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PFA-127

pendulum

PFA-127

CW & Pulsed RF Power & Frequency Analyzer to 27 GHz

DATA SHEET

- RF Power & Frequency Analyzer to 15, 20, or 27 GHz
- CW and Pulsed RF measurements down to 50 ns (Pulse Width), 100 ns (Frequency), and 200 ns (Power)
- Peak and Average power meter
- View simultaneous fast frequency and power changes up to 20 million samples/s
- Best-in-class 2-Ch 400 MHz Time Interval Analyzer included
- Ultra-high resolution:
  - RF pulse width: 200 ps rms
  - Power: 0.01 dB/µs;
  - Frequency: 12-13 digits/s
  - Time (Ch. A & B): 14 ps rms
- Gap-free zero-dead-time frequency/power measurements
- Graphic touch screen display for settings and result display, incl. modulation domain
- Screen can be mouse controlled and/or controlled via web-server from anywhere in the world
- Intelligent and easy-to-use

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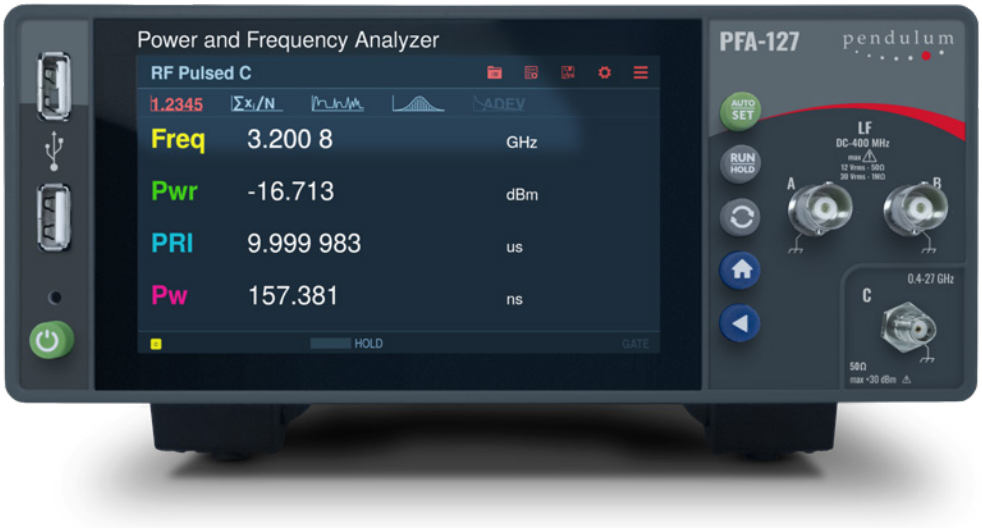

Pendulum PFA-127 is a revolutionary new concept for ***CW & Pulsed RF Power & Frequency analysis up to 27 GHz.*** Replace a Peak/Average power meter and a Frequency Analyzer in one single instrument. Track frequency and Power vs. time in parallel on the graphic screen, for trend or modulation analysis, with high resolution up to 20 MSa/s. PFA-127 features zero dead-time gap-free measurements, and includes also an outstanding 2-Ch. 400 MHz Time Interval Analyzer with down to 14 ps resolution (7 ps optional).

New analysis features for Microwave R&D

- Track Frequency and Power changes simultaneously with ultra-high resolution, down to 50 ns between samples
- Follow fast frequency changes, like Frequency Agile hopping frequencies, over up to 27 GHz analysis bandwidth
- Measure fast modulation like FM, PWM, FSK, BPSK, and AM on RF signals
- Pulsed RF analysis include simultaneous view of RF Pulse Width, PRI, Frequency in pulse, Power in pulse, and Pulse-to-pulse analysis of Width, PRI, Frequency, and Power
- Zero-dead-time gap-free measurements provide back-to-back measurements without losing any information, even in a very long measurement sequence
- PFA-127 is a high-performance Modulation Domain Analyzer (MDA). Thanks to the high 20 MSa/s measurement speed, very fast frequency or power level changes can be captured in real time. You can pan and zoom in the graphs with cursor readouts
- PFA-127 includes a powerful 2-channel base-band analyzer to 400 MHz, using the same time scale as the RF part. This allows for example to time correlate external arming events with RF pulse timing, or to view/measure base band frequency in parallel to an upconverted RF frequency.

Save money in production test

- The combined high performance 27 GHz power meter and frequency counter in the same box, can replace existing Spectrum Analyzers in your test system, a huge cost saving!
- PFA-127 enables 2 parallel frequency measurements in one box, replacing 2 instruments; one base band frequency counter to 400 MHz on LF-channels A or B, and one microwave frequency counter up to 27 GHz on RF-channel C
- High speed over Ethernet reduces test time in ATE test systems. Perform fast block measurements to up to 170k Sa/s, or continuous data streaming to an external PC “forever” of up to 20k Samples/s. Test time is reduced compared to existing solutions, and time is money.

Outstanding accuracy in metrology

- Ultra-high stability OCXO timebase oscillators, with up to 9 accurate result digits, or the use of an external atomic clock reference, makes the PFA-127 an excellent RF frequency calibrator
- RF power is typically accurate to 0.5 dB (2-σ) at room temperature, for frequencies of 1.5 to 15 GHz. For full frequency range, the 2-σ accuracy is 0.8 dB
- Calibration of RF sweep time and PRI with high accuracy.

Easy-to-understand Graphical Presentation

One of the great features of the PFA-127 is the graphic display with its multiple views. Measurement values are presented both numerically and graphically, and both RF Frequency and RF Power are displayed simultaneously.

The graphical presentation of results (distribution, modulation, trends, live ADEV) gives a much better understanding of the nature of signal stability, or instability. It also provides you with a much better view of changes vs time, from slow drift to fast modulation. The same data set can be viewed in Numerical, Distribution, and Trend view modes. It is very easy to capture and toggle between views of the same data set.

A zoom and pan function with cursor read-out further enhances analysis.

View RF Power and Frequency, simultaneously on screen. 2 instruments in one!

Powerful Modulation Analysis

The PFA-127 features built-in modulation domain analysis, displaying Frequency changes vs. time, on inputs A or B, and C simultaneously. Plus Power changes vs. time on input C.

Thanks to the high resolution, and the high measurement speed of 20M values/s , you can follow for example:

- FM, FSK, BPSK, PWM, PPM and other time, phase or frequency modulation schemes on up to 27 GHz CW signals, up to several MHz modulation rates
- LFM ("chirp") radar with frequency samples every 50 ns
- Frequency hopping, sweep, transients, switching, settling, etc,. with up to 27 GHz analysis bandwidth
- AM & Power hopping, sweep, transients, switching, settling...
- Frequency and Power stability, short-and long-term
- Advanced Pulsed RF analysis, including pulse-to-pulse analysis of Frequency, Power, Pulse Width and PRI/PRF.

View fast FM/AM, or any time/phase/frequency /power modulation, on screen. This example shows AM with 10 kHz modulation. Modulation period (100 µs) is measured via cursor read-out over 10 modulation cycles.

Average and fast Peak Power with high resolution

The PFA-127 samples the RF power in down to 50 ns gate time, or 20 million times per second. That means that PFA-127 can follow very fast changing signals, as well as accurately calculate the average power over thousands or millions of samples.

The linearity error at room temperature is <0.3 dB for -25 to +25 dBm power range, and 1.5-15 GHz frequency range.

Resolution is very high for power measurements, impressive <0.01 dB at a short gate time of 1 microsecond.

Peak power in pulses can be measured down to 200 ns. For Frequency measurements, the minimum pulse width is 100 ns, and for measurements of the RF pulse width alone, the minimum width is 50 ns.

PAPR, Peak to Average Power Ratio, is automatically calulated and displayed in the statistics screen, an important parameter for many modern complex wireless standards.

Internal and external triggerring, with or without a start delay, enables time gated measurements in bursted or TDMA signals.

Looking at wireless signals

Below picture shows a view of the power level from an 802.11 Wi-Fi router, as seen by a receiving antenna during 10 s.

And below picture shows the frequency variations on one of the Wi-Fi channels in the 2.4 GHz band during a 2.4 ms observation period. 24 frequency samples were taken every 100 microseconds. Pan and zoom in graph with cursor readout is used.

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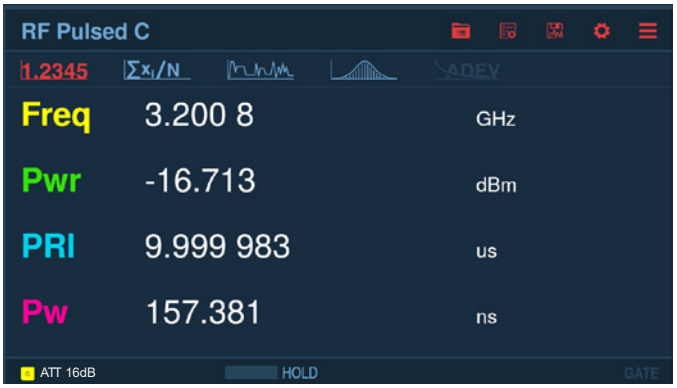
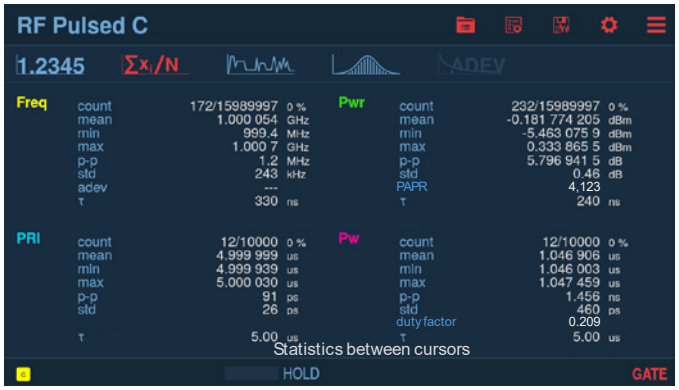
Pulsed RF measurements

One of the features in PFA-127 is the possibility to analyze Pulsed RF signals, for example pulsed radar signals, showing all important basic parameters simultaneously on the same screen.

The screen shot below shows the values screen, sample by sample, of the carrier Frequency, the Power level, the Pulse Repetition Interval (PRI), and the Pulse Width (PW) of the pulsed RF signal.

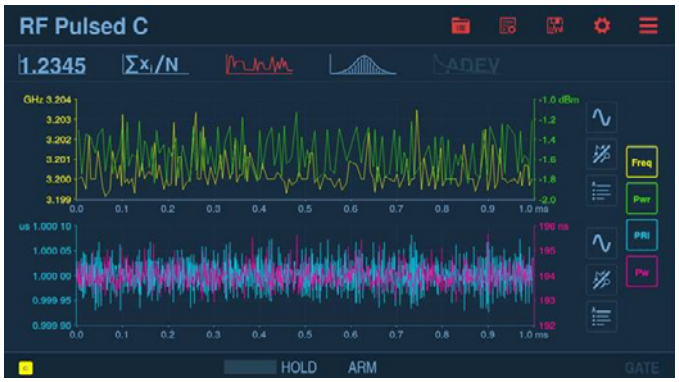


The Statistics screen below, on a different signal, reveals important information, like the mean value of Frequency, Power, Pulse-Width and PRI over mutiple pulses, the standard devation of each measurement, the peak-peak variations of each measurement, the caculated PARP (Peak-to-Average Power Ratio) and the duty factor of the repetititive RF pulse.



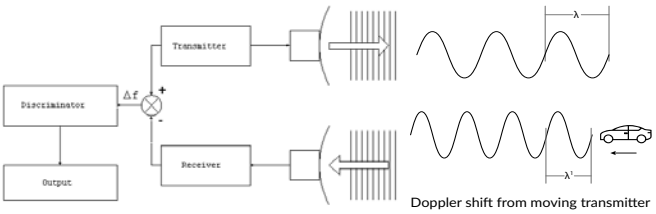
The Timeline graph show individual, pulse by pulse, values of all 4 parameters. Color coded Frequency and Power on top, and color coded PRI and PW at the bottom. To ease the read-out, you can individually select the parameter(s) to be displayed.

And you can zoom and pan into the region of interest, when needed.



CW and FMCW Radar testing

CW (Doppler) Radar for velocity measurements

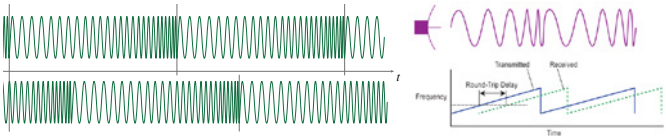


CW Doppler radars measure velocity, not distance, and are used e.g. in speed camera equipment. They use a fixed CW frequency, e.g. 24 GHz,and have separate antennas for transmit and receive. The reflexions from a moving object causes a shift in the received frequency, F_D, in echoed CW (Doppler effect). Target velocity v (m/s) is calculated from: $F_D = 2*F_{CW}*v/c$.

PFA-127 can measure very small frequency offset in the constant transmitter CW, and very small Doppler shifts of the received echo, and follow fast changes. Example: v=15 m/s (54 km/h) gives F_D = 2.4 kHz, when F_{CW}= 24 GHz. The resolution of PFA-127 is 24 Hz for a 10 ms gate time and a CW frequency of 24 GHz.

Using a 1s gate time, the corresponding velocity resolution of PFA-127 is as good as 1.5 mm/s for velocity sensor calibration.

FMCW Radar for both velocity and distance measurements



FMCW adds distance measurement to CW radar, and is used e.g. in weather radars and altimeters in airplanes. The CW is not constant, but linearly modulated (swept) in a saw-tooth or triangle shape. For a constant distance to target, the ΔF between transmit and receive frequency is constant inside the ramp, and proportional to the distance . PFA-127 measures ΔF with high resolution and follows fast changes.

The picture below shows an FMCW radar in the 24 GHz ISM band with a set ramp time of 750 µs. The frequency ramp time for a set 100 MHz sweep, the yellow curve, is easily verified using the pan and zoom feature with cursor readouts (746 µs and 100.0 MHz measured in this example). The green curve is the simultaneous power vs. time graph. Samples are taken continuously and gap-free every microsecond in this example.

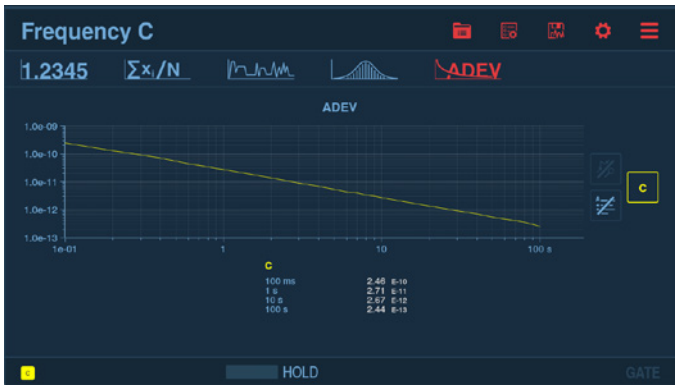
FM-Pulse ("chirp") Radar for hi-resolution distance measurements

Unlike normal Pulse Radar, an FM-Pulse radar has a linearly swept frequency inside the pulse, instead of a fixed frequency.

The PFA-127 can follow fast frequency changes inside the pulse, with hi-resolution samples every 50 ns.

View Frequency stability of microwave oscillators

The optional Allan Deviation (ADEV) graph view shows the short-term frequency stability of the input signals during measurement. Beneath the graph you have individual numeric tables for the input signals.

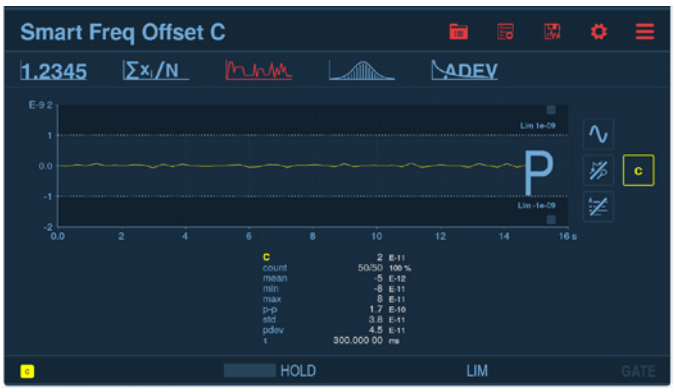


Frequency Offset Meter (option 152)

In ***Frequency Offset Meter mode***, the user only enters required relative test tolerance, e.g. $1x10^{-8}$, and the number of samples. All other instrument settings are performed automatically, and optimized for the current measurement. The user does not even need to know the nominal frequency on beforehand, the instrument will find it for him.

Tolerance limits are displayed and gives direct graphical feedback whether limits are passed or failed. In the example below, a 3.2 GHz oscillator is connected to input C, with relative tolerance limit $\pm 1x10^{-9}$ or ±3.2 Hz.

The oscillator is clearly inside limit range. The big blue letter "P" indicates Pass. A possible Fail would have been indicated with a big letter "F" instead.



Very flexible configuration

The PFA-127 series can be configured as you like it to fit performance demands and/or budget

- Choose between 3 timebase oscillator options; TCXO (standard), high-stability OCXO, and ultra-high-stability OCXO
- The base model has 15 GHz frequency range, and can be SW upgraded to 20, or 27 GHz via user installed license keys at any time (*SW*)
- Upgrade from 14 ps resolution to 7 ps (SW)
- Add an optional 0.5 Hz to 100 MHz pulse generator (*SW*)
- Add optional TIE measurements for jitter and wander analysis on all inputs (*SW*).
- Add optional Frequency Offset measurements, for guided automatic settings for ultimate accurate and easy-to-operate Frequency calibration (SW).
- Add optional ADEV graph view to characterize microwave oscillator short-term stability. (SW).

With later SW license upgrade, you do not risk to either under-buy, or over-pay, at original purchase!

Outstanding ease-of-use

The big color touch screen with its intuitive menus, lets you make your settings via a simple finger touch. Alternatively you could instead make your settings via mouse clicks on screen, via the front panel USB ports. Or you could use the web-server interface to control PFA-127 from a large PC-screen on your bench.

When adjusting a frequency or power source to given limits, the graphic display gives fast and accurate visual calibration guidance.

The intelligent AUTO SET will help you to make best settings for each measurement function.

Full flexibility for remote control

The PFA-127 comes as standard with Ethernet interface for remote control and data transfer. You can use:

- Wired Ethernet via RJ45 connector on rear panel
- Wireless Ethernet or WLAN (via a user provided USB dongle at one of the front panel host ports)
- USB
- Optional GPIB interface

Select your desired interface and connect to the instrument to control settings, read data and read status.

You can access, control, and download measurement data from your lab bench, or from anywhere in the world, using the integrated web server interface function.

Summary

The NEW PFA-127 series CW & Pulsed RF Power & Frequency Analyzer is a one-box solution for fast and accurate frequency and peak/average/pulsed power measurements, with outstanding analysis. And with the 2-channel 400 MHz Time Interval Analyzer included, PFA-127 outperforms every existing benchtop frequency counter, power meter and time interval analyzer on the market, independent of measurement task.

The high-performance PFA-127 is the ultimate tool for CW and Pulsed RF Power & Frequency measurements, analysis, and calibration up to 27 GHz.

General

Multi-channel

PFA-127: Measure 1 or 2 input signals in parallel

Display modes

Values/Statistics: Numeric display of Measurement values or Statistics parameters with large digits. Values mode also display auxiliary parameter values (with less resolution).

Time-line/Distribution/ADEV: Measurements are displayed graphically. Multi-channel graphs are color-coded. Statistics values are also displayed beneath the graphs.

ADEV display mode: A, B, and C:

Calculation of Allan Deviation in real time from Frequency, Period or TIE basic measurements.

Floor @1s:

- $1x10^{-11}$ (7 ps resolution, option 121)
- $2x10^{-11}$ (14 ps resolution, standard)

Floor @1000s:

- $1x10^{-14}$ (7 ps resolution, option 121)
- $2.2x10^{-14}$ (14 ps resolution, standard)

Resolution/Speed

Measure frequency, period average, or TIE of one LF plus one RF input signal in parallel with 12 digits/s resolution, at a speed of up to 20 MSa/s

Smart Frequency/Period Avg. calculation mode

Basic resolution for frequency / period average is 12 digits in 1 s measuring time. Statistics resolution enhancement algorithm (*smart mode*) gives up to 13 digits/s. Smart mode is applicable for gate times > 80 us.

Measuring Functions - input C: RF CW

CW Frequency C

Mode: Back-to-back, with or without smart calculation

Range: 400 MHz to 15, 20 or 27 GHz;

Resolution: 12-13 digits in 1s gate time
6 digits in 1 µs gate time

Aux. Parameter: Period C; CW Power C

NOTE: CW Power C is measured and displayed simultaneously in parallel

CW Power C

Mode: Back-to-back, with or without smart calculation

Unit (selectable):

- dBm (default)
- mW (W) in 50 Ω
- mVrms (Vrms) in 50 Ω

Frequency Range: See CW Frequency specification

Power Range: -30 dBm to + 30 dBm

Resolution: 0.01 dB @ 1µs measuring time

Linearity uncertainty: (20-26 °C, attenuator =16dB)

- -25 to +25 dBm, 1.5 to 15 GHz: <0.3 dB (6.7%)
- -30 to +30 dBm, 0.4 to 27 GHz: <0.6 dB (12.9%)

Attenuator setting uncertainty: <0.1 dB (2.3%)

Temperature dependent uncertainty: -20 to +25 dBm

- +20 to +30 °C: <0.2 dB (4.5%)
- +15 to +35 °C <0.4 dB (8.8%)

Calibration uncertainty: <0.2 dB (4.5%)

Aux. Parameter: CW Frequency C

NOTE: CW Frequency C is measured and displayed simultaneously in parallel

Peak-to-Average Power Ratio C (PAPR)

Mode: Analyze Power samples in a single block capture (CW or pulsed). Numeric calculation and numeric display of Peak Power, Average Power and Peak/Average Power Ratio in Statistics display mode.

Measuring Functions - Input C: Pulsed RF

General

Measurements of Frequency and Power inside a pulse are made back-to-back, with a mininimum time between samples of 50 ns.

Display: Either one parameter at a time, or Simultaneous group display of PRI, PW, Frequency in Pulse, and Power in Pulse

Frequency Range: See CW Power & Frequency specifications

Duty cycle range: 0.0001 to 0.5

Minimum Power ON/OFF Ratio: >15 dB

Power trigger level: HIGH/MED/LOW/AUTO

Frequency in pulse C

Mode: Back-to-back

Minimum Sample Interval (gate time): 50 ns

Pulse Width: 100 ns to 1s

Min. Pulse Width: 100 ns (CW >1 GHz)
increasing to 600 ns (CW = 400 MHz)

Resolution: 6 digits in 1 µs gate time
4 digits in 50 ns gate time

For repetitive pulses, the mean value accuracy is enhanced by statistics

Aux. Parameter: Pulsed Power C; PRI; PW

Power in pulse C

Mode: Back-to-back

Minimum Sample Interval (gate time): 50 ns

Pulse Width: 200 ns to 1s

Min. Pulse Width: 200 ns (CW >2 GHz)
increasing to 1 µs (CW = 400 MHz)

Resolution: <0.01 dB in 1µs measuring time

For repetitive pulses, the mean value accuracy is enhanced by statistics

Added Pulsed Power uncertainty compared to CW:

1 to 22 GHz:

- PW <300 ns: <0.4 dB (8.8%)
- 300 ns <PW < 10 µs: <0.3 dB (6.7%)
- PW >10 µs: <0.1 dB (2.3%)

0.4 to 27 GHz: < 0.5 dB (11%)

Aux. Parameter: Pulsed Frequency C; PRI;PW

PRI (Pulse Repetition Interval) C

Range: 100 ns to 1 s

Resolution: <200 ps (Single-shot)

Accuracy: < 1 ns

Aux. Parameter: PW

PRF (Pulse Repetition Frequency) C

Range: 1 Hz to 10 MHz

Calculated as 1/PRI using Math functions

RF Pulse Width C

Pulse Width: 100 ns to 1 s

Resolution: <200 ps (Single-shot)

Accuracy: <20 ns

Aux. Parameter: PRI

Other Measuring Functions inputs A, B, C

Frequency A, B, C

Mode: Parallel measurements on 2 inputs. Back-to-back, with or without smart calculation

Range A, B: 0.001 Hz to 400 MHz

Range C: See input C

Aux. Parameter:

- Ch. A, B: Vmax, Vmin, Vp-p
- Ch. C: Period C

Frequency Offset A, B, C (SW option 152)

Mode: Parallel measurements on 2 inputs. Back-to-back, with smart calculation

Intended for easy-to-use high-performance frequency calibration. The user sets tolerance limits for the DUT, e.g. $\pm 1x10^{-9}$, and all other background settings are auto-set.

The display shows graphical frequency limits, and alerts if the values are outside tolerance

Frequency Ratio (A, B, C) / (A, B, C)

Mode: ***Parallel measurements*** on 2 inputs plus division.

Range: $(4x10^{-14})$ to $2.4x10^{13}$

Input Frequency: See inputs A, B, and C

Aux Parameters: Freq 1, Freq 2

Frequency Diff (A, B, C) / (A, B, C)

Mode: ***Parallel measurements*** on 2 inputs plus subtraction

Range: $(4x10^{-14})$ to $2.4x10^{13}$

Input Frequency: See inputs A, B, and C

Aux Parameters: Freq 1, Freq 2

Period A, B, C average

Mode: ***Parallel measurements*** on 2 inputs Back-to-back, with or without smart calculation

Range: See the inverse of Frequency specifications

Aux. Parameter:

- Ch. A, B: Vmax, Vmin, Vp-p
- Ch. C: Frequency C

TIE A, B, C (Option 151)

TIE = Time Interval Error, calculated as: *Accumulated period - Expected ("ideal") accumulated period*

Mode: ***Parallel measurements*** on 2 inputs. Back-to-back.

Freq range: See Frequency specifications

Aux. Parameter: Reference Frequency

Period A, B single

Mode: ***Parallel measurements*** on 2 inputs

Range: 2.5 ns to 1000 s.

Aux. Parameter: Vmax, Vmin, Vp-p

Time Interval A, B

Mode: Parallel timestamping of trigger events on 2 inputs on continuous or single-shot signals.

Start and stop channel: any of A, B

Note: each input can produce 1 or 2 trigger events with individual trigger level and slope

Accumulated Time Interval: ON or OFF (adding or subtracting one start channel period to the Time Interval, when required, provided that the input signals have the same nominal repetition rate)

Range: -1000 s to +1000 s

Repetition rate: up to 300 MHz or single-shot events

Min. Pulse width: 1.5 ns

Positive and Negative Pulse Width A, B

Mode: ***Parallel measurements*** on 2 inputs

Range: 1.5 ns to 1000 s.

Repetition rate: up to 300 MHz or single-shot events

Rise/Fall Time, and Slew Rate A, B

Mode 1: ***Parallel measurements*** on 2 inputs of Rise OR Fall time, or

Mode 2: ***Single*** input measurement of simultaneous Rise AND Fall time on the same pulse, or

Mode 3: ***Parallel measurements*** on 2 inputs of Pos OR Neg Slew Rate (80% of Vp-p) / (Rise or Fall Time)

Range: 1.5 ns to 1000 s.

Min pulse width (between 10% and 90% trigger points)**:** 1,5 ns

Aux. Parameters: Slew rate or Rise/Fall, Vmax, Vmin

Positive and Negative Duty Cycle A, B

Mode: ***Single*** input meaurement

Range: 0.000001 to 0.999999

Repetition rate: up to 300 MHz

Min pulse width: 1,5 ns

Aux. parameters: Period, Pulse width

Phase Ch. 1 Relative Ch. 2

Inputs: A , B
Mode: Intended for phase shift or delay measurements of two signals with identical frequency
Accumulated Phase: OFF or ON (adding or subtracting 360° to the Phase, when required)
Range: -180° to +180° (Acc. Phase is OFF)
Resolution: 0.00003° to 100 kHz, decreasing to 0.03° >100 MHz. (10k sample statistics averaging)
Freq. Range: up to 300 MHz
Aux. Parameters: Freq (ch. 1), V(ch. 1)/V(ch.2) in dB

Totalize A, B

Basic mode: Tot (event counts) on A, B
Processed mode: Tot X+Y; X-Y; X/Y;
X and Y are the event counts on inputs A, B
Range: 1 to 10^{15} counts
Freq range: up to 400 MHz
Start control: Manual, start arming
Stop control: Manual, stop arming, timed

Vmax, Vmin, Vp-p, DC Offset A, B

Range: -5 V to +5 V, -50 V to +50 V
Freq. Range: DC, 1 Hz to 200 MHz
DC Offset: Mean value of Vmax and Vmin for a DC input signal
Coupling: Sine (AC>100 Hz or DC), Square (DC only)
Resolution: 1 mV (5 V range), 10 mV (50 V range)
Uncertainty (5 V range):

- DC, 1 Hz to 1 kHz: <1% +15 mV
- 1 kHz to 20 MHz sine: 3% +15 mV (typ.)
- 20 to 100 MHz sine: 10% +15 mV (typ.)
- 100 to 200 MHz sine: 30% +15 mV (typ.)

(For square waves add 10% to Vmax,/min & 20% to Vp-p)
(For 50 V range, add 2% + 150 mV)
Aux parameters: Vmin, Vmax, Vp-p

LF Input Specifications A, B

Inputs A, B

Frequency Range:

- DC-Coupled: DC to 400 MHz
- AC-Coupled: 10 Hz to 400 MHz

Impedance: 1MΩ // 40 pF or 50 Ω (VSWR ≤2:1 typ.)
Trigger Slope: Positive or negative
Channel-channel skew: 25 ps rms (after calibration)
Sensitivity (typical):

- DC-400 MHz: <70 mVrms (PreAmp = OFF)
- DC-100 MHz: 15 mVrms (PreAmp = ON)
- 100-200 MHz: 25 mVrms (PreAmp = ON)
- 200-400 MHz: 35 mVrms (PreAmp = ON)

Hysteresis window: approx. 20 mV (PreAmp=OFF)
Attenuation: x1, x10
Dynamic Range (x1):
PreAmp = OFF: 0.2 to 10 Vp-p within ±5 V window
PreAmp = ON: 0.01 to 2 V p-p within ±1 V window
Trigger Level: Read-out in menu

- Resolution: 1 mV
- Uncertainty (x1): ±(15 mV + 1% of trigger level)

Trigger Level modes: Manual, Relative (to Vp-p), Auto
Auto Trigger Level is set to:

- 50% point of input signal's Vp-p, combined with a wide hysteresis between the 40% and 60% points, for frequency, period average, TIE
- 10% and 90% points, for Rise/Fall Time, Slew rate, combined with minimum hysteresis
- 50% point with minimum hysteresis for all other functions
- Min. voltage 200 mVp-p

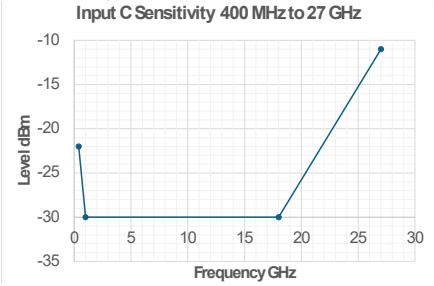
Analog LP Filter: Nominal 10kHz, 100kHz selectable
Max Voltage Without Damage:

- 1MΩ: 350 V (DC + AC pk) to 440 Hz, falling to 12 Vrms at 1MHz.
- 50 Ω: 12 Vrms

Connector: BNC

RF Input Specifications C

Freq. Range: 0.4 to 27 GHz; SW license enabled to 15, 20 or 27 GHz



Attenuator settings: 0 dB, 16 dB, or 32 dB. Default setting is 16 dB
Recommended Operating Input Power Ranges:

- **Attenuator 32 dB:** +5 dBm to +30 dBm
- **Attenuator 16 dB:** -15 to +15 dBm
- **Attenuator 0 dB:** -30 to -5 dBm

Note: *All accuracy figures given in the data sheet are based on using recommended attenuator setting*
1 dB compression:
Attenuator 32 dB +30 dBm (by design)
Attenuator 16dB +19 dBm
Attenuator 0 dB +3 dBm
Prescaler Factor: Selectable

- **4** <1.6 GHz
- **8** <3.2 GHz
- **16** <6.4 GHz
- **32** <13 GHz
- **64** <27 GHz
- **AUTO**

Default setting is 64
Impedance: 50 Ω nominal
VSWR:

- **0.4 to 10 GHz:** <1.5:1
- **10 to 20 GHz:** <1.7:1
- **20 to 27 GHz:** <2.0:1

AM tolerance: > 90% within sensitivity range
Max Power Without Damage:

- **Attenuator 16 or 32 dB:** +30 dBm
- **Attenuator 0 dB:** +24 dBm

Connector: 2.92 mm, SMA compatible, Female

Rear Panel Inputs and Outputs

Reference Frequency Input

Frequency: 1, 5 or 10 MHz; 0.2 to 5Vrms sine (nom.)
Impedance: 50 Ω (nom.)
Connector: BNC

Reference Frequency Output

Source: External input if used, otherwise internal
Frequency: External ref freq., or 10 MHz (internal)
Output impedance: 50 Ω
Amplitude: 1Vrms sine into 50 Ω (nom.)
Connector: BNC

Arming Input

Arming of all measuring functions

- **Impedance:** Approx. 1 kΩ
- **Freq. Range:** DC to 160 MHz
- **Trigger level:** approx. 1.5 V fixed
- **Trigger slope:** Pos. or neg. selectable

Connector: BNC

Programmable Pulse Output (Option 132)

Pulse mode: Pulse generator, Gate open, Limit Alarm
Period range: 10 ns-2 s in 2 ns steps
Pos. Pulse width range: 4 ns-2 s in 2 ns steps
Min negative pulse width : 6 ns
Rise time: 2.5 ns (nom.)
Output impedance: 50 Ω (nom.)
Output level: Low <0.4 V; High: 4.5-5.25 V (open output); 2.0-2.5 V (50 ohm load).
Connector: BNC

Auxiliary Functions

Trigger Hold-Off

Time Delay Range: 20 ns to 2 s in 10 ns steps

External Start and Stop Arming

Modes:

- Start Arming
- Stop Arming
- Ext. Gate (combined Start and Stop Arming)

Arming channels: A, B, rear panel EXT ARM, or internal arming in Pulsed RF mode
Arming delay to first trigger ready: <5 ns
Start/Stop Time Delay Range: 20 ns to 2 sec. in 10 ns steps

Statistics

Calculation range: All data or data between cursors
Functions: Maximum, Minimum, Mean, Δmax-min, Standard Deviation and Allan Deviation
Display: Numeric or frequency distribution graph
Sample Size: 2 to 16x10^6 samples
Max. sample rate:

- up to 140 kSa/s calculated
- up to 20 MSa/s captured

Limit alarm

Graphical indication of limits with Pass/Fail message on front panel, and level shift on optional Pulse Output
Limit Qualifier: OFF or Capture values above, below, or inside limits

Sample Interval (Gate time)

The Sample Interval sets the measuring time (gate) in Frequency/Period/Power modes, the timing gate in Totalized timed measurements, and the time between measurements/samples in all other modes
Range:

- OFF or 50 ns to 1000 s

Mathematics

Functions: OFF, (K*X-L)/M, (K/X-L)/M, X/M-1
X is current reading, and K (Scale factor), L (Nulling value) and M (Reference value) are constants

Other Functions

Timebase Reference: Internal, External or Auto-selected
Restart: Aborts current measurement and starts a new
Run/Hold: Switch between RUN (continuous measurements) and HOLD (Freezes result, until a new measurement is initiated via Restart)

Save and Recall Settings and Measurements

Instrument Set-ups can be saved, recalled. & user protected.**Measurement results (RAM)** can be saved in connected PC, in internal non-volatile memory, and on USB stick.
Max. Measurement Speed and Storage size (RAM):
up to 20 MSa/s; 16 k values;
up to 12.5 MSa/s; 32M values; 1 channel
up to 6.25 MSa/s; 32M values; 2 parallel channels
up to 3.125 MSa/s; 32M values; 4 parallel channels
(Pulsed RF C uses 4 parallel channels)

Display

Display: Graphic screen for menu control, numerical read-out, status information, plus distribution, trend, time-line, and ADEV graphs
Resolution: 1280x720 pixels
Type: Color Touch 5" TFT LCD display with backlight
Accessible tools: Graph smoothing, pan and zoom, cursor read-out, max-min detection

Remote interfaces

Remote operation

Programmable Functions: All front panel accessible functions

Data Output format: ASCII, IEEE double precision floating point, or packed

USB interface

USB version: 2.0

Front panel connectors: 2x Type A; (Host) 5 V (nom.) max. 0.5 A. Used for FW updates, mouse/keyboard connection, external result storage, WiFi dongle.

Rear panel connector: 1x Type B; (Device) used for remote communication and data transfer both ways

Protocol: RNDIS (Ethernet over USB)

LAN & WLAN interface

Speed: 10/100/1000 Mbps

Capabilities:

- Web server
- SCPI over HiSLIP protocol, compatibility with VISA

Max. measurement rate (depending on input signal and measurement settings)**:**

Block mode: up to 170 k readings/s

Individual results: up to 425 readings/s

Continuous streaming: up to 20 k readings/s per channel

Supported WiFi USB-dongles:

TP-Link TL-WN321G, TP-LINK Archer T4U v.2, TP-LINK Archer T4U v.3

GPIB interface (Option 26)

Compatibility: IEEE 488.2-1987, SCPI 1999

Interface functions: SH1, AH1, T6, L4, SR1, RL1, E2, DC1

Max. measurement rate (depending on input signal and measurement settings)**:**

Block mode: up to 7.3 k readings/s

Individual results: up to 220 readings/s

Internal Calibration

Timebase Oscillator

Mode: Closed case, electronic calibration, menu controlled. Calibration menu is password protected.

Ref. Cal. Frequencies: 1, 5, 10, 1.544 or 2.048 MHz

Power reference

Mode: Closed case, electronic calibration, menu controlled. Calibration menu is password protected.

General Specifications

Environmental Data

Class: MIL-PRF-28800G, Class 3

Installation category: II

Operating Temp:

0°C to +50°C / 5 to 75% RH, bench-top,
0°C to +40°C / 5 to 75% RH, rack-mount

Storage Temp: -40°C to +71°C

Max altitude: 4600 m

Vibration: Random and sinusoidal according to MIL-PRF-28800G, Class 3

Shock: Half-sine 30G per MIL-PRF-28800G; Bench handling

Transit drop test: According to MIL-PRF-28800G

Safety: EN 61010-1:2011, pollution degree 2, installation/over voltage category II, measurement category I, CE, indoor use only
CSA C22.2 No 61010-1-12

EMC: EN 61326-1:2013-06, increased test levels according to EN 61000-6-2:2008, Group 1, Class B, CE

Power Requirements

Mains Voltage: 100 to 240 V_{AC} (nom.)

Mains Frequency: 50 to 60 Hz (nom.); 400 Hz[1] (nom.)

Power: <70 W; max. configuration

1: Safety certificate to 60 Hz (nom.)

Dimensions and Weight

Width x Height x Depth: 210 x 90 x 395 mm (8.25 x 3.6 x 15.6 in)

Weight: Net 3 kg (6.6 lb)

Ordering Information

Basic model

PFA-127: RF Power & Frequency Analyzer, 2x 400 MHz plus 1x 15 GHz inputs, 14 ps resolution, std. TCXO timebase

Timebase Oscillator options

Option 30: Very High Stability, OCXO $5x10^{-8}$/year

Option 40: Ultra High Stability, OCXO $1.5x10^{-8}$/year

Input C Frequency upgrade options[2]

Option 115/20: upgrade from 15 to 20 GHz (SW license)

Option 115/27: upgrade from 20 to 27 GHz (SW license)

NOTE: *Upgrade from 15 to 27 GHz requires purchase of both options 115/20 and 115/27.*

Other options (SW license enabled)[2]

Option 121: Upgrade resolution from 14 ps/timestamp to 7 ps/timestamp

Option 132 Enable pulse output 0.5 Hz to 100 MHz

Option 151 Add TIE measurements

Option 152: Frequency offset function for accurate and easy guided frequency calibration

Option 161 Add Allan Deviation graph view to user interface

2: These options can be installed at any time by the user

Other options (HW)[3]

Option 11A: rear panel inputs for input A and B

Option 11C: rear panel inputs for input C

Option 26: Add GPIB interface

3: These HW options are factory installed

Calibration and services options

- **Option 90/00:** Timebase aging measurement with report, per week. ***NOTE*** This option includes NO Calibration, which must be ordered separately
- **Option 90/03:** Timebase Calibration Certificate with Protocol; Standard TCXO oscillator
- **Option 90/06:** Timebase Calibration Certificate with Protocol; Oven oscillator
- **Option 90/06A:** Accredited ISO 17025 time-base Calibration certificate w. protocol, Oven oscillator
- **Option 92/27:** RF Power measurement calibration, with protocol.
- **Option 95/05:** Extended warranty 2 extra years
- **Option 99/11:** Service agreement 1 year. Includes yearly functional check, calibration of time-base oscillator, calibration of RF Power, priority repair and more. See separate data sheet. ***NOTE:*** the Service agreement is not available in all countries. Please contact Pendulum Instruments.

Included with Instrument:

- 2 year product warranty[4]
- Line cord (*dependent on destination country*)
- Link to User documentation
- Certificate of Calibration
- Important information document

4: Warranty period may be extended to 3 years, at no cost, by registrating the product

Optional Accessories

- **Option 22/90:** Rack-Mount Kit- 1 unit
- **Option 22/05:** Rack-Mount Kit -2 units
- **Option 27:** Carrying Case - soft
- **Option 27H:** Heavy-duty Hard Transport Case
- **Option 31:** GPIB connector extender: needed for simultaneous connection of GPIB and Ethernet cables
- **OM-127:** User's Manual English (printed)[5]
- **PM-100:** Programmer's Manual English (printed)[5]
- **SM-100:** Service Manual English

5: Always available on-line, or as downloadable PDF, from the Pendulum website

Time Base Options

Option model	Standard	30	40
Time base type:	TCXO	OCXO	OCXO
Uncertainty due to: -Aging per 24h per month per year -Temperature variations: 0˚C to 50˚C 20˚C to 26˚C (typ. values)	 n/a <$2x10^{-7}$ (typ.) <$1x10^{-6}$ <$5x10^{-7}$ n/a	 <$5x10^{-10}$ (6) <$1x10^{-8}$ <$5x10^{-8}$ <$5x10^{-9}$ $<1x10^{-9}$	 <$3x10^{-10}$ (6) <$3x10^{-9}$ <$1.5x10^{-8}$ <$2.5x10^{-9}$ $<4x10^{-10}$
Short-term stability: τ =1s (root Allan Variance) τ =10s	<$1x10^{-9}$ (typ.)	$<1x10^{-11}$ $<1x10^{-11}$	$<1x10^{-12}$ $<1x10^{-12}$
Power-on stability: Deviation vs. final value after 24 h on time, after a warm-up time of:	 <$1x10^{-6}$ 5 min	 <$1x10^{-8}$ 10 min	 <$5x10^{-9}$ 10 min
Typical total uncertainty, for operating temperature 20˚C to 26˚C, at 2σ (95%) confidence interval: -1 year after calibration -2 years after calibration	 <$1.2x10^{-6}$ <$2.4x10^{-6}$	 <$6x10^{-8}$ <$1.2x10^{-7}$	 <$1.8x10^{-8}$ <$3.5x10^{-8}$

4: After 1 month of continuous operation

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Specifications subject to change or improvements without notice.

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pendulum

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