for n-channel models n “Channel i“ (i=1..n) tabs are available.

Reference

The device can be configured to either use the internal reference oscillator or a reference frequency provided by the user. The reference frequency can be configured to be provided at the reference output of the device. This is how the reference source and output are configured.

Select reference

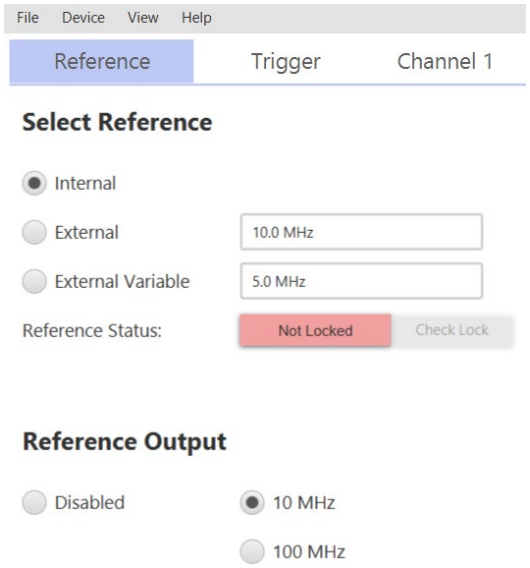
“Internal”

“External” 10.0 MHz (“REF IN” connector)

“External variable” (“REF IN” connector) in 100 MHz steps

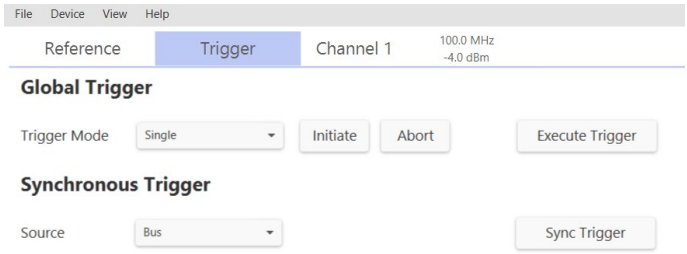
Reference output (“REF OUT” connector)

Select between “10 MHz” and “100 MHz” or “Disabled”



[1] The APVSG GUI can be downloaded from the AnaPico website:
https://www.anapico.com/downloads/software-and-firmware/

Trigger



Global Trigger

Trigger events will be broadcasted to all subsystems with very short delay of the APVSG, no matter if a subsystem expects a trigger or not. Trigger events of individual channels are not phase synchronized.
With “Trigger mode” trigger can be set to “Single” (start by pushing “Initiate”) or “Continuous”. “Single” trigger mode may be stopped by selecting “Abort”.
A global trigger may be activated by selecting “Execute Trigger”.

Synchronous Trigger

Suitable in multichannel devices when extremely precise synchronization between channels is required. The trigger events of individual channels are in this case mutually synchronized very precisely but exhibit approximately 120 ns higher delay than the “Global Trigger”.

Channel

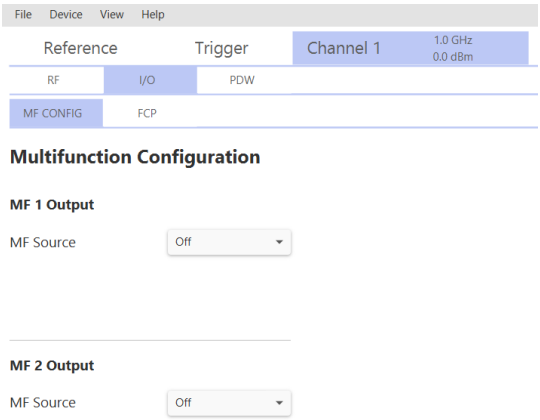
On this GUI level the user can configure the RF output of each channel, including the carrier and its modulations, as well as I/O settings.

RF Output

Allows definition of carrier and modulation signal. See below.

Input / Output

Under this tab Multifunction connector outputs are configured.



MF CONFIG, configure multifunction outputs (connectors MF1 OUT and MF2 OUT)

MF1 or MF2 Output:

Off	-	Inactivates the respective output
Low	-	Sets the respective output to logical low
High	-	Sets the respective output to logical high
Pulse	-	If “Pulse” is chosen in “Analog Modulation” mode, the modulation pulses will appear at the respective output
Arbitrary	-	In the arbitrary modulation mode “Marker” or “Trigger” signals can be provided at the respective output. Marker signals must be defined for the replayed segment selected in the “Segment” tab. The arbitrary trigger can be configured in the modulation section.
Sweep	-	When the carrier sweep is active, either the valid state of the RF output or the sweep trigger can be provided at the multifunction output. The sweep trigger can be configured in the “Sweep” tab of the carrier section in the “RF” output tab.
PDW	-	The pulse descriptor word option supports a selection of signals for the multifunction output. The first option is the PDW trigger signal which can be configured in the “PDW” tab. The second option is one of the PDW markers that are set for each pulse individually. The third option is a video signal that represents the pulse state during PDW simulations.

“FCP” (Option FCP)

For fact control port (FCP) details, please refer to:

AN6002: Fast Control Port

AN6008: Pulse Descriptor Word

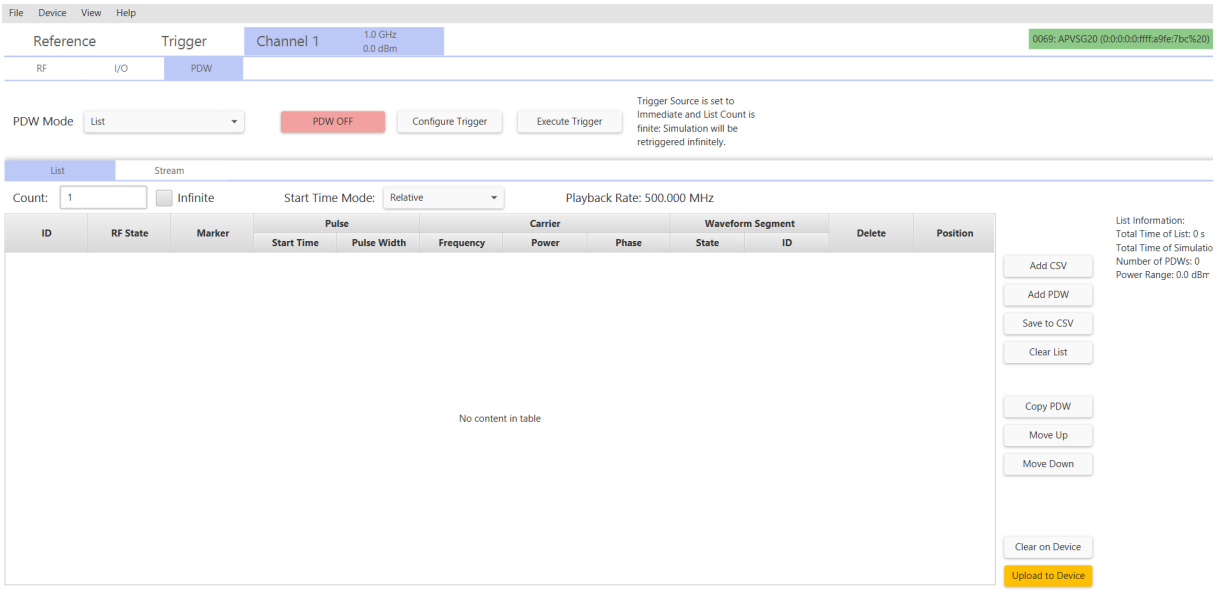
AN6009: Control Descriptor Word

https://www.anapico.com/downloads/application-notes-and-videos/

Pulse Descriptor Word

Using Pulse Descriptor Word (PDW) requires Option PDW.

A PDW consists of a set of PDW parameters defining an output signal (modulation options, carrier settings and more). Duration and timing between modulations can be controlled. Using PDWs to set modulations reduces the required memory space compared to storing IQ modulation data.



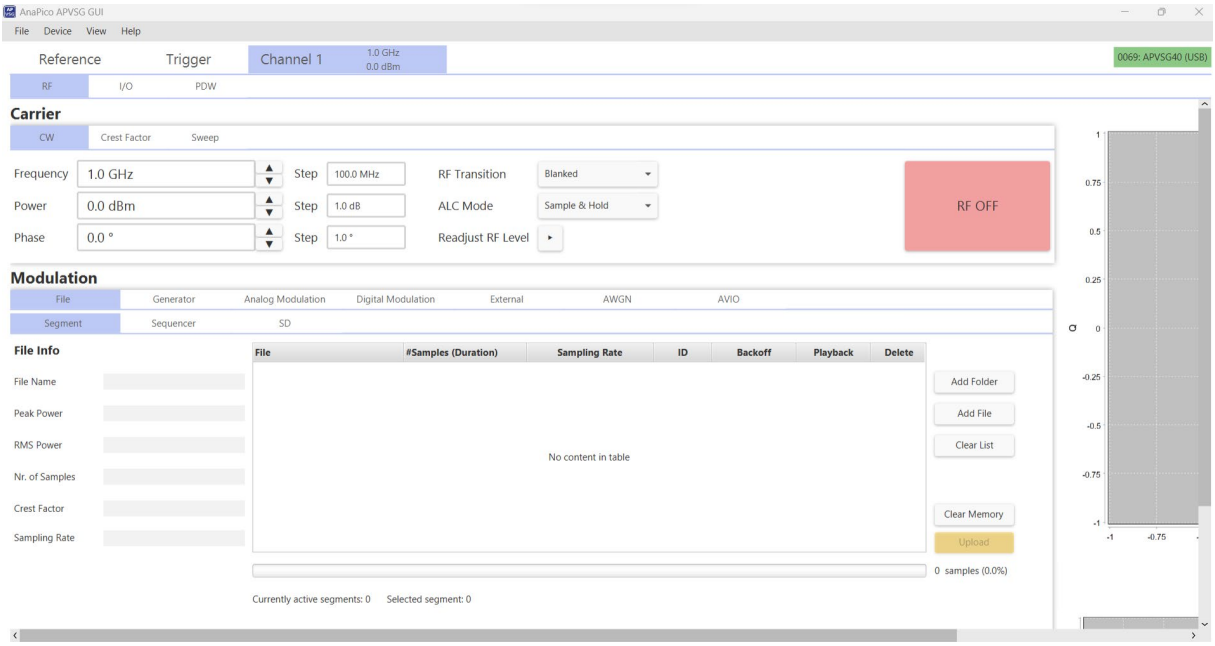
For details, please refer to:
AN6008: Pulse Descriptor Word
https://www.anapico.com/downloads/application-notes-and-videos/

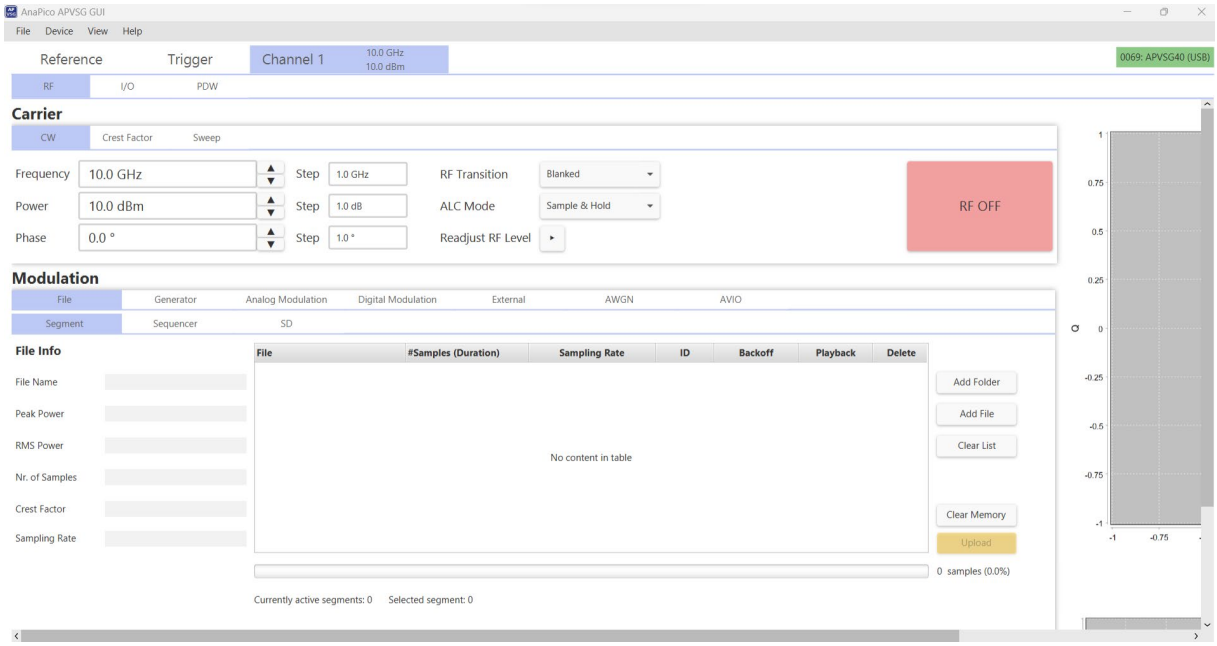
Carrier Section

CW signal

The vector signal generator APVSG can generate unmodulated as well as modulated carriers. The carrier must be defined in the “Carrier” section of the GUI in any case in a first step or may be changed later. Then the user may choose from a variety of modulation signals in the “Modulation section”.

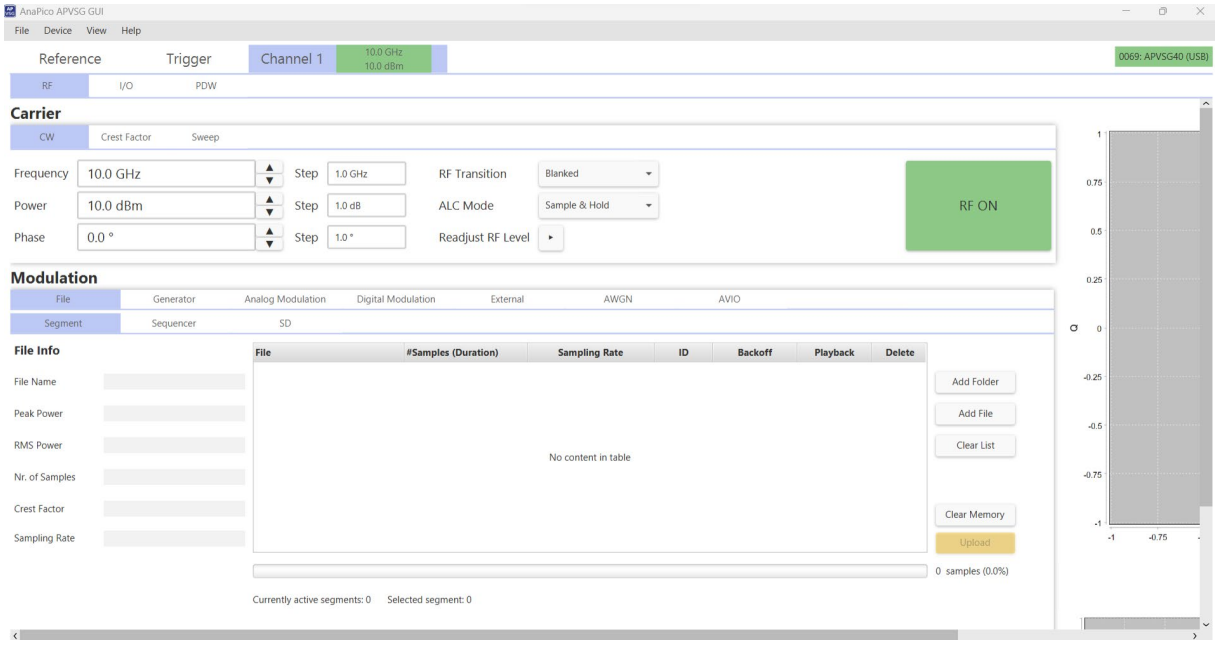
Screen after startup and connection to a device:





Vary “Power”, “Frequency” and “Phase” (carrier setting of selected channel) by pushing the related arrow buttons (change “Step” if required by entering the appropriate value). Alternatively, the values may be entered directly in the respective fields.

Push “RF ON”/”RF OFF” button to turn the RF output on (button will turn green and show “RF ON”).



Crest Factor

In this tab in the “Carrier” section the user may define or retrieve the crest factor (peak-to-average ratio in dB) of the modulated signal:

Manual	-	Here, a value for desired maximum crest factor may be entered
Automatic	-	Depending on the chosen modulation the calculated and automatically set crest factor will be provided (for AM, FM, PM and DME, ILS, VOR of Option AVIO)
AWGN	-	Here, the crest factor of the gaussian noise is provided if the additive noise is enabled.
Total	-	Provides the combined crest factor of modulated carrier and AWGN (if enabled)
Refresh	-	Updates actual crest factor values after a modulation has been changed.

Reference:
AN6006: RF Output Modes of APVSGs
https://www.anapico.com/downloads/application-notes-and-videos/

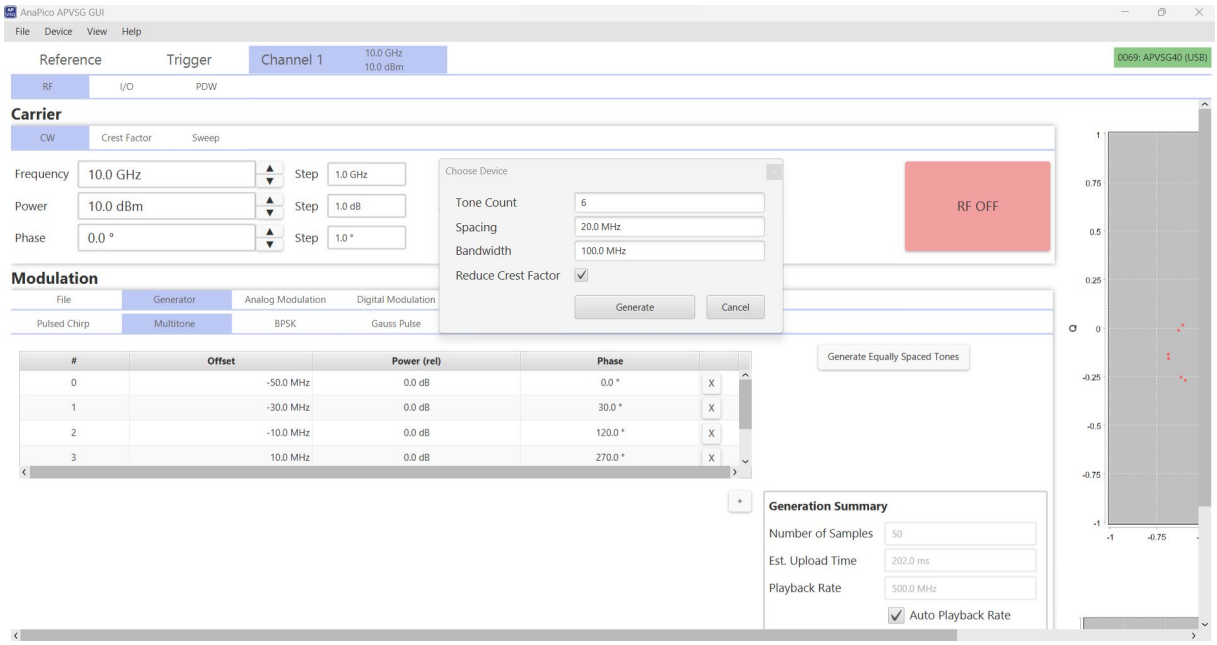
Modulation Section

Generator

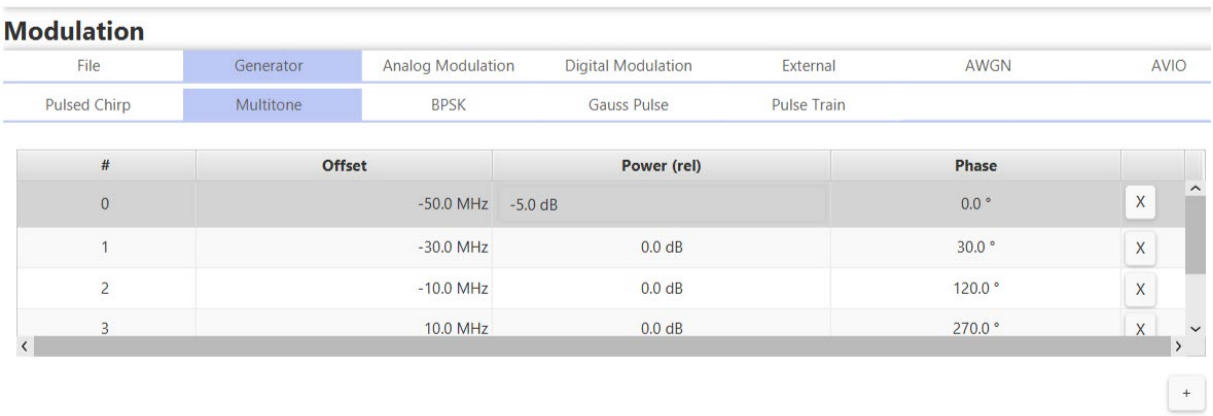
In the “Generator” tab the user may choose between the following internally generated modulations: “Pulsed chirp” (chirped carrier bursts), “Multitone”, “BPSK” (binary phase shift keying), “Gauss pulse”, and “Pulse Train”.

Example: Multitone generation

Choose the “CW” tab and appropriate carrier parameters in the “Carrier” section and “Multitone” in the “Generator” tab of the Modulation section.



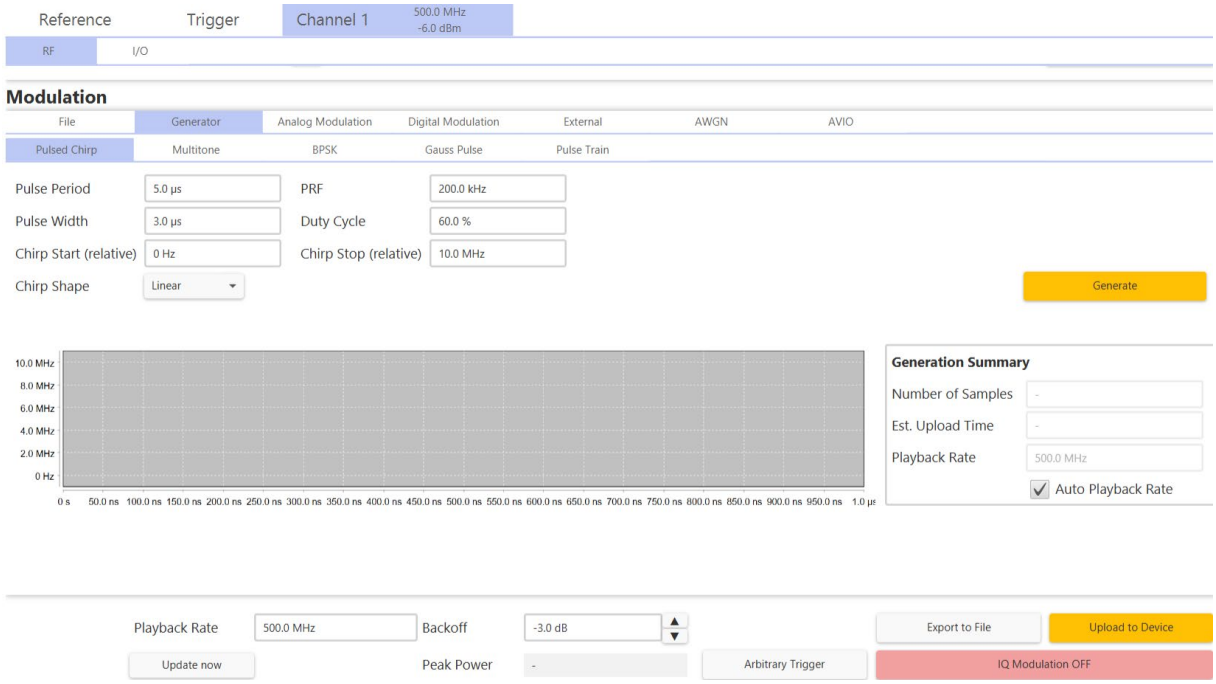
Open Generate “Equally Spaced Tones” window and set number of tones and either “Spacing” or “Bandwidth.” Tick “Reduce Crest Factor” if required.
Tone frequencies and relative powers are displayed (scroll down if not all tones are visible on the screen).
Change relative power by manually entering the desired value in the “Power (rel)” field.
Add more carriers by pushing the “+” button and enter “Offset” and (if required) “Power (rel) and “Phase,” respectively. Remove a particular carrier by pushing the “x” button next to that carrier.



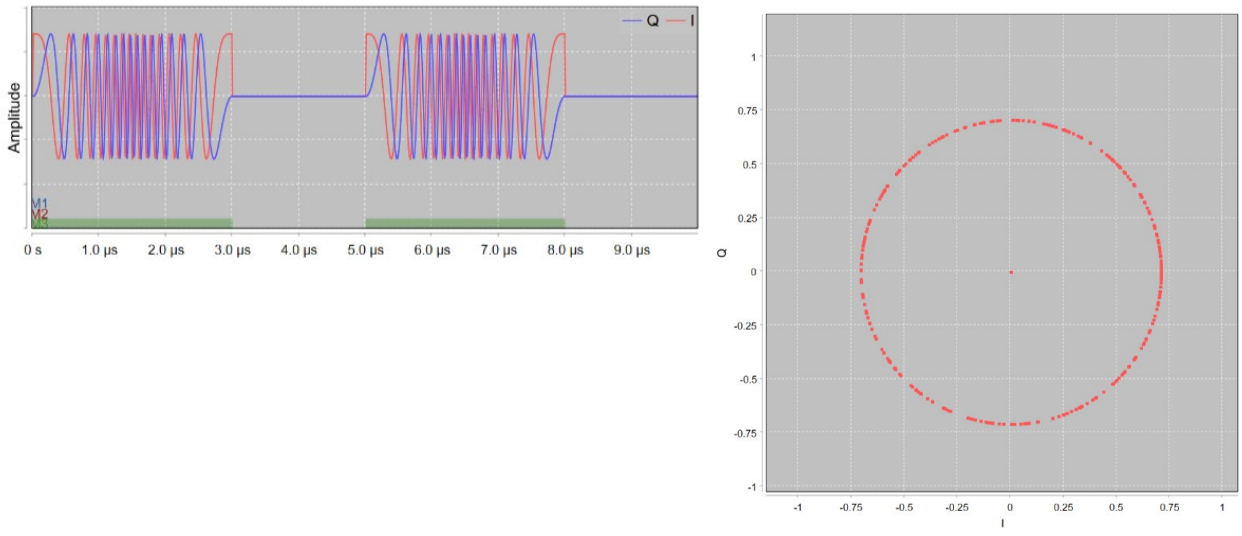
Pushing the “RF ON”/“RF OFF” button activates the RF output.

Example: Pulsed chirp

Choose “CW” and appropriate carrier parameters in the “Carrier” section. Now choose “Pulsed Chirp” in the “Generator” tab in the “Modulation” section and specify the pulse parameters, as shown below.

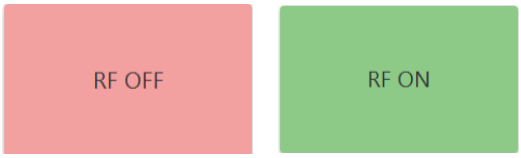


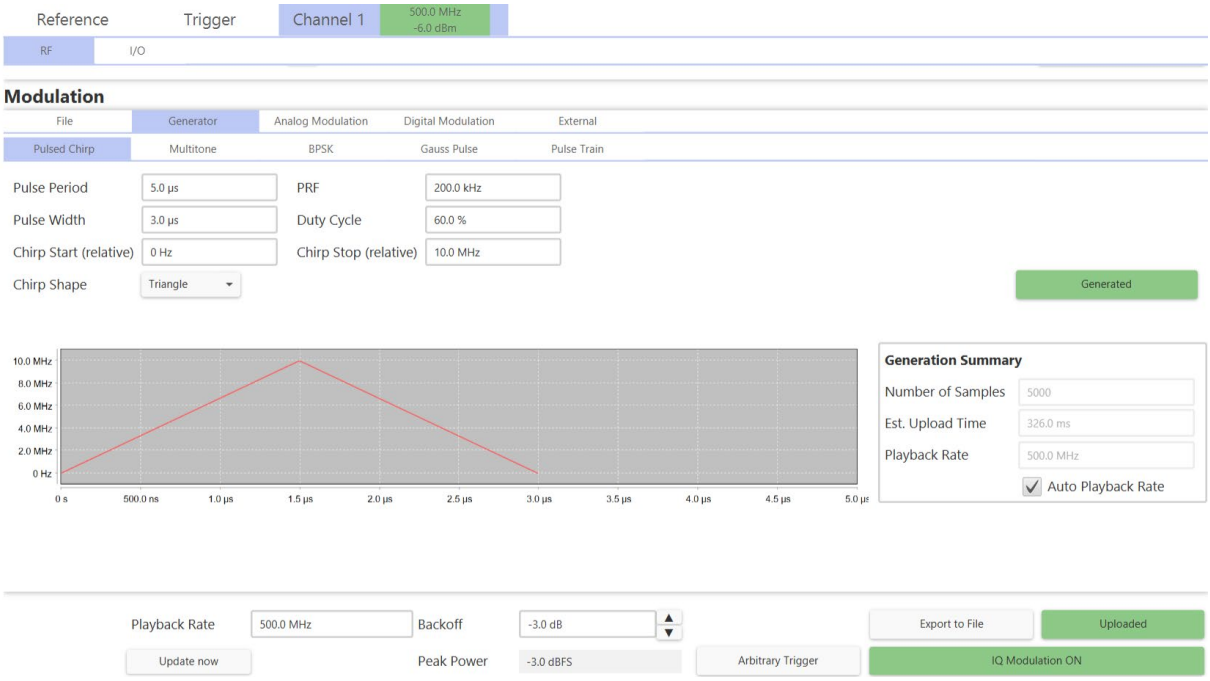
After pushing the “Generate” button the frequency deviation vs. time will be shown in a diagram. A diagram, representing I and Q modulation signals vs. time as well as an IQ phasor plot will also be provided, respectively, as well as the number of samples and the estimated upload time.



The generated modulation will be uploaded to the APVSG when the “Uploaded” button is pushed. With the “IQ Modulation” button the modulation of the carrier is activated.

Pushing the “RF ON”/“RF OFF” button turns the RF output on and the frequency and power fields in the “Channel” tab turn green.





“Pulse Train” modulation

Here a pulse modulation of the previously specified carrier can be defined. “None” means simple amplitude modulation. Other modulation formats are “FM Chirp”, “Barker” and “BPSK” (binary phase shift keying).

“Pulse type”:
The two modulation pulse shapes “Trapezoidal” and “Raised-Cosine” are available.

“Pulses”:
In this list pulse sections can be defined.

“Patterns”:
In this list pulse sections defined in the “Pulses“ list may be concatenated arbitrarily (including repetitions) to define various pulse patterns defining modulation signals.

“PRI”:
Pulse repetition interval (period of the pulse train).

“Peak Power”:
Indicates the maximum instantaneous power of the modulation signal.

“Backoff”:
For setting the difference in dB between DAC full scale power and the peak instantaneous power of the actual modulation signal.

“Upload to device”:
The IQ data to generate the modulation signal will be uploaded to the device when pushed.

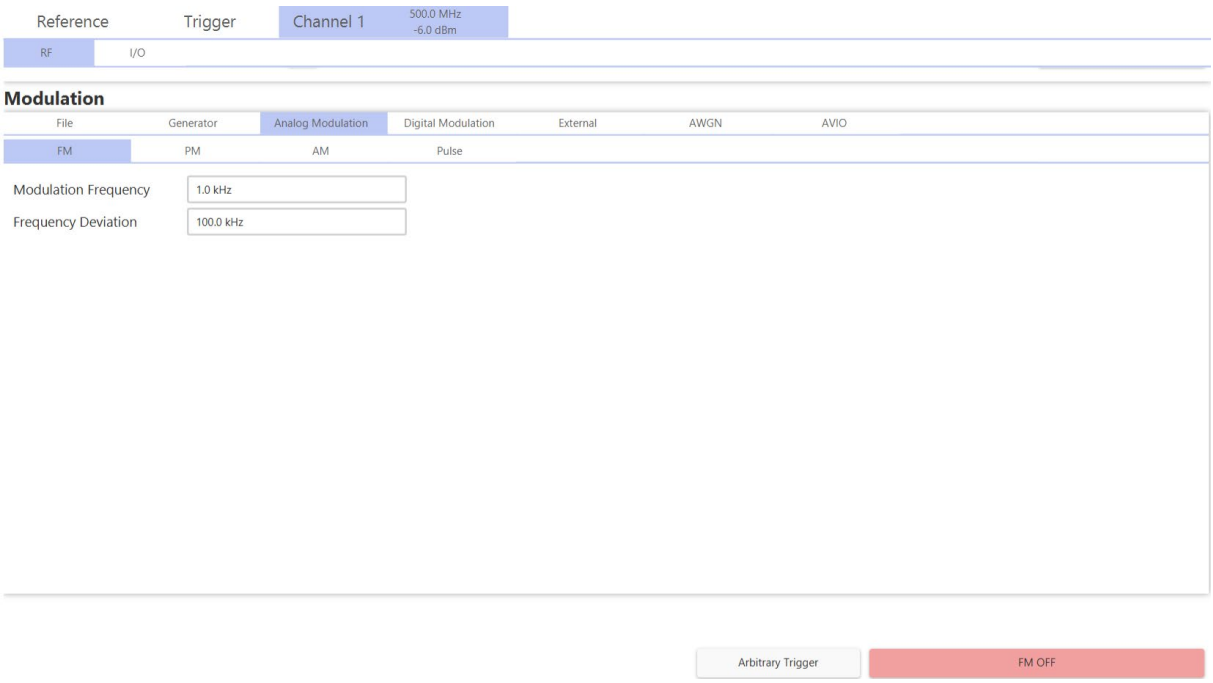
“Arbitrary Trigger”, “Playback Rate”, “Auto Playback Rate”, “Update now”:
See “General” section.

Analog Modulation

In the “Analog Modulation” (Option MOD, Internal analog modulations) tab the user may choose between the following modulations:
“FM” (frequency modulation), “PM“ (phase modulation), “AM” (amplitude modulation) and “Pulse” (pulse modulation).

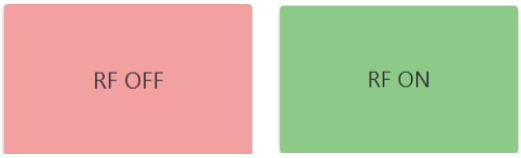
Example: FM (frequency modulation)

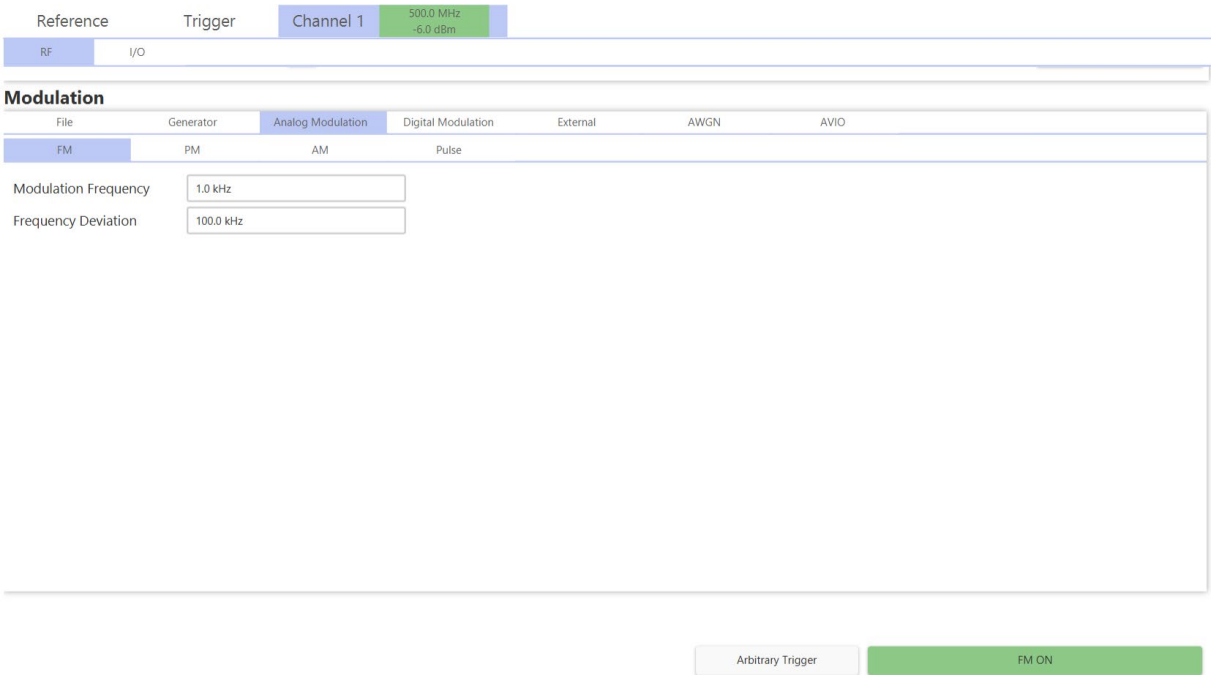
Choose “CW” and appropriate carrier parameters in the “Carrier” section. Now choose “FM” in the “Analog Modulation” tab in the “Modulation” section and specify the frequency modulation parameters “Modulation Frequency” and “Frequency Deviation”, respectively, as shown below.



With the “FM ON/OFF” button the modulation of the carrier is activated.

Pushing the “RF ON”/“RF OFF” button turns the RF output on and the frequency and power fields in the “Channel” tab turn green.





For pulse modulation (“Pulse”) additional parameters can be defined as listed below.

“Pulse Polarity”:
A (rectangular) modulating pulse is basically defined by its width and duty cycle. The width defines the time interval for 100% amplitude and the rest of the period, defined by the duty cycle determines the 0% amplitude time interval. This describes “Normal” pulse polarity, whereas for “Inverted” pulse polarity the roles of 100% and 0% amplitude are exchanged.

“Pulse Modulator”:
When “BB” (baseband) is selected fast pulse modulation with 8ns resolution is performed. High extinction ratio. Modulation bandwidth is 400 MHz, steep pulse slope with pulse jitter around ±1ns.
“RF” mode yields slower switching but significantly lower pulse jitter in the ps range.

“Pulse Output Polarity”:
With this function the pulse at the MF1 or MF2 output can be inverted w.r.t. the defined pulse polarity.

“Pulse Source”:
Defines the source for the pulse modulation signal. The modulating pulses can be generated internally (“Internal”) or supplied externally through multifunction in-/outputs MF1 or MF2.

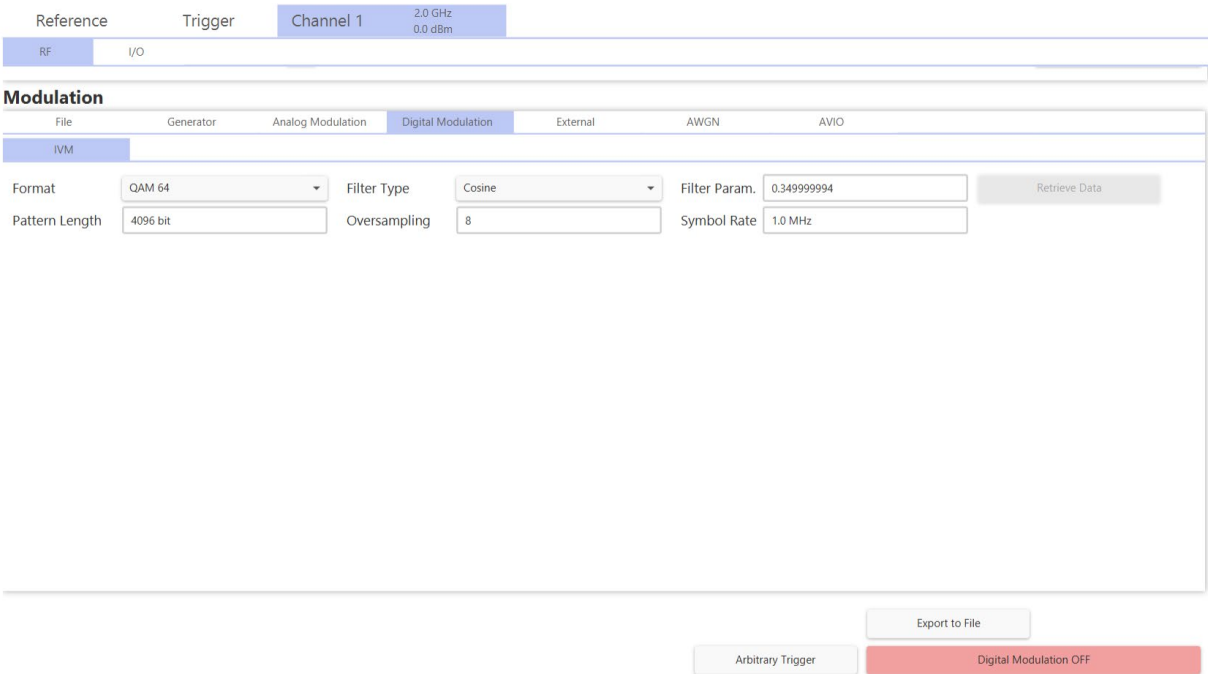
“Arbitrary Trigger”, “Playback Rate”, “Auto Playback Rate”, “Update now”:
See General section.

Digital modulation

In the “Digital Modulation” (Option IVM[2], Internal digital modulation schemes) tab the user may choose between the following internally generated modulations:
Quadrature amplitude modulation “QAM 8”, “QAM 16”, “QAM 32”, “QAM 64”, “QAM 128”, “QAM 256”, “QAM 512”, “QAM 1024”, “QAM 2048”, “QAM 4096” with a maximum symbol rate of 500 MHz.

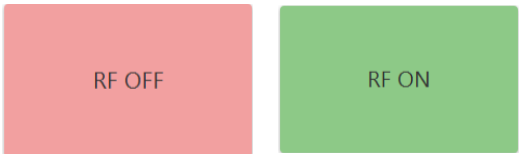
Example: “QAM 64” (quadrature amplitude modulation with 64 different states)

Choose “CW” and desired carrier parameters in the “Carrier section”. Now choose Format “QAM 64” in the “Digital Modulation” tab in the “Modulation” section and specify the QAM parameters “Filter Type”, “Filter Param.”, “Pattern Length”, “Oversampling” and “Symbol Rate”, respectively, as shown below.

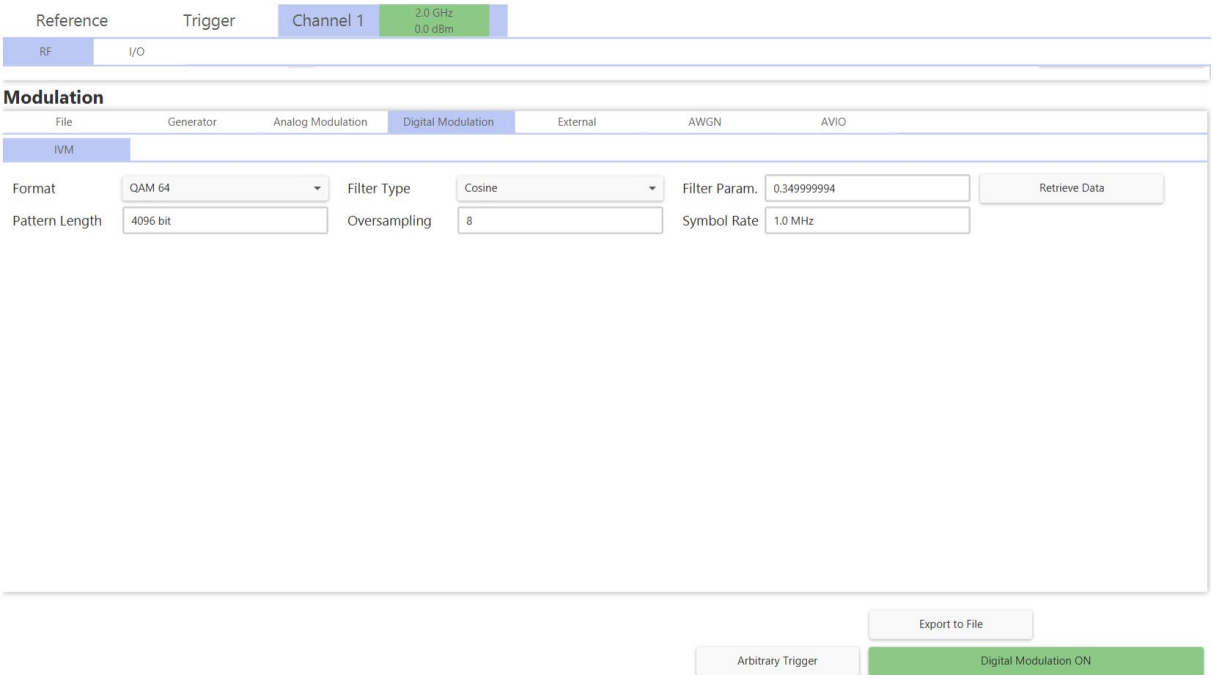


With the “Digital Modulation ON/OFF” button the modulation of the carrier is activated.

Pushing the “RF ON”/“RF OFF” button turns the RF output on and the frequency and power fields in the “Channel” tab turn green.



[2] ”Internal vector modulation”.



For parameters “Arbitrary Trigger”, “Playback Rate”, “Auto Playback Rate”, “Update now” see “General” section.

External Modulation

External modulation is possible with Option FCP via Fast Control Port (FCP).

For details, please refer to:
AN6002: Fast Control Port
AN6008: Pulse Descriptor Word
AN6009: Control Descriptor Word
https://www.anapico.com/downloads/application-notes-and-videos/

An external analog I/Q modulation input (Option AIQ) accepts externally supplied analog I and Q modulation signals from the “I IN” and “Q IN” (for each channel) connectors.

For details, please refer to:
AN6007: Analog Input

For parameters “Arbitrary Trigger”, “Playback Rate”, “Auto Playback Rate”, “Update now” see “General” section.

AWGN Modulation

Additive white gaussian noise, Option AWGN.

For details, please refer to:
AN6005: Additive White Gaussian Noise
https://www.anapico.com/downloads/application-notes-and-videos/

AVIO Modulation

Avionic modulations, Option AVIO.

For details, please refer to:
"AVIO Modulation Option Application Note", Berkeley Nucleonics Corporation, 2019.
https://www.berkeleynucleonics.com/sites/default/files/products/resources/avio_modulation_option_app_note.pdf

Arbitrary Waveform Modulation

In the "Segment" tab, waveform files can be uploaded to a specific segment in the device's memory. Each waveform file contains IQ samples that can be used to modulate the carrier signal. When played back, segments are repeated periodically.
These segments can be concatenated in arbitrary number and order in the "Sequencer" tab, thereby forming sequences of segments that can be replayed.
Accepted file formats: .qi, .qid, .wvd, .csv, .tdms, .iq.tar, and others.

For details on segments and sequences, please refer to:
AN6003: Memory Segmentation

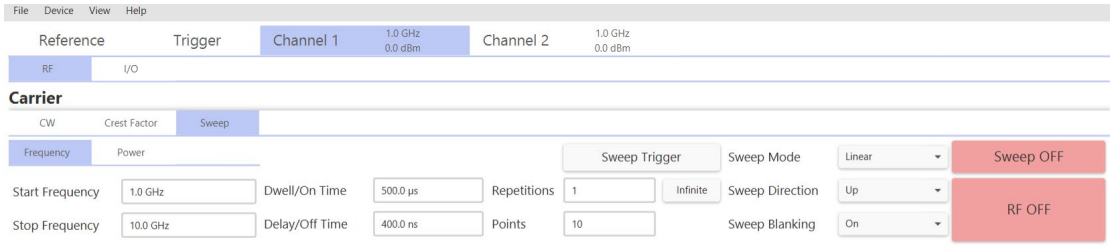
For parameters "Arbitrary Trigger", "Playback Rate", "Auto Playback Rate", "Update now" see "General" section.

"Upload to SD" (Option SD):
To upload IQ modulation signal data to a MicroSD card (secure digital memory card) in the proprietary AnaPico .qid format.

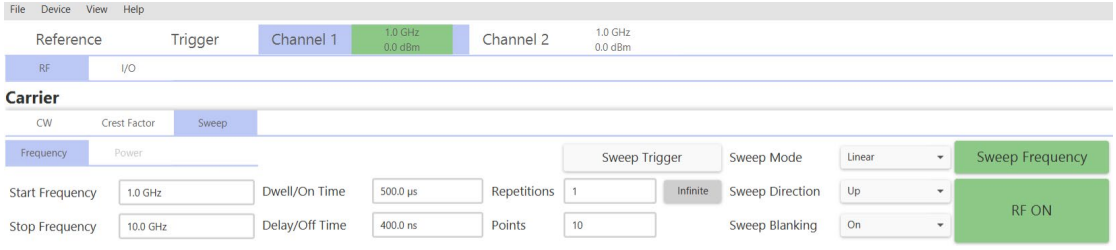
For details, please refer to:
AN6004: APVSG Permanent Data Storage SD
AN6001: APVSG – AnaPico IQ File Format
https://www.anapico.com/downloads/application-notes-and-videos/

Sweep

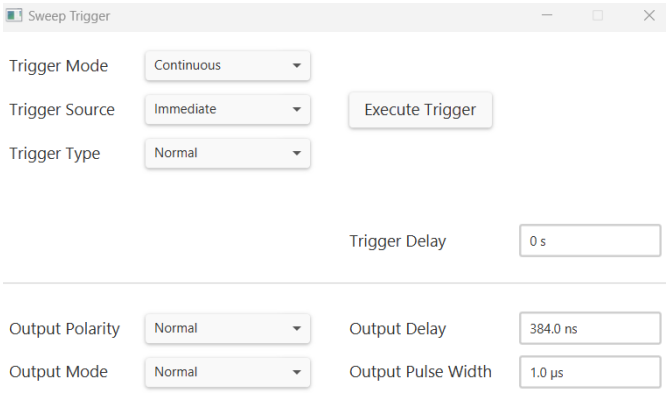
Set "Start Frequency" and "Stop Frequency" to define the sweep range. "Sweep Mode" is always "Linear". Sweep direction may be chosen "Up" or "Down". "Sweep Blanking" – if turned on - suppresses potential artifacts occurring between the end of a sweep step and the beginning of the new sweep step.
"Dwell/On Time" and "Dwell/Off Time" define the time the APVSG stays at a certain frequency point and is suppressed before moving to the next frequency point, respectively.



Set the number of repetitions (here "Infinite") and push the "Sweep ON/OFF" and "RF ON/OFF" buttons to activate the sweep:



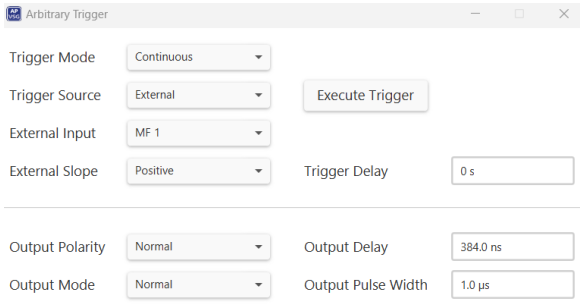
“Sweep Trigger”:

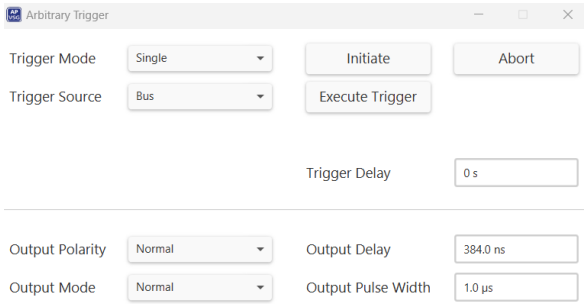


General

Some functions that are available for various modulations are listed here.

“Arbitrary Trigger”:
A pulse train or other modulation may be started as soon as a trigger event happens. The internal trigger may act immediately (“Immediate”) or via “Bus” (SCPI command). An external trigger can be chosen from one of the available trigger input connectors (“MF1”, “MF2”), i.e. as soon as the trigger slope (“Positive” or “Negative”, “Single” or “Continuous” to be defined) of the defined external trigger source appears at the selected connector.
The trigger may also be executed manually by pushing the “Execute Trigger” button. A “Trigger Delay” can be defined.
The trigger signal can be selected to appear at the “MF1 OUT” or “MF2 OUT” connector, as described in section *“I/O” tab*. The arbitrary trigger output signal’s polarity, width, and additional delay may be set with the “Output Polarity”, “Output Pulse Width” and “Output Delay” buttons, respectively.





“Playback Rate”:
Each modulation signal has its own sampling rate that is either set automatically or given in the QI Metafile. If no information is given, a default sampling rate of 500MHz is assumed. The playback rate is set according to the sampling rate and may be changed (changing the modulation signal and bandwidth accordingly).

“Auto Playback Rate”:
Sets the sampling and playback rate automatically when generating a modulation.

“Update now”:
To be pushed to update the playback rate after a change.

“Export to File”:
IQ modulation signal data may be exported to a file in AnaPico’s proprietary .qid format.

For details on the .qid format please refer to:
AN6001: APVSG – AnaPico IQ File Format
https://www.anapico.com/downloads/application-notes-and-videos/

Signal Levels and Timing

For details on signal levels and timing please refer to the APVSG datasheet:
https://www.anapico.com/products/rf-signal-generators/single-output-vector-signal-generators/apvsg-vector-signal-generators-up-to-40-ghz/

Logging

Tick ”Activate Logging” in the “Help” tab and choose a filename to log APVSG entries.

References

Datasheet, programmer's manual

Datasheet APVSG(-X) Specification V1.30 Single- and Multi-Channel Ultra-Agile Vector Signal Generators Models up to 4, 6, 12, 20 and 40 GHz

https://www.anapico.com/category/rf-signal-generators/single-output-vector-signal-generators/

https://www.anapico.com/products/rf-signal-generators/multi-channel-analog-and-digital-signal-generator/apvsg04-x-multi-channel-vector-signal-generator/

Programmer's Manual | Signal Generators & Frequency Synthesizers

https://www.anapico.com/downloads/manuals/

Applications notes

AN6001: AnaPico IQ File Format

AN6002: Fast Control Port

AN6003: Memory Segmentation

AN6004: Permanent Data Storage SD

AN6005: Additive White Gaussian Noise

AN6006: RF Output Modes

AN6007: Analog Input

AN6008: Pulse Descriptor Word

AN6009: Control Descriptor Word

https://www.anapico.com/downloads/application-notes-and-videos/

Videos

Channel to channel phase settling accuracy and stability of AnaPico APVSG multi-channel VSGs

Time-synchronized waveform playback of pulsed chirp signals on AnaPico APVSG multi-channel VSGs

https://www.anapico.com/downloads/application-notes-and-videos/

Maintenance and Warranty Information

Adjustments and Calibration

To maintain optimum measurement performance, the instrument should be calibrated every 24 months. It is recommended that the instruments be returned to AnaPico or to an authorized calibration facility. For more information, please contact our Customer Service Department as indicated on www.anapico.com.

Repair

The signal generator contains no user-serviceable parts. Repair or calibration of the signal generator requires specialized test equipment and must be performed by AnaPico or its authorized repair specialists.

Warranty Information

All AnaPico instruments are warranted against defects in material and workmanship for a period of **two years** from the date of shipment. AnaPico will, at its option, repair or replace products that prove to be defective during the warranty period, provided they are returned to AnaPico and provided the preventative maintenance procedures are followed. Repairs necessitated by misuse of the product are not covered by this warranty. No other warranties are expressed or implied, including but not limited to implied warranties of merchantability and fitness for a particular purpose. AnaPico is not liable for consequential damages.

Equipment Returns

For instruments requiring service, either in or out of warranty, contact your local distributor or AnaPico Customer Service Department at the address given below for pricing and instructions before returning your instrument.

When you call, be sure to have the following information available:

- Model number.
- Serial number.
- Full description of the failure condition.

Note: Model and serial number can be found on the rear of the instrument, next to the power plug.

You will get a Return Merchandise Authorization (RMA) number from AnaPico, please put it on the outside of the package.

Instruments that are eligible for in-warranty repair will be returned prepaid to the customer. For all other situations the customer is responsible for all shipping charges. An evaluation fee may be charged for processing units that are found to have no functional or performance defects.

For out of warranty instruments, AnaPico will provide an estimate for the cost of repair. Customer approval of the charges will be required before repairs can be made. For units deemed to be beyond repair, or in situations where the customer declines to authorize repair, an evaluation charge may be assessed by AnaPico.

Document History

Version	Date	Author	Notes
1.0	23.03.2021	AH	Initial Version
1.1	30.10.2023	SH	Added new chapter “APVSG Operation”
1.2	09.04.2024	AH	Minor updates

AnaPico of Switzerland

Europa-Strasse 9
8152 Glattbrugg
Switzerland

Phone +41 44 440 00 50
Email sales@anapico.com

www.anapico.com
www.anapico.com/downloads/

NOTES