

# Vector Signal Generator

## Model AP5041A and AP5042A

Single- and Multi-Channel Performance Generators  
100 kHz to 40 GHz



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# Definitions and Conditions

**Specifications** represent warranted performance of a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature 23 °C, unless otherwise stated, and after a 45-minute warm-up period. The specifications include measurement uncertainty. Data represented in this document are specifications unless otherwise noted.

**Nominal** (nom) values indicate the expected mean or average performance, or an attribute whose performance is by design, such as the 50-ohm connector. This data is not warranted and is measured at room temperature (approximately 23 °C).

**Measured** (meas) describes an attribute measured during the design phase for purposes of communicating expected performance, such as amplitude drift vs. time. This data is not warranted and is measured at room temperature (approximately 23 °C).

# Channels

| Model   | Channel Count                               |
|---------|---------------------------------------------|
| AP5041A | 1                                           |
| AP5042A | 1, 2, 3 or 4 independent and phase coherent |

# Frequency

| Frequency Option | CW Frequency Range | Settable CW Frequency Range | RF Output Connector (AP5041A) | RF Output Connector (AP5042A) |
|------------------|--------------------|-----------------------------|-------------------------------|-------------------------------|
| 504              | 100 kHz to 4 GHz   | 100 kHz to 4.15 GHz         | Type-N (f)                    | SMA (f)                       |
| 506              | 100 kHz to 6 GHz   | 100 kHz to 6.6 GHz          | Type-N (f)                    | SMA (f)                       |
| 512              | 100 kHz to 12 GHz  | 100 kHz to 12 GHz           | Type-N (f)                    | SMA (f)                       |
| 520              | 100 kHz to 20 GHz  | 100 kHz to 20 GHz           | 2.92 mm (m)                   | SMA (f)                       |
| 540              | 100 kHz to 40 GHz  | 100 kHz to 43.5 GHz         | 2.92 mm (m)                   | 2.92 mm (f)                   |

## Frequency Resolution

|    |          |
|----|----------|
| CW | 0.001 Hz |
|----|----------|

## Phase Adjustment

|                         |            |
|-------------------------|------------|
| Phase offset range      | 0° to 360° |
| Phase offset resolution | 0.01°      |

## Frequency Switching Modes

|    |                                                                                                                            |
|----|----------------------------------------------------------------------------------------------------------------------------|
| F1 | Normal mode (random phase)                                                                                                 |
| F2 | Phase coherent switching (Opt. PHS):<br>Between $\geq 2$ AP504xA units using Option SNC or between channels in one AP5042A |
| F3 | Phase calibratable mode (Opt. PCM) (supported to 20 GHz only)                                                              |

# Frequency Reference

| Frequency Accuracy            | Option LN1             |                | Option LN2     |
|-------------------------------|------------------------|----------------|----------------|
| Initial accuracy (nom)        | $\pm 10$ ppb           |                |                |
| Aging rate (nom) <sup>1</sup> | First year             | $<\pm 500$ ppb | $<\pm 20$ ppb  |
|                               | Per day                | $<\pm 5$ ppb   | $<\pm 0.5$ ppb |
| Temperature effects (nom)     | Full temperature range | $<\pm 100$ ppb | $<\pm 20$ ppb  |

## External Reference Input

|                   |                                           |
|-------------------|-------------------------------------------|
| Mode              | Phase lock to external reference          |
| Frequency         | 10 MHz                                    |
| Input power (nom) | -5 dBm to +10 dBm                         |
| Impedance (nom)   | 50 $\Omega$                               |
| Lock range (nom)  | $\pm 1.5$ ppm<br>$\pm 0.3$ ppm (Opt. LN2) |
| Connector         | BNC (f)                                   |

## Flexible Reference Input (Option 1ER)

|                      |                                                      |
|----------------------|------------------------------------------------------|
| Mode                 | Phase lock to external reference (Opt. LN2 disabled) |
| Frequency            | 5 MHz to 250 MHz                                     |
| Frequency resolution | 1 MHz                                                |
| Input power (nom)    | -5 dBm to +10 dBm                                    |
| Impedance (nom)      | 50 $\Omega$                                          |
| Lock range (nom)     | $\pm 1.5$ ppm                                        |

## Reference Output

|                  |                             |
|------------------|-----------------------------|
| Frequency        | 10 MHz, 100 MHz             |
| Power (measured) | $> 0$ dBm, 50 $\Omega$ load |
| Connector        | BNC (f)                     |

<sup>1</sup> After 30 days of continuous operation

**High Performance Reference Input (Option SNC)**

|                   |                              |
|-------------------|------------------------------|
| Mode              | Bypass of internal reference |
| Frequency         | 6 GHz                        |
| Input power (nom) | 0 dBm to +10 dBm             |
| Impedance (nom)   | 50 $\Omega$                  |
| Connector         | SMA (f)                      |

**High Performance Reference Output (Option SNC)**

|                  |                           |
|------------------|---------------------------|
| Frequency        | 6 GHz                     |
| Power (measured) | > 3 dBm, 50 $\Omega$ load |
| Connector        | SMA (f)                   |

**Sweep Mode (Frequency and Power)**

|                             |                                                           |
|-----------------------------|-----------------------------------------------------------|
| Operating mode              | Linear step sweep (equally spaced frequency or amplitude) |
| Amplitude range             | A3 (ALC OFF (agile mode))                                 |
| Sweep shape                 | Sawtooth                                                  |
| Dwell time settable         | 500 $\mu$ s to 30 s<br>8 ns to 30 s (opt. UNZ)            |
| Delay time settable         | 200 ns to 30s<br>8 ns to 30s (opt. UNZ)                   |
| Dwell/delay time resolution | 8 ns                                                      |
| Number of points:           | 2 to 9,999 (SCPI: 2 to $2^{32}-1$ )                       |
| Sweep count:                | Infinite or 1 to 9,999 (SCPI: 1 to $2^{32}-1$ )           |
| Triggering                  | See "Trigger" section of datasheet                        |
| Trigger type                | Continuous (full sweep)                                   |
| Continuous Mode             | Free run, trigger and run                                 |

# Power

## Output Parameters

|                             |                                                                                                  |                                                                                       |
|-----------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Leveling modes              | A1 – ALC ON and hold ON<br>A2 – ALC OFF<br>A3 – ALC OFF (agile mode)                             | Leveling on parameter change or on command,<br>active modulations will be interrupted |
| Resolution (nom)            | 0.01 dB (A1, A2)<br>0.5 dB (A3)                                                                  |                                                                                       |
| Attenuator Type             | Opt. 1E2 for 504<br>Opt. 2E2 for 506, 512, 520<br>Opt. 1EH for 506, 512, 520<br>Opt. 3E2 for 540 | Electronic                                                                            |
|                             | Opt. 1E1                                                                                         | Mechanical                                                                            |
| Output impedance (nom)      | 50 $\Omega$                                                                                      |                                                                                       |
| Maximum reverse power (nom) | 0.5 W, 5 VDC                                                                                     |                                                                                       |

## Settable Range

| Levelling Mode | Standard       | Opt. 1E2       | Opt. 2E2       | Opt. 1EH       | Opt. 3E2       | Opt. 1E1        |
|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|
| A1, A2         | -20 to +25 dBm | -55 to +25 dBm | -80 to +25 dBm | -80 to +25 dBm | -80 to +25 dBm | -135 to +25 dBm |
| A3             | -20 to +15 dBm | -55 to +15 dBm | -80 to +15 dBm | -80 to +15 dBm | -80 to +15 dBm | -20 to +15 dBm  |

## Maximum Output Power in CW, A1, A2 Mode (Measured), (Option 504)

| Frequency Range      | Standard | UNZ     | 1E1     | 1E2     | 1E2 + UNZ |
|----------------------|----------|---------|---------|---------|-----------|
| 100 kHz to 10 MHz    | +8 dBm   | +8 dBm  | +8 dBm  | +8 dBm  | +8 dBm    |
| > 10 MHz to 100 MHz  | +17 dBm  | +17 dBm | +17 dBm | +15 dBm | +15 dBm   |
| > 100 MHz to 2.2 GHz | +22 dBm  | +23 dBm | +21 dBm | +20 dBm | +21 dBm   |
| > 2.2 GHz to 4 GHz   | +20 dBm  | +23 dBm | +19 dBm | +17 dBm | +20 dBm   |

## Maximum Output Power in CW, A1, A2 Mode (Measured) (Option 520)

| Frequency Range      | Standard |
|----------------------|----------|
| 100 kHz to 10 MHz    | +10 dBm  |
| > 10 MHz to 50 MHz   | +17 dBm  |
| > 50 MHz to 200 MHz  | +20 dBm  |
| > 200 MHz to 2.2 GHz | +23 dBm  |
| > 2.2 GHz to 4 GHz   | +19 dBm  |
| > 4 GHz to <4.9 GHz  | +16 dBm  |
| 4.9 GHz to 10 GHz    | +20 dBm  |
| > 10 GHz to 20 GHz   | +16 dBm  |

#### Maximum Output Power in CW, A1, A2 Mode (Measured) (Option 540)

| Frequency Range      | Standard | 1E1       |
|----------------------|----------|-----------|
| 100 kHz to 10 MHz    | +10 dBm  | +10 dBm   |
| > 10 MHz to 50 MHz   | +17 dBm  | +17 dBm   |
| > 50 MHz to 200 MHz  | +20 dBm  | + 20 dBm  |
| > 200 MHz to 2.2 GHz | +23 dBm  | +23 dBm   |
| > 2.2 GHz to 4 GHz   | +19 dBm  | +19 dBm   |
| > 4 GHz to <4.9 GHz  | +16 dBm  | +16 dBm   |
| 4.9 GHz to 11 GHz    | +22 dBm  | +20 dBm   |
| > 11 GHz to 20 GHz   | +20 dBm  | +19 dBm   |
| 20 GHz to 27 GHz     | +18 dBm  | +16.5 dBm |
| 27 GHz to 31 GHz     | +15 dBm  | +12 dBm   |
| 31 GHz to 38 GHz     | +16 dBm  | +13.5 dBm |
| 38 GHz to 40 GHz     | +15 dBm  | +11 dBm   |

#### Absolute Level Accuracy in CW, A1, (Measured) (Option 504)

| Frequency Range     | +15 dBm to -20 dBm | Option 1E2:<br>-20 dBm to -55 dBm | Option 1E1:<br>-20 dBm to -65 dBm | Option 1E1:<br>-65 dBm to -120 dBm |
|---------------------|--------------------|-----------------------------------|-----------------------------------|------------------------------------|
| 100 kHz to 300 kHz  | ±3.0 dB            | ±3.0 dB                           | ±3.0 dB                           | ±3.0 dB                            |
| > 300 kHz to 20 MHz | ±1.5 dB            | ±1.5 dB                           | ±1.5 dB                           | ±3.0 dB                            |
| > 20 MHz to 4 GHz   | ±0.3 dB            | ±0.8 dB                           | ±0.4 dB                           | ±1.0dB                             |

#### Absolute Level Accuracy in CW, A1, (Measured) (Option 520)

| Frequency Range     | Standard<br>+15 dBm to -20 dBm |
|---------------------|--------------------------------|
| 100 kHz to 3 MHz    | ±1.5 dB                        |
| > 3 MHz to 10 MHz   | ±0.8 dB                        |
| > 10 MHz to 200 MHz | ±0.4 dB                        |
| > 200 MHz to 4 GHz  | ±0.2 dB                        |
| > 4 GHz to 20 GHz   | ±0.4 dB                        |

**Absolute Level Accuracy in CW, A1, (Measured) (Option 540)**

| Frequency Range     | Standard<br>+15 dBm to -20 dBm |
|---------------------|--------------------------------|
| 100 kHz to 3 MHz    | $\pm 1.5$ dB                   |
| > 3 MHz to 10 MHz   | $\pm 0.8$ dB                   |
| > 10 MHz to 200 MHz | $\pm 0.4$ dB                   |
| > 200 MHz to 4 GHz  | $\pm 0.2$ dB                   |
| > 4 GHz to 21 GHz   | $\pm 0.4$ dB                   |
| > 21 GHz to 40 GHz  | $\pm 0.5$ dB                   |

**Absolute Level Accuracy in CW, A3, (Measured) (Option 504)**

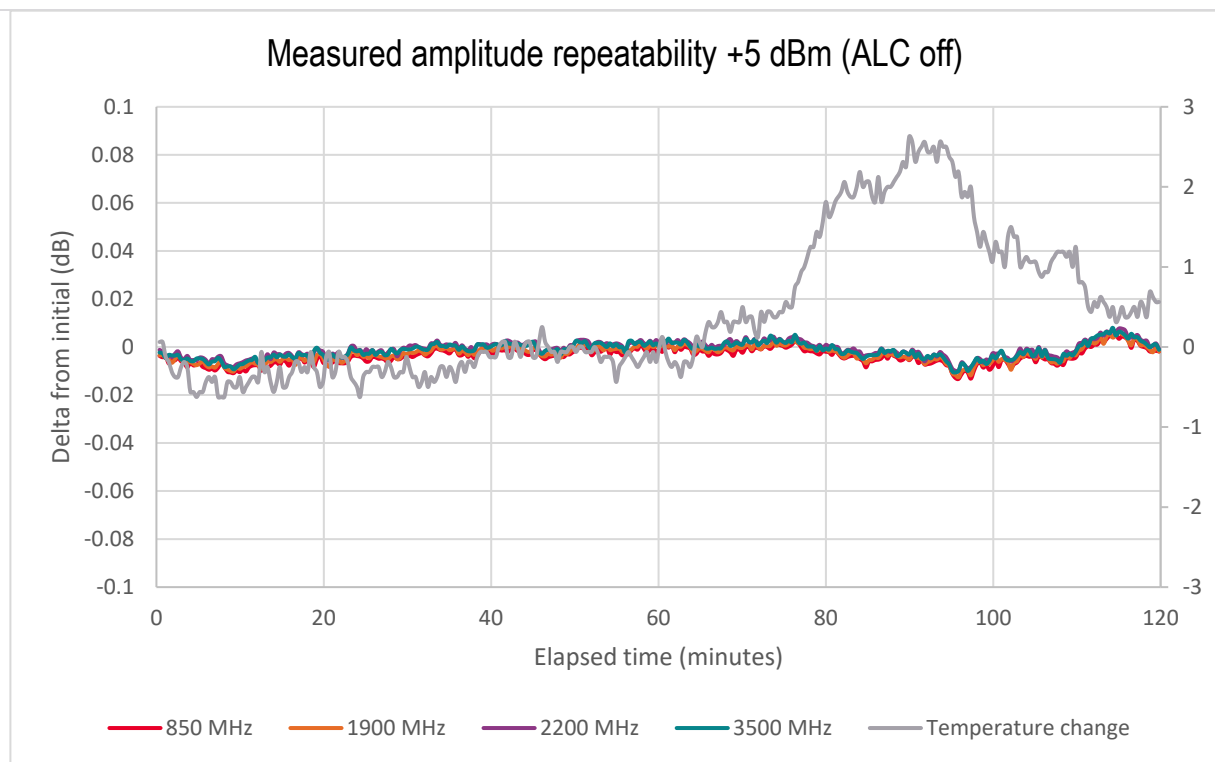
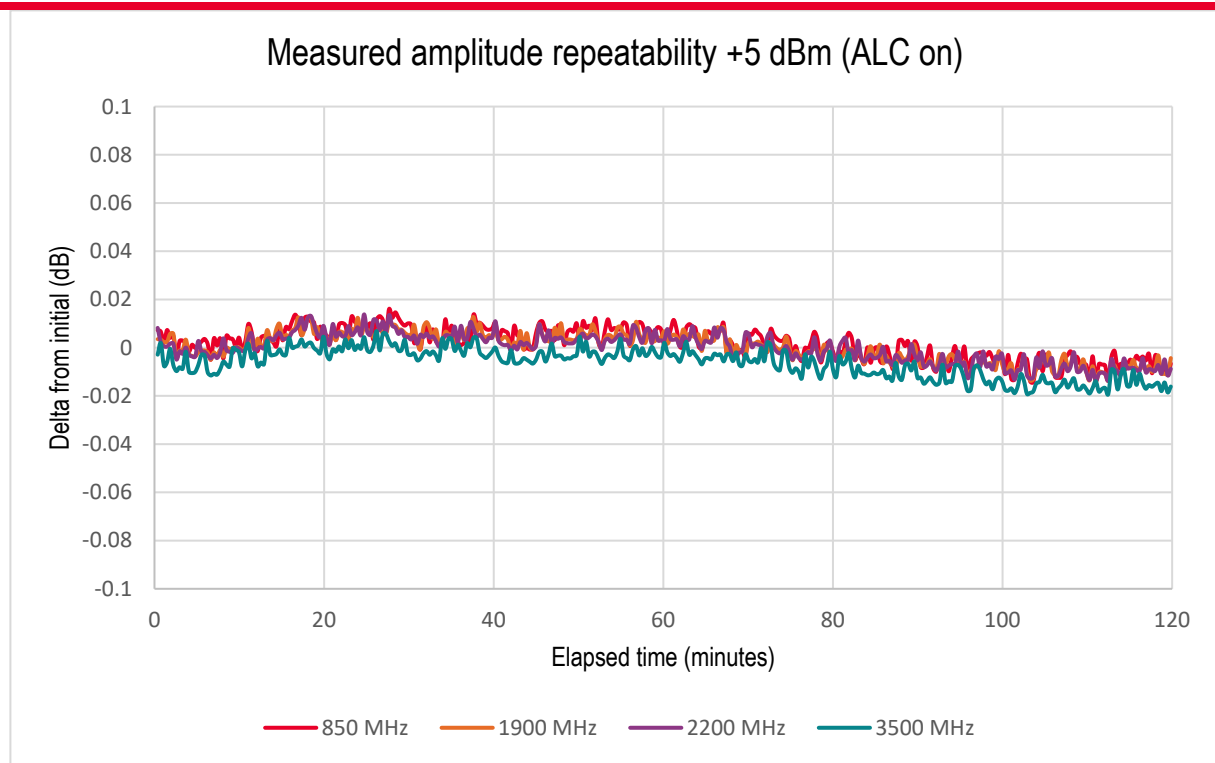
| Frequency Range     | +15 dBm to -20 dBm | Option 1E2:<br>-20 dBm to -55 dBm | Option 1E1:<br>-20 dBm to -65 dBm | Option 1E1:<br>-65 dBm to -120 dBm |
|---------------------|--------------------|-----------------------------------|-----------------------------------|------------------------------------|
| 100 kHz to 300 kHz  | $\pm 3.0$ dB       | $\pm 3.0$ dB                      | $\pm 3.0$ dB                      | $\pm 3.0$ dB                       |
| > 300 kHz to 20 MHz | $\pm 1.5$ dB       | $\pm 1.5$ dB                      | $\pm 1.5$ dB                      | $\pm 3.0$ dB                       |
| > 20 MHz to 4 GHz   | $\pm 0.8$ dB       | $\pm 1.2$ dB                      | $\pm 0.8$ dB                      | $\pm 1.2$ dB                       |

**Absolute Level Accuracy in CW, A3, (Measured) (Option 520)**

| Frequency Range        | Standard<br>+15 dBm to -20 dBm |
|------------------------|--------------------------------|
| 100 kHz to 100 MHz     | $\pm 1.0$ dB                   |
| > 100 MHz to < 4.9 GHz | $\pm 0.5$ dB                   |
| 4.9 GHz to 20 GHz      | $\pm 0.9$ dB                   |

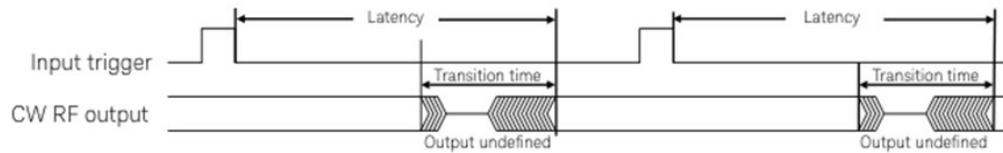
**Absolute Level Accuracy in CW, A3, (Measured) (Option 540)**

| Frequency Range        | Standard<br>+15 dBm to -20 dBm |
|------------------------|--------------------------------|
| 100 kHz to 100 MHz     | $\pm 1.0$ dB                   |
| > 100 MHz to < 4.9 GHz | $\pm 0.5$ dB                   |
| 4.9 GHz to 27 GHz      | $\pm 0.9$ dB                   |
| > 27 GHz to 40 GHz     | $\pm 2.0$ dB                   |



Repeatability measures the ability of the instrument to return a given power setting after a random excursion to any other frequency and power setting. It should not be confused with absolute level accuracy.

# Switching Speed



**Latency and RF Transition Time for Frequency Changes (F1-F3) and Amplitude Changes (A1, A2) (Measured)<sup>2</sup>**

|                       |         |
|-----------------------|---------|
| CW operation          | < 10 ms |
| I/Q modulation active | < 10 ms |

**RF Transition Time for Frequency Changes (F1-F3) and Amplitude Changes (A3) (Measured)<sup>3</sup>**

| Configuration                   | Opt. 504    | Opt. 506, 512, 520 | Opt. 540    |
|---------------------------------|-------------|--------------------|-------------|
| Standard (no attenuator option) | 2.0 $\mu$ s | 2.3 $\mu$ s        | 5.1 $\mu$ s |
| Opt. 1E2, 2E2, 3E2              | 2.0 $\mu$ s | 2.7 $\mu$ s        | 5.3 $\mu$ s |
| Opt. PHS (no attenuator option) | 2.5 $\mu$ s | 3.5 $\mu$ s        | 5.9 $\mu$ s |
| Opt. 1E2, 2E2, 3E2 and Opt. PHS | 3.0 $\mu$ s | 3.9 $\mu$ s        | 6.2 $\mu$ s |

**Latency for Frequency Changes (F1-F3) and Amplitude Changes (A3) (Measured)<sup>4</sup>**

| Configuration                                        | Opt. 504    | Opt. 506, 512, 520 | Opt. 540    |
|------------------------------------------------------|-------------|--------------------|-------------|
| Standard                                             | 0.5 ms      | 0.5 ms             | 0.5 ms      |
| Opt. UNZ                                             | 2.6 $\mu$ s | 3.1 $\mu$ s        | 5.9 $\mu$ s |
| Opt. UNZ and Opt. 1E2 / 2E2 / 3E / 1EH               | 3.0 $\mu$ s | 3.9 $\mu$ s        | 6.5 $\mu$ s |
| Opt. UNZ and Opt. PHS                                | 3.5 $\mu$ s | 4.7 $\mu$ s        | 7.1 $\mu$ s |
| Opt. UNZ and Opt. 1E2 / 2E2 / 3E2 / 1EH and Opt. PHS | 4.0 $\mu$ s | 5.1 $\mu$ s        | 7.4 $\mu$ s |

<sup>2</sup> Defined from receipt of SCPI command to next valid RF signal (phase settled to 0.2 rad, amplitude within 1dB of final value).

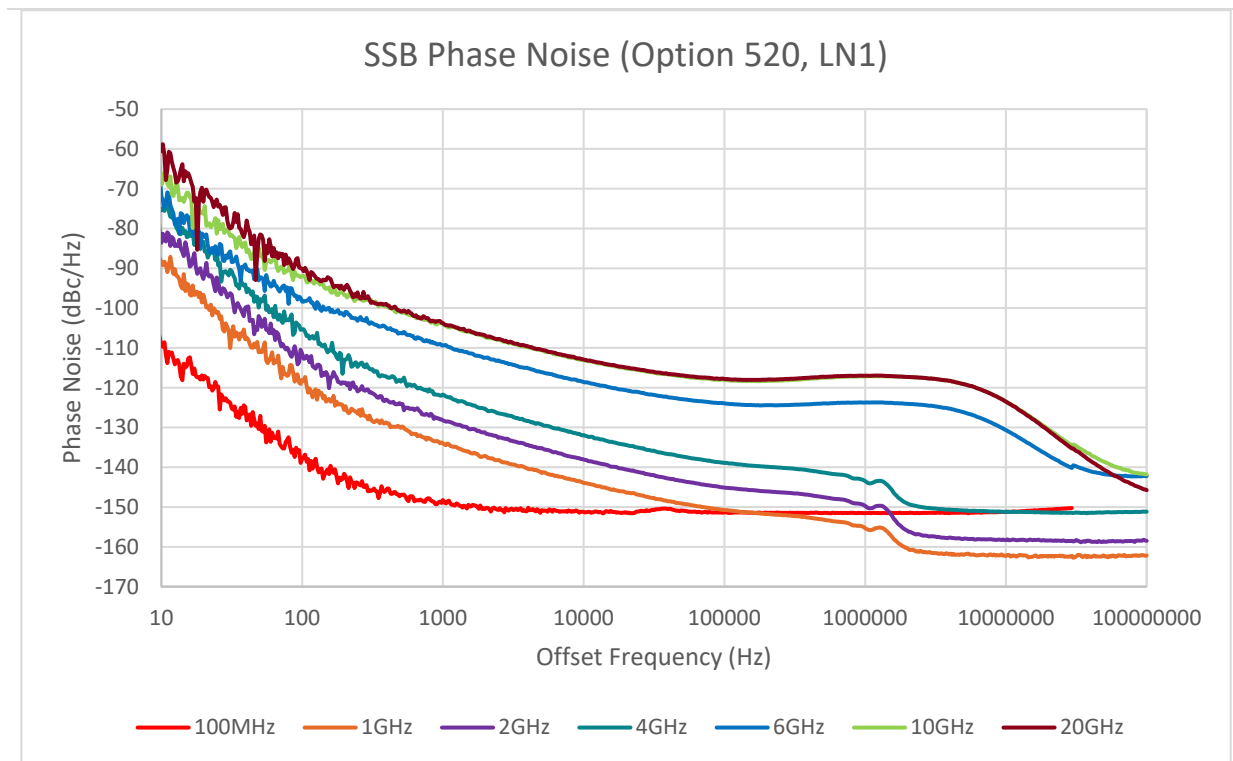
<sup>3</sup> Defined from valid RF signal to next valid RF signal (phase settled to 0.2 rad, amplitude within 1dB of final value). The RF signal will be blanked during transition.

<sup>4</sup> Defined from received trigger command to RF invalid.

# Phase Noise

Absolute SSB Phase Noise (CW) at +10 dBm or Maximum Output Power in dBc/Hz, (Measured) (Option LN1), [ ] = Option LN2

| Frequency | 10 Hz       | 100 Hz      | 1 kHz | 10 kHz | 100 kHz | 1 MHz | 10 MHz | 100 MHz |
|-----------|-------------|-------------|-------|--------|---------|-------|--------|---------|
| 100 MHz   | -110 [-120] | -136 [-133] | -148  | -150   | -151    | -151  | -151   | -       |
| 1 GHz     | -89 [-102]  | -117 [-112] | -133  | -142   | -150    | -155  | -162   | -162    |
| 2 GHz     | -83 [-96]   | -111 [-106] | -127  | -136   | -144    | -150  | -158   | -158    |
| 4 GHz     | -76 [-90]   | -105 [-99]  | -121  | -130   | -138    | -143  | -151   | -151    |
| 6 GHz     | -72 [-80]   | -98 [-91]   | -109  | -119   | -124    | -123  | -130   | -142    |
| 10 GHz    | -67 [-76]   | -92 [-89]   | -103  | -113   | -118    | -116  | -124   | -142    |
| 20 GHz    | -60 [-74]   | -85 [-85]   | -103  | -113   | -118    | -116  | -124   | -146    |
| 40 GHz    | -54 [-69]   | -80 [80]    | -103  | -113   | -118    | -116  | -124   | -146    |



**Absolute SSB Phase Noise (CW) at +10 dBm or Maximum Output Power in dBc/Hz, (Measured) (Option LN1 + UNZ), [ ] = Option LN2 + UNZ**

| Frequency | 10 Hz       | 100 Hz      | 1 kHz | 10 kHz | 100 kHz | 1 MHz | 10 MHz | 100 MHz |
|-----------|-------------|-------------|-------|--------|---------|-------|--------|---------|
| 100 MHz   | -110 [-120] | -136 [-133] | -148  | -150   | -151    | -151  | -151   | -       |
| 1 GHz     | -89 [-102]  | -117 [-112] | -133  | -142   | -150    | -155  | -162   | -162    |
| 2 GHz     | -83 [-96]   | -111 [-106] | -127  | -136   | -144    | -150  | -158   | -158    |
| 4 GHz     | -76 [-90]   | -105 [-99]  | -121  | -130   | -138    | -143  | -151   | -151    |
| 6 GHz     | -72 [-80]   | -98 [-91]   | -109  | -119   | -124    | -118  | -116   | -142    |
| 10 GHz    | -67 [-76]   | -92 [-89]   | -103  | -113   | -118    | -116  | -117   | -142    |
| 20 GHz    | -60 [-74]   | -85 [-85]   | -103  | -113   | -118    | -116  | -117   | -146    |
| 40 GHz    | -54 [-69]   | -80 [80]    | -103  | -113   | -118    | -116  | -117   | -146    |

## Spectral Purity

**Harmonics (CW), at 0 dBm, () = Measured (Option 504)**

| Frequency Range  | Standard            | UNZ                 |
|------------------|---------------------|---------------------|
| 100 kHz to 2 MHz | < -20 dBc           | < -20 dBc           |
| > 2 MHz to 4 GHz | < -41 dBc (-45 dBc) | < -38 dBc (-42 dBc) |

**Harmonics (CW), at 0 dBm, Measured (Option 520)**

| Frequency Range     | Standard  |
|---------------------|-----------|
| 100 kHz to 2 MHz    | < -20 dBc |
| > 2 MHz to <4.9 GHz | < -42 dBc |
| 4.9 GHz to 12 GHz   | < -30 dBc |
| > 12 GHz to 17 GHz  | < -65 dBc |
| >17 GHz to 20 GHz   | < -60 dBc |

**Harmonics (CW), at 0 dBm, Measured (Option 540)**

| Frequency Range       | Standard  |
|-----------------------|-----------|
| 100 kHz to 300 kHz    | < -30 dBc |
| > 300 kHz to <4.9 GHz | < -43 dBc |
| > 4.9 GHz to 7.5 GHz  | < -32 dBc |
| > 7.5 GHz to 12 GHz   | < -35 dBc |
| > 12 GHz to 17 GHz    | < -30 dBc |
| > 17 GHz to 25 GHz    | < -27 dBc |

**Non-Harmonics (CW), at 0 dBm, Measured, (Option 504)**

| Frequency Range    | Standard  | Option UNZ |
|--------------------|-----------|------------|
| > 100 kHz to 4 GHz | < -60 dBc | < -55 dBc  |

**Non-Harmonics (CW), at 0 dBm, Measured, (Option 520)**

| Frequency Range     | Standard  |
|---------------------|-----------|
| > 100 kHz to 6 GHz  | < -60 dBc |
| > 6 GHz to 8.5 GHz  | < -57 dBc |
| > 8.5 GHz to 15 GHz | < -50 dBc |
| > 15 GHz to 17 GHz  | < -60 dBc |
| > 17 GHz to 20 GHz  | < -48 dBc |

**Non-Harmonics (CW), at 0 dBm, Measured, (Option 540)**

| Frequency Range        | Standard  |
|------------------------|-----------|
| > 100 kHz to 7 GHz     | < -60 dBc |
| > 7 GHz to 12 GHz      | < -50 dBc |
| > 12 GHz to 16 GHz     | < -60 dBc |
| > 17.8 GHz to 17.9 GHz | < -45 dBc |
| > 17.9 GHz to 31.6 GHz | < -60 dBc |
| > 31.6 GHz to 32.7 GHz | < -39 dBc |
| > 32.7 GHz to 40 GHz   | < -50 dBc |

**Subharmonics (CW), Measured**

|      |
|------|
| None |
|------|

# Pulse Modulation (Option PMR)

## Pulse Modulation

|                                                                      | I/Q (Base Band) Modulator           | RF Modulator |
|----------------------------------------------------------------------|-------------------------------------|--------------|
| On/off ratio (meas)                                                  | 90 dB                               | 40 dB        |
| Rise/fall times (meas)                                               | 5 ns                                | 5 ns         |
| Video feed-through (meas)<br>at PRF=500 kHz, 0 dBm<br>50% duty cycle | -70 dB at 1 GHz<br>-50 dB at 20 GHz | -            |
| RF delay to video (meas)                                             | 400 to 1000 ns                      | 10 ns        |
| Pulse overshoot (meas)                                               | $\pm 1$ dB                          | $\pm 1$ dB   |
| External pulse jitter (nom)                                          | $\pm 8$ ns                          | $\pm 10$ ps  |
| External pulse delay (meas)                                          | < 1 $\mu$ s                         | 20 ns        |
| External pulse input                                                 | MF1 IN, MF2 IN                      |              |

## Internal Pulse Generator

|                 |                                    |
|-----------------|------------------------------------|
| Pulse period    | 16 ns to 10 s                      |
| Pulse width     | 8 ns to 10 s                       |
| Resolution      | 8 ns                               |
| Triggering      | See "Trigger" section of datasheet |
| Trigger type    | Continuous (full sweep)            |
| Continuous mode | Free run, trigger and run          |

# Pulse Descriptor Words (Option PDW)<sup>5</sup>

The PDW option enables agile control of frequency, amplitude, phase, time, and waveform inside the instantaneous bandwidth. Each PDW will address an I/Q waveform segment or create the I/Q waveform in real time, including pulse modulation.

This feature can only be configured over SCPI or the PC software.

## PDW

|                                    |                                                                                                                                                                        |                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Amplitude operation                | A3 (ALC OFF (agile mode))                                                                                                                                              |                                |
| Upload methods                     | Individual SCPI commands, SCPI block data (.csv through PC software)                                                                                                   |                                |
| Pulse width, start time range      | 96 ns to 208 days                                                                                                                                                      | 8 ns to 208 days with opt. UNZ |
| Pulse width, start time resolution | 8 ns                                                                                                                                                                   |                                |
| Pulse execution rate               | Up to 498 k pulses/s, depends on configuration of the device, see table<br>"RF transition time for frequency changes (F1-F3) and amplitude changes (A3)" + pulse width |                                |
| PDW time mode                      | Absolute, relative                                                                                                                                                     |                                |
| PDW parameters                     | Start time, pulse width, frequency, power, phase, waveform segment <sup>6</sup> , 8bit marker                                                                          |                                |
| Intra-pulse modulation             | (pulsed) Linear phase sweep                                                                                                                                            |                                |
| Phase sweep step time              | 8 ns to 4.29 s                                                                                                                                                         |                                |

## PDW List Mode

|                                                                                                      |                                    |                                                                                        |
|------------------------------------------------------------------------------------------------------|------------------------------------|----------------------------------------------------------------------------------------|
| The list mode plays a predefined list of PDWs located in and read from the instrument's FPGA memory. |                                    |                                                                                        |
| Number of PDWs                                                                                       | 1 to 1024                          | 1 to 60 M with limited pulse execution rate of 166 k pulses/s (using SCPI if > 1M PDW) |
| List repetition                                                                                      | Infinite or 1 to 65 k              |                                                                                        |
| List triggering                                                                                      | See "Trigger" section of datasheet |                                                                                        |
| Trigger type                                                                                         | Continuous                         |                                                                                        |
| Continuous modes                                                                                     | Free run, trigger and run          |                                                                                        |

## PDW Streaming Mode Over FCP Interface (Requires Option FCP)

|                                                                                                                                                                                                                                                                                                                        |                                               |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|--|
| Streaming provides agile control of PDW parameters via a continuous stream of PDWs transferred from Fast Control Port (Option FCP). Each PDW consists of up to 255 Bytes. The streaming PDWs are queued in a buffer and scheduled for synchronous execution based on the time stamp information contained in each PDW. |                                               |  |
| FCP interface rate                                                                                                                                                                                                                                                                                                     | > Pulse execution rate                        |  |
| FCP sample rate                                                                                                                                                                                                                                                                                                        | 250 MHz                                       |  |
| FCP data format                                                                                                                                                                                                                                                                                                        | Address (8 bits), data (8 bits), valid signal |  |
| PDW streaming buffer size                                                                                                                                                                                                                                                                                              | 1024                                          |  |
| PDW streaming trigger                                                                                                                                                                                                                                                                                                  | none                                          |  |

<sup>5</sup> Keysight has self-classified AP504xA option PDW as subject to ITAR export control when in the United States and therefore notifying the customer that the items should be treated as ITAR once received into the United States.

<sup>6</sup> I/Q-modulator sample rate fixed at 500 MHz

# Vector Modulation

## Internal I/Q Baseband Generator Adjustments

|                                                |      |
|------------------------------------------------|------|
| Internal I/Q adjustments                       | None |
| Internal real-time complex digital I/Q filters | None |

## Carrier Leakage

|                               |
|-------------------------------|
| None (digital I/Q modulation) |
|-------------------------------|

## Frequency Response Over Full Modulation Bandwidth, Measured, (Option 504)

| Frequency Range  | Standard                           | UNZ                                | 1E1                                | 1E2                                | 1E2 + UNZ                           |
|------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|-------------------------------------|
| 300 MHz to 4 GHz | $\pm 1.4 \text{ dB} / \pm 7^\circ$ | $\pm 0.9 \text{ dB} / \pm 7^\circ$ | $\pm 1.4 \text{ dB} / \pm 8^\circ$ | $\pm 1.6 \text{ dB} / \pm 8^\circ$ | $\pm 1.4 \text{ dB} / \pm 12^\circ$ |

## Frequency Response Over Full Modulation Bandwidth, Measured, (Option 520)

| Frequency Range   | Standard                            |
|-------------------|-------------------------------------|
| 1 GHz to 4 GHz    | $\pm 1.2 \text{ dB} / \pm 8^\circ$  |
| 4 GHz to 8.5 GHz  | $\pm 1.5 \text{ dB} / \pm 10^\circ$ |
| 8.5 GHz to 12 GHz | $\pm 3.2 \text{ dB} / \pm 12^\circ$ |
| 12 GHz to 20 GHz  | $\pm 3.2 \text{ dB} / \pm 10^\circ$ |

## Frequency Response Over Full Modulation Bandwidth, Measured, (Option 540)

| Frequency Range       | Standard                            |
|-----------------------|-------------------------------------|
| 1 GHz to 4 GHz        | $\pm 1.2 \text{ dB} / \pm 8^\circ$  |
| > 4.9 GHz to 16.5 GHz | $\pm 2.4 \text{ dB} / \pm 14^\circ$ |
| > 16.5 GHz to 23 GHz  | $\pm 3.8 \text{ dB} / \pm 18^\circ$ |
| > 23 GHz to 28 GHz    | $\pm 2.4 \text{ dB} / \pm 13^\circ$ |
| > 28 GHz to 35 GHz    | $\pm 3.6 \text{ dB} / \pm 22^\circ$ |
| > 35 GHz to 40 GHz    | $\pm 2.4 \text{ dB} / \pm 15^\circ$ |

## Frequency Response Over $\pm 50 \text{ Mhz}$ Modulation Bandwidth, Measured, (Option 540)

| Frequency Range    | Standard                            |
|--------------------|-------------------------------------|
| > 4 GHz to 20 GHz  | $\pm 1.0 \text{ dB} / \pm 5^\circ$  |
| > 20 GHz to 40 GHz | $\pm 2.0 \text{ dB} / \pm 12^\circ$ |

# Internal Baseband Generator

This feature can only be configured over SCPI and the PC software AP504xA VSG GUI, except for options: UNT, 403.

## Internal Baseband Generator

|                                    |                              |
|------------------------------------|------------------------------|
| I/Q file resolution                | 16 bits                      |
| Waveform granularity               | 1 sample                     |
| Frequency offset                   | $\pm$ half maximum bandwidth |
| Sample rate resolution             | 1 Hz                         |
| Maximum RF (I + Q) bandwidth (nom) | 400 MHz                      |
| Sample rate                        | 1 Hz to 500 MHz              |

## Arbitrary Waveform Memory

|                                            |                            |         |
|--------------------------------------------|----------------------------|---------|
| Maximum arbitrary waveform playback memory | Without marker             | 512 MSa |
|                                            | With marker signals active | 334 MSa |

## Waveform Transfer Rates, No Markers, Unencrypted (Meas)

|                                  |                        |
|----------------------------------|------------------------|
| GUI to base band generator (LAN) | 50 Mbit/s or 1.5 MSa/s |
|----------------------------------|------------------------|

## Waveform Segments

|                                     |                                                |
|-------------------------------------|------------------------------------------------|
| Segment length minimum <sup>7</sup> | 96<br>246, with markers signals active         |
| Segment length maximum              | See Maximum arbitrary waveform playback memory |
| Segment length quantum              | See Waveform granularity                       |
| Maximum number of segments          | 8192                                           |
| Segment changeover mode             | Seamless, immediate                            |
| Switching speed (meas) <sup>8</sup> | 2 $\mu$ s                                      |

## Waveform Sequences

|                                                       |      |
|-------------------------------------------------------|------|
| Maximum number of sequences                           | 1    |
| Maximum number of segments per sequences <sup>9</sup> | 2048 |
| Maximum number of repetitions                         | 10 M |

<sup>7</sup> Shorter Waveforms will be automatically extended by cyclically repeating the waveform.

<sup>8</sup> Waveforms are pre-loaded, at 500 MHz sample rate, immediate segment changeover with Opt. FCP interface.

<sup>9</sup> All uploaded segments must have the same playback rate and the same marker configuration.

### Waveform Triggers

|                  |                                    |
|------------------|------------------------------------|
| Type             | Continuous                         |
| Continuous modes | Free run, trigger and run          |
| Other parameters | See "Trigger" section of datasheet |

### Markers<sup>10</sup>

|                            |                            |                         |
|----------------------------|----------------------------|-------------------------|
| Number of markers          | 4                          |                         |
| Marker (nom)               | Sample rate $\leq$ 125 MHz | Sample rate $>$ 125 MHz |
| Duration minimum value     | 1 sample                   | 4 samples               |
| Maximum duration variation | $\pm$ 1 sample             | $\pm$ 8 ns              |
| Maximum additional jitter  | $\pm$ 1 sample             | $\pm$ 8 ns              |

### AWGN (Option 403)

|                                         |                                                                                                                                              |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Type                                    | Real-time                                                                                                                                    |
| Modes of operation                      | Standalone or digitally added to the arbitrary waveform                                                                                      |
| Distribution density                    | Gaussian, statistical, $\mu = 0$ , $\sigma^2 = 1$ (separate for I and Q)                                                                     |
| Crest factor (nom)                      | $\leq$ 21 dB                                                                                                                                 |
| Periodicity                             | $> 1 \times 10^{40}$ hours                                                                                                                   |
| Carrier-to-noise ratio (nom)            | -60 dB to +90 dB                                                                                                                             |
| Carrier-to-noise ratio resolution (nom) | 0.01 dB                                                                                                                                      |
| Carrier-to-noise ratio formats          | C/N                                                                                                                                          |
| Noise bandwidth                         | Standalone: See sample rate specification of the baseband generator<br>Digitally added: 0.8 of the actual set baseband generator sample rate |

<sup>10</sup> Markers are defined during the waveform generation process and cannot be modified afterwards.

### I/Q Based Analog Modulation (Opt. UNT)

|                             |                        |
|-----------------------------|------------------------|
| <b>Amplitude Modulation</b> |                        |
| Waveform                    | Sine                   |
| AM-rate                     | 0.1 Hz to 100 MHz      |
| AM depth                    | 0 to 100 %             |
| <b>Frequency Modulation</b> |                        |
| Waveform                    | Sine                   |
| FM-rate                     | 0.1 Hz to 100 MHz      |
| FM deviation                | 0 Hz to 200 MHz (peak) |
| <b>Phase Modulation</b>     |                        |
| Waveform                    | Sine                   |
| ΦM-rate                     | 0.1 Hz to 100 MHz      |
| ΦM deviation                | 0 to 100 rad           |

### Simultaneous Modulation

|                                                      | AM | FM | ΦM | Pulse | Waveform I/Q | AWGN |
|------------------------------------------------------|----|----|----|-------|--------------|------|
| AM                                                   | +  | -  | -  | +     | -            | +    |
| FM                                                   | -  | +  | -  | +     | -            | +    |
| ΦM                                                   | -  | -  | +  | +     | -            | +    |
| Pulse                                                | +  | +  | +  | +     | +            | +    |
| Arbitrary I/Q                                        | -  | -  | +  | +     | +            | +    |
| AWGN                                                 | +  | +  | +  | +     | +            | +    |
| + = compatible                      - = incompatible |    |    |    |       |              |      |

# Avionics Modulation (AP5041A only, Option 302)

Avionics Modulation, () = Measured

| DME                                                                                                 |                                                                 |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| Operating modes                                                                                     | Interrogation & reply                                           |
| DME channel                                                                                         | X, Y                                                            |
| Frequency range                                                                                     | 960 MHz to 1215 MHz                                             |
| Pulse pattern repetition rate / - resolution / accuracy                                             | 10 Hz to 5 kHz / 0.1 Hz / $\pm 0.1$ Hz                          |
| Pulse-to-pulse level range / - accuracy                                                             | -80 dB to 80 dB / $\leq \pm 0.2$ dB ( $\pm 0.1$ dB)             |
| Main pulse width / - resolution / - accuracy (up to 4 additional pulses / pairs)                    | 100 ns to 100 $\mu$ s / 0.1 ns / $\leq \pm 17$ ns ( $\pm 1$ ns) |
| Main pulse rise/fall time / - resolution / - accuracy                                               | 100 ns to 100 $\mu$ s / 0.1 ns / $\leq \pm 7$ ns                |
| Main pulse pair spacing / - resolution / - accuracy                                                 | 100 ns to 100 $\mu$ s / 0.1 ns / $\leq \pm 17$ ns               |
| Echo pulse pair delay / - resolution / - accuracy                                                   | 2 $\mu$ s to 8 $\mu$ s / 0.1 ns / $\leq \pm 17$ ns              |
| Echo pulse pair attenuation range / - resolution / - accuracy                                       | -3 dB to +12 dB / 0.001 dB / $\leq \pm 0.2$ dB                  |
| Interference delay / - resolution / - accuracy                                                      | 1 $\mu$ s to 8 $\mu$ s / 0.1 ns / $\leq \pm 17$ ns              |
| Interference attenuation range / - resolution / - accuracy                                          | 0 dB to 30 dB / 0.001 dB / $\leq \pm 0.2$ dB                    |
| Receiver dead time test pulse pair delay / - resolution / - accuracy                                | 10 $\mu$ s to 100 $\mu$ s / 0.1 ns / $\leq \pm 17$ ns           |
| Identification code transmission                                                                    | 3-character code: Repetition period, morse dot length           |
| VOR                                                                                                 |                                                                 |
| Carrier frequency range                                                                             | 108 MHz to 118 MHz                                              |
| Bearing direction                                                                                   | From / to                                                       |
| Bearing range / - resolution / - accuracy                                                           | 0 to 360° / 0.001° / $\pm 1^\circ$                              |
| AM0 component (30 Hz navigation variable signal)<br>Depth range / - resolution / - accuracy         | 0 to 50% / 0.01% / $\pm 0.5\%$                                  |
| AM0 distortion (THD)                                                                                | $\leq 2\%$                                                      |
| AM1 component (9'960 Hz navigation reference subcarrier)<br>Depth range / - resolution / - accuracy | 0 to 50% / 0.01% / $\pm 0.5\%$ ( $\pm 0.3\%$ )                  |
| AM1 component frequency range / - resolution / - accuracy                                           | 5 kHz to 15 kHz / 0.1 Hz / $\pm 0.1$ mHz                        |
| AM1 distortion (THD)                                                                                | $\leq 2\%$                                                      |
| FM component (30 Hz navigation reference signal)<br>Index / - resolution / - accuracy               | 0 to 33.3 / 0.01 / ( $\pm 0.033$ )                              |
| FM component deviation accuracy, 480 Hz deviation                                                   | $\pm 1$ Hz ( $\pm 0.5$ Hz)                                      |
| Identification code component (4 characters code)<br>AM frequency range / - resolution / - accuracy | 300 Hz to 1.74 kHz / 0.1 Hz / $\pm 0.1$ mHz                     |
| Identification code component<br>AM depths range / - resolution / - accuracy                        | 0 to 50% / 0.01% / $\pm 0.5\%$ ( $\pm 0.3\%$ )                  |

**Avionics Modulation, () = Measured**

| <b>ILS: Localizer (LOC)</b>                                                                   |                                  |                                                                                   |
|-----------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------------|
| Carrier frequency range                                                                       |                                  | 108 MHz to 118 MHz                                                                |
| DDM range / - resolution                                                                      |                                  | -20% to 20% / 0.01%                                                               |
| DDM accuracy                                                                                  | at 0 $\mu$ A DDM                 | $\pm 1.0 \mu\text{A}$ ( $\pm 0.1 \mu\text{A}$ ) or $\pm 0.1\%$ ( $\pm 0.01\%$ )   |
|                                                                                               | within $\pm 10 \mu\text{A}$ DDM  | $\pm 1.0 \mu\text{A}$ ( $\pm 0.1 \mu\text{A}$ ) or $\pm 0.1\%$ ( $\pm 0.01\%$ )   |
|                                                                                               | within $\pm 150 \mu\text{A}$ DDM | $\pm 5.0 \mu\text{A}$ ( $\pm 0.1 \mu\text{A}$ ) or $\pm 0.5\%$ ( $\pm 0.01\%$ )   |
| SDM range / - resolution / - accuracy                                                         |                                  | 20% to 60% / 0.01% / $\pm 1\%$ ( $\pm 0.1\%$ )                                    |
| SDM accuracy, setting 40% RF -30 dBm                                                          |                                  | 1.0%                                                                              |
| AM0 component (90 Hz left beam)<br>Depth (change DDSM/SDM) / - resolution / - accuracy        |                                  | 10% to 30% / 0.01% / $\pm 0.5\%$                                                  |
| AM0 component frequency range / - resolution / - accuracy                                     |                                  | 88 Hz to 92 Hz / 0.5 mHz / $\pm 0.5$ mHz                                          |
| AM1 component (150 Hz right beam)<br>Depth (change DDSM/SDM) / - resolution / - accuracy      |                                  | 10% to 30% / 0.01% / $\pm 0.5\%$                                                  |
| AM1 component frequency range / - resolution / - accuracy                                     |                                  | 147 Hz to 154 Hz / 0.5 mHz / $\pm 0.5$ mHz                                        |
| AM1 component range to relative phase AM0 component / - resolution / - accuracy               |                                  | 0 to 360° / 0.001° / $\pm 1^\circ$ ( $\pm 0.1^\circ$ )                            |
| Identification code component (4 characters code)<br>AM frequency / - resolution / - accuracy |                                  | 300 Hz to 1.74 kHz / 0.5 mHz / $\pm 0.5$ mHz                                      |
| Identification code component<br>AM depth range / - resolution / - accuracy                   |                                  | 0 to 50% / 0.01% / $\pm 0.5\%$                                                    |
| <b>ILS: Glide Slope (GS)</b>                                                                  |                                  |                                                                                   |
| Carrier frequency range                                                                       |                                  | 329 MHz to 335 MHz                                                                |
| DDM range / - resolution                                                                      |                                  | -40% to 40% / 0.01%                                                               |
| DDM accuracy                                                                                  | at 0 $\mu$ A DDM                 | $\pm 0.8 \mu\text{A}$ ( $\pm 0.1 \mu\text{A}$ ) or $\pm 0.1\%$ ( $\pm 0.012\%$ )  |
|                                                                                               | within $\pm 10 \mu\text{A}$ DDM  | $\pm 0.88 \mu\text{A}$ ( $\pm 0.1 \mu\text{A}$ ) or $\pm 0.1\%$ ( $\pm 0.012\%$ ) |
|                                                                                               | within $\pm 150 \mu\text{A}$ DDM | $\pm 4.4 \mu\text{A}$ ( $\pm 0.2 \mu\text{A}$ ) or $\pm 0.5\%$ ( $\pm 0.024\%$ )  |
| SDM range / - resolution / - accuracy                                                         |                                  | 40% to 120% / 0.01% / $\pm 2\%$ ( $\pm 0.1\%$ )                                   |
| SDM accuracy at 80% RF – 30 dBm                                                               |                                  | $\pm 1\%$                                                                         |
| AM0 component (90 Hz upper beam)<br>Depth (change DDSM/SDM) / - resolution / - accuracy       |                                  | 20% to 60% / 0.01% / $\pm 0.5\%$                                                  |
| AM0 component frequency range / - resolution / - accuracy                                     |                                  | 88 Hz to 92 Hz / 0.5 mHz / $\pm 0.5$ mHz                                          |
| AM1 component (150 Hz lower beam)<br>Depth (change DDSM/SDM) / - resolution / - accuracy      |                                  | 20% to 60% / 0.01% / $\pm 0.5\%$                                                  |
| AM1 component frequency range / - resolution / - accuracy                                     |                                  | 147 Hz to 154 Hz / 0.5 mHz / $\pm 0.5$ mHz                                        |
| AM1 component range to relative phase AM0 component / - resolution / - accuracy               |                                  | 0 to 360° / 0.001° / $\pm 1^\circ$ ( $\pm 0.1^\circ$ )                            |
| <b>Marker Beacon</b>                                                                          |                                  |                                                                                   |
| AM depth setting range / - resolution                                                         |                                  | 0 to 100% / 0.01%                                                                 |
| AM tone accuracy                                                                              | 95% depth                        | (0.3%)                                                                            |
| AM tone distortion                                                                            | 95% depth                        | (2%)                                                                              |

# Trigger

## Trigger Input

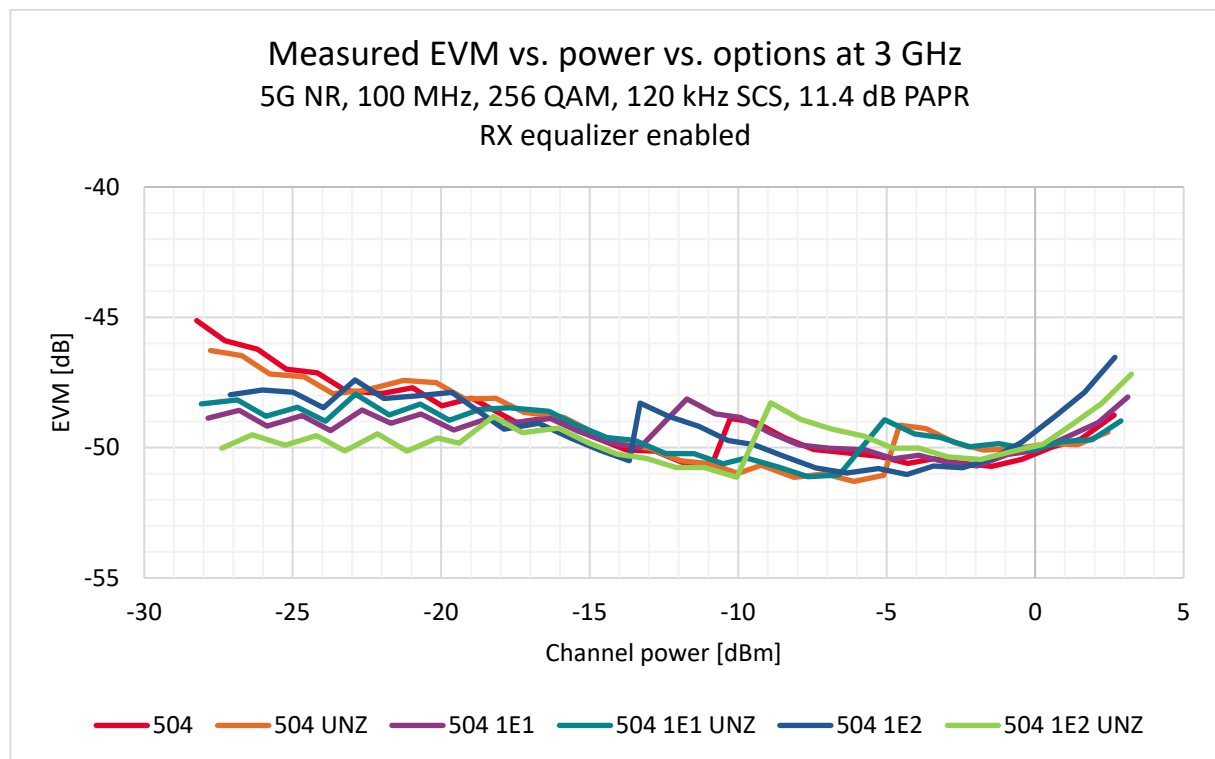
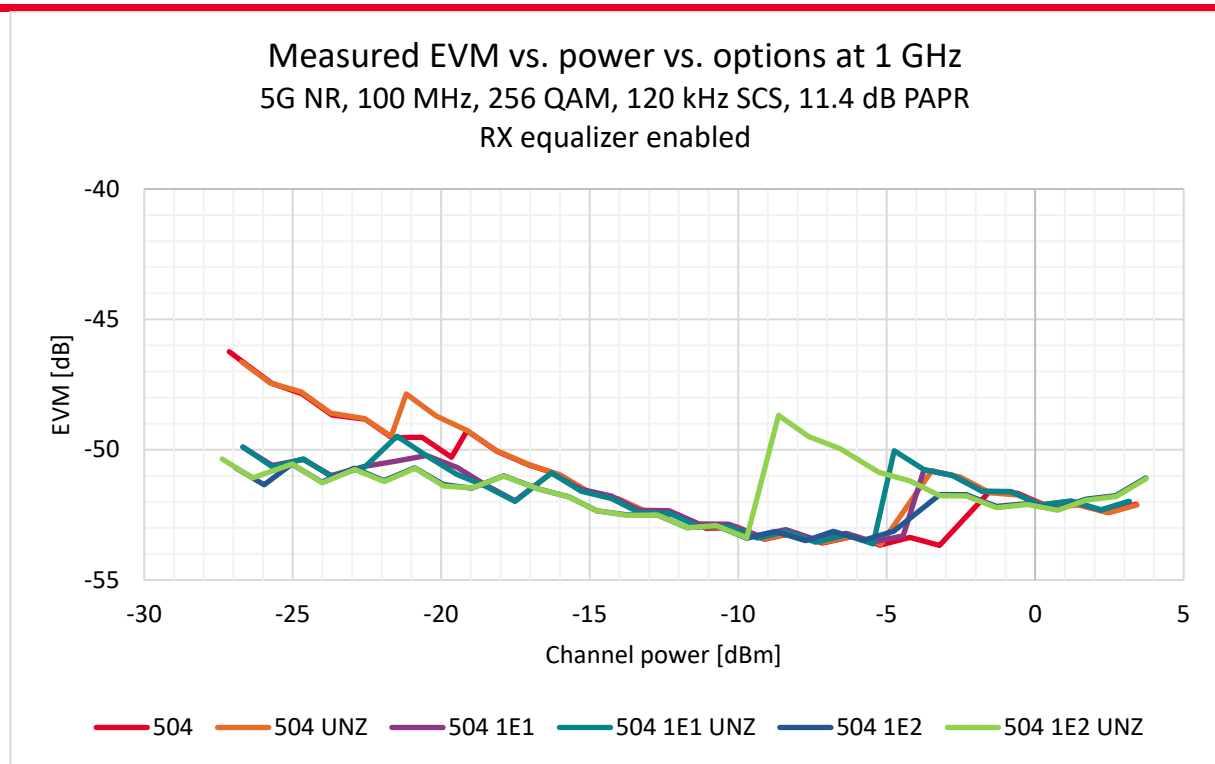
|                                            |                                                                                           |
|--------------------------------------------|-------------------------------------------------------------------------------------------|
| Sources                                    | Immediate, external, bus (GPIB, LAN, USB), global trigger, Synchronous trigger (Opt. SNC) |
| External input connector                   | MF1 IN, MF2 IN                                                                            |
| External delay time                        | 0 to 8.5 s                                                                                |
| External delay resolution                  | 2 ns                                                                                      |
| Additional external trigger latency (meas) | 100 ns                                                                                    |
| External latency jitter                    | $\pm 2$ ns                                                                                |
| External slope                             | Rising, falling                                                                           |

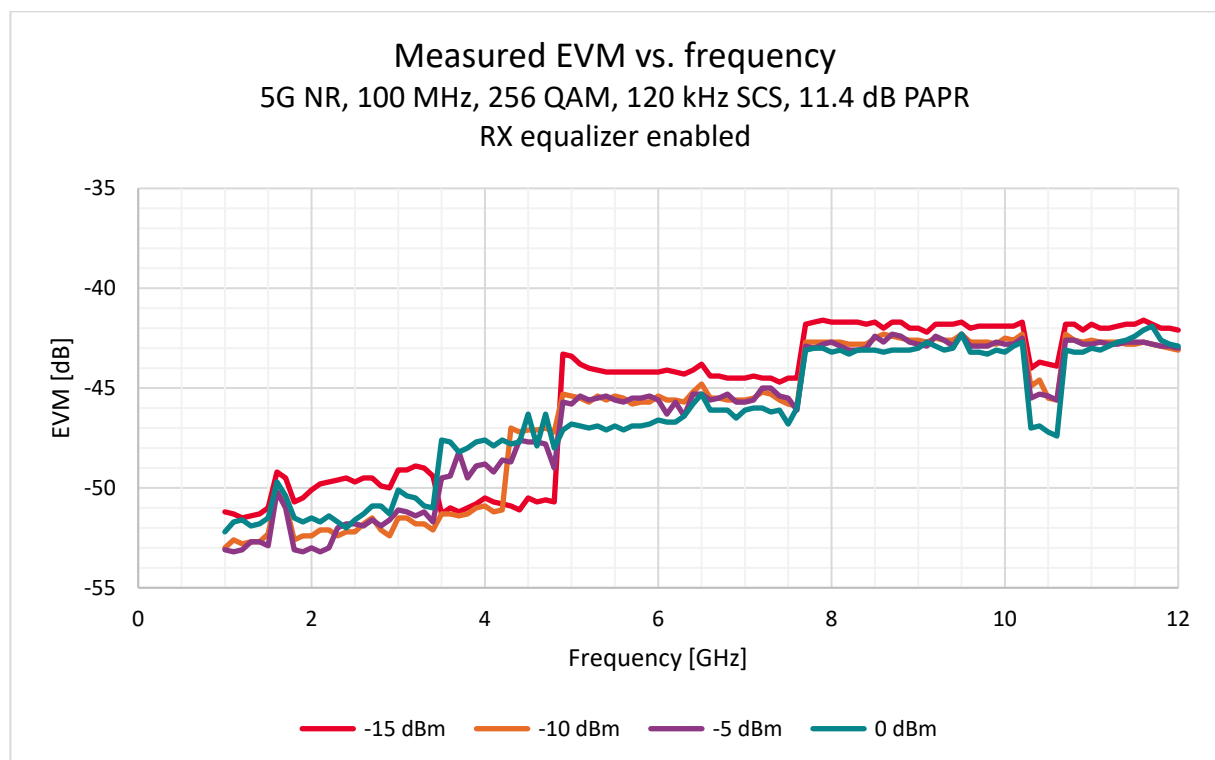
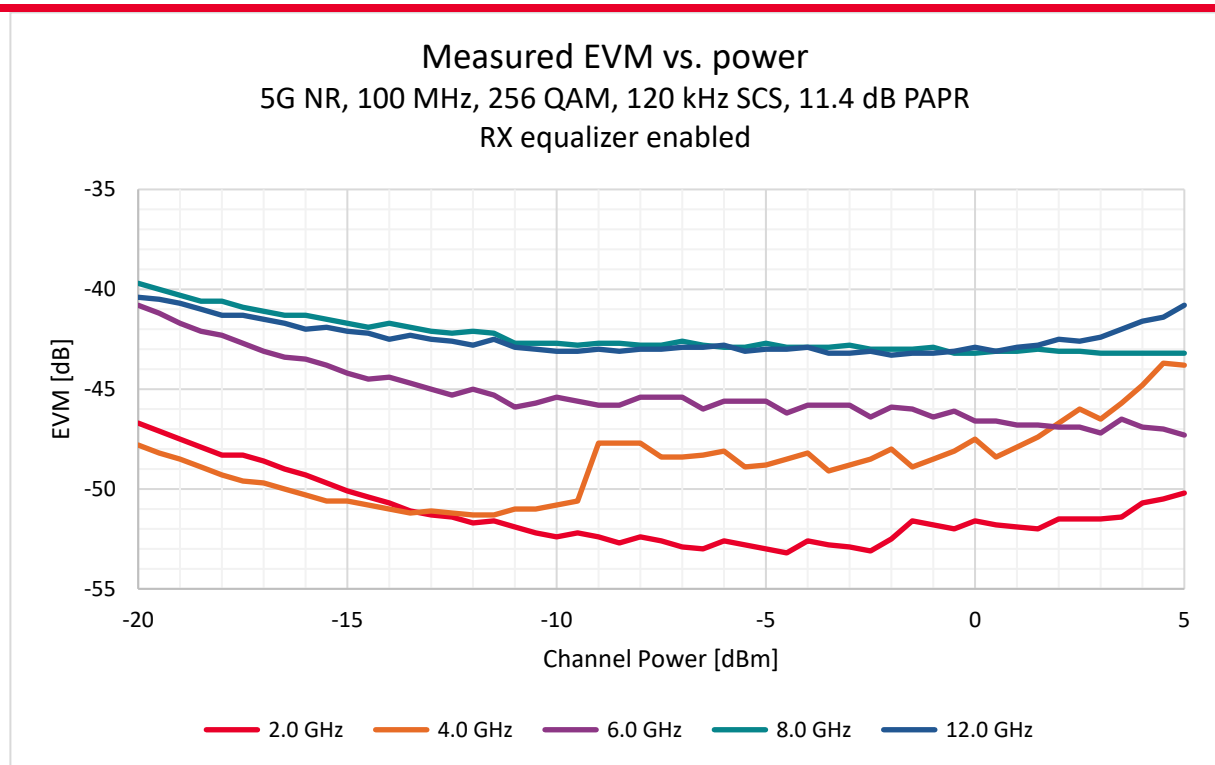
## Trigger Output

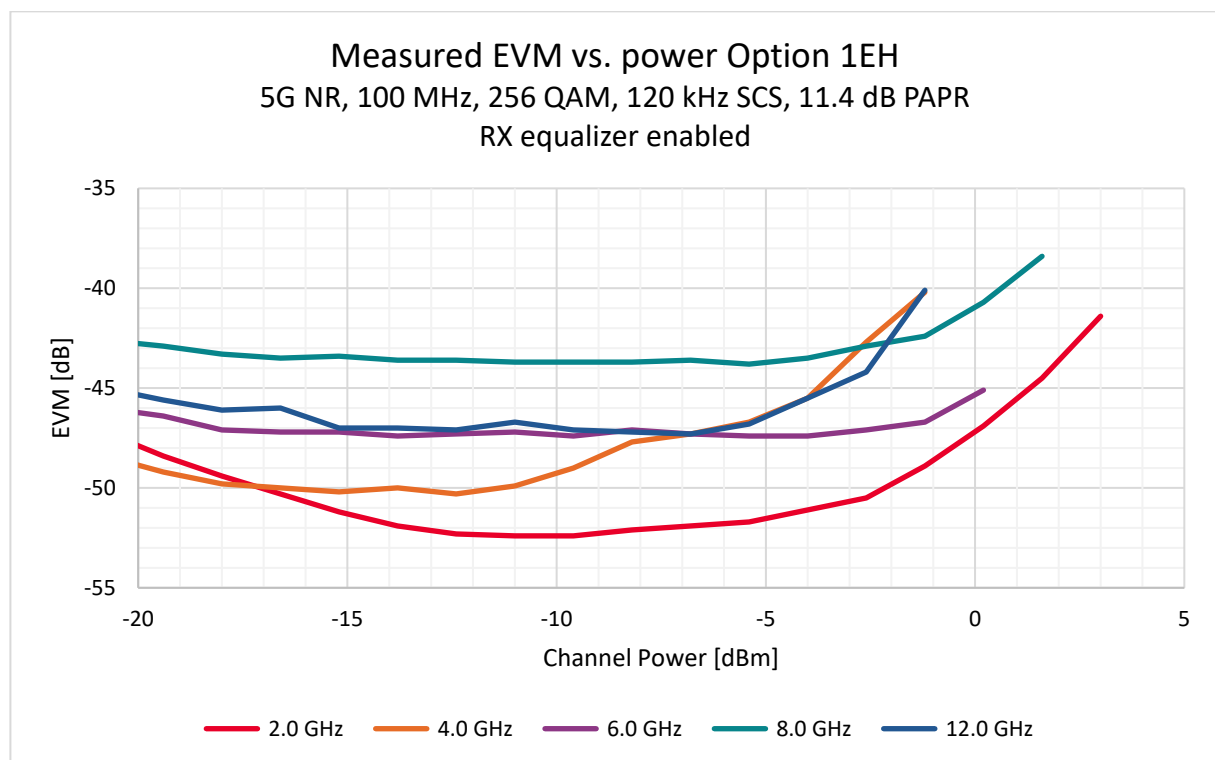
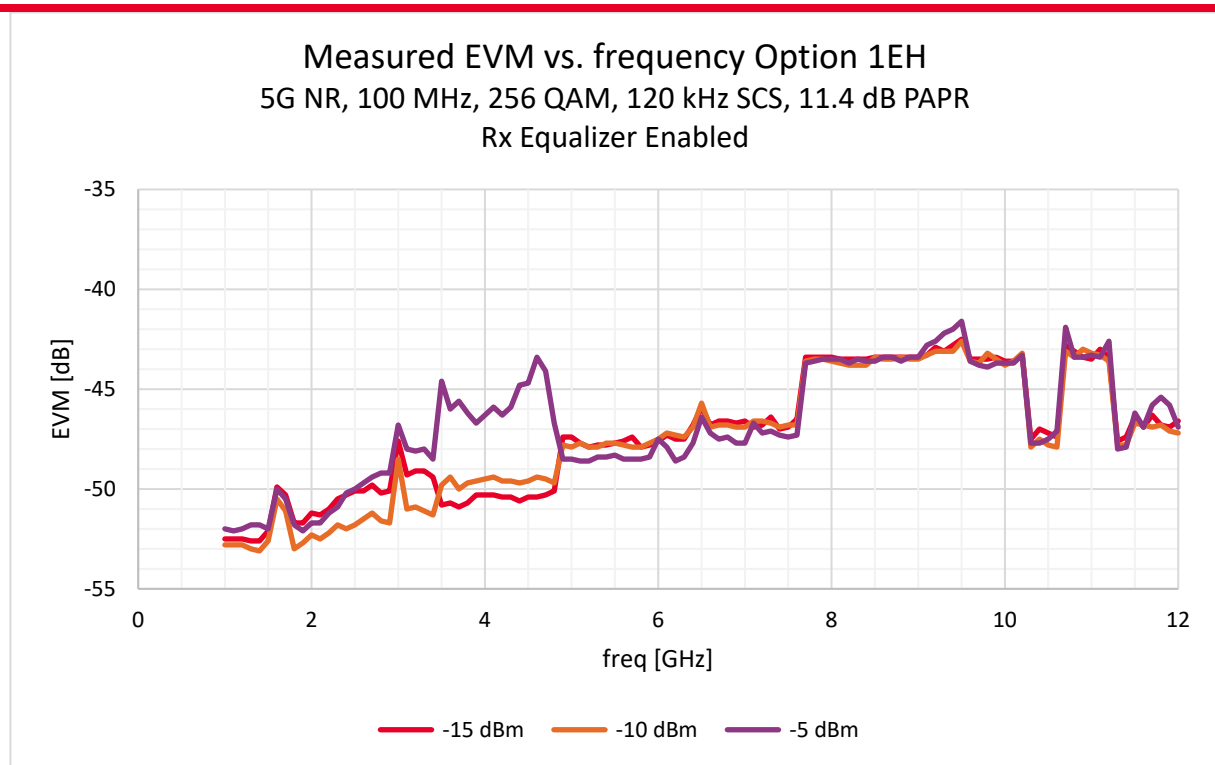
|                                       |                    |
|---------------------------------------|--------------------|
| Trigger output connector              | MF1 OUT, MF2 OUT   |
| Trigger output polarity               | Normal, inverted   |
| Trigger output delay time             | 0 to 2 $\mu$ s     |
| Trigger output delay resolution       | 2 ns               |
| Trigger output pulse width            | 8 ns to 16 $\mu$ s |
| Trigger output pulse width resolution | 8 ns               |

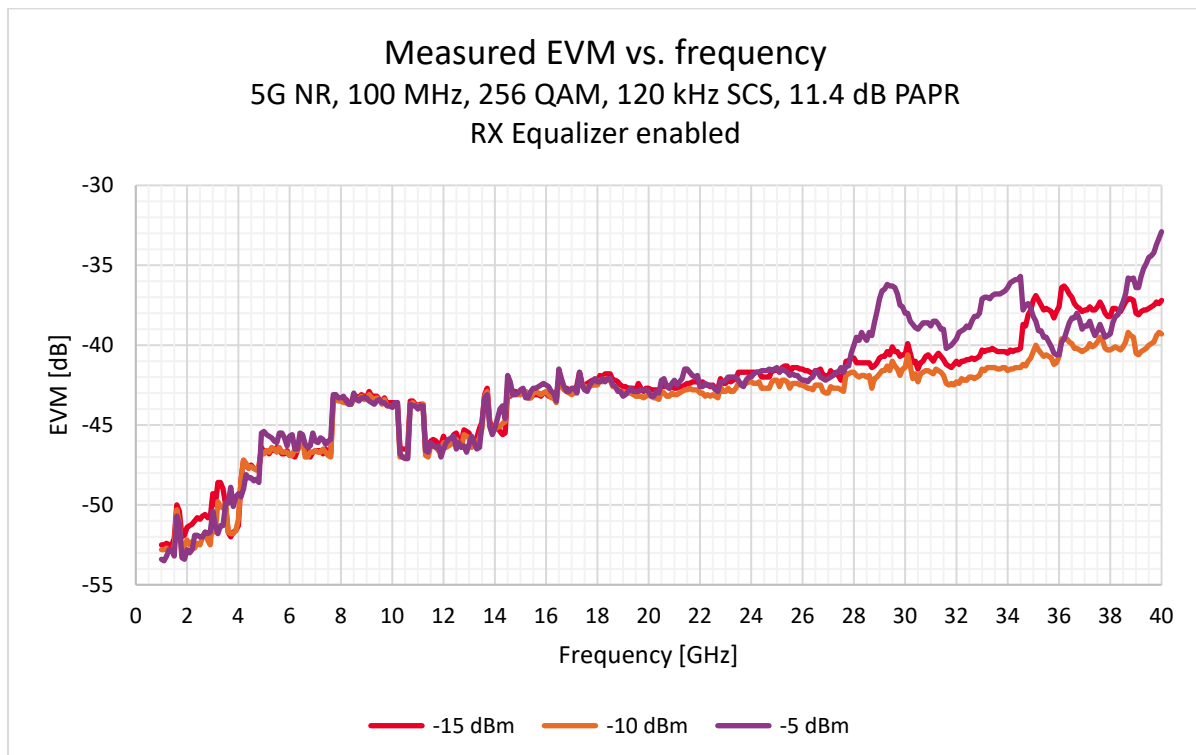
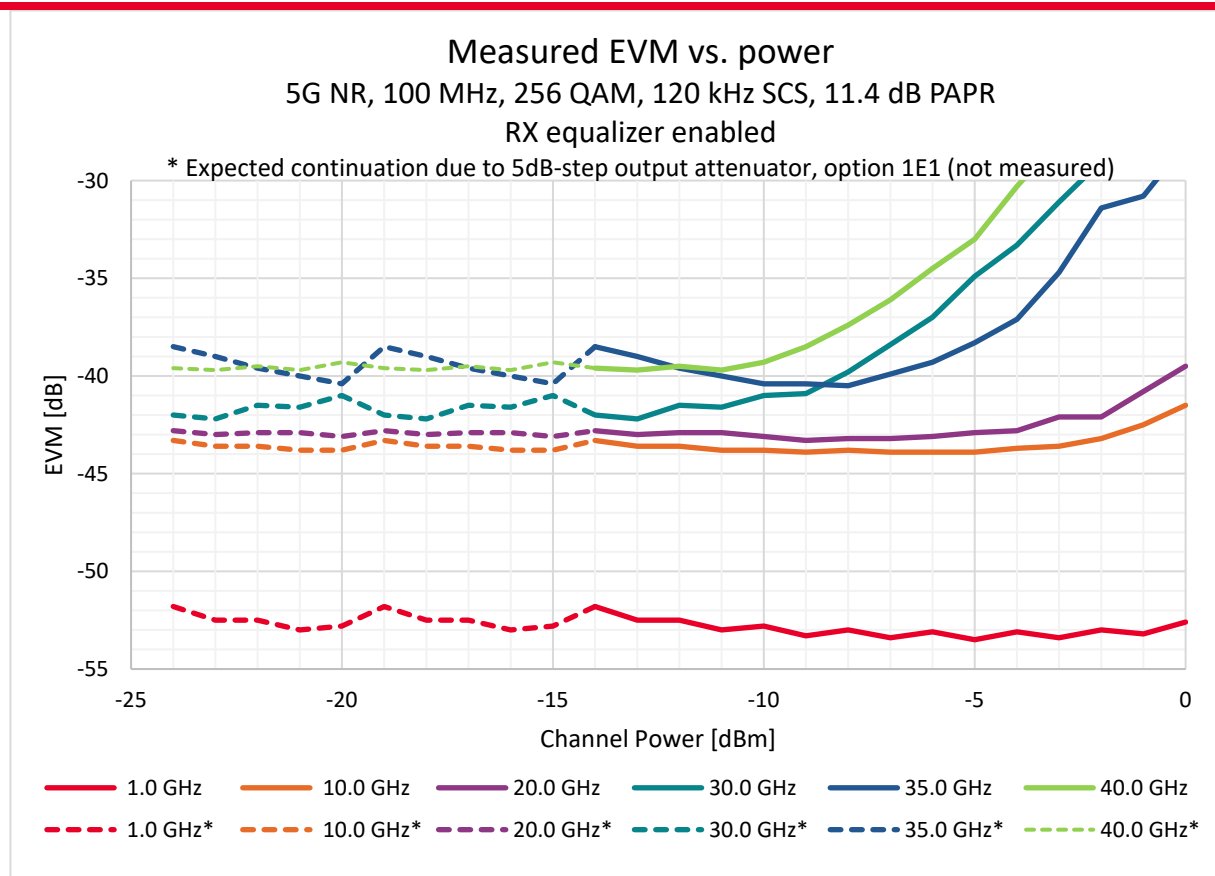
# Error Vector Magnitude (EVM)

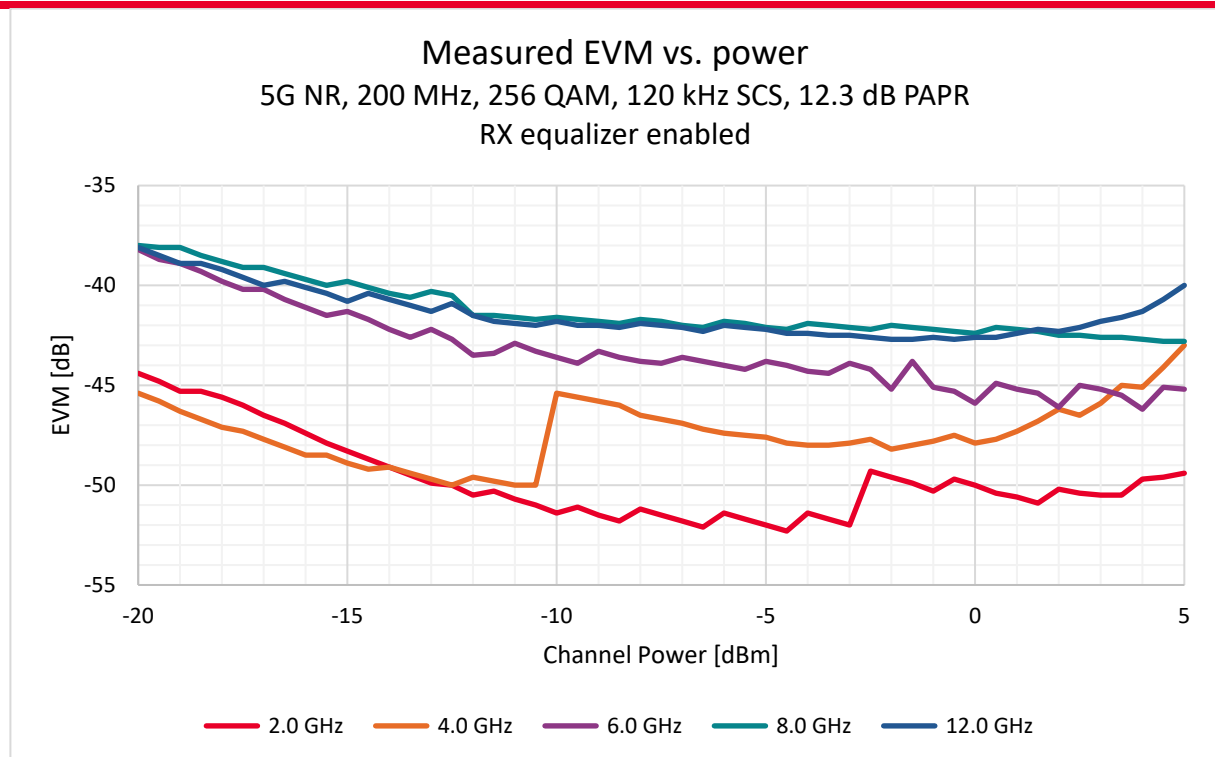
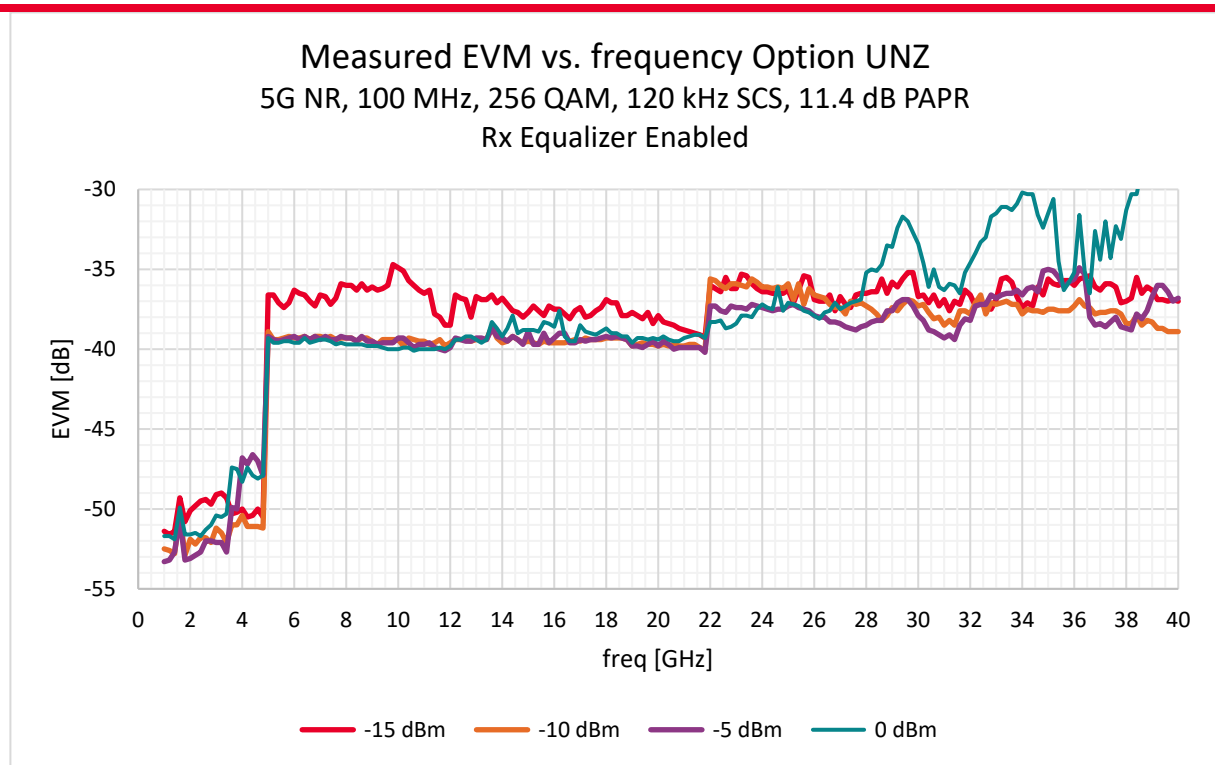
EVM for 5G NR 100 MHz Bandwidth, Measured (Option 504)

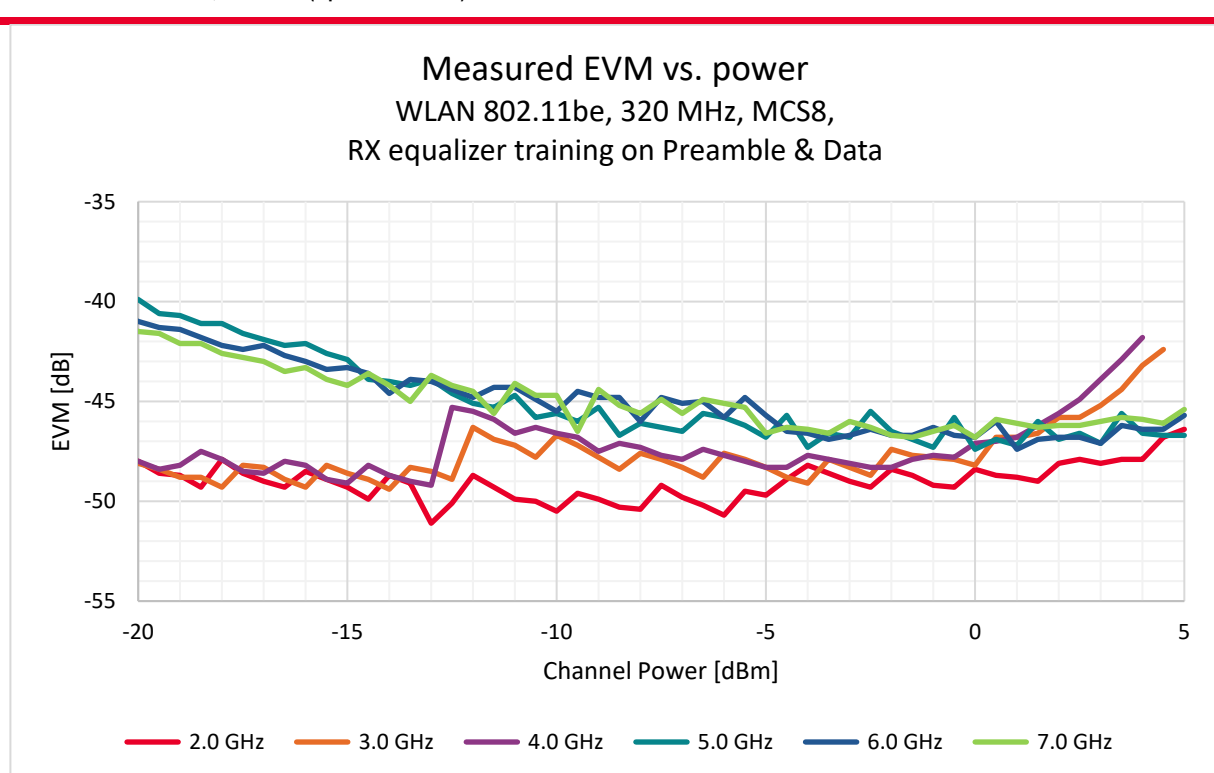
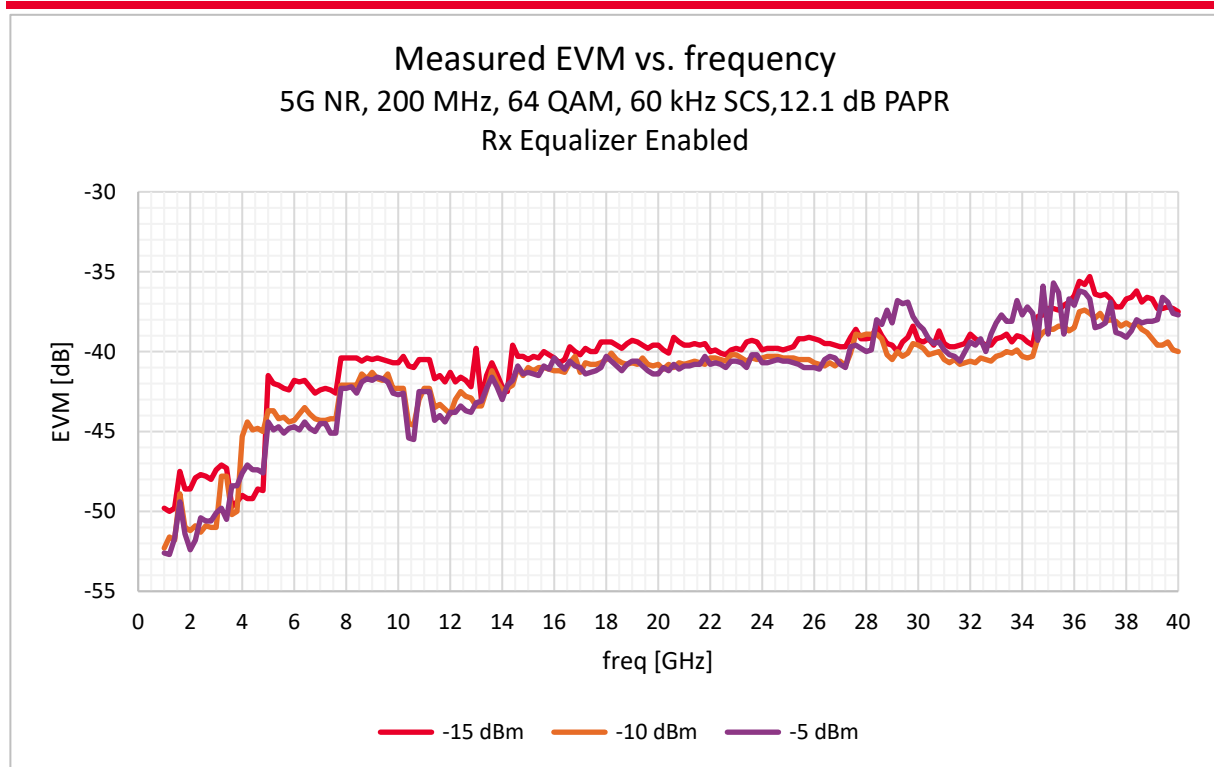


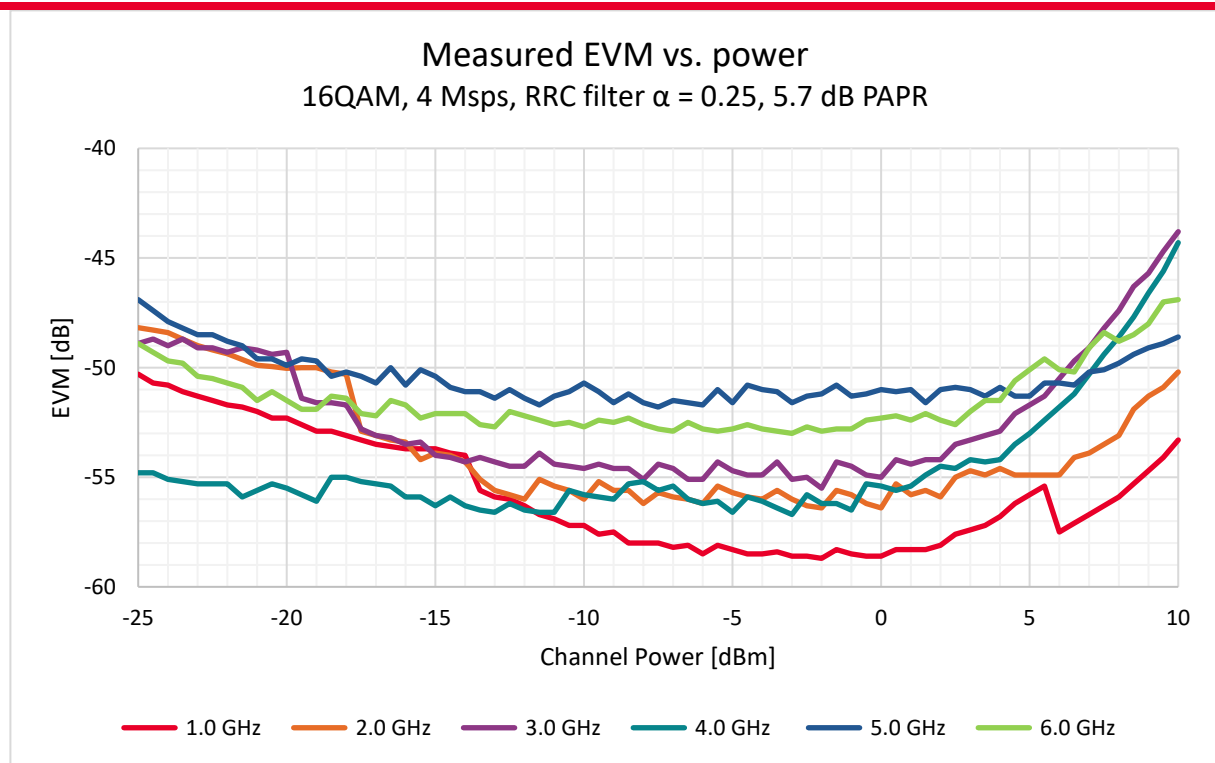






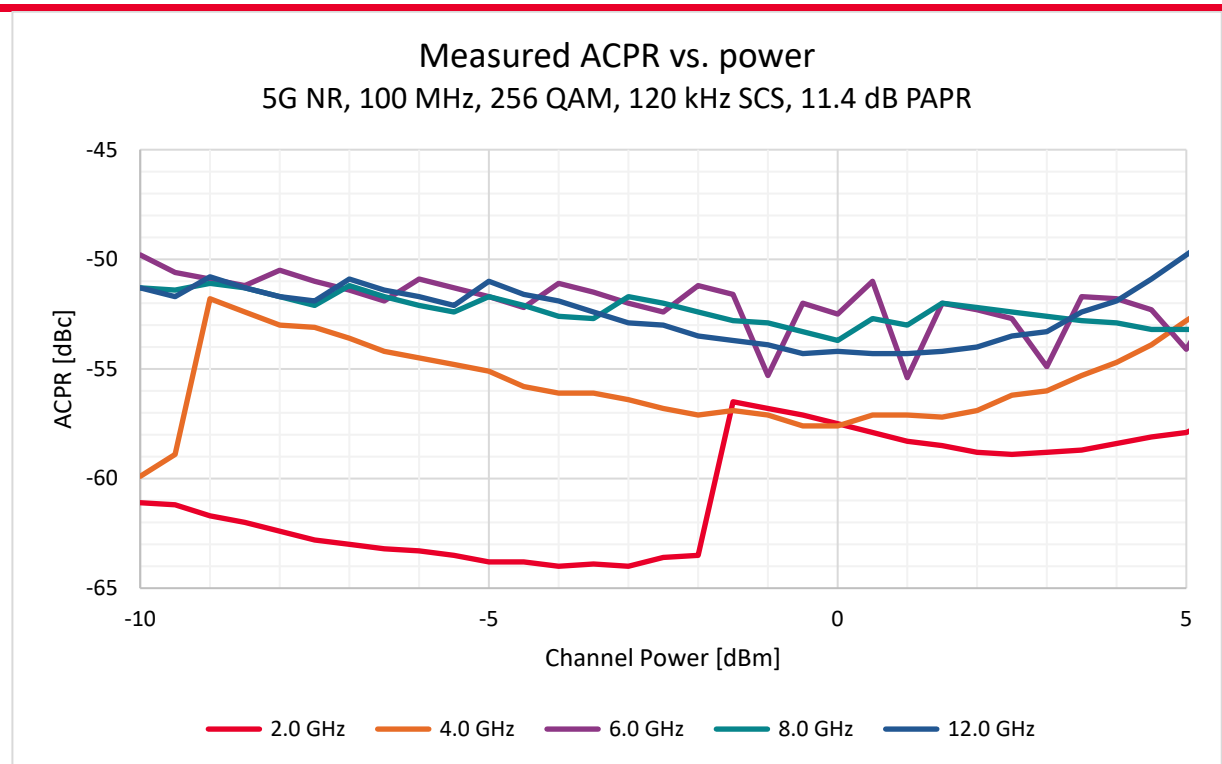






# Distortion Performance (ACPR)

ACPR for 5G NR 100 MHz Bandwidth, Measured (Option 504 to 512)



# External Multi-Function Inputs and Outputs (MF)

## Digital Inputs (MF1 IN, MF2 IN)

|                           |                                     |
|---------------------------|-------------------------------------|
| Connector type            | SMB (m)                             |
| Input impedance (nom)     | 10 k $\Omega$ DC and 50 $\Omega$ AC |
| Input voltage range (nom) | 0 to 3.3 V                          |
| Input damage level        | $\leq -0.5$ V and $\geq +5.5$ V     |
| Threshold voltage (nom)   | 0.9 V                               |

## Digital Outputs (MF1 OUT, MF2 OUT)

|                            |                                 |
|----------------------------|---------------------------------|
| Connector type             | SMB (m)                         |
| Output impedance (nom)     | 50 $\Omega$                     |
| Output voltage range (nom) | 0 to 3.3 V                      |
| Input damage level         | $\leq -0.5$ V and $\geq +5.5$ V |

# External Analog Inputs (Option EXT)

## Analog Inputs (I IN, Q IN)

|                           |                                                                       |
|---------------------------|-----------------------------------------------------------------------|
| Connector type            | SMB (m)                                                               |
| Input impedance (nom)     | 50 $\Omega$                                                           |
| Input voltage range (nom) | -0.5 V to +0.5 V                                                      |
| Input damage level        | $< -2$ V and $> +2$ V                                                 |
| Analog bandwidth (meas)   | 50 MHz                                                                |
| Operation modes           | Analog I/Q modulation,<br>External AM, FM modulation (Opt. UNT)       |
| Additional features       | Individual digital gain and DC offset adjustment, overrange detection |

## Fast Control Port (Option FCP)

For fast, time critical settings and data streaming the Vector Signal Generator can be controlled over an optional external fast control port. The FCP system can only be configured over SCPI and the PC software.

### Fast Control Port

|                 |                                                              |
|-----------------|--------------------------------------------------------------|
| Interface       | 18 bits parallel LVDS receiver with 100 $\Omega$ termination |
| Operation modes | I/Q data streaming, waveform segment ID streaming            |
| Connector type  | 36-pin mini-D, MDR                                           |

### I/Q Data Streaming Over FCP

|                 |                                     |
|-----------------|-------------------------------------|
| I/Q sample rate | 125 or 250 MHz                      |
| Data format     | data (16 bits), clock, valid signal |

### Waveform Segment ID Streaming Over FCP

|             |                              |
|-------------|------------------------------|
| Sample rate | 250 MHz                      |
| Data format | data (16 bits), valid signal |

## SD Card (Option 006)

Removable solid-state memory (micro-SD card) from rear panel. The SD card is not included. Used only for non-volatile I/Q waveform files (.QID, .QIM, .WFM).<sup>11</sup>

### SD Card

|                |                                  |
|----------------|----------------------------------|
| Supported SD   | Up to 2 GB with FAT 12 or FAT 16 |
| Supported SDHC | Up to 32 GB with FAT 32          |

<sup>11</sup> Not hot plug capable (must be inserted before Instrument is powered on)

# Remote Programming

## Remote Programming

|                  |                                                                                                         |
|------------------|---------------------------------------------------------------------------------------------------------|
| Interfaces       | LAN 1000BaseT LAN interface<br>USB Version 2.0<br>GPIB IEEE-488.2, 1987 with listen and talk (Opt. GPB) |
| Control language | SCPI Version 1999.0                                                                                     |

## Software Compatibility

|                 |                                                                       |
|-----------------|-----------------------------------------------------------------------|
| AP504XA VSG GUI | PC software to control the instrument                                 |
| Signal Studio   | Various applications supported (see AP504xA configuration guides)     |
| IQ tools        | Flexible waveform generation tool for AP504xA, version $\geq 1.0.0.0$ |
| VSA2026         | Keysight 89600 Vector Signal Analyzer software (future)               |

## Software AP504XA VSG GUI - Hardware Requirements

|                                |                     |
|--------------------------------|---------------------|
| CPU architecture:              | X64                 |
| Memory                         | 2 GB                |
| Storage                        | 380 MB              |
| Recommended display resolution | Full HD 1920x1080   |
| Ports                          | Ethernet or USB     |
| Supported OS:                  | Windows 10 or newer |

## Software AP504XA VSG GUI – Supported I/Q-Waveform File Formats

| Type                              | Extension | Remarks                                                                                                                                                   |
|-----------------------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Quadrature In-phase Extended Data | .qid      | Metadata found in accompanying .qim file. (for further information see application note Vector Signal Generator - IQ Data Format and Device Upload)       |
| Quadrature In-phase Binary Data   | .qi       |                                                                                                                                                           |
| In-phase Quadrature Data          | .iq       |                                                                                                                                                           |
| Comma Separated Values            | .csv      | Supported Configurations: Delimiter: ';', ',' Decimal separator: '.', ',' Data format: '0 to 65535', '-1 to 1' Data orientation: 'vertical', 'horizontal' |
| Anritsu Quadrature In-phase Data  | .wvd      |                                                                                                                                                           |
| Keysight 16-bit I/Q pairs         | .keysight | LSB first                                                                                                                                                 |
| NI TDMS                           | .tdms     |                                                                                                                                                           |
| R&S IQ Tarball                    | .tar      |                                                                                                                                                           |
| Keysight Waveform                 | .wfm      |                                                                                                                                                           |
| Matlab Data                       | .mat      | Supports a list 'Y' of complex numbers. The real part of the number is I, the imaginary part of the number is Q. Can be generated in Keysight IQTools.    |

## Software AP504XA VSG GUI – Limitations

|                                      |            |
|--------------------------------------|------------|
| Number of PDWs in list editor        | 1 to 1,000 |
| Number of PDWs in bulk upload (.csv) | 1 to 1 M   |

# General Specifications

## Physical Specifications (AP5041A)

|            |                                              |                         |
|------------|----------------------------------------------|-------------------------|
| Weight     | Opt. 504                                     | < 6.5 kg                |
|            | Opt. 506, 512, 520, 540                      | < 7.5 kg                |
| Dimensions | Height incl. feet                            | 96.8 mm                 |
|            | Height without feet                          | 83 mm                   |
|            | Width incl. front handles                    | 244 mm                  |
|            | Width without front handles                  | 224 mm                  |
|            | Length incl. connectors (opt. 504, 506, 512) | 391.3 mm                |
|            | Length incl. connectors (opt. 520, 540)      | 393.4 mm                |
| Display    | Resolution                                   | 800 x 480               |
|            | Size                                         | 5 in (12.7 cm) diagonal |

## Physical Specifications (AP5042A)

|            |                         |           |
|------------|-------------------------|-----------|
| Weight     |                         | < 22.5 kg |
| Dimensions | Height                  | 88 mm     |
|            | Width                   | 444 mm    |
|            | Length incl. connectors | 594 mm    |

## Power Requirements (AP5041A)

|                                  |                                                                                                                                                                          |      |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Power requirements               | 100-240 VAC, 50/60 Hz, 150 W Max (Opt. AC1)<br>100-240 VAC, 50/60 Hz, 165 W Max (Opt. DC1), if external, supplied 24 VDC power adapter used or 24 VDC, 6A Max (Opt. DC1) |      |
| Average power consumption (meas) | Opt. 504                                                                                                                                                                 | 70 W |
|                                  | Opt. 506, 512, 520, 540                                                                                                                                                  | 90 W |

## Power Requirements (AP5042A)

| Number of Channels | Frequency Option                    | Power Requirements                | Average Power Consumption (Measured) |
|--------------------|-------------------------------------|-----------------------------------|--------------------------------------|
| 1 (Opt. 001)       | Opt. 504<br>Opt. 506, 512, 520, 540 | 100-240 VAC, 50/60 H<br>350 W Max | 60 W<br>80W                          |
| 2 (Opt. 002)       | Opt. 504<br>Opt. 506, 512, 520, 540 |                                   | 100 W<br>140 W                       |
| 3 (Opt. 003)       | Opt. 504<br>Opt. 506, 512, 520, 540 |                                   | 140 W<br>180 W                       |
| 4 (Opt. 004)       | Opt. 504<br>Opt. 506, 512, 520, 540 |                                   | 180 W<br>220 W                       |

### Environmental Specifications

|                                     |                                      |
|-------------------------------------|--------------------------------------|
| Operating ambient temperature range | 0 to +45 °C                          |
| Storage ambient temperature range   | -40 to +70 °C                        |
| Operating and storage altitude      | up to 15,000 feet / 4600 m           |
| Indoor use                          | For indoor use only                  |
| Humidity                            | Relative humidity range: 20 to 85%RH |

### Safety, EMC

Safety complies to applicable safety regulation IEC/EN 61010-1.

This product complies with directive 2011/65/EU.

CE notice EMC complies to EMC regulations and directives for emission and immunity to interference (EN 61326-1 Industrial, EN/IEC 61326-2-1).

### Recommended Calibration Cycle

2 years

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at [www.keysight.com](http://www.keysight.com).



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