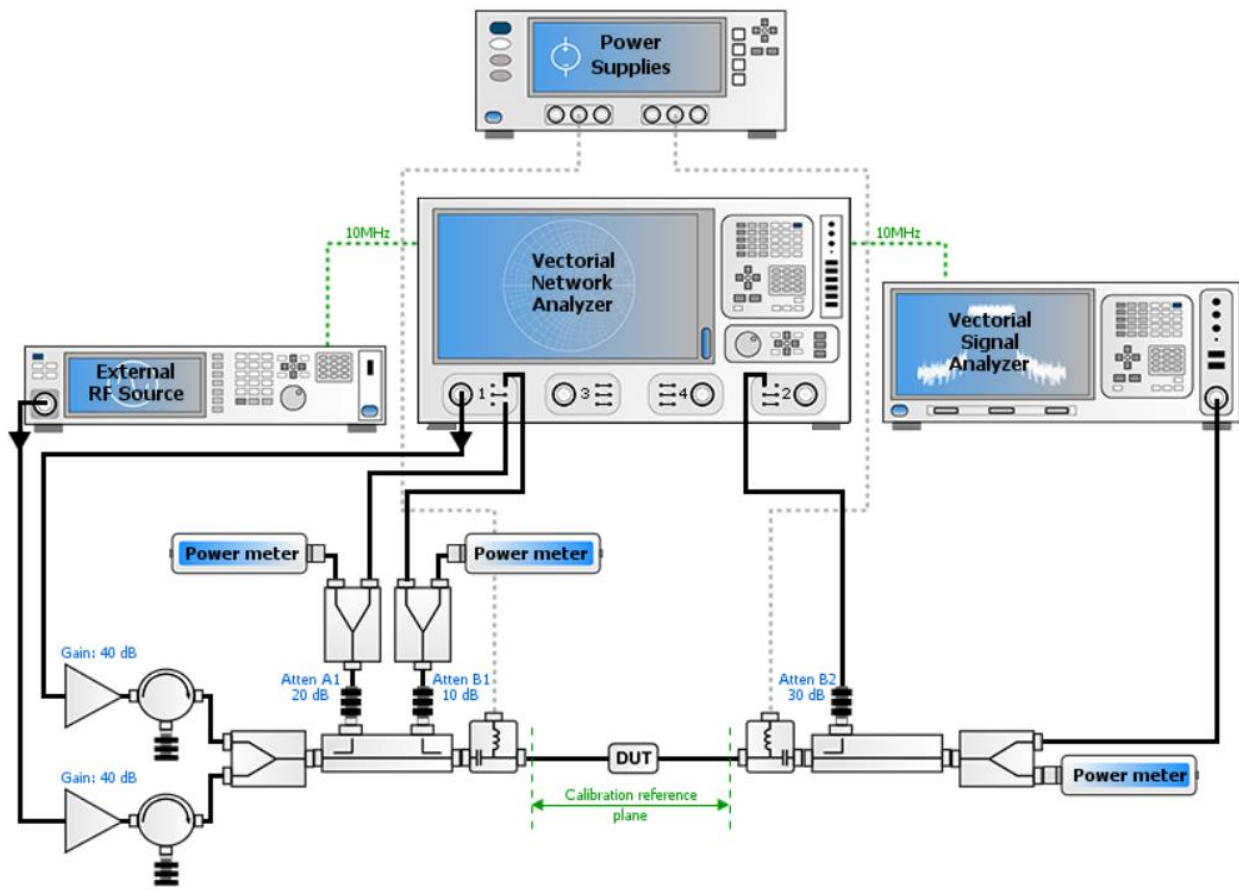


Standardize your Testing Procedures and Speed up your Design Cycle

IQSTAR_{1.5}

Turnkey Solution to Accelerate and Automatize Circuit Test Flow

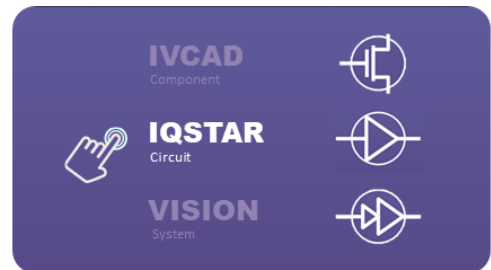


IQSTAR

Multiple measurements with a single test bench

Production testing of RF/microwave components and circuits is becoming a real challenge for many companies. Eager to get their latest developments to market, they must achieve performances highlighting their products' superiority over the competition.

IQSTAR enables multiple measurement configurations with your existing test benches with its highly flexible and versatile setups.



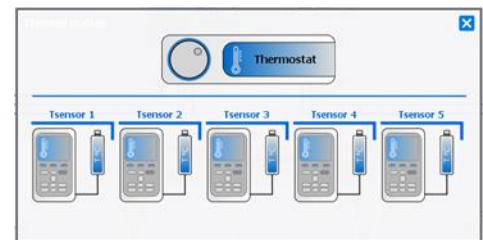
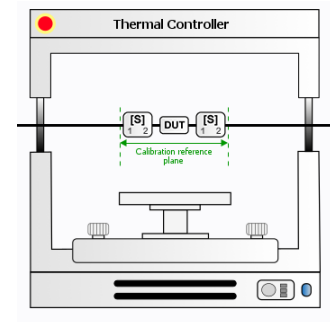
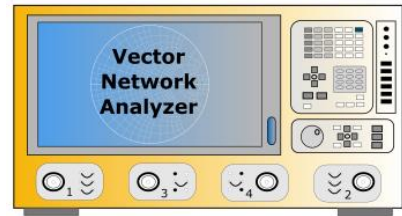
IQSTAR Features

- ✓ Turnkey software solution for 50Ω circuit characterization
- ✓ Fully customizable with a flexible setup schematic
- ✓ Complete characterization flow, including
 - Instrument control
 - Calibration process
 - Different measurement configurations
 - S-Parameters (Pulsed and CW)
 - 1-Tone (Pulsed and CW)
 - Constant VSWR testing
 - 2-tone signals
 - Fast Spurious Detection
 - Multi-DUT Measurements
 - Modulated signal
 - Noise Power Ration (NPR)
 - DPD evaluation
 - Flexible DC measurements and control (up to 32 DC stages)
 - Automation and test sequencing
 - Data export to standard formats (MDIF, CSV...)
 - Data analysis
 - Reporting
- ✓ Instrument agnostic solution
 - A large list of instrument drivers is available (more than 1000 references)
 - Compatible with most instrument vendors
 - A simple implementation of new drivers using a Driver Wizard.

- ✓ No programming skills required
- ✓ Compatible with coaxial, waveguide, fixtured, and on-wafer measurements
- ✓ Export data files in CSV or MDIF formats for commercial circuit simulators

Benefits of IQSTAR

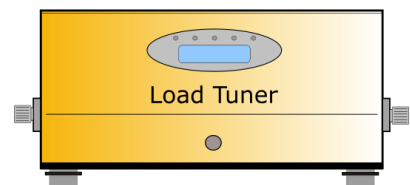
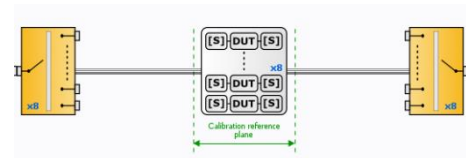
- Re-use of existing hardware in the lab
 - A cost-effective testing solution
 - Quicker development time and faster time to market
 - Less downtime and reduced maintenance costs
- Faster test times
 - Automatize your tests.
 - Combine multiple measurement types.
 - Single calibration, multiple measurements
 - Multi-DUT measurements using a Switch Matrix
 - From the calibration to the test report in One-touch button.
- High Accuracy
 - Proven calibration process
 - Vector and scalar calibration available
 - Embedded validation and verification procedures
- Flexible setups
 - Great adaptability to future test requirements
 - Instrument driver wizard for new hardware
 - Multi-brand instrument setups are supported.
 - Independent Thermal Control
 - Multi-Temperature Sensor monitoring
 - Configurable switch matrices
 - RF Stress capabilities during the characterization



The World most versatile and flexible bench control software

IQSTAR brings speed, accuracy, and ease-of-use to common RF measurements, in coaxial, fixtured and on-wafer environments. Measurements include:

- S-Parameters (CW and Pulsed)
- 1-Tone (CW and Pulsed)
 - Power & frequency sweeps
 - Gain Compression
 - Constant VSWR testing
 - PAE
 - Harmonics
 - Spurious detection
 - Spectrum traces
- 2-Tone
 - Intermodulation
 - Video Bandwidth
- Modulated signal and IQ Analysis
 - ACPR
 - EVM
 - CCDF
 - NPR
 - Dynamic AM-AM
 - Dynamic AM-PM
 - Spectrum
 - DPD analysis



Case Study 1

A new design division of a large component supplier got their test capabilities ready on day one with available test equipment in their lab.

Challenges

This customer offers 27 product lines with over 10,000 active models. Their products are widely used in commercial, industrial, and defense applications. This customer opened a new design center for Power Amplifiers. The new lab was equipped with newly acquired instruments and legacy instruments. The objective was to build a few benches with limited CAPEX. To test, debug, and validate their new designs, the team needed measurement software capable of controlling the benches and speeding up their time to market. The key challenges included:

- Capability to control instruments from different vendors, new and legacy ones.
- Multiple measurement types are needed.
- Significant retesting of devices
- Limited programming skills of their design team

Results

IQSTAR's ability to control multiple instruments from different vendors, including legacy ones and allow a single setup, multiple measurements provided:

- A cost-effective solution, reducing CAPEX and re-using existing hardware.
- A turnkey bench control software allowing testing, tuning, and validation of the design.
- Faster measurement with an automation procedure
- The design team was focused on the RF product design rather than on the programming of the testing procedures.
- Monitor multiple benches simultaneously, increasing throughput.
- Four benches were operating after an Online training of the test engineers.

Case Study 2

A large device manufacturer with labs on 3 continents had to increase its measurement capabilities by adding new instruments and functionalities to its in-house bench control software.

Challenges

With more than 40 measurement benches over more than 5 sites, the manufacturer developed an in-house application to perform the required measurements over the last 15 years. An RF manager and a software engineer supported the software.

With the increase in the number of benches and the number of functionalities, different sites were using different versions leading to the following:

- Results correlation issues between sites
- Incompatibility of data formats between teams
- Exceedingly long support lead time
- Difficulty in upgrading or changing instruments due to missing drivers.
- The throughput was reduced considerably due to outdated software.

Results

With the purchase of IQSTAR, the customer upgraded his hardware without investing in high-end instruments. The user-friendly interface was easy to learn, and minimum training was necessary to keep the teams running. Multiple benches were updated, and the throughput was increased considerably with minimum downtime.

A support contract was signed with AMCAD to ensure that all the teams receive the latest version enhancements and potential fixes. The customer can receive around-the-clock support from North America, Europe, and Asia application engineers.

IQSTAR Modules

IQSTAR can be configured with different plugins depending on the applications and required measurements.

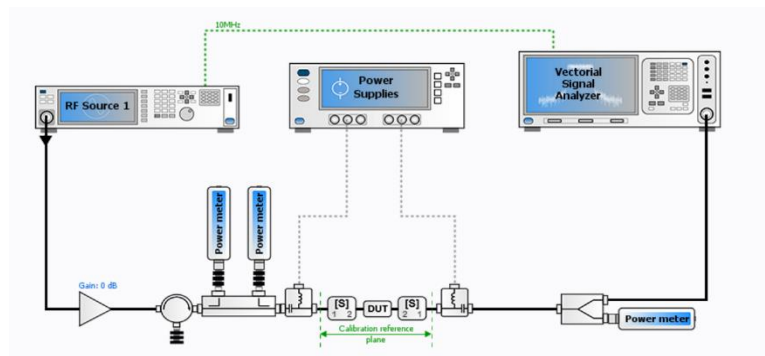
IQS100B-10: Scalar Bench Control, 1-Tone Measurements

This module represents the basic plugin of IQSTAR and the prerequisite for other measurement modules. It includes all the configuration capabilities needed to initialize a setup and ensure proper measurement conditions of the DUT.

Schematic Editor

IQSTAR is turnkey software with a versatile and customizable schematic editor for building a test bench with available laboratory instruments.

Multiple test configurations are possible depending on the measurements required. IQS100B-10 supports a scalar setup with various configurations. In addition, devices and circuits can be coaxial, fixtured or on-wafer. Each instrument selected in the setup can be controlled using specific drivers allowing full automation of the measurements. With 15 years of device characterization

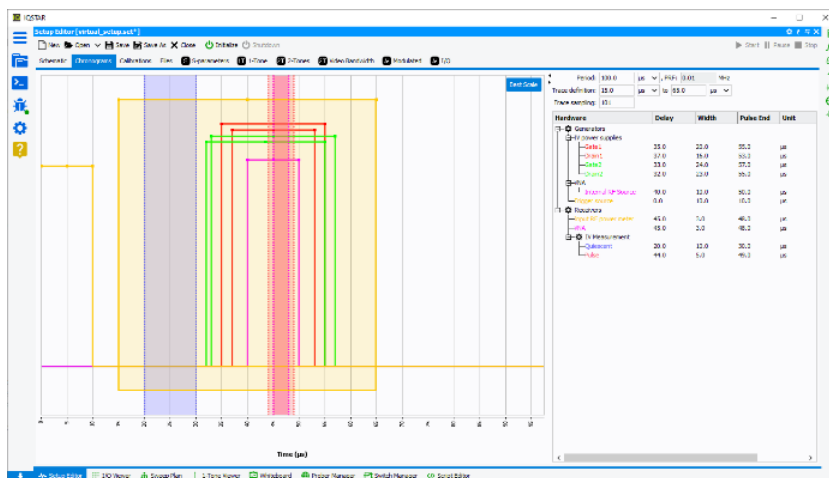


software development, AMCAD masters instrument controls and provides drivers that optimize the measurement speed without sacrificing accuracy. Each instrument can be set with different options and in different modes.

Chronogram

High-power devices require measurements in pulsed mode to mitigate thermal effects. However, pulsed options often add complexity to settings. Therefore, IQSTAR provides a simple user interface to fully control the pulse generators, the receivers, and the trigger signals. In addition, different instruments in the setup can be set with appropriate timings for the pulse setting and pulse measurements.

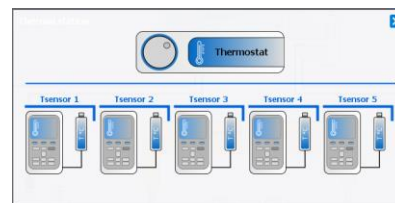
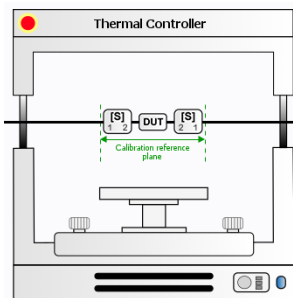
To simplify the task for the end-user, IQSTAR embeds a Chronogram that describes, on a time axis, the pulse mode settings and a configuration panel where all the timing specifications can be set at once. All instruments in pulsed mode are automatically showing up in the appropriate section of the chronogram: generators (RF signal Generators, DC supplies) and receivers (VNA, Multimeters, Power-Meters)



The measurement windows can be configured for each receiver, and once the chronogram is closed, all the settings are configured automatically in the appropriate instruments.

Thermal Control

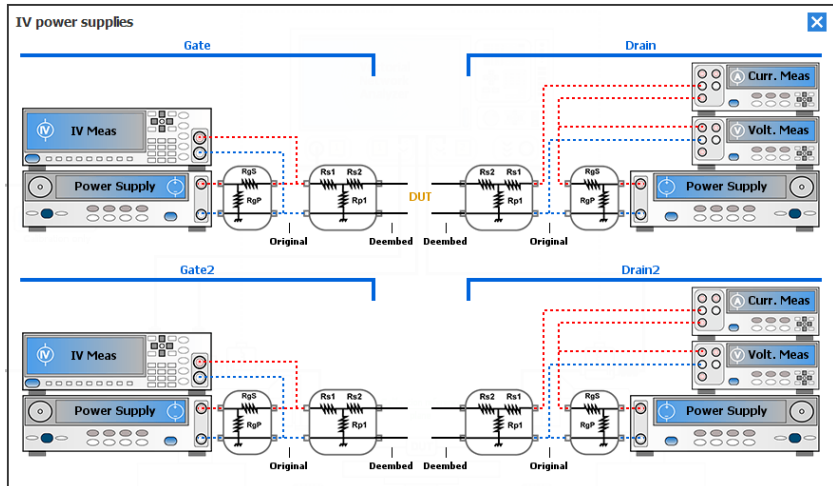
Characterizing Power Amplifiers may require measurements at variable ambient temperatures to specify the operating condition limits. Therefore, test engineers use thermal chambers or heated plates to control the temperature and use sensors to monitor it. IQSTAR embeds dedicated temperature control and monitoring capabilities to ensure a proper qualification of the Power amplifier under test



DC supplies

Power amplifier measurements can be particularly challenging when dealing with multistage circuits. IQSTAR allows the control of up to **32** Power supplies with associated IV measurements

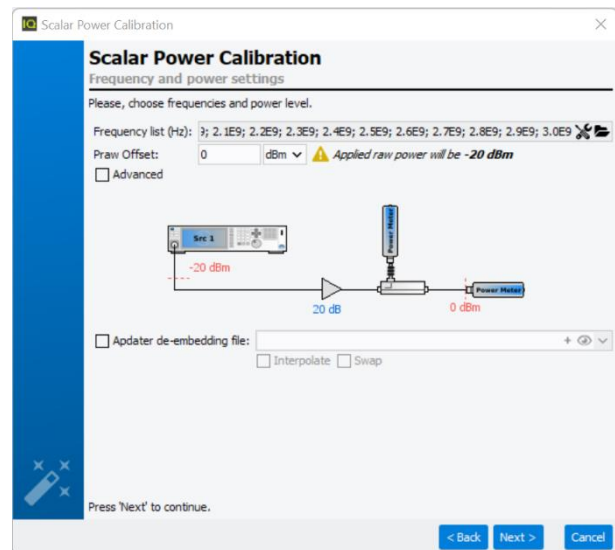
either from the power supplies or using DC multimeters and oscilloscopes. The flexibility of the DC power supply settings allows custom labeling of each instrument and its associated IV parameters to simplify the biasing procedure of multistage circuits. A resistive network can also be configured to de-embed the measurements and the voltage settings to the DUT reference plane in case of current or voltage drop through serial or parallel resistances. Customized formulas can be defined to calculate power consumption.



Calibration

IQSTAR provides corrected data at the DUT reference plane. The correction terms are calculated during the calibration process using a step-by-step wizard. Depending on the setup configuration, different calibrations can be performed.

For scalar setups, the calibration procedure is based on power measurements using power meters and signal generators. Calibrating the setup using two (2) or three (3) power meters to include the reflected power is possible. A three power-meters setup permits DUT characterization with additional parameters like Operating Gain (Gp), delivered input power and power-added efficiency (PAE).

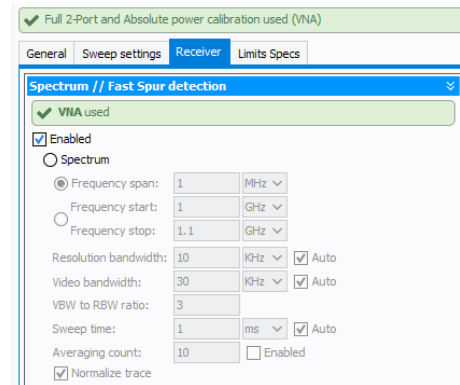


Spectrum Mode

The Spectrum Mode can be enabled if the setup includes a Spectrum Analyzer when using a scalar setup or a PNA-X with option S93090 when using a vectorial setup.

The Spectrum mode consists of measuring the spectrum traces for each power step. It can be useful if the need is to see the evolution of the DUT output signal spectrum in the function of the input power.

Multiple options are available to set the spectrum analyzer or the VNA and optimize the measurement speed and accuracy.



1-Tone measurements using a coaxial scalar setup

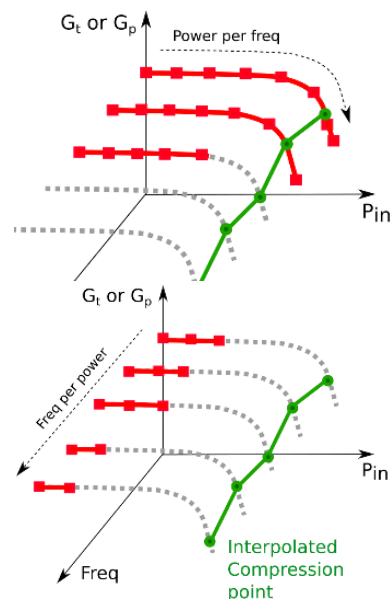
IQS100B-10 enables a scalar characterization of the DUT using a signal generator and power meters.

Different **sweep settings** are available to the end-user allowing appropriate characterization of different power amplifier technologies. Following the calibration parameters of frequency bandwidth and power range, it is possible to execute sweeps in different acquisition modes.

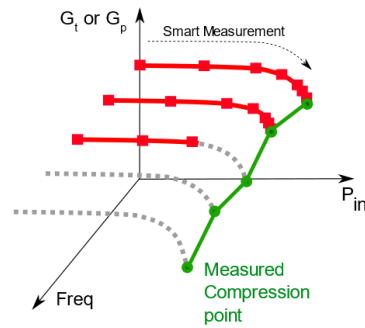
The **acquisition mode** helps the user characterize the DUT in the right conditions to minimize the effects of technology-related phenomena (Thermal, Traps...). IQSTAR embeds four (4) different acquisition modes:

Power per Frequency: for each frequency acquisition, a ramp of RF power is applied to the DUT up to a used defined stop criteria, such as gain compression, current consumption, dissipated power ...

Frequency Per Power: for each power, the acquisition is done for all frequencies to speed up the measurement sweep. Post processing enables to plot the data per frequency.



Smart Measurements: an advanced power per frequency mode. The power step used during the power sweep is adaptative to reach in a timely manner a certain target set by the user (compression level, output power...).



Measurement parameters

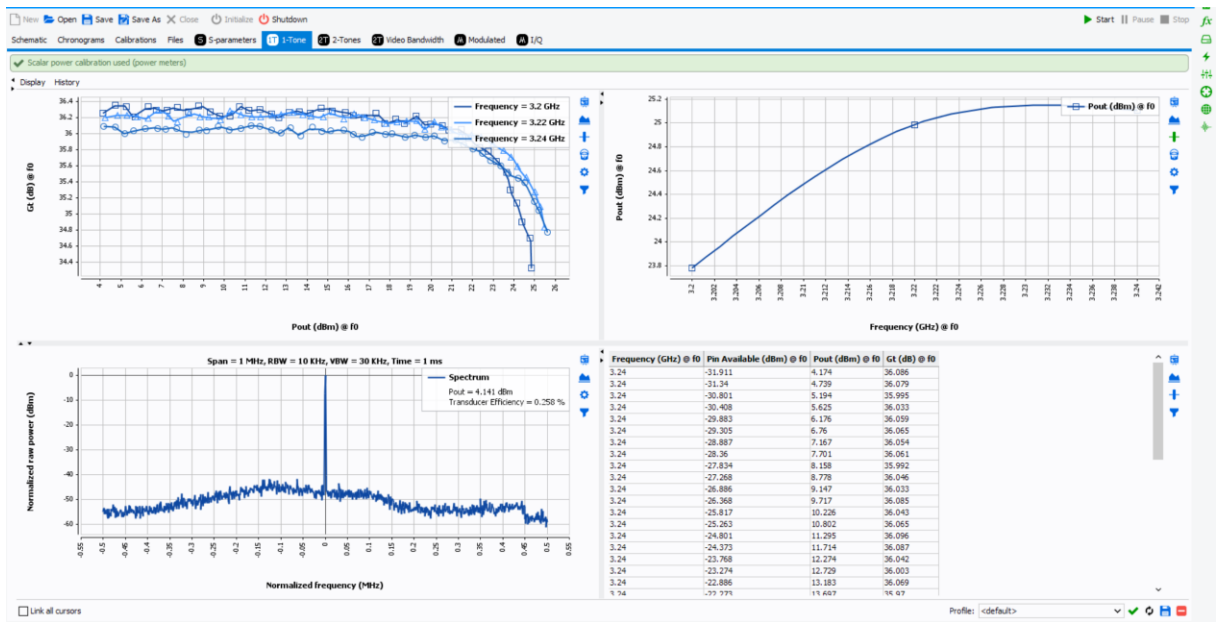
Operating and **transducer gain compression** modes are available to characterize a power amplifier, including compression from linear and compression from maximum gain.

GaN-based power amplifiers need more cautious characterization as the power sweeps always need to start from the same trapping level. IQSTAR embeds a **quiescent current stabilization** option to monitor the current settling in the quiescent state over time. It ensures it reaches the right level before triggering a new power sweep.

Measurement speed is an important factor when characterizing Power Amplifiers. Most of the measurement time is spent on instrument triggering and data transfer to the computer. Therefore, IQSTAR embeds a **DC Measurement selection** capability that lets the user choose the critical DC parameters that need to be measured continuously from the instruments (ex: Output Currents) and the less critical parameters that do not vary during the measurements for which he can keep the initial set value.

Depending on the setup configuration, an extensive list of predefined parameters is available and available during the live visualization. In addition, user-defined parameters can also be added to the predefined list.

The user can consult the results using the visualization tool in real-time during the measurements. Besides the history measurements available for display, it is also possible to set some specifications limits the circuit under test needs to reach. A colour-coded display allows a fast evaluation of the DUT and indicates if it passes or fails.



DUT Protection

Protecting the test bench and the measured circuits are top priorities for RF power characterization. Therefore, the software can set multiple stop conditions: Gain compression, Maximum output power, efficiency compression, Input Gamma and more.

IQSTAR embeds a Robust optimization algorithm of the input power level at the DUT reference plans to allow complete control independently of the RF source, driver amplifier drift, or bias voltage drop.



Tips from our experts:

When the DUT presents hysteresis due to trapping effect or thermal effects, it is recommended to sweep frequency per power rather than power per frequency, or to use the Quiescent Current stabilization options to reduce the effects from previous measurements. Reverse power sweeps from high power to low power level can also be an alternative.

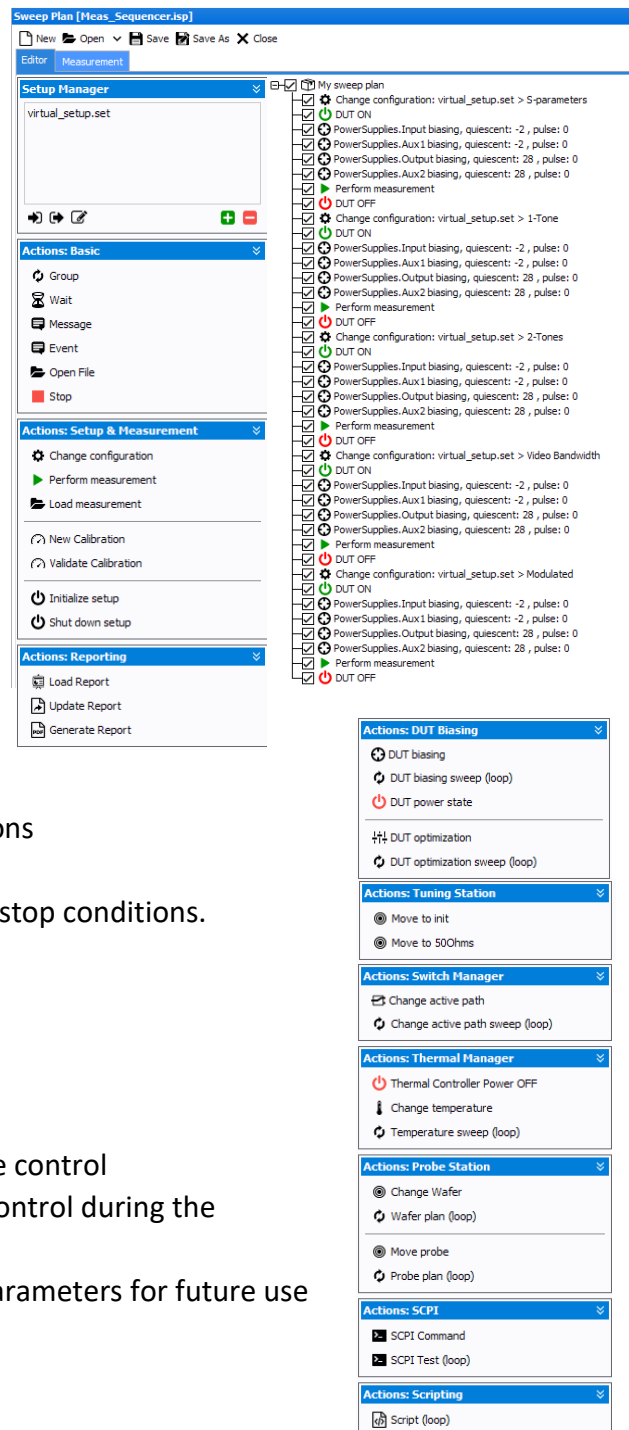
Sweep Plan

Automated measurement is an easy task with IQSTAR. Sequencing measurements with minimum human intervention is key to optimal testing efficiency. One person can run multiple benches simultaneously to speed up testing capabilities. Through **drag-and-drop actions**, it is possible to define several tasks to be performed and run the complete measurement scenario automatically.

The “Sweep Plan” takes advantage of all GUI tools already available in the bench definition or measurement interface. This way, defining a complete measurement task is possible without programming skills and any loss of flexibility.

IQSTAR automation capabilities using the “Sweep Plan” allow:

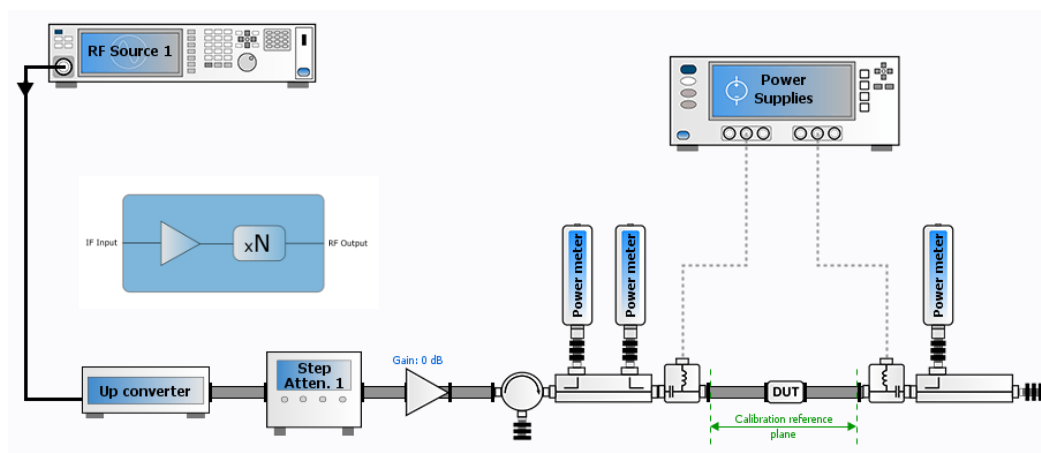
- Single-setup and multi-setup configurations
- Calibration and validation of the bench
- Measurement sequencing with loop and stop conditions.
- Nested measurements sweep
- DUT bias control & optimization
- Impedance Tuner Control
- Switch matrix control
- Probe station control
- Chuck and thermal chamber temperature control
- SCPI commands for specific instrument control during the automation
- Possibility to save sweep plans with all parameters for future use



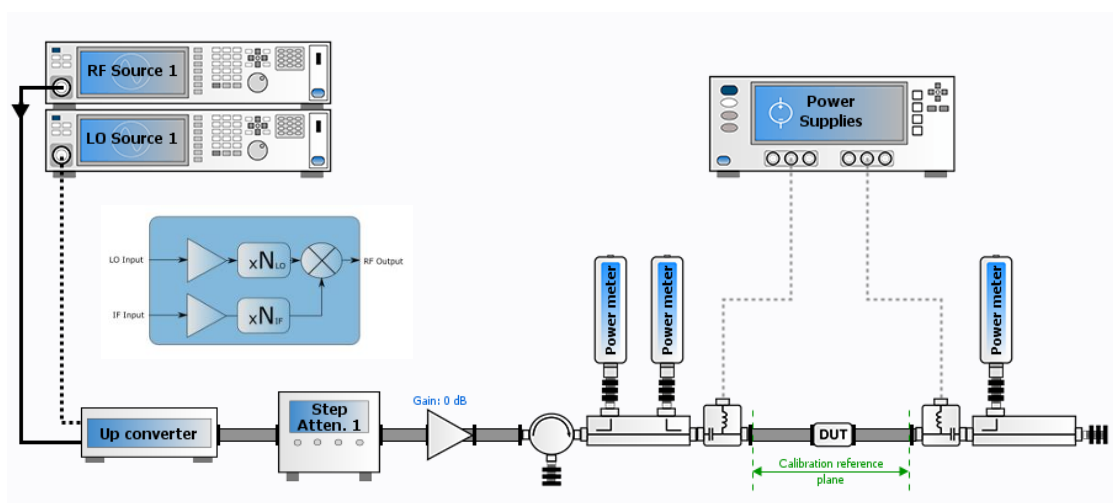
IQS200B-10: Waveguide Scalar Bench Control, 1-Tone Measurements

Similarly to the module IQS100B-10, described above, the IQS200B-10 module represents the basic plugin of IQSTAR and the prerequisite for other measurement modules. It includes all the configuration capabilities needed to initialize a setup and ensure proper measurement conditions of the DUT. IQS200B-10 enables a scalar waveguide characterization of the DUT using a signal generator, power meters, frequency up and down converters and waveguide step attenuators.

Different **frequency conversion setups** are available, allowing end-user to control of up & down converter. Up & Down converters can be configured in Mixer mode or Multiplier/Divider mode, offering flexibility regarding the LO source configuration.



Scalar waveguide setup for 1-ToneMeasurements (IQS200B-10) in Multiplier and/or Divider mode



Scalar waveguide setup for 1-ToneMeasurements (IQS200B-10) in Mixer mode with external LO source

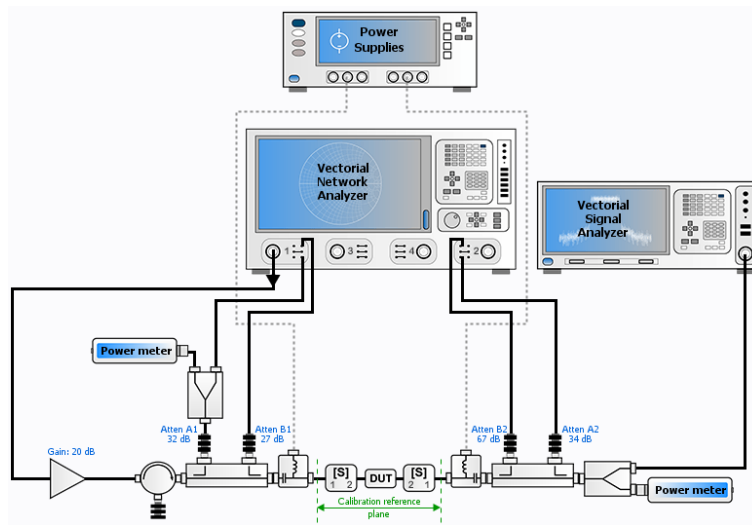
In a waveguide setup, the power level is controlled by an external waveguide step attenuator to avoid nonlinearities provided by the upconverter. As done in IQS100B-10, it's possible to use two

or three power sensors to measure Pin, Pout and Prefl and extract additional parameters such as IRL, Pin delivered, Gp ...

IQS100B-11: Vector Bench Add-On, S-Parameters Measurements

The Vector Bench module IQS100B-11 includes all the capabilities described in the IQS100B-10 module, adding vector measurements using a Vector Network Analyzer (VNA). With such a setup, the amplitude and phase information can be captured using the receivers of the VNA. When both measurement possibilities are enabled in the setup (Scalar and Vectorial), choosing which instruments to use for the characterization is possible by selecting the corresponding calibration.

The module IQS100B-10 is a prerequisite to the module IQS100B-11.



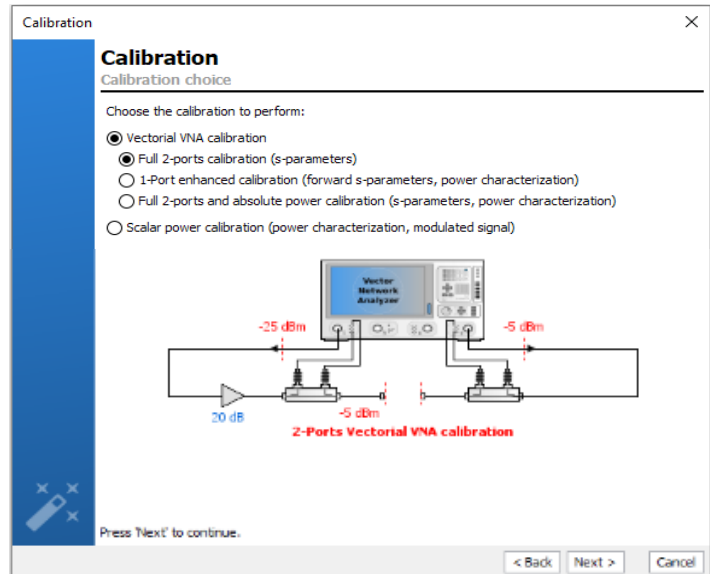
Vector Setup for 1-Tone and S-Par Measurements (IQS100B-10 and B-11)

Calibration

IQSTAR provides corrected data at the DUT reference plane. The correction terms are calculated during the calibration process using a step-by-step wizard. Depending on the setup configuration, different calibrations can be performed.

The Vector Network Analyzer (VNA) calibration is necessary for vector setups to extract the error terms.

Furthermore, the vector and power calibration can differ depending on the VNA configuration, which can be set to use three (3) or four (4) receivers. Therefore, to minimize the source of errors, IQSTAR provides a state-of-the-art calibration wizard that relies on the schematic setup to identify the type of



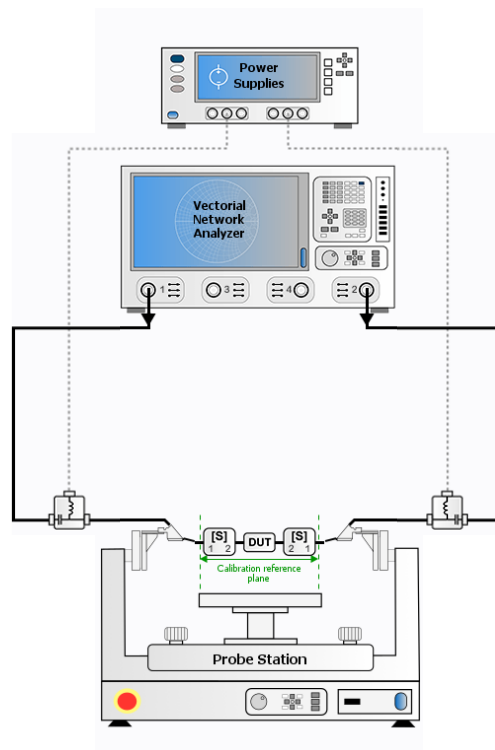
calibration possible to perform and guides the end-user through all the steps, including the validation process verifying and assessing the expected accuracy.

S-Parameters

Perform a frequency sweep on the VNA and display the corrected S-parameters at the DUT reference plane using the live visualization tool.

Device tuning becomes easier with trace history as up to fifty (50) iterations and measurements can be displayed on the same graph. Import S2P simulation files and compare them with measurements in different display formats.

With Probe station control, measure multiple devices with one click. IQSTAR supports major automatic probe station vendors and remotely controls the wafer movement. Adding the bias conditions to the sweep plan, one can generate a large amount of data with minimum interaction with the instruments.



1-Tone measurements using a vector setup

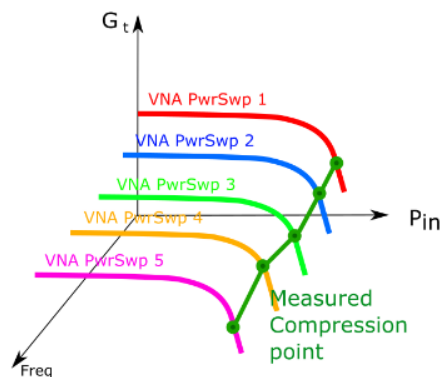
1-Tone measurements with IQS100B-11 module include all the capabilities of IQS100B-10 regarding the sweep settings, the acquisition modes, and stop conditions for DUT protection and visualization, with some additional features.

Acquisition Modes

Additional to the acquisition modes available in a scalar setup, the Fast CW mode is enabled with a vector setup

Fast CW: a sweeping method used to improve the measurement speed. Using the Power per Frequency mode, the power ramp is done in the VNA, and the measured values (RF and DC data) are kept in a buffer inside each instrument until the end of the measurements which results in a great speed improvement.

This measurement methodology is crucial for the test of high-power amplifiers. Indeed, because of the self-heating when the RF signal is turned on, RF sweeps have to be run in a few milliseconds to keep the device under tests is safe operating conditions.



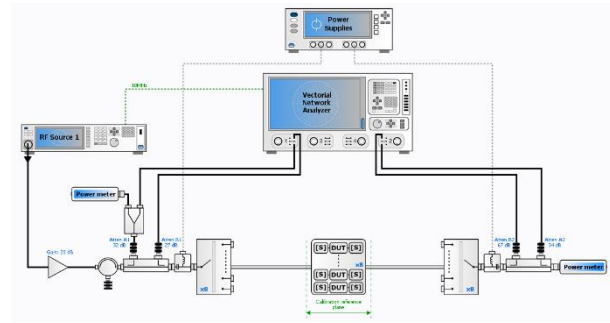
Measurement parameters

In addition to the measurement parameters obtained in a Scalar mode, the vector mode enables phase measurements to extract the input Gamma of the DUT and AM-PM conversion.

IQS100B-12: Multi-DUT Measurements

IQS100B-12 is an Add-on to the Module IQS100B-10.

IQSTAR enables test engineers to characterize multiple 2-port devices sequentially in the same setup to increase the throughput or to measure different configurations of a multipath system. The setup editor is updated with a new instrument type: I/O Switch. The switch is controlled using a VISA protocol and is configurable depending on the number of paths needed. (in IQSTAR 1.5, the number of paths is limited to 8). Each path can be identified and associated with a channel of the switch matrix.



Each patch is calibrated individually to extract the measurement at the DUT reference plane. S-parameters of the test fixture can also be added to each path.

Multi-DUT Measurement module can be added to scalar and vectorial setups, and all the measurement types are supported (1-Tone, 2-Tone, modulated signal, NPR, and IQ data).



Tips from our experts:

Use our Rackmount Switch matrix system to measure several DUTs in parallel with IQSTAR !

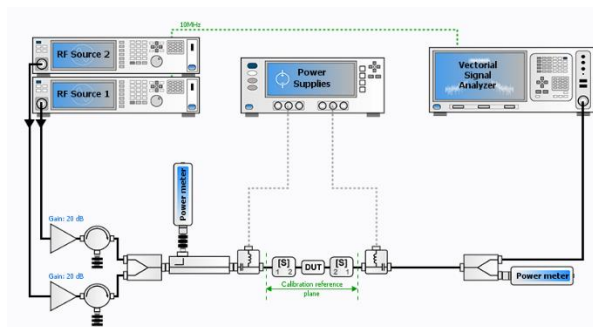
<https://www.amcad-engineering.com/rackmount-rf-switch-systems/>

IQS100B-20: IMD Control, 2-Tone Measurements

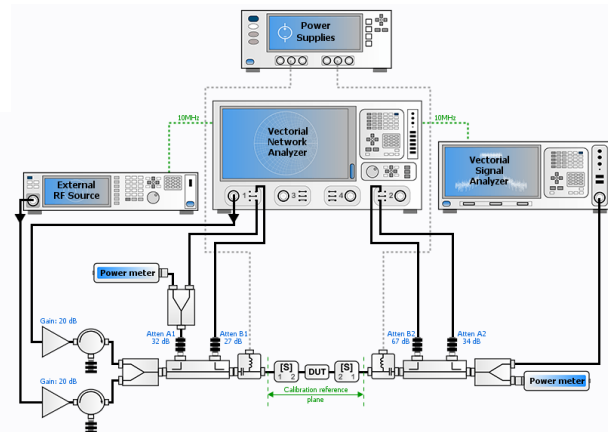
IQS100B-20 is an Add-On to the module IQS100B-10.

IQSTAR allows multiple configurations to measure intermodulation distortion (IMD) with a 2-Tone signal.

Using two combined analog RF sources or one vector signal generator, a spectrum analyzer, or a vector network analyzer, IQSTAR guides you through a simplified calibration procedure and provides high measurement accuracy.



2-Tone Scalar Setup (IQS100B-10 and B-20)

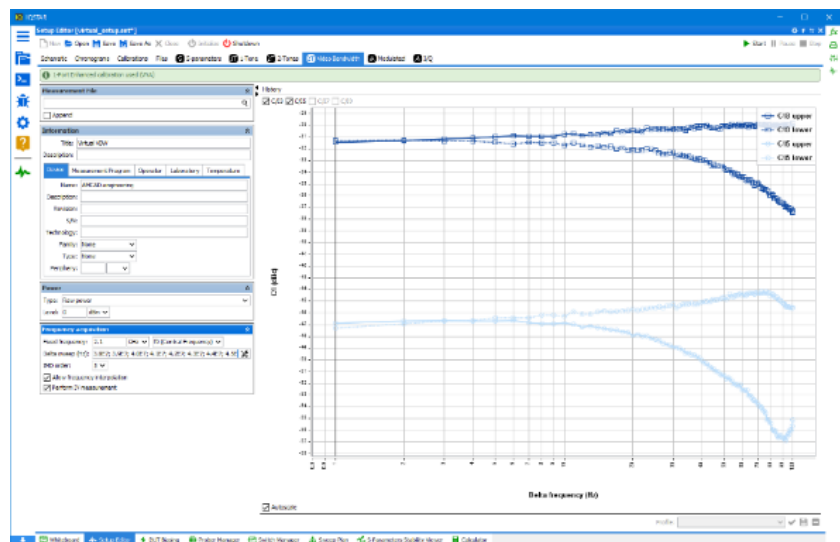


2-Tone Vector Setup (IQS100B-10, B-11 and B-20)

When a scalar setup is used, the software can control the spectrum analyzer to measure the power of each spectrum component at the output of the DUT and extract intermodulation distortion up to the ninth order and intercept points. This configuration requires the IQS100B-10 module.

Using a VNA instead, IQSTAR takes advantage of the dynamic range of the vector receivers and measures the a-and b-waves to extract the intermodulation product signals and the two carrier tones to calculate the IMD up to the ninth level.

The “Frequency Offset” option is required in the VNA for these measurements. As for the generators, IQSTAR handles



sources from the VNA, independent sources, or a combination of both and balances the two tones levels for an accurate IMD characterization.

This configuration requires the IQS100B-10 and IQS100B-11 modules.

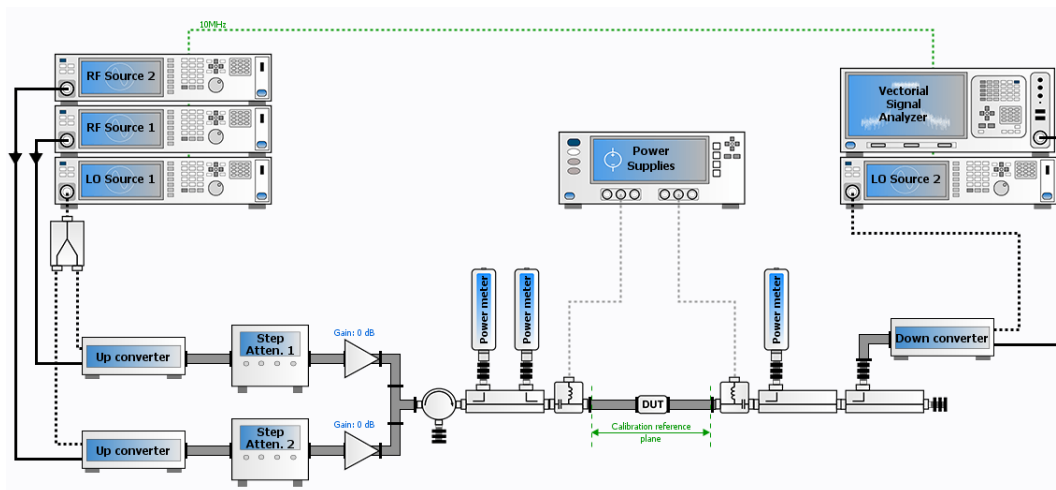
A 3D nested sweep, including the carrier frequency, the power, and the spacing of the tones, can be performed to extract a complete IMD characterization of the Power Amplifier in one step.

VBW measurements represent a challenging measurement task. However, IQSTAR handles this measurement efficiently, setting the amplitude of the tones according to the target third-order intermodulation distortion (IMD3) value set by the user. Then, the software sweeps the spacing between the tones and adjusts the balance between them before recording the intermodulation—up to the ninth order. Taking advantage of the speed of VNA sweeps, this measurement takes just a few minutes.

IQS200B-20: IMD Control, 2-Tones Measurements for Waveguide setup

This module is an Add-On to the IQS200B-10. As described above for IQS100B-20 modules, IQS200B-20 allows multiple configurations to measure intermodulation distortion (IMD) with a 2-Tone signal.

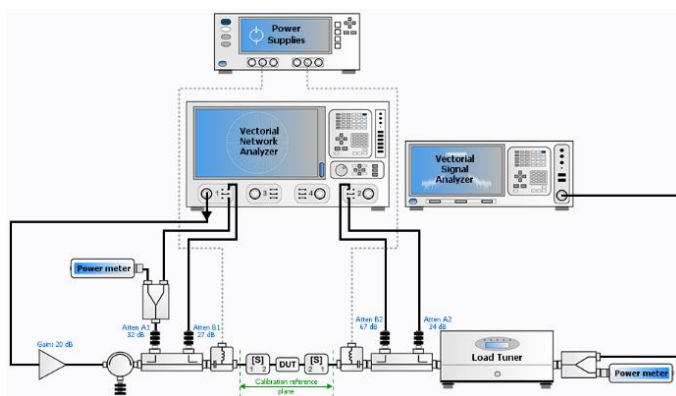
This module uses analog RF sources combined after an upconverter through waveguide “magic tee” and a downconverter to analyze IMD with a Spectrum Analyzer. In this case, two upconverters and two step-attenuators control f1 and f2 independently.



Scalar waveguide setup for 2-Tones Measurements (IQS200B-20) using two independent LO sources for Up & Down converters.

IQS100B-22: Constant VSWR Control

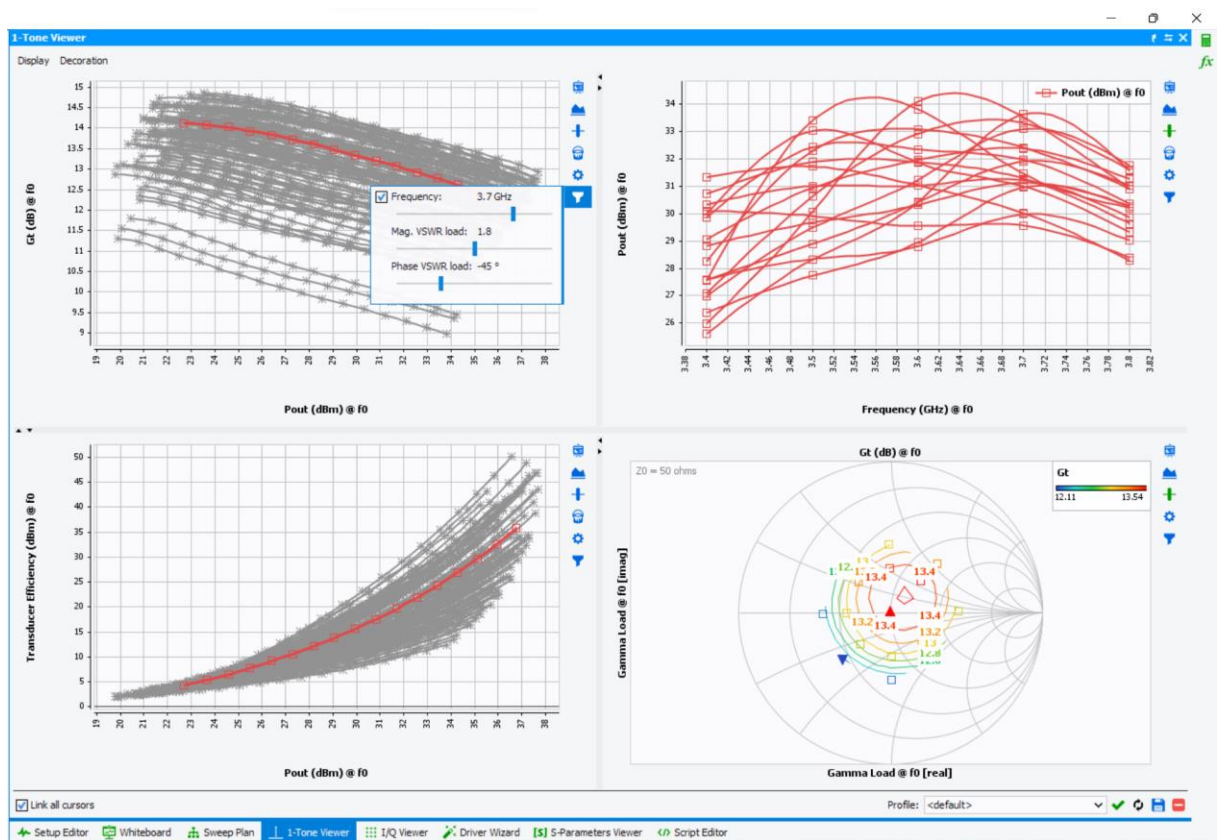
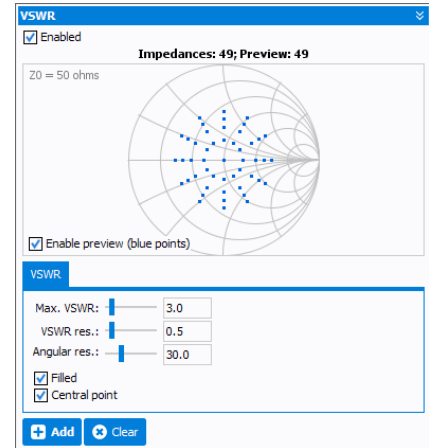
The IQS100B-22 module is an add-on to the IQS100B-11 to add an electro-mechanical impedance tuner to the setup and perform measurements under VSWR variation. This option is only supported for a Vector Bench setup. By default, a basic two-dimensional (2D) sweep is available in IQSTAR, where the user can enter a list of **frequencies** and **power levels**. Since release 1.3, the **VSWR** sweep has been added with the module IQS100B-22, allowing a three-dimensional (3D) nested loop sweep.



Controlling a load impedance tuner, the user can generate an impedance pattern in the shape of constant VSWR circles with different magnitudes and phase steps.

This functionality ensures that the power amplifier under test delivers the expected performances for different powers, frequencies, and load impedances.

IQSTAR enables a smooth combination of these different test conditions to launch measurements on the fly through a seamless control of Maury Microwave tuners.



IQS100B-25: Fast Spurious Detection or IQS200B-25 Fast Spurious Detection for Waveguide setup

This module is an Add-on to the IQS100B-10 or IQS200B-10, enabling spurious analysis. This module is compatible with Scalar and vector Coaxial and scalar Waveguide setups. If a Coaxial Vector bench is used, the IQS100B-11 module is a prerequisite.

IQSTAR enables Spurious detection using a spectrum analyzer, and starting IQSTAR 1.5 release, Fast Spurious detection is also available using option S93090 of the PNA-X. This module allows a fast search and analysis of spurious signals, using the spectrum analyzer to recover the trace for each swept parameter. A processing algorithm is then employed to dissociate spurious frequencies from signal frequencies. Detection-per-frequency segment is possible when different criteria based are needed for each band.

Spurious detection is an important step in the Design Validation Testing (DVT) and the Production validation testing (PVT) of RF and Microwave power amplifiers. Spurious emissions decrease the system performance and cause interference in adjacent frequency bands. Some industries like aerospace and defense must detect very low-level spurs.

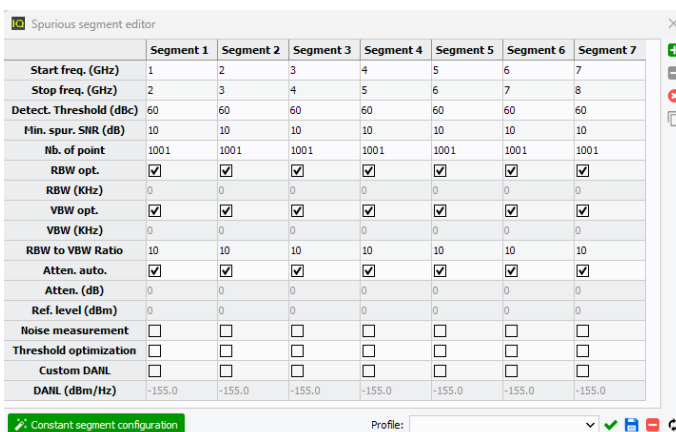
A classical technique consists of reducing the resolution bandwidth to the narrowest to lower the noise floor of the equipment. However, the implementation simplicity of this technique comes at the cost of a very long measurement time, especially since the spurious location cannot be predicted in advance, which imposes a full scan of a large frequency bandwidth at a very low RBW level.

Even with new fast spectrum analyzers, spurious detection can take hours or even days when combined with nested loops of frequencies, biases, power levels, VSWR circles...

IQSTAR uses fast spectrum analyzers using FFT filters to search spurs and reduce testing time. The spurious research algorithm embedded in IQSTAR automates and speeds up the process.

A simple GUI is used to identify the frequency segments for spurious detection with different noise levels, spurious threshold levels, number of points and more settings.

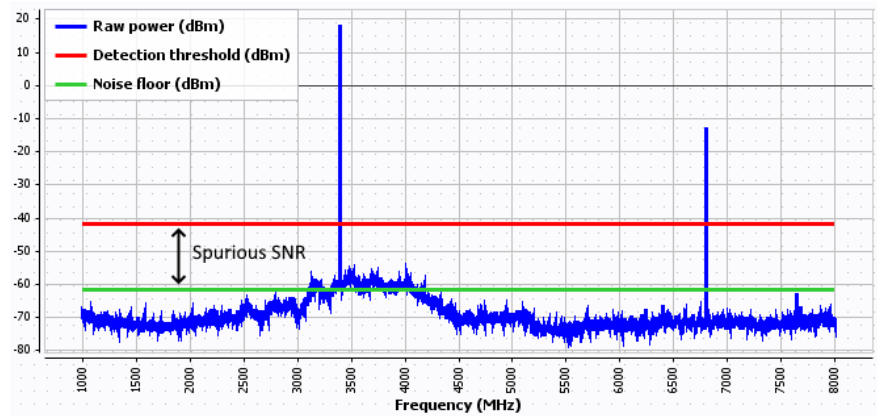
The software optimizes the RBW level automatically to find the best trade-off between the detection threshold and the measurement speed.



	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
Start freq. (GHz)	1	2	3	4	5	6	7
Stop freq. (GHz)	2	3	4	5	6	7	8
Detect. Threshold (dBc)	60	60	60	60	60	60	60
Min. spur. SNR (dB)	10	10	10	10	10	10	10
Nb. of point	1001	1001	1001	1001	1001	1001	1001
RBW opt.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
RBW (KHz)	0	0	0	0	0	0	0
VBW opt.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
VBW (KHz)	0	0	0	0	0	0	0
RBW to VBW Ratio	10	10	10	10	10	10	10
Atten. auto.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Atten. (dB)	0	0	0	0	0	0	0
Ref. level (dBm)	0	0	0	0	0	0	0
Noise measurement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Threshold optimization	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Custom DANL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DANL (dBm/Hz)	-155.0	-155.0	-155.0	-155.0	-155.0	-155.0	-155.0

Constant segment configuration Profile: [dropdown] [OK] [Cancel] [Help]

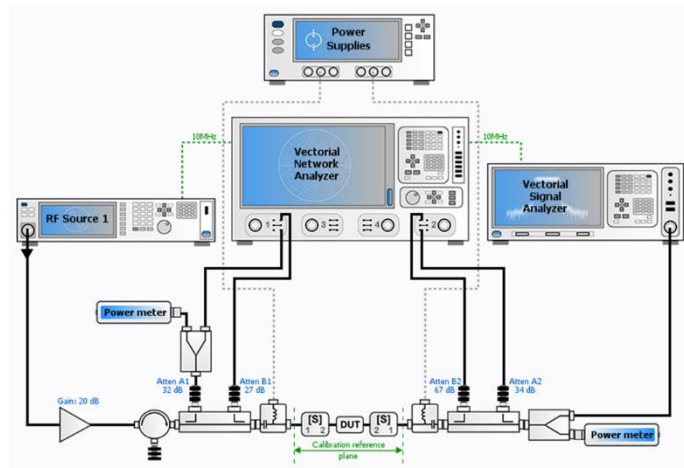
In other words, the RBW is set to the lowest level to detect real spurs at required frequencies and higher in the ranges where no potential spurs have been detected. Spurs generated by the analyzer, called residuals, are identified and automatically removed from the result list.



IQS100B-30: Modulated Signal Control and Measurements

This module is an Add-On to the IQS100B-10. The DUT can be characterized using a complex RF signal, and different figure-of-merit related to a modulated signal excitation can be extracted.

In IQSTAR 1.5 release, modulated signal measurement can use the Spectrum option of the PNA-X vector network analyser of Keysight Technologies, to measure ACPR and Spectrum directly from the VNA at the DUT reference plane using the a- and b-waves. When using a VNA, the modulated signal measurement module requires IQS100B-11 as a prerequisite.



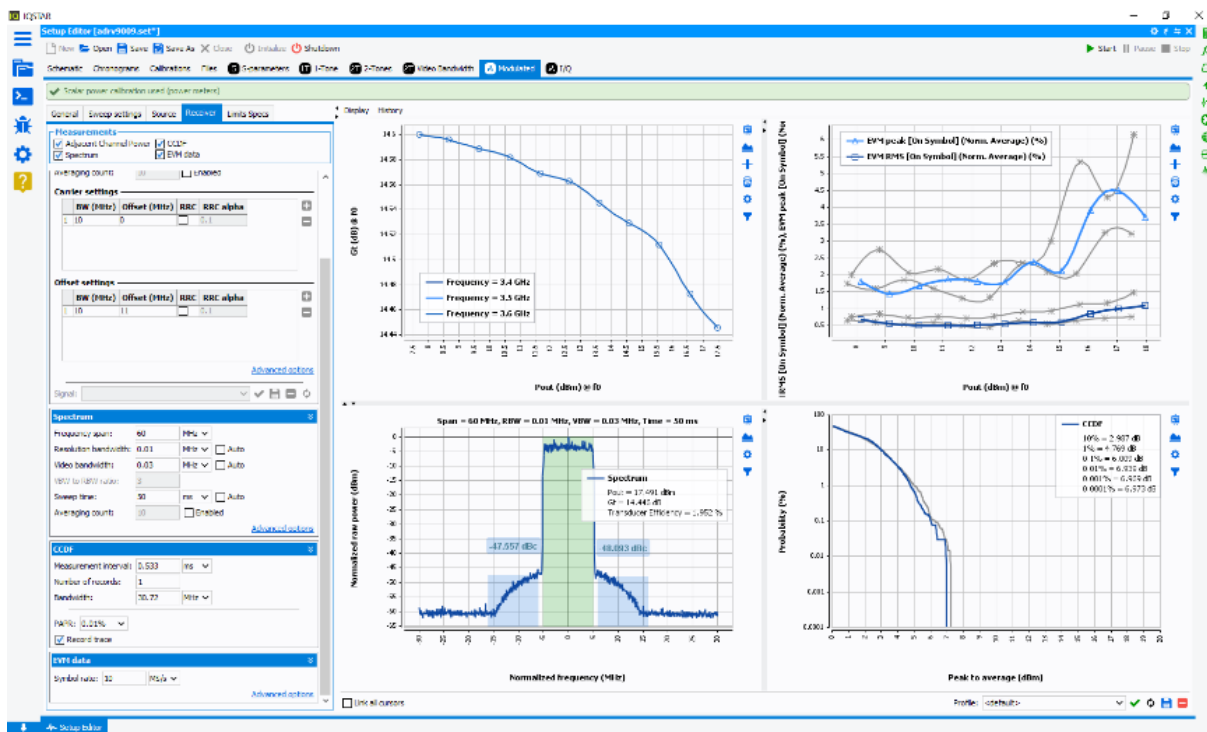
The growing complexity of wireless systems imposes a thorough and detailed characterization of RF power amplifiers using wideband signals. IQSTAR enables high-speed and signals quality measurements to extract the DUT performances (EVM, ACPR, CCDF, PAPR...)

With full control of the vector signal generator, it is possible to set the modulation scheme manually with adequate settings and have IQSTAR recall the required state on the instrument. Otherwise, it is possible to generate an IQ waveform using IQSTAR Waveform Generator or any third-party software and use it directly in IQSTAR by loading a text file containing the columns "I" and "Q".

The Vector Network Analyzer or Signal analyzer, with appropriate options and power meters, is used to measure different parameters like:

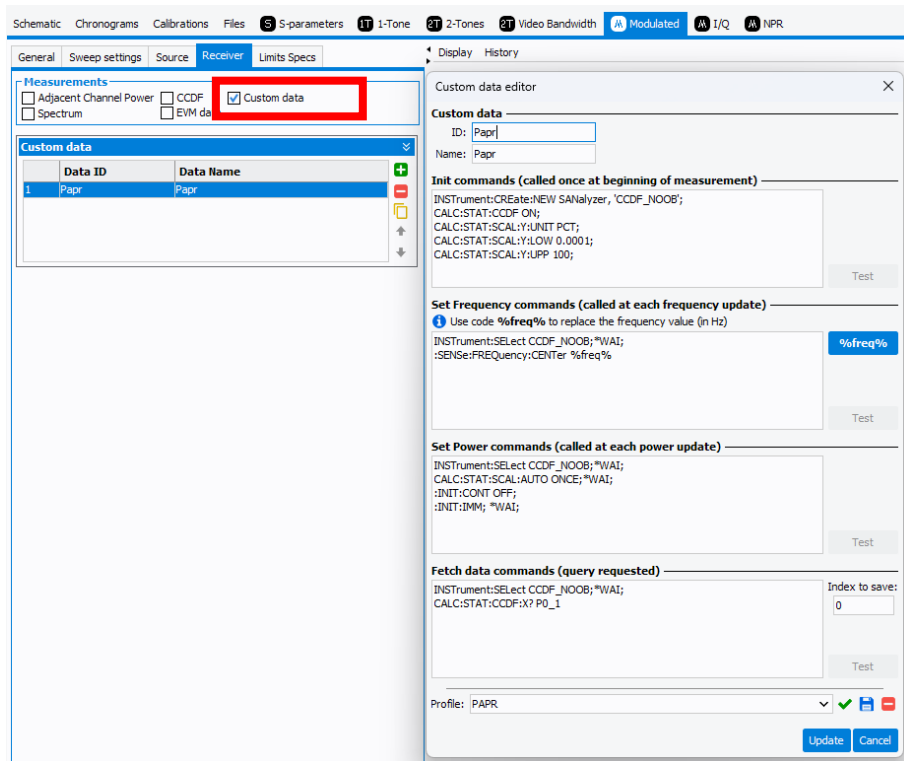
- Adjacent Channel Power Ratio (ACPR)
- Error Vector Magnitude (EVM)- *using Signal Analyzer only*
- Complementary-Cumulative-Distribution-Function (CCDF)- *using Signal Analyzer only*
- Peak-to-Average Power Ratio (PAPR)- *using Signal Analyzer only*
- Spectrum

IQSTAR Modulation measurements support multiple combinations of vector signal generators and signal analyzers from different vendors, allowing the test engineers to switch between instruments seamlessly and reduce the cost of ownership as he does not have to learn a new instrument user interface.



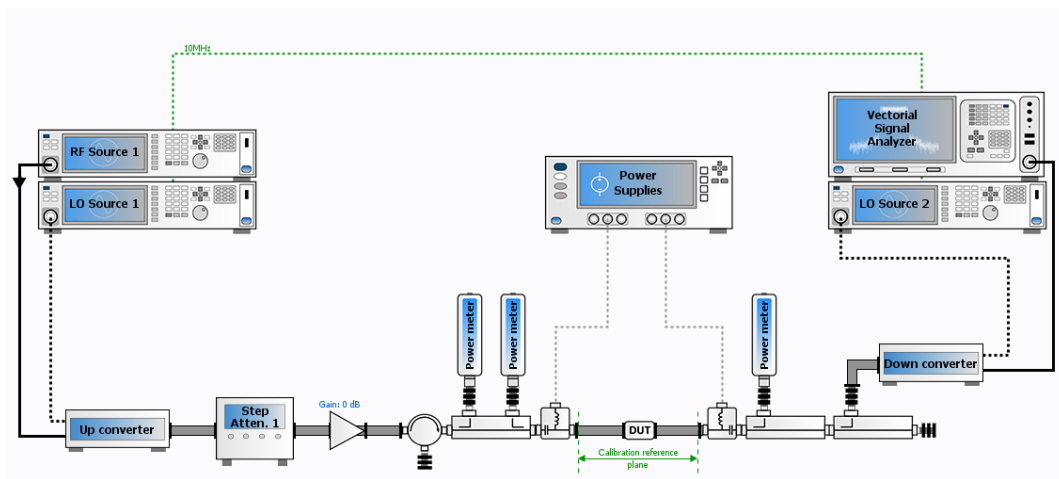
Power amplifier characterization using modulated signals requires instruments with different options to enable the modulation and demodulation personalities based on the modulated signal used. These options are necessary when signal demodulation is needed to measure the required parameters, like EVM. Moreover, Test engineers may need different EVM measurements (EVMavg, EVM peak, EVM rms) and developing drivers sustaining different instruments from different vendors and with multiple personalities becomes difficult to support. Therefore, IQSTAR 1.5 embeds a user data configuration allowing the user to set the instrument in the right personality and fetch the parameter using SCPI commands.

Multiple parameters can be measured in different configurations giving the user access to all the instrument's capabilities.



IQS200B-30: Modulated Signal Control and Measurements for Waveguide Setup

This module is an Add-On to the IQS200B-10. The DUT can be characterized using a complex RF signal, and different figure-of-merit related to a modulated signal excitation can be extracted. As described above for the IQS100B-30 module, IQS200B-30 fetches the main Figures-of-Merit provided by Vector Signal Analyzer in a wideband signal configuration as ACPR, CCDF; PAPR ... in a waveguide configuration.



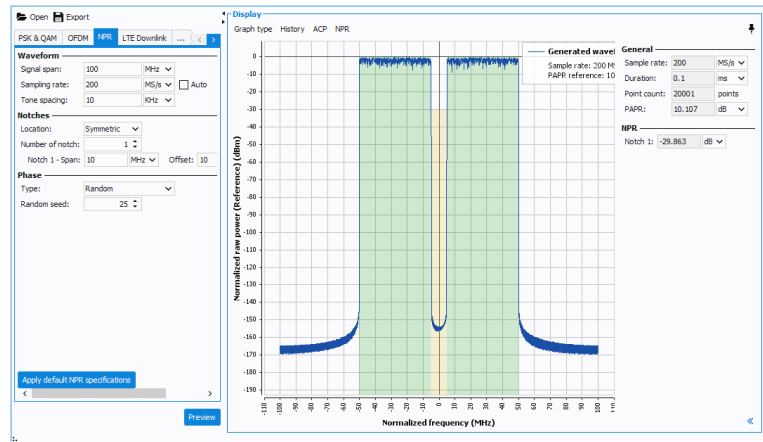
Scalar waveguide setup for Modulated Measurements. IQS200B-30 using shared LO sources for Up & Down converters.

IQS100B-31: Noise Power Ratio (NPR)

This module is an add-on to IQS100B-11.

NPR is a figure of Merit measured in Aerospace applications to characterize the in-band linearity of active devices using very wideband signals. This signal is used instead of typical communication modulation signals because the modulation type is usually not known in advance.

The Spectrum regrowth in the notch due to the intermodulation distortion generated by the power amplifier is measured. The NPR is considered a reliable method to characterize the in-band linearity of active devices with a wideband signal.



The NPR measurement module requires IQS100B-11 as the measurements are done using a VNA (Keysight PNA-X). The a- and b-waves are measured at the input and output of DUT using the spectrum option of the PNA-X (S93090).

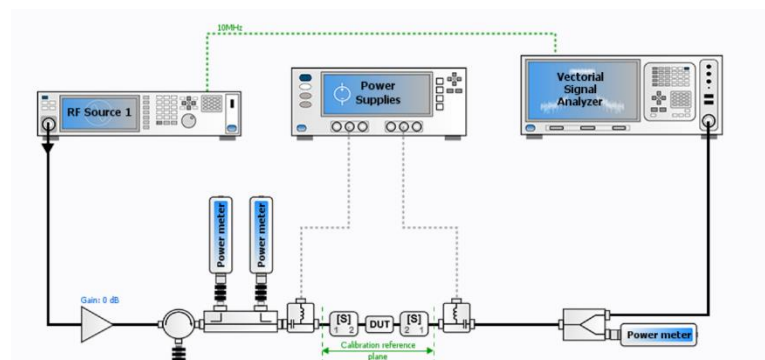
New NPR Modulation in the Waveform Generator

New NPR modulation in the Waveform Generator was developed to help measure the Noise Power Ratio on a Power amplifier. Test engineers can customize the characteristics of the signal by choosing the number of notches and their positions (Symmetric or Offset) on top of the bandwidth and sampling rate. The NPR Waveform Generator is included in the IQS100B-12 module.

IQS100B-40: IQ Data Control and Measurements

This Module is an Add-on to IQS100B-10.

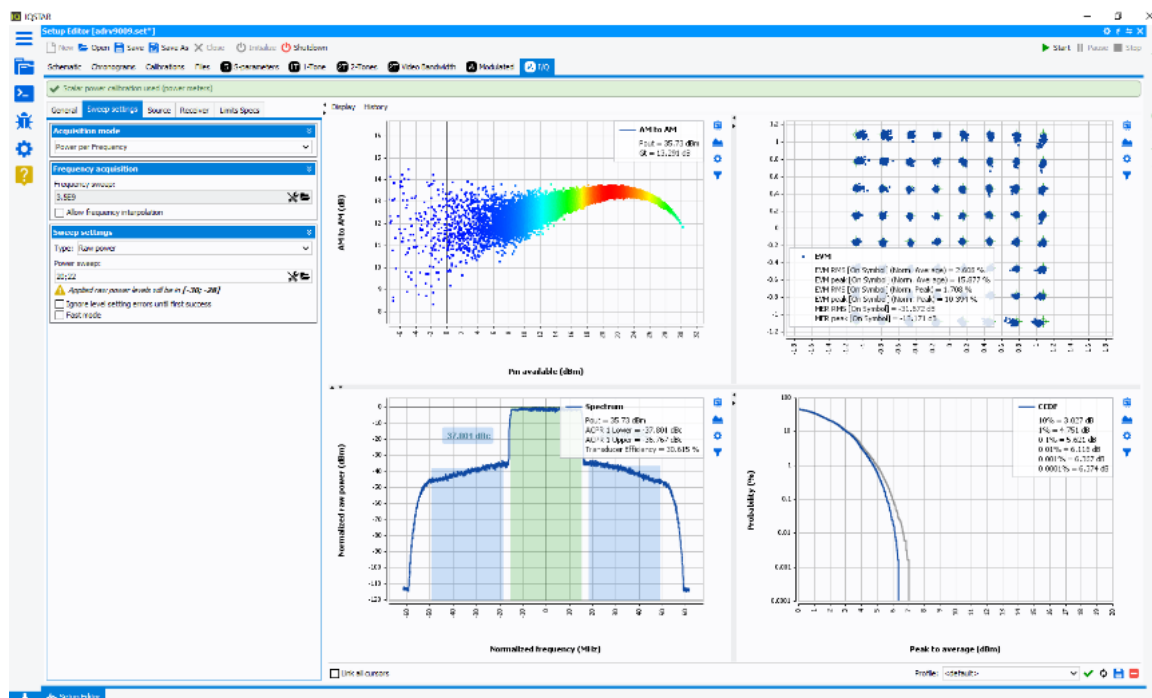
IQSTAR uses IQ values sent to the Vector Signal Generator (VSG) and fetched from the Vector Signal Analyzer (VSA). The IQ data is resized, realigned, and analyzed in IQSTAR to extract user-selected parameters (ACPR, CCDF, PAPR, Dynamic AM-AM...). With this option, the VSA does not need any software options, as IQSTAR makes sure to align the IQ signals at the input and the output and extract all requested parameters.



The Available Measurements are:

- IQ Data
- EVM on Signal
- ACPR
- CCDF with Trace
- Dynamic AM/AM and AM/PM
- Instrument-based DPD

With the IQ Module, no software options (excluding DPD) are required in the instruments to analyze the signal, making it a scalable solution with minimum hardware updates. The setup is only limited by the instantaneous bandwidth of the signal generator and the signal analyzer. IQSTAR features the IQ Measurement Interval selection tool to speed up the measurement process, identifying the most appropriate signal segment that best represents the original one regarding statistical characteristics. This feature is very useful when a trade-off between measurement speed and accuracy is required. When instruments are equipped with DPD analysis options, the IQ Module can control these options. It uses appropriate instrument drivers and enhances the power amplifier characterization by verifying its linearizability.

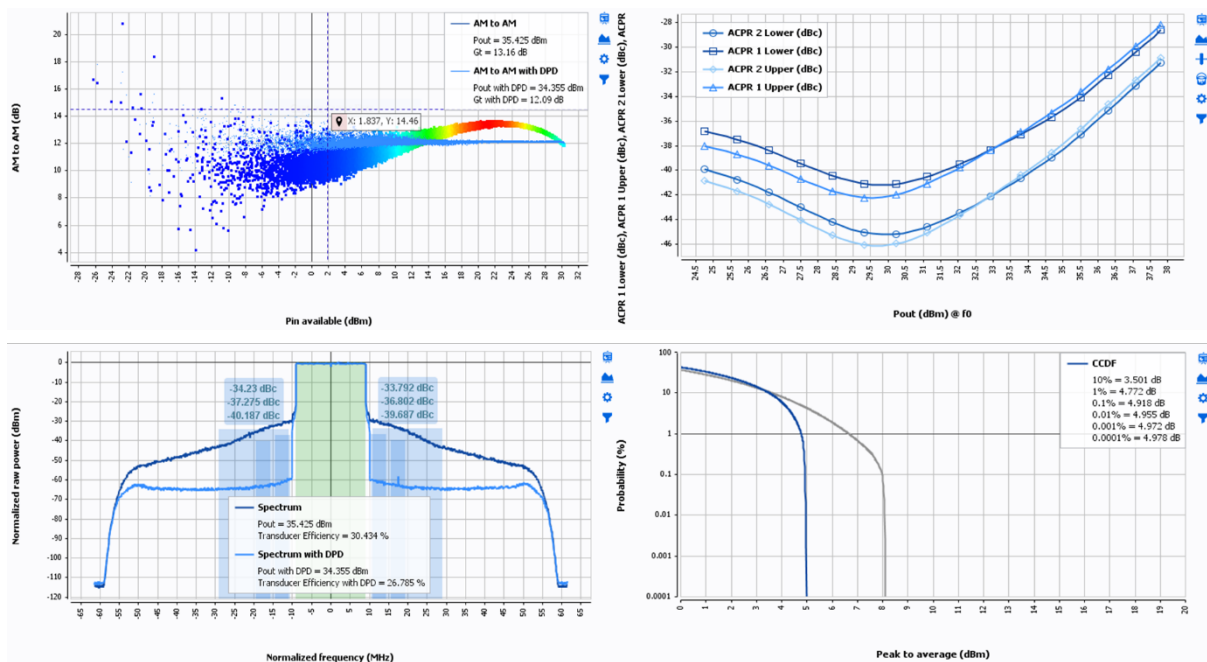


IQS100B-41: DPD Module

This module is an Add-On to the IQS100B-40 module to apply different DPD techniques.

Power Amplifiers are inherently nonlinear components in a communication system and are the most critical components. The nonlinearity generates spectral regrowth, which leads to adjacent channel interference and violations of the out-of-band emission requirements. The nonlinearity also causes in-band distortion degrading the bit error rate (BER) performance. It is possible to reduce the nonlinearity by backing off the power amplifier to work in the linear region. Still, this method is not viable because of the low efficiency of the power amplifier in this regime.

Power amplifiers must be linearized using different techniques to enhance efficiency without compromising the linearity. IQSTAR introduced several DPD techniques and algorithms to verify that the Power amplifier under test can be linearized with more or less complexity.



When different DPD techniques must be tested on the Power amplifier, the software must make more than one algorithm available. Starting version 1.2 of IQSTAR, a dedicated DPD module was released to respond to this request:

- Sample-based
 - This technique is an iterative measurement-based method that allows for achieving quasi-ideal linearization results for reference purposes. Indeed, this method is used during the PA verification and development phase and cannot be implemented as a real-time DPD algorithm in a transmitter.
- Memoryless (M)
 - Memoryless models focus on the power amplifier with a memoryless nonlinearity: the current output depends only on the current input through a nonlinear mechanism. This instantaneous nonlinearity is usually characterized by the power

amplifier's AM/AM and AM/PM responses. The amplitude and phase deviation of the power amplifier output signal is given as functions of the amplitude of its current input.

- Memory Polynomial (MP)
 - o The memory model is commonly used as the signal bandwidth gets wide and the power amplifiers exhibit memory effects, especially for high-power amplifiers used in wireless base stations. Consequently, the current output of the power amplifier depends on the current input and the past input values.
- Generalized Memory Polynomial (GMP)
 - o This model is built by augmenting the Memory Polynomial model considering the cross-term order. The user can set this order.
- Nanosemi Single-band Algorithm (DLL to be acquired by the customer)
 - o This option controls the Nanosemi single-band algorithm through a DLL and applies it externally to the measurements using instruments from different vendors. The Nanosemi DLL must be acquired separately.
- Nanosemi Dual-Band Algorithm (DLL to be acquired by the customer)
 - o This option controls the Nanosemi dual-band algorithm through a DLL and applies it externally to the measurements using instruments from different vendors. The Nanosemi DLL must be acquired separately.
- Matlab-based customer-developed DPD algorithm
 - o This option is a gateway to run a Matlab-based DPD algorithm developed by the user. This option also offers an Open-source MP algorithm that the user can adjust and optimize to his power amplifier under test. Matlab licenses must be acquired separately.

Recent versions of IQSTAR introduced drivers to instrument-based DPD. Some instruments with high data process capabilities can embed proprietary DPD algorithms that can be used for power amplifier linearization. With IQSTAR Version 1.5, the development team added the control of the AMD-Xilinx FPGA with the embedded DPD algorithm to evaluate the linearization level of Power amplifiers.

WFG100-11: Advanced Waveform Generator

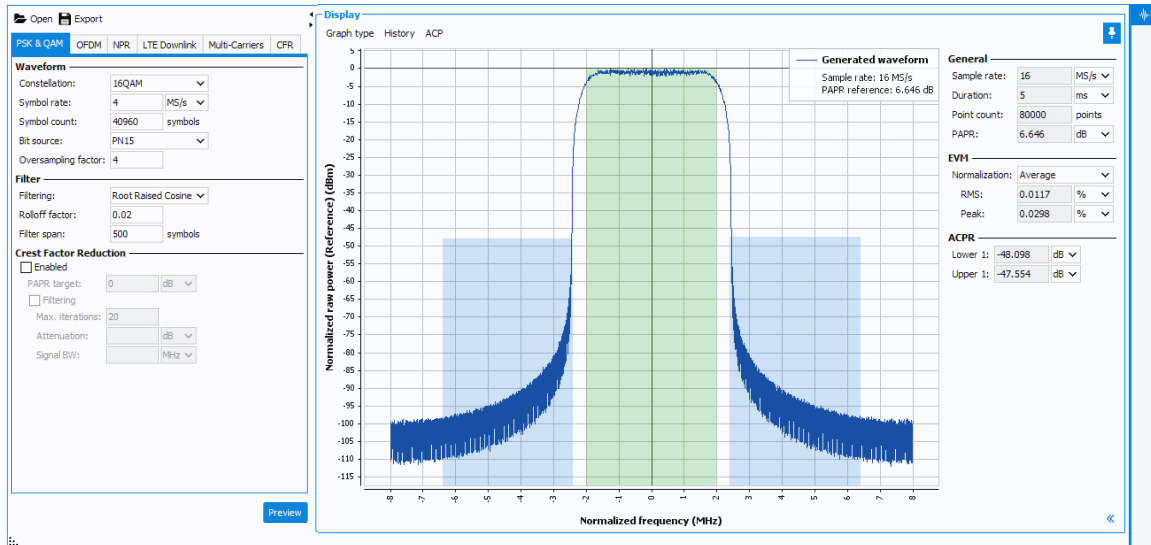
This module is a standalone yearly subscription-based software. It helps generate different waveforms used in modulated or IQ signal modules.

IQSTAR embeds a basic waveform generator that can create different PSK and QAM signals and inject them directly into the signal generator. Starting with IQSTAR release 1.3, an Advanced Waveform Generator is available. As this module is standalone, it can be used independently from IQSTAR. The different waveforms can be used for different modulation schemes:

- PSK & QAM
- Custom OFDM
- LTE Downlink FDD/TDD

- Multi-Carrier Signal
- NPR
- Crest Factor Reduction

The waveform can automatically generate the signal sent to the Vector Signal Generator or be exported to a *.txt file to be used with a third-party application.



SCRPT: Scripting Add-On

SCRPT is an add-on module to IQS100-B10/B11/B20/B30/B40, enabling advanced measurement sequencing using a dedicated scripting language and running applications from third-party software.

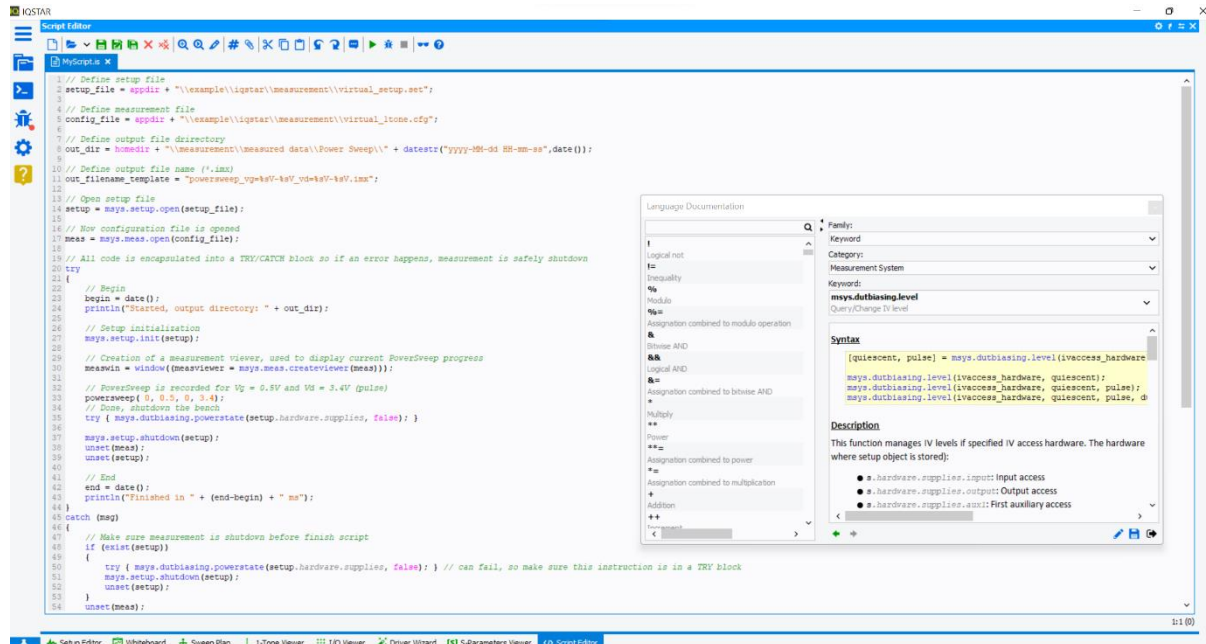
SCRPT enables only the functions related to the IQS100B module available in the software license.

Scripting is available internally to IQSTAR through a dedicated editor. Starting Rev 1.3, Scripting is also available via an external script server and controlled in slave mode by a third-party application or software.

Multiple functions are included in the script editor and divided into different categories:

- **Measurements System:** these functions allow full automation of the measurement process, including the setup creation, the measurement configurations, the device biasing, the biasing optimization, the wafer mapping and many more.
- **User Interface:** these functions are related to creating 2D and 3D graphs, dialogue boxes, and different utilities.
- **Math functions:** an extensive mathematical library is available to compute necessary parameters. These functions include array manipulations like SVD and LU operations, polynomial modeling, curve fittings, and many more functions.

- **Native:** This category of functions is very useful when dealing with external DLL that must be controlled during the measurements.
- **Net Visa:** Dedicated Visa-based instruments control is allowed directly from the script to integrate additional instruments to the bench, like thermal chambers.



IQS-UNPLG: Unplugged Mode

Unplugged mode allows running IQSTAR in virtual to develop script offline.

With this module associated with the SCRPT add-on, the development team can support their test engineers in automating measurements without depriving them of a license that can be used on a bench.

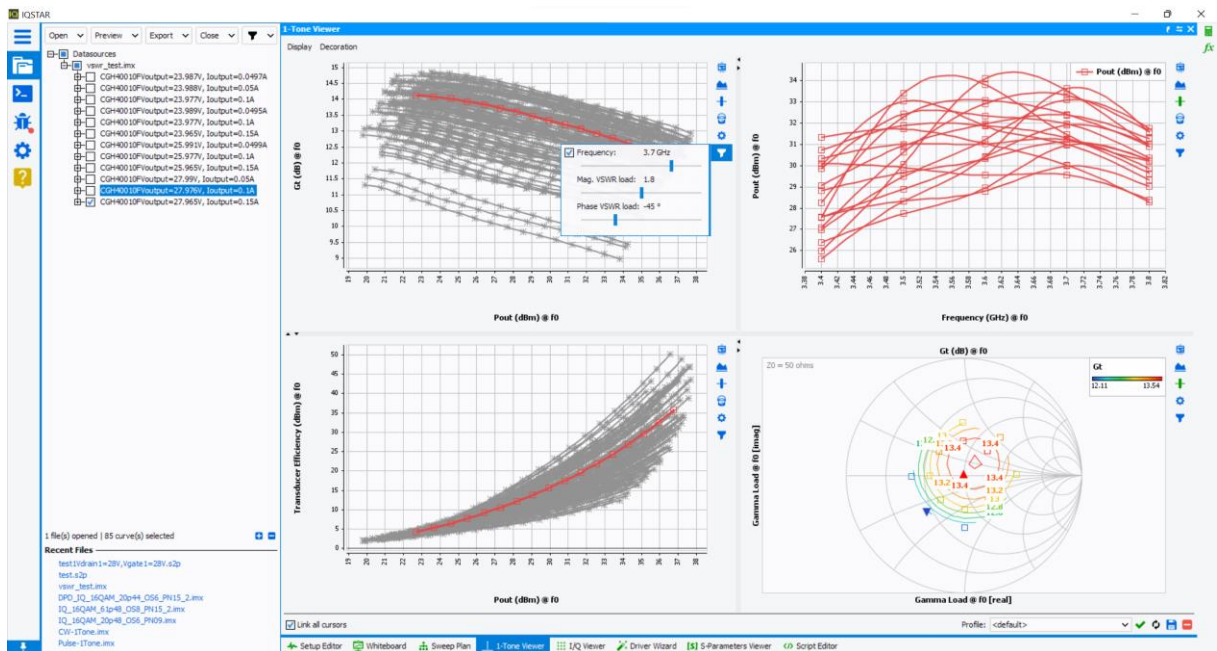
Regarding standardizing and automating measurements, IQSTAR embeds a new module allowing the software to work in demo mode to enable users to develop measurements script offline. This new module uses all the functionalities of the software to create setups, configurations, templates and sweep plans without the need to monopolize real measurement instruments for this activity; this way, the test instruments can be kept available for measurement activities. This module is meant for development teams that need a license of IQSTAR to build specific test sequences and debug such sweep plans in virtual mode before deploying them on the test benches.

Visualization Tool

IQSTAR is provided with a visualization tool for each measurement module. Different displays are made available, allowing single or multiple graphs. Depending on the performed measurements, an extensive list of graph types is predefined, including

- XY Graphs
- Smith Charts
- Polar
- Tables
- Spectrum
- CCDF traces
- EVM constellation
- ACPR Mask

Different controls and filters allow the display of different parameters at a specific frequency, power, or VSWR level, making the performance evaluation of the device easier to analyze. User-defined templates can be saved and recalled. Measurement data can be exported to standard formats like CSV and MDIF.



IQSTAR Configuration Information

	IQSTAR Module	Prerequisite
IQSTAR Coaxial Setup		
1-Tone measurements with Scalar Setup	IQS100B-10	
1-Tone measurements with Vector Setup	IQS100B-11	IQS100B-10
S-Parameters measurements	IQS100B-11	IQS100B-10
Multi-DUT Measurements	IQS100B-12	IQS100B-10 OR B-11
2-Tone measurements with Scalar Setup	IQS100B-20	IQS100B-10
2-Tone measurements with Vector Setup	IQS100B-20	IQS100B-10 IQS100B-11
VSWR measurement	IQS100B-22	IQS100B-10 IQS100B-11
FAST Spurious Detection	IQS100B-25	IQS100B-10
Modulated Signal Module	IQS100B-30	IQS100B-10
Noise Power Ration – Vector Signal Control and Meas.	IQS100B-31	IQS100B-11 IQS100B-30 OR B-40
IQ Module	IQS100B-40	IQS100B-10
DPD Module	IQS100B-41	IQS100B-40 IQS100B-10
IQSTAR Waveguide Setup		
1-Tone measurements with Scalar Waveguide Setup	IQS200B-10	
2-Tone measurements with Scalar Waveguide Setup	IQS200B-20	IQS200B-10
FAST Spurious Detection with Waveguide Setup	IQS200B-25	IQS200B-10
Modulated Signal Module with Waveguide Setup	IQS200B-30	IQS200B-10
Add-On		
Advanced Waveform Gen.	WFG100-11	
Scripting Add-On	SCRPT	IQS100B-10 or WHIT01
Unplugged Mode	IQS-UNPLG	Measurement modules needed for development

Note: IQS100B-X designates modules concerning Coaxial Setup, while IQS200B-X designates modules concerning Waveguide Setup

MAINTENANCE

AMCAD Engineering considers maintenance a critical asset for its customers to provide a premium assistance program. After the initial period of one year from the purchase, AMCAD offers an extended support agreement of one year, two-year, or 3-year maintenance and support agreement.

Different maintenance and support programs can be offered depending on customer needs. It may include annual online training for new engineers, on-site advanced training, or driver customization and development.

In addition to ongoing customer support, this maintenance program keeps your software version up to date so that you can benefit from all the improvements and fixes available with the latest releases.

This information is subject to change without notice and must not be reproduced, modified, adapted, published, translated, in any way, in whole or in part, or disclosed to a third party without the prior written consent of AMCAD engineering

© Amcad Engineering, March 21, 2020

