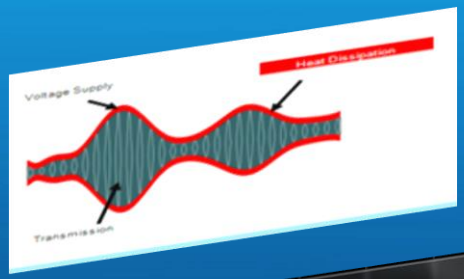
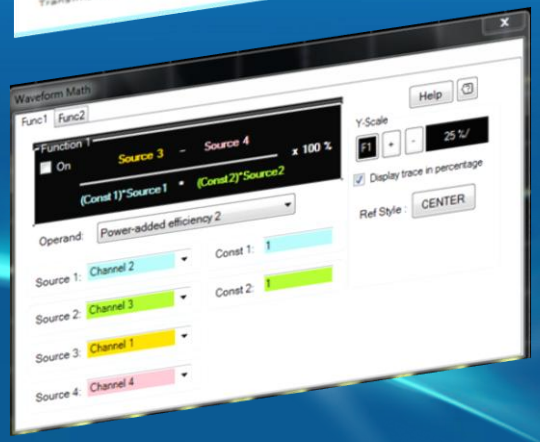
Envelope Tracking 을 적용한 Power Amp의 PAE 최신 측정법 소개





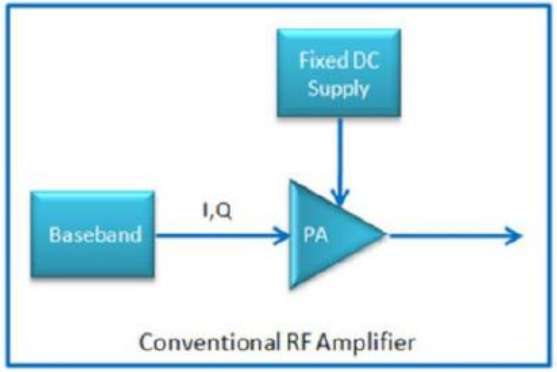
Agenda

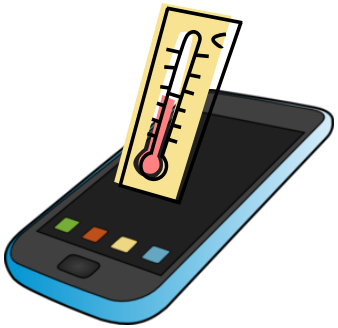
- Envelope Tracking (ET) Overview（New emerging technology)
- Power Added Efficiency (PAE) test overview
- PAE test set up using 8990B peak power analyzer
- Other 8990B test parameters in ET application
- Overview of 8990B

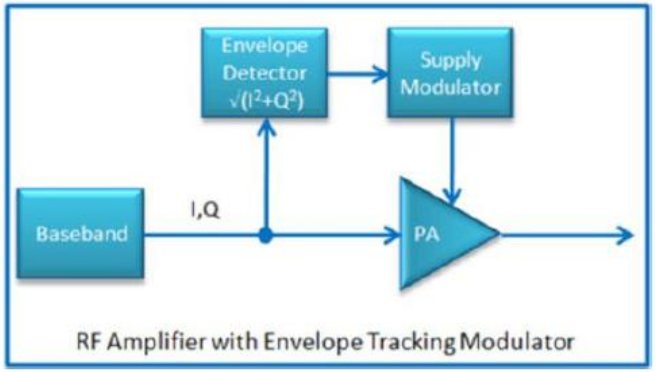
Envelope Tracking (ET) Overview

Saves Battery Life of Smartphones and handsets

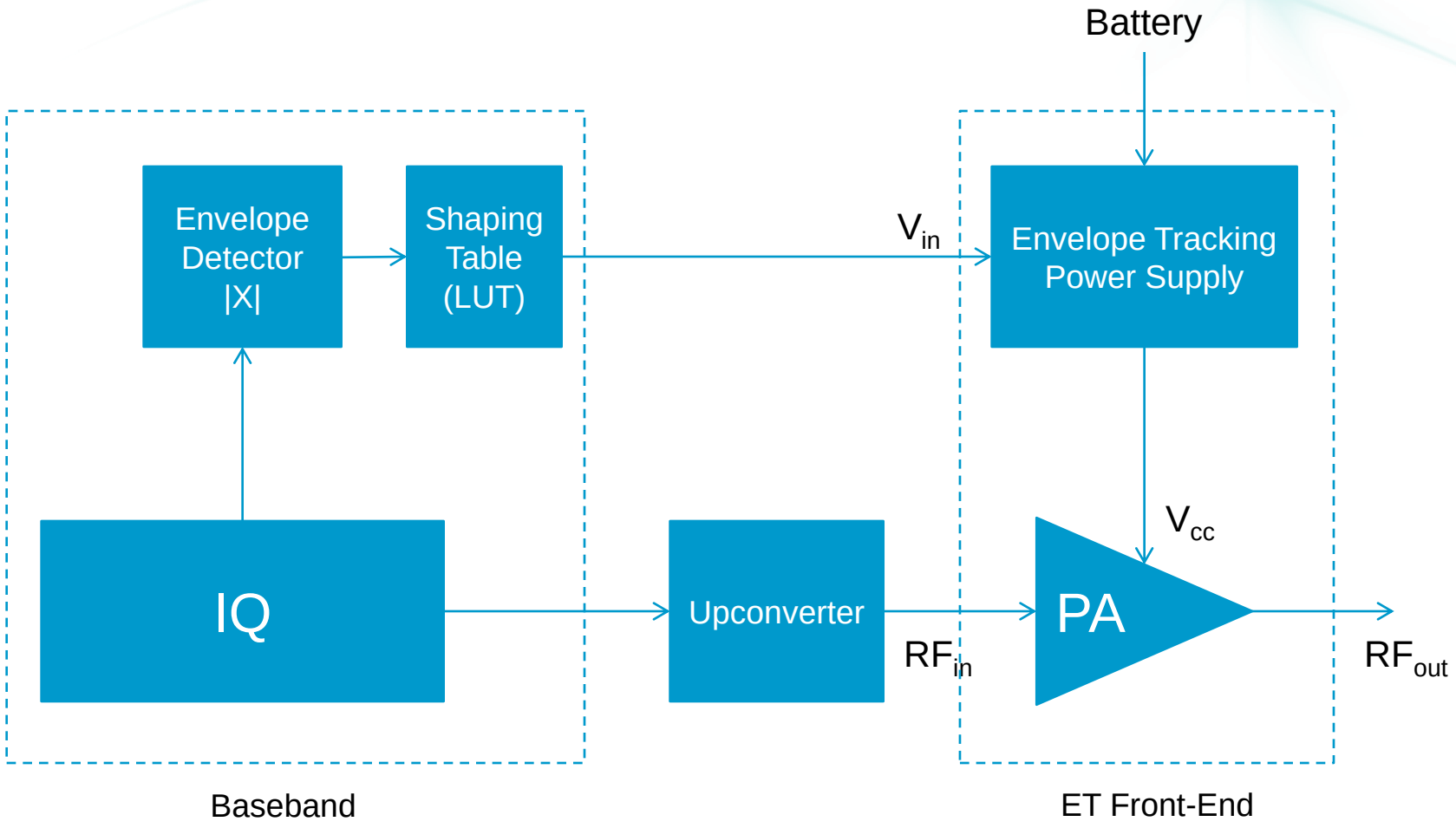
Source: OpenET Alliance







ET System Block Diagram

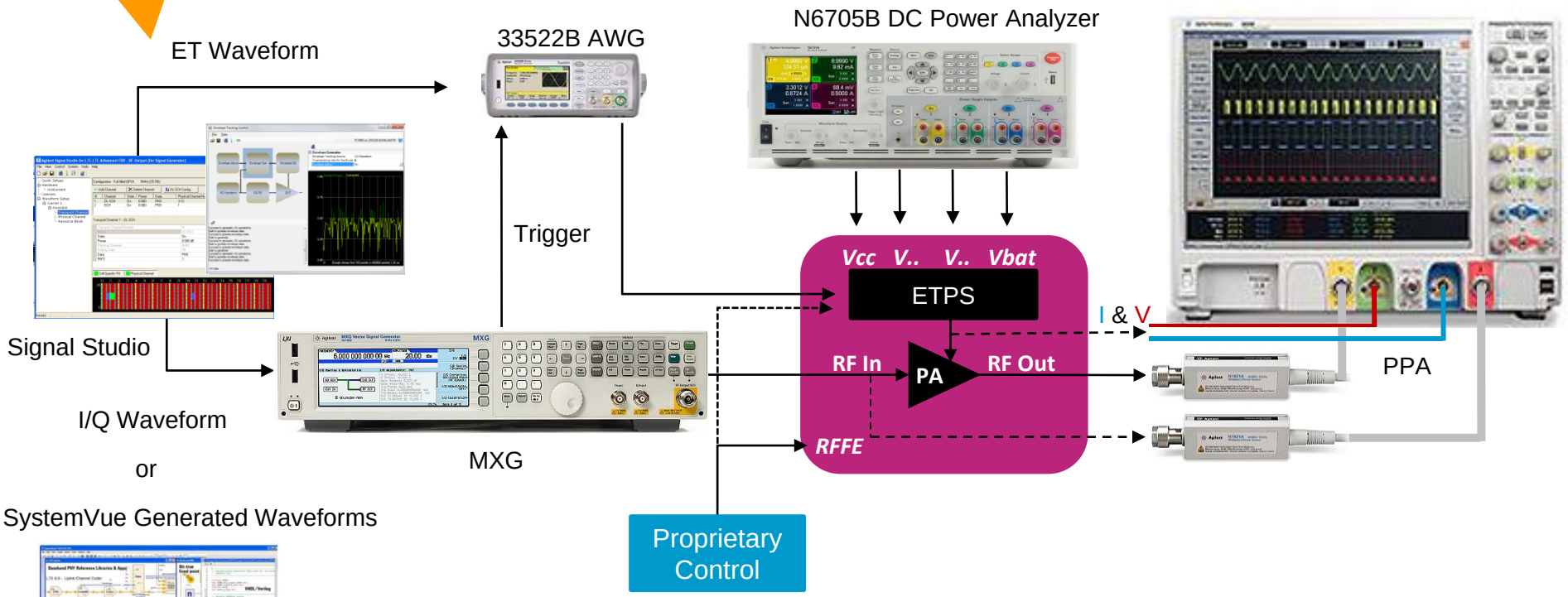


ET Measurement setup/ block diagram

Waveform creation includes shaped envelope & envelope download

High performance, low cost envelope generation

Time alignment & linearity (AM/AM, Gain compression, PAE)

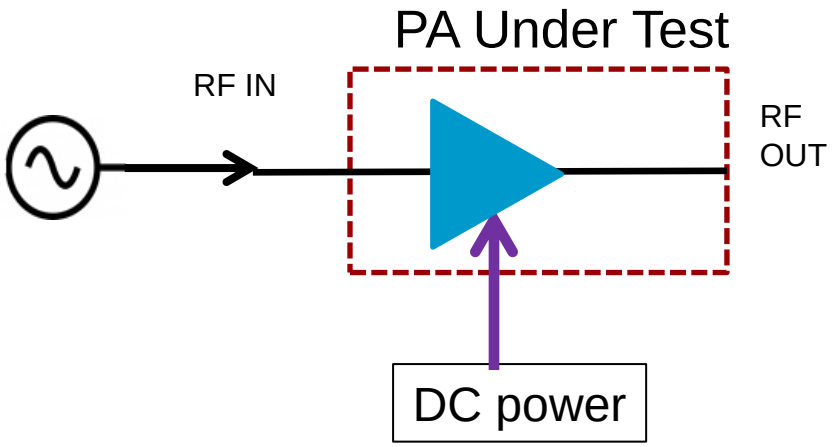


8990B PPA provide simplified PAE testing with 1 box solution (2 RF & 2 analog channel) for amplitude and timing solution.

PAE Test Overview

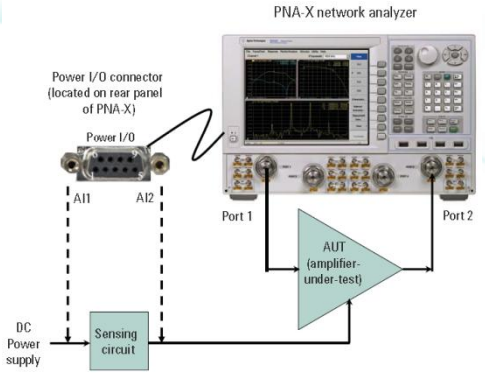
- PAE is one of the most important test parameters in Envelope Tracking application。
- Other parameters include gain, output power, S-parameters, P_{1dB}, IP_3, etc
- PAE is ：

$$\text{PAE (in percentage)} = \frac{\text{Power (RF\_out)} - \text{Power (RF\_in)}}{\text{Power\_dc}} * 100\%$$



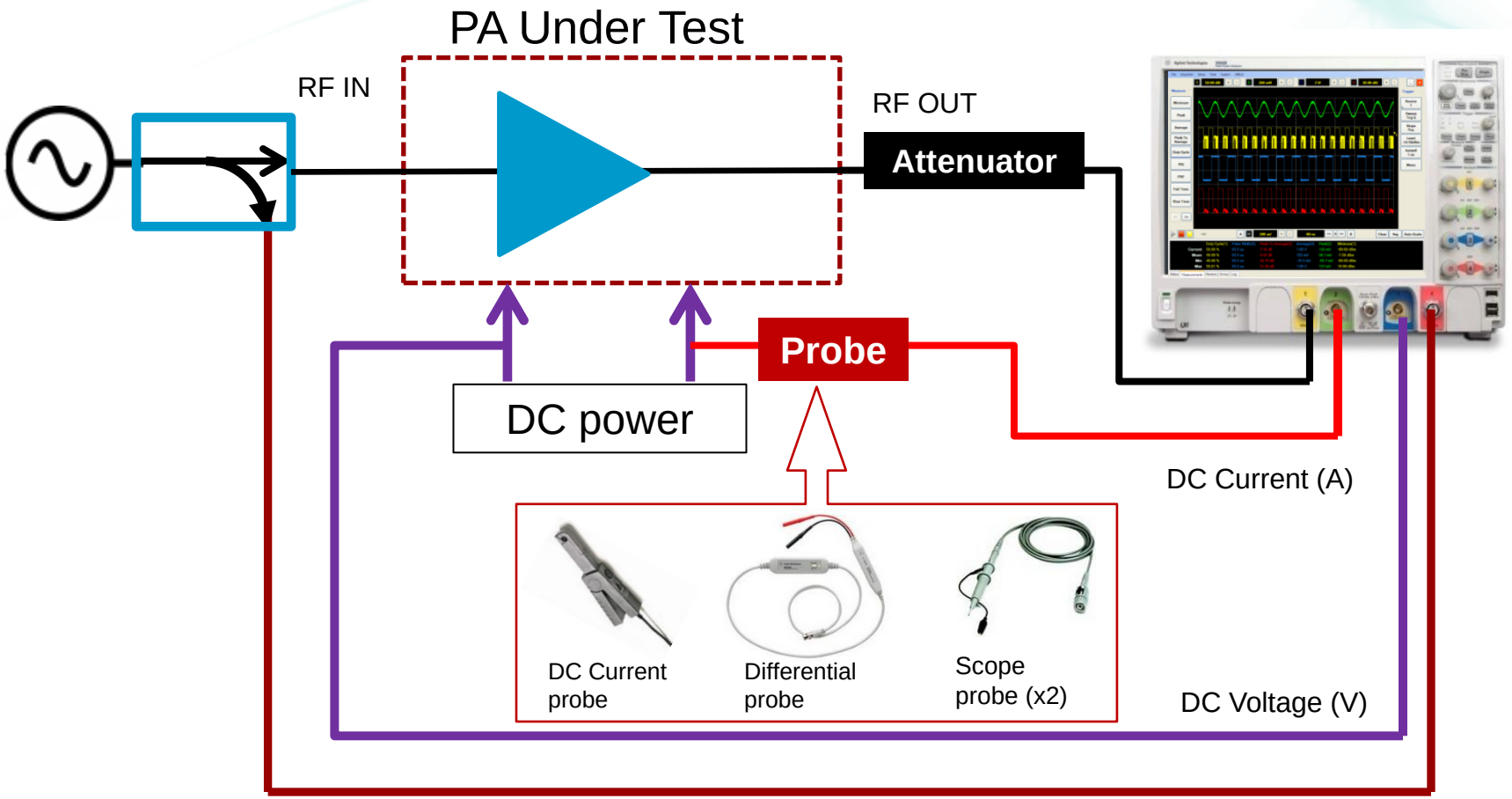
How to measure PAE?

- Using PNA
- DC power analyzer + power meter/sensor
- DC power analyzer + scope (with RF detector)
- DVM + Power meter/sensors
- Oscilloscope (for DC power) + detector (for RF power)
- **8990B Peak Power Analyzer**



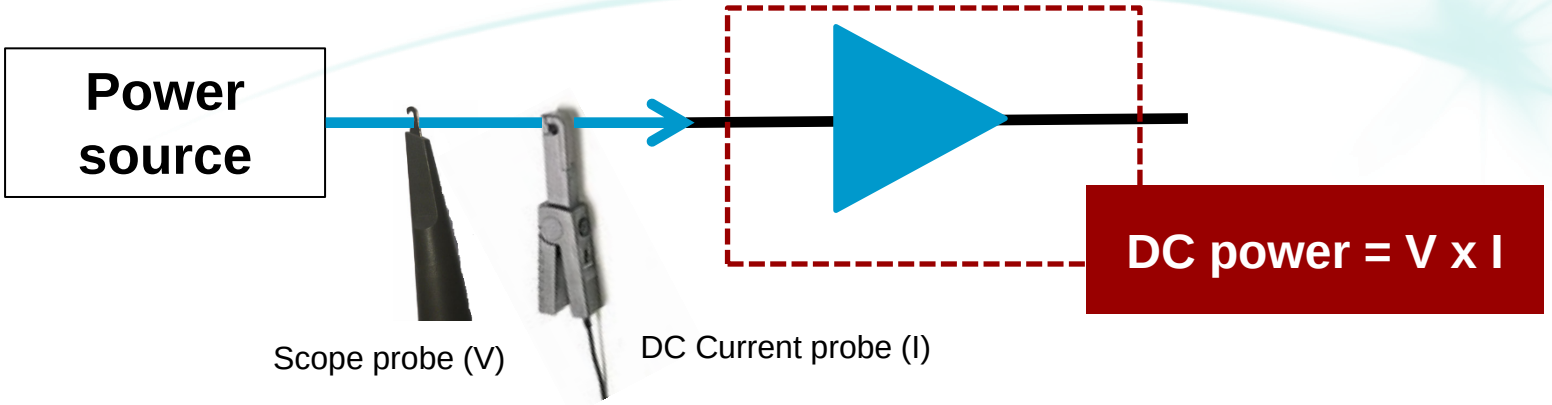
Each solutions has its pro and cons, and depends on the user preferences

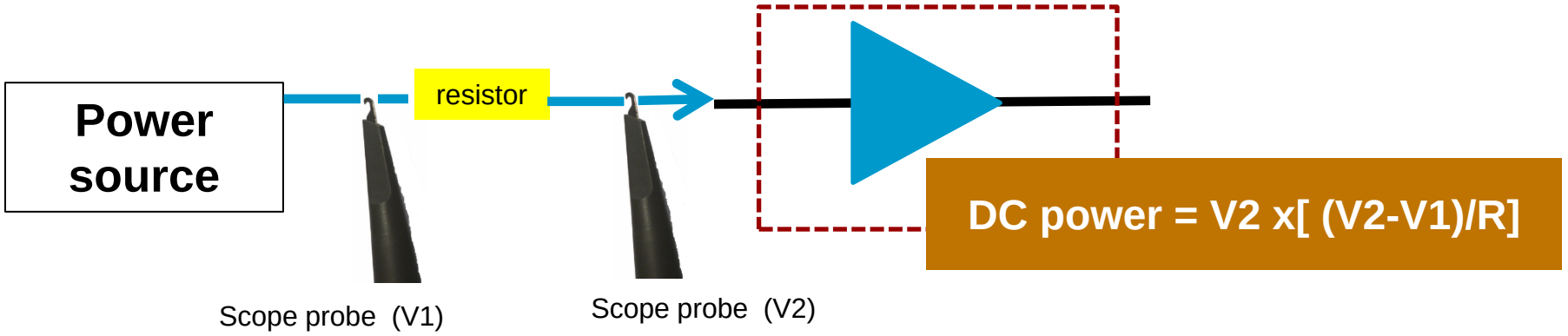
8990B Power Added Efficiency Test

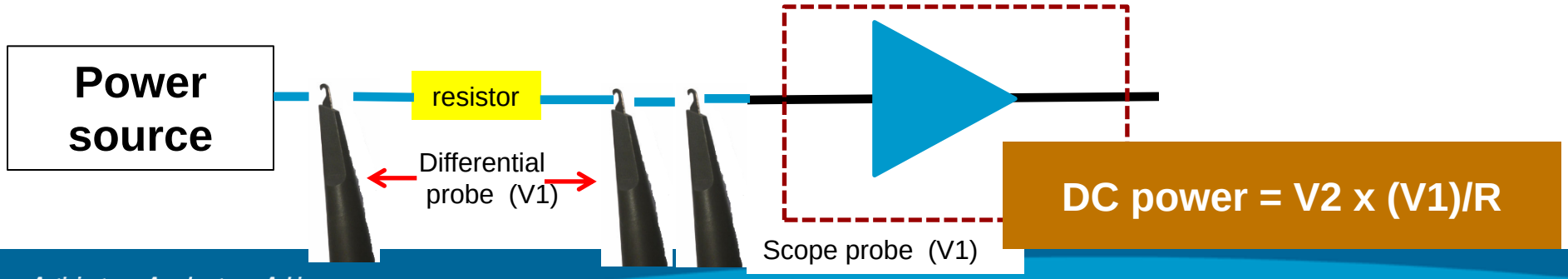


Measure RF, Voltage and Current in one box

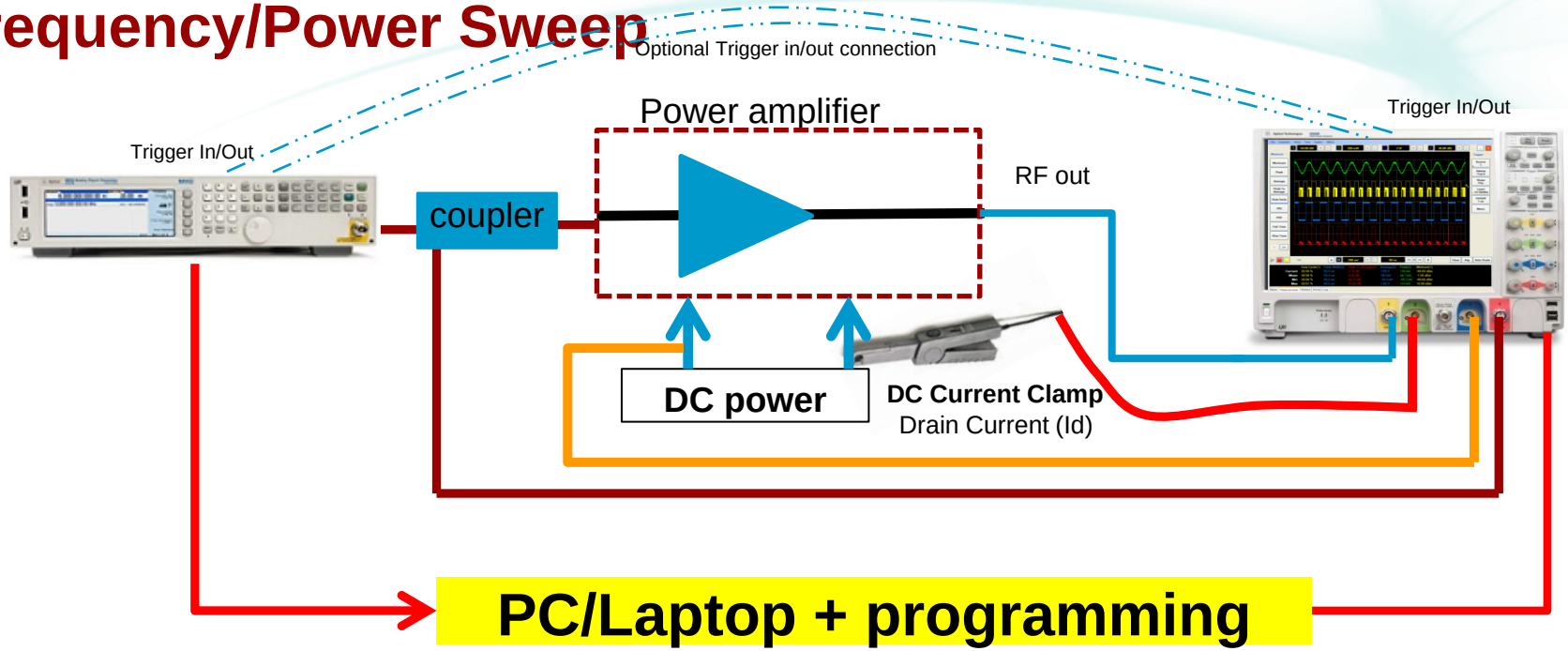
8990B Power Added Efficiency Test – DC power test





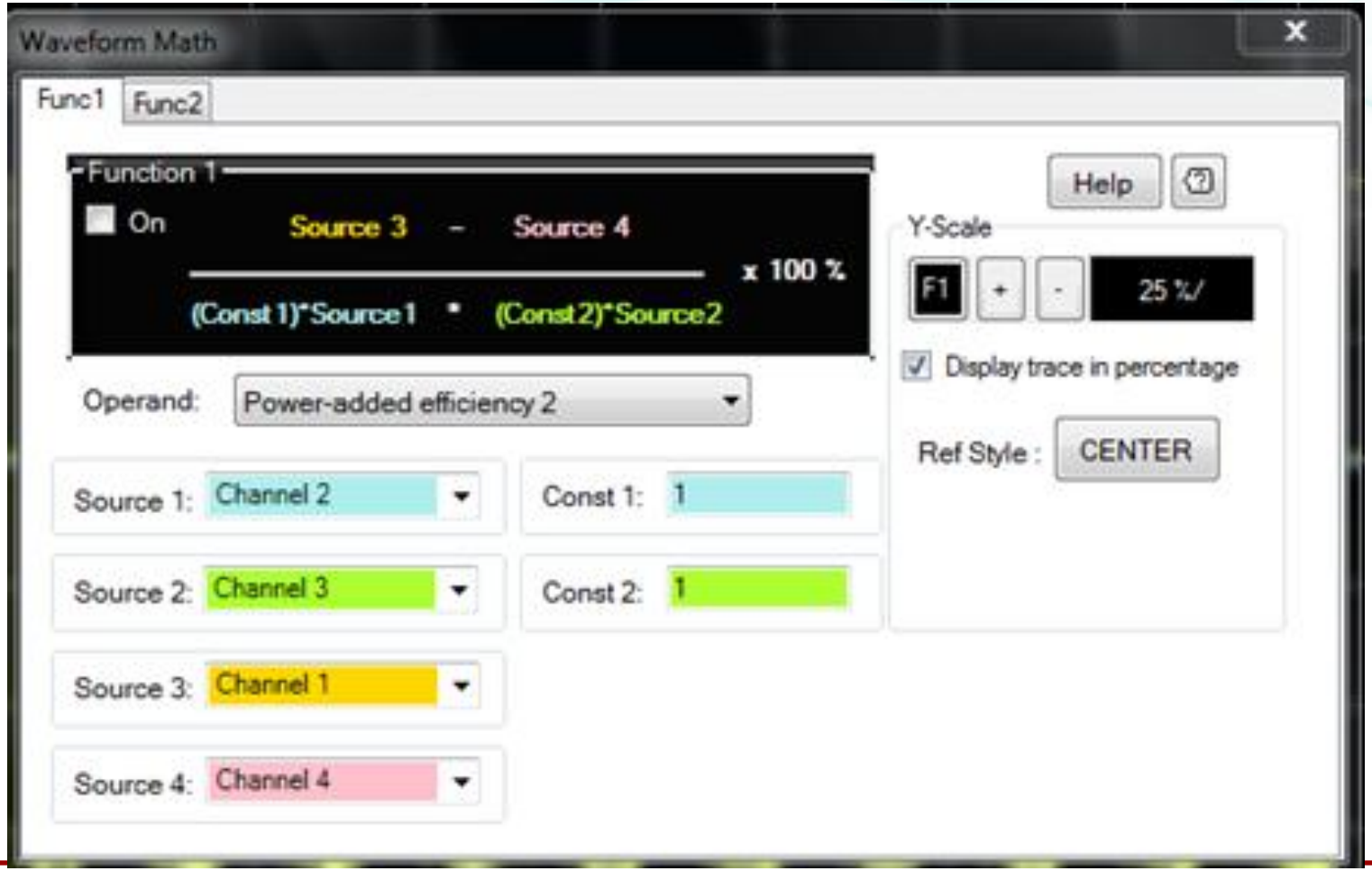


8990B Power Added Efficiency Test – Frequency/Power Sweep



- Utilizing remote programming (SCPI, VEE, LabView etc), the signal source can be programmed to sweep power or frequency
- The 8990B PPA can compute the PAE result versus frequency of versus input power, or versus output power

8990B Power Added Efficiency Test – Waveform Math



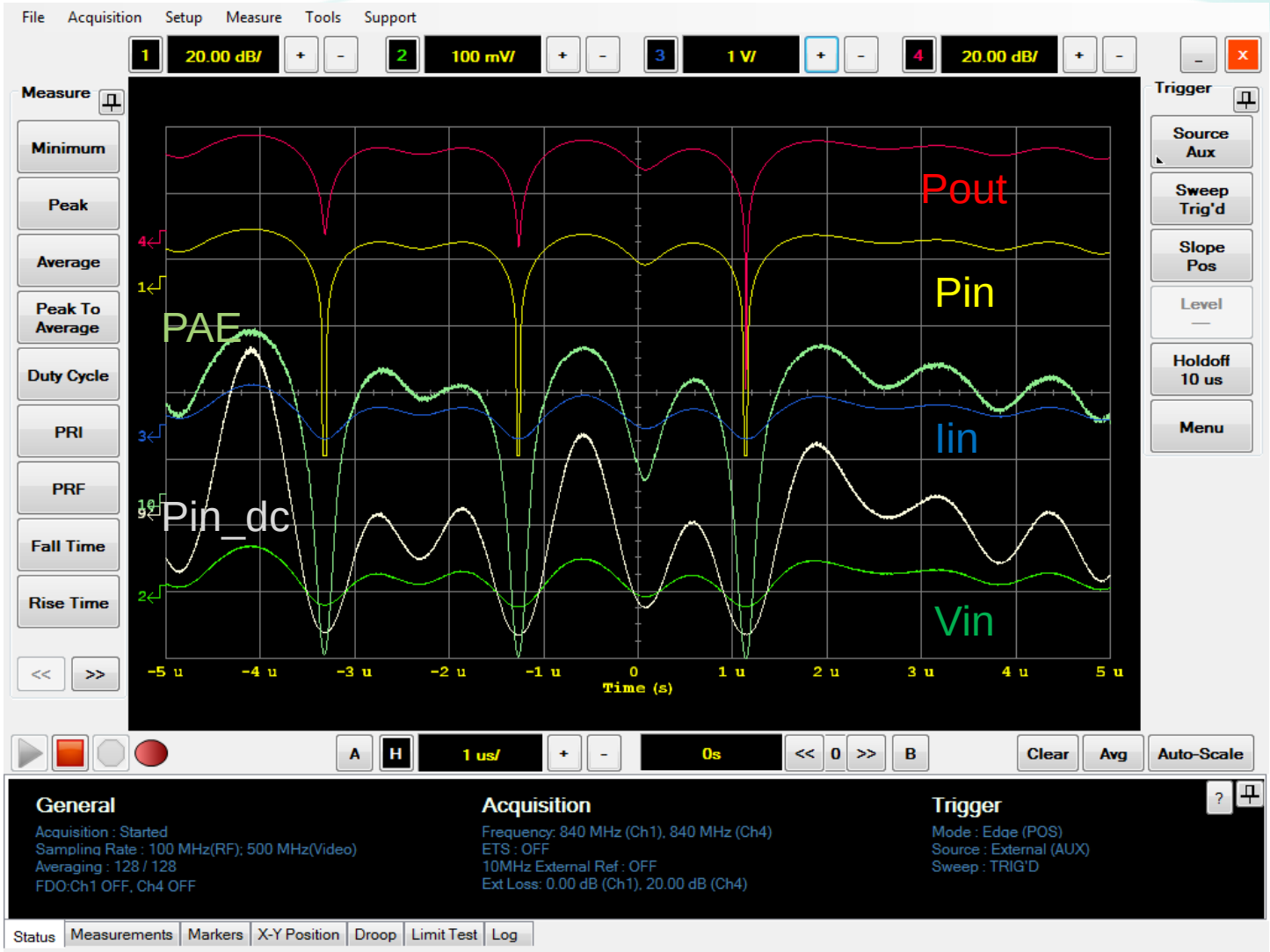
1) Go to Setup → Waveform Math
2) Choose from the pull down menu:
3) Newly added: Power Added Efficiency 1 and 2
4) To get PAE measurement result → click the “Average” and choose Function 1 or 2

8990B Power Added Efficiency Test – Trace Display & Calculation

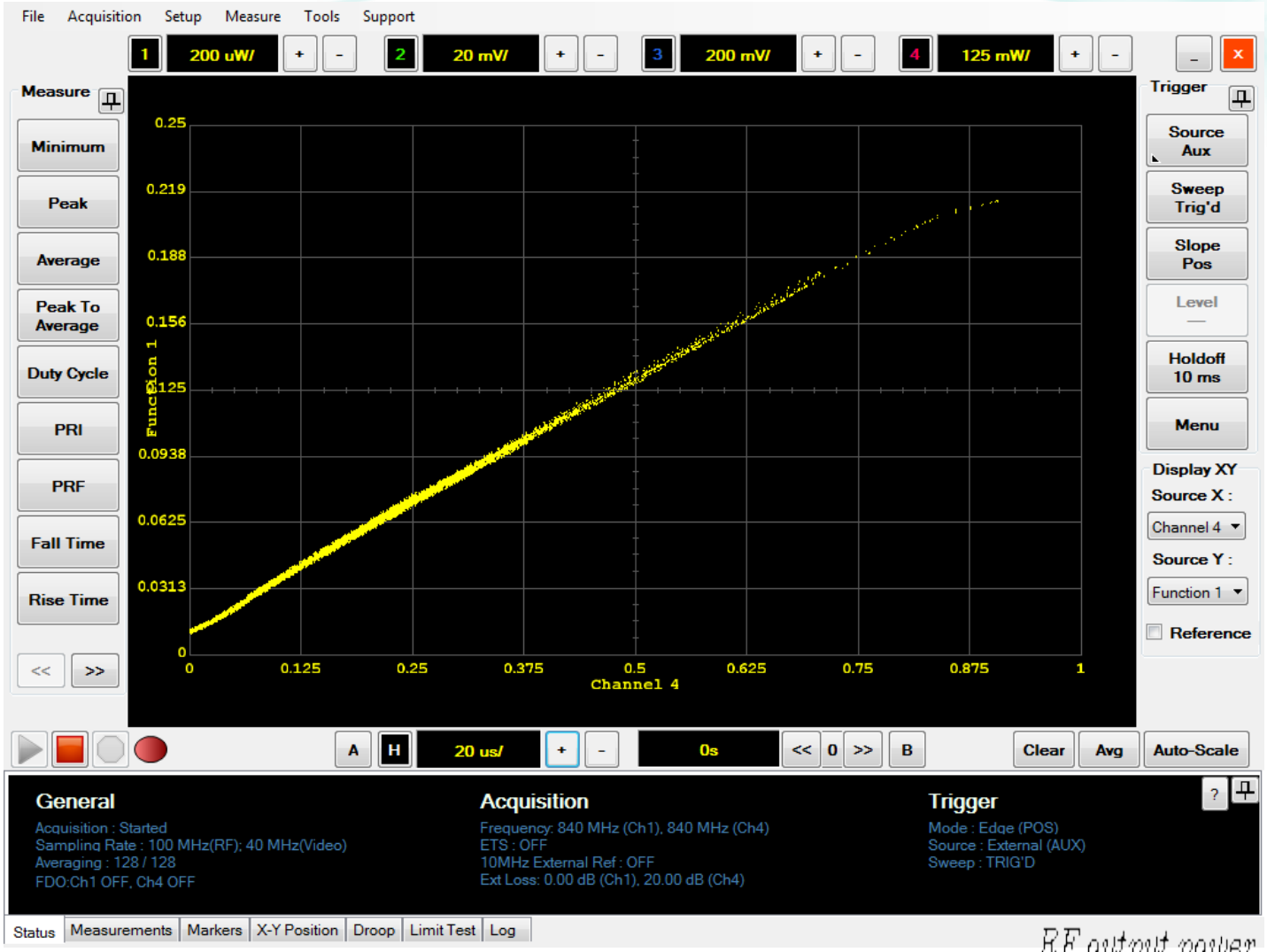
8990B displaying all 4 waveforms

8990B displaying PAE waveform (white trace)

Display all the time traces

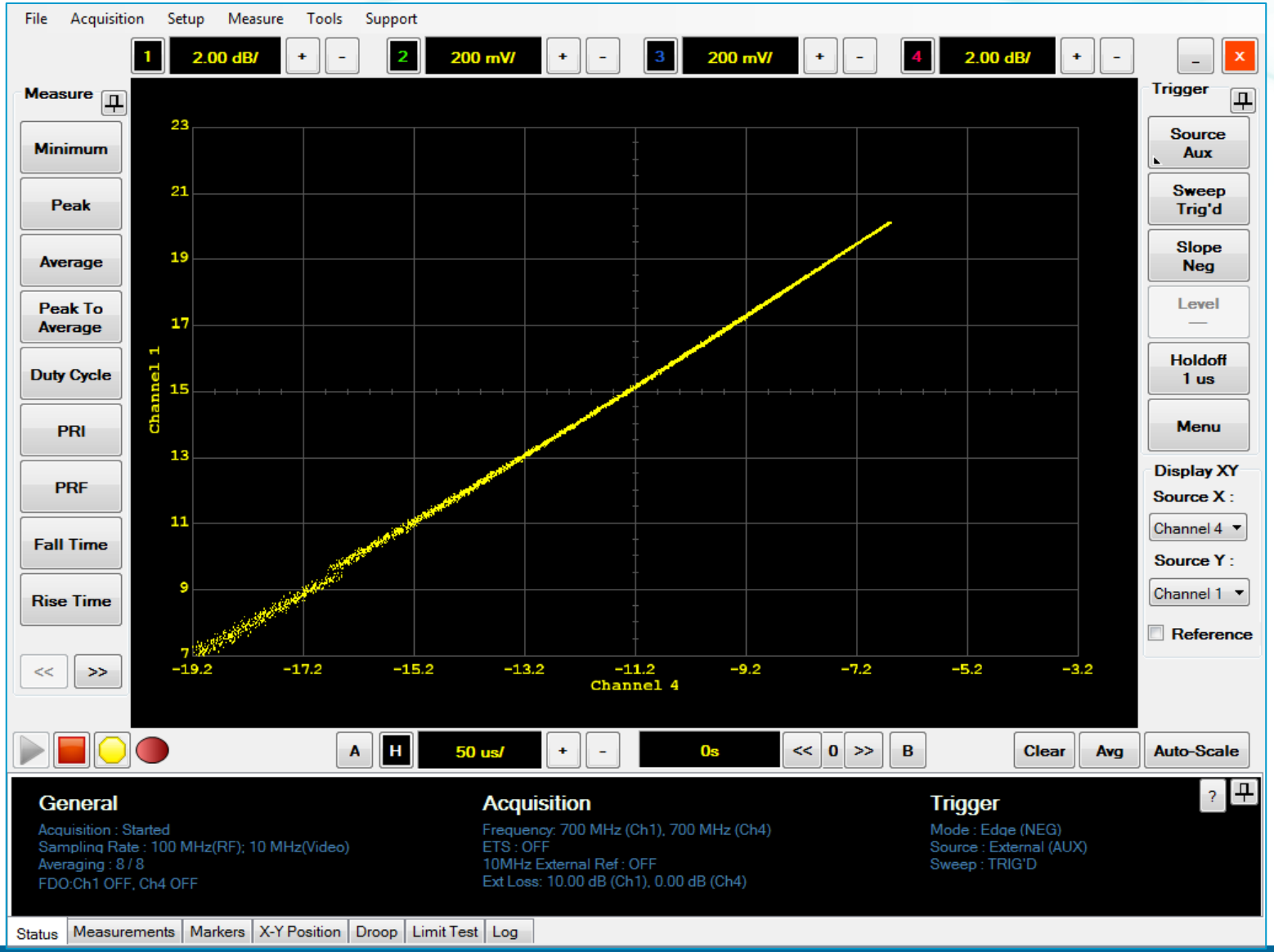


DC_Input Power vs Output Power

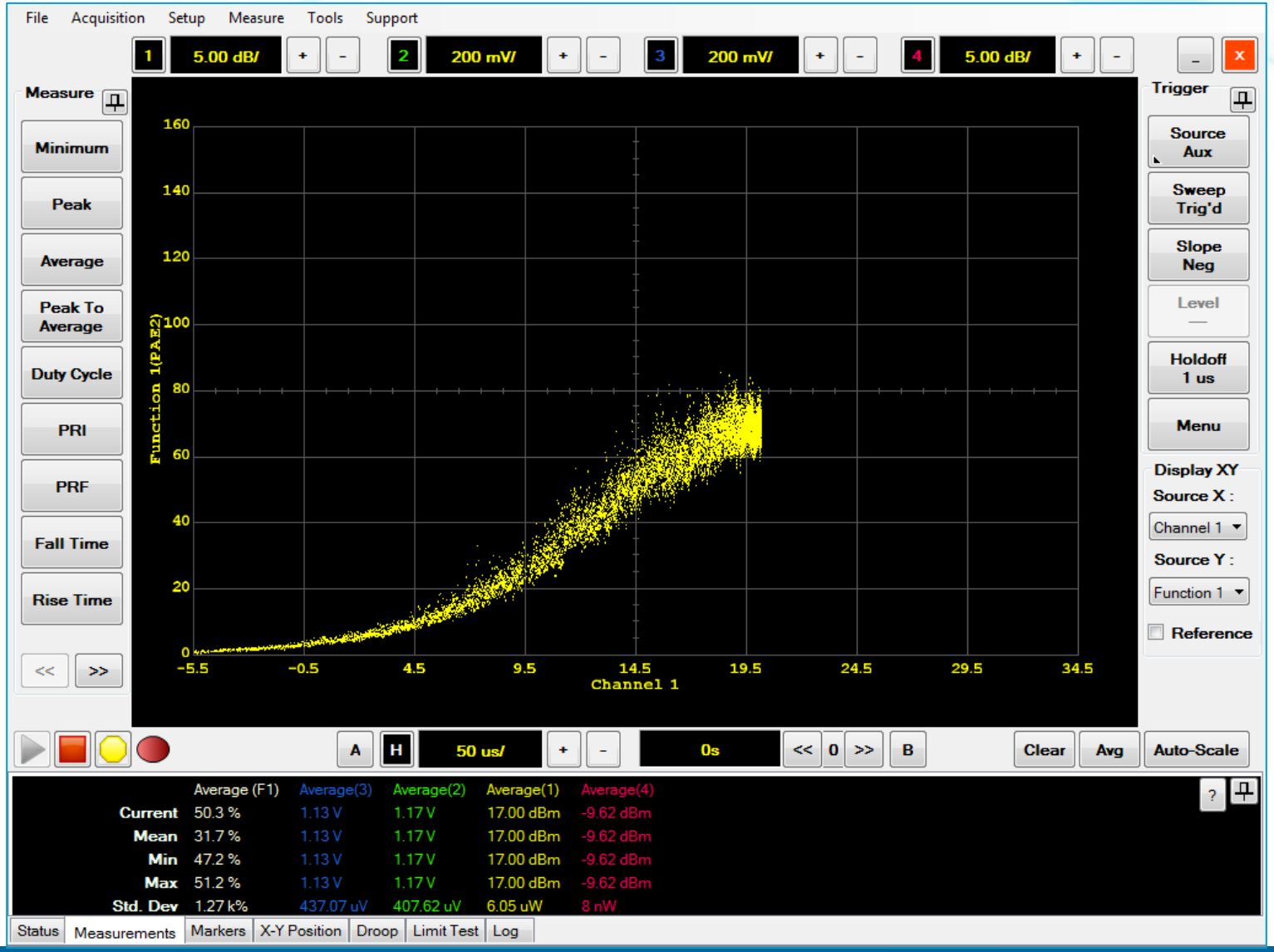


$$Efficiency = \frac{RF\ output\ power\ (W)}{DC\ input\ power\ (W)} \times 100 \quad (\%)$$

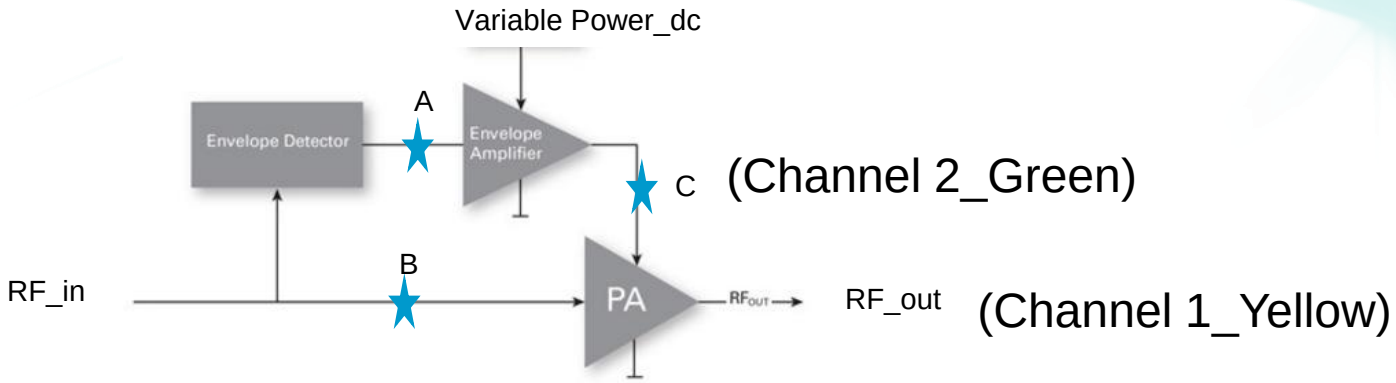
Pout vs. Pin Plot (XY Display function)

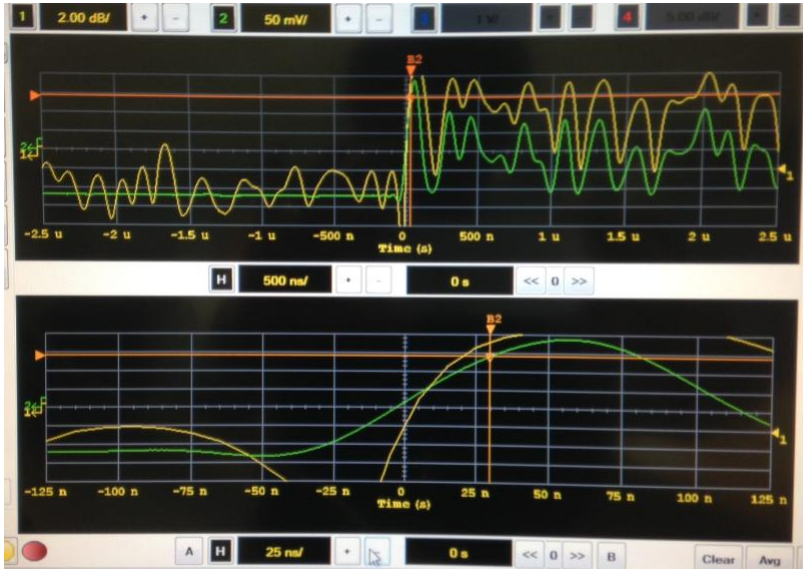


PAE vs. Pout Plot (XY Display Function)



8990B PPA Other Applications in Envelope Tracking

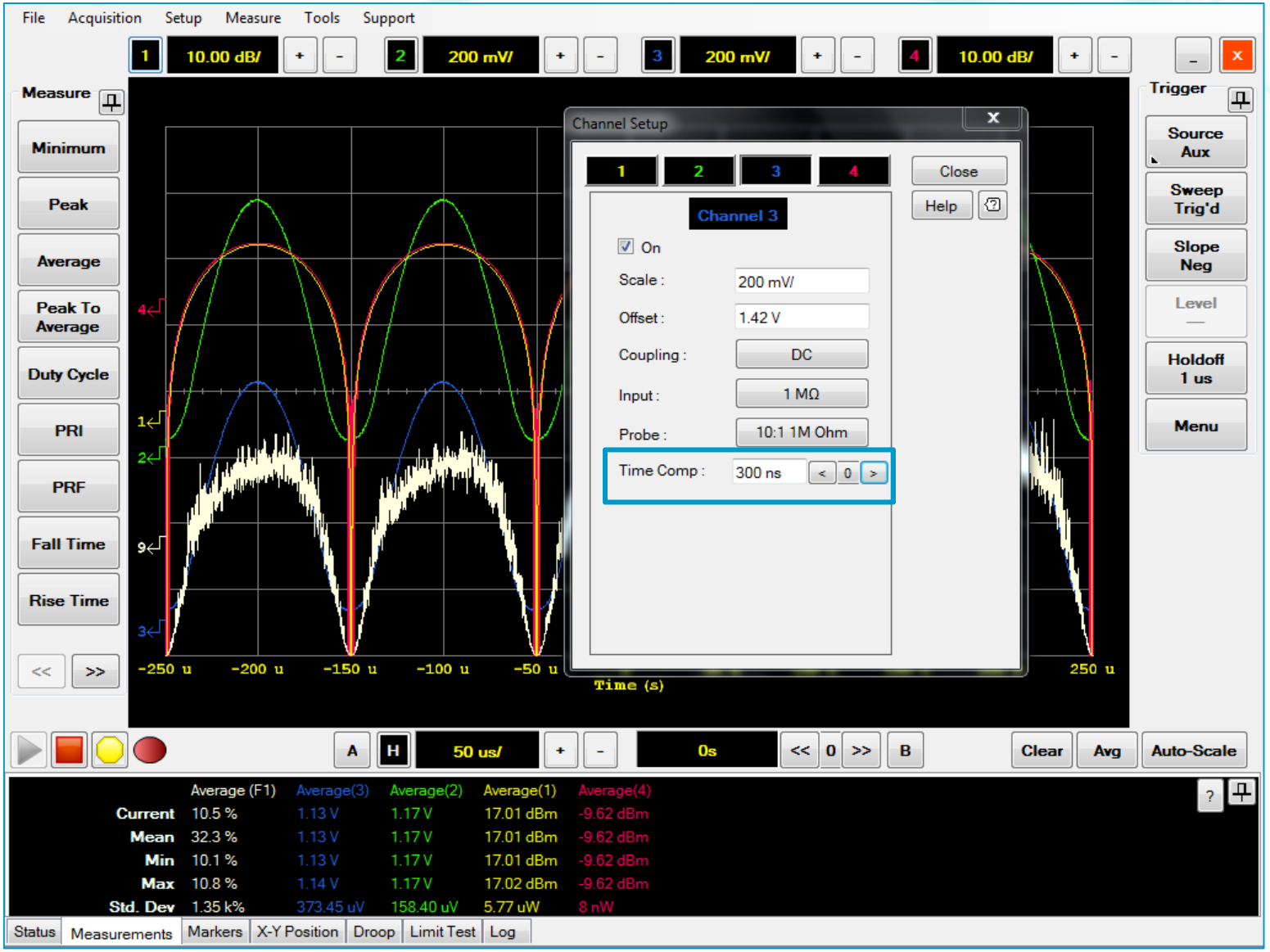




Timing analysis of variable DC_Power (**Green**) versus the RF envelope (**Yellow**)

8990B PPA zoom features and markers measurement between the two signals

Time Compensation Function



8990B PPA's Value for measure PAE

- **Measure amplifier linearity versus RF frequency:** 8990B provides fast, cost effective way of providing dual channel wideband envelope analysis
- **Measure PAE:** 8990B has internally synchronised capture of supply current/voltage and RF waveforms
- **One-Box-Solution:** though having all the measurement results in one instrument

Agilent Peak Power Analyzer 8990B

Key Applications

- Radar pulse analysis
- Wireless standard/ non-standard pulse measurement

Key Specifications

- Frequency Range: 50MHz to 40GHz (sensor dependent)
- System Rise / Fall Time: 5nsec (-20 to +20 dBm)
- Video BW: 30MHz (single shot)
  150MHz (repetitive)
- Dynamic Range: -35 to +20 dBm (CW)
  -25 to +20 dBm (Pulse)
- Sampling Rate: 100 MSa/sec

Key Features

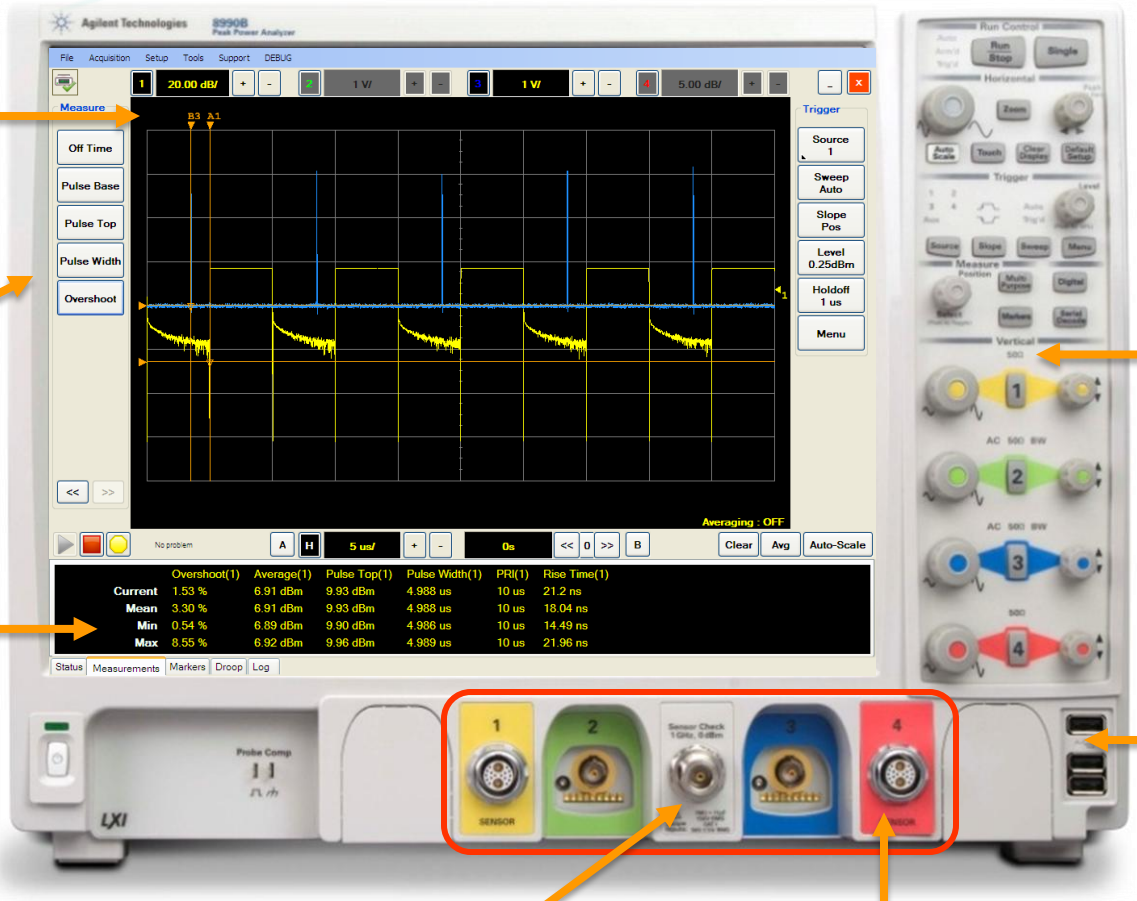
- ✓ 15” XGA Color Display + Touch Screen
- ✓ 4 channels (Two RF and two Analog)
- ✓ Internal Zero and Calibration
- ✓ 15 Pulse Characterization Measurements
- ✓ Multi-Pulse Analysis Features
- ✓ Added Power Added Efficiency math function
- ✓ Automatic pulse delay measurement between channels

8990B Peak Power Analyzer Overview

15 inch XGA color display + Touch Screen

Soft key menu

15 automatic pulse characteristics measurements



Interactive controls with color coded knobs for each channel.

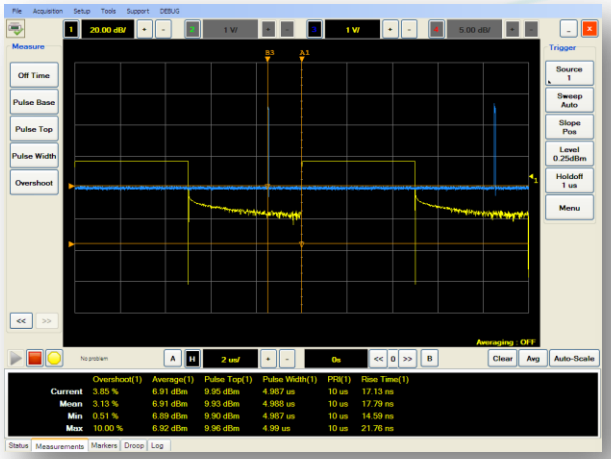
Standard Agilent Oscilloscope knobs layout – easy to get familiarize

Easy waveform storage

1.05GHz absolute Accurate source for calibration

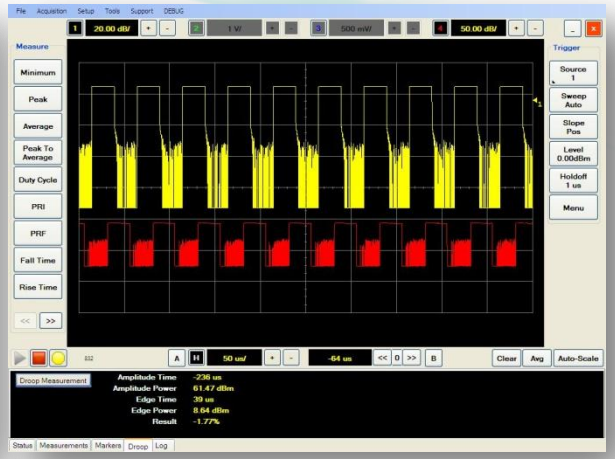
Two RF channels and two Analog channels with color coded

8990B other features

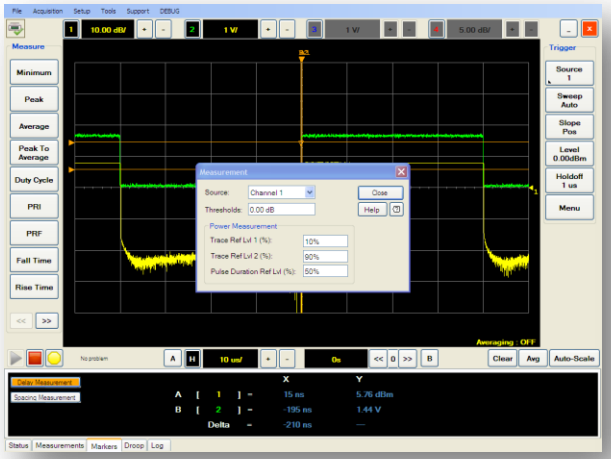


Test Screen

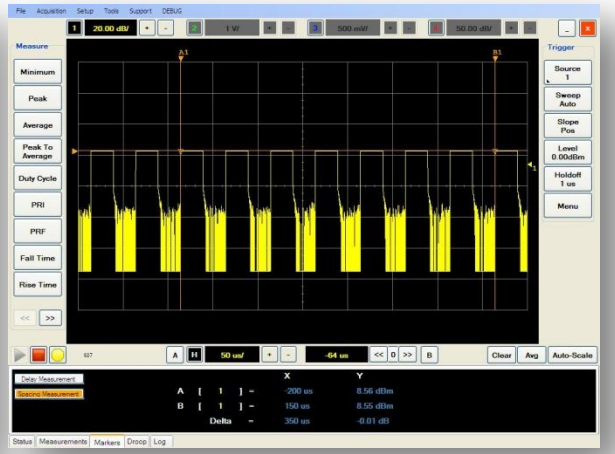
Automatic Time-Delay Measurement



Automatic Droop Measurement



Threshold Settings



Pulse Spacing Measurements

Zoom Function

For more information

1. Agilent official website – www.agilent.com/find/powermeter

2. PAE application note – http://cp.literature.agilent.com/litweb/pdf/5991-2677EN.pdf

3。8990B Peak Power Analyzer Datasheet：
http://cp.literature.agilent.com/litweb/pdf/5990-8126EN.pdf

4. Solutions and Measurement Tools for Use in Average Power and Envelope Tracking Design
http://cdm.marketing.agilent.com/Wireless%20-%20LTE/App%20Notes/Envelope%20Tracking_5991-0797EN%202-6-13x.pdf

Q & A