

# N5185A MXG

## Analog Signal Generator

### Introduction

This data sheet provides key features and specifications for the N5185A MXG analog signal generator.



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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 of 0 to 55 °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.

**Typical (typ)** describes additional product performance information that is not covered by the product warranty. It is performance beyond specifications that 80 percent of the units exhibit with a 90 percent confidence level at room temperature (approximately 25 °C). Typical performance does not include measurement uncertainty.

**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 25 °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 25 °C).

# Frequency

## Frequency options

| Option     | CW frequency range |
|------------|--------------------|
| N5185A-503 | 9 kHz to 3 GHz     |
| N5185A-506 | 9 kHz to 6 GHz     |
| N5185A-508 | 9 kHz to 8.5 GHz   |

## Frequency resolution

|    |            |
|----|------------|
| CW | 0.00001 Hz |
|----|------------|

## Phase adjustments

|                                       |
|---------------------------------------|
| Adjustable in nominal 0.1° increments |
|---------------------------------------|

## Relative phase adjustments<sup>1</sup> (Option PCH)

|                                  |                            |
|----------------------------------|----------------------------|
| Relative phase offset range      | ± 180°                     |
| Relative phase offset resolution | 0.001°                     |
| Relative phase repeatability     | 0.0001° (nom) <sup>2</sup> |

## Frequency switching speed <sup>3</sup>, ( ) = typical

| CW mode         | Standard | Option UNZ          |
|-----------------|----------|---------------------|
| SCPI mode       | (≤ 8 ms) | n/a                 |
| Step/ list mode | (≤ 5 ms) | ≤ 900 us (≤ 800 us) |

<sup>1</sup> Channel 1 relative to Channel 2, for example.

<sup>2</sup> When tuning from f1 to f2 and back to f1.

<sup>3</sup> Time from receipt of SCPI command or trigger signal to within 0.1 ppm of final frequency or within 100 Hz, whichever is greater.

# Frequency Reference

## Frequency resolution

|                                                                 |                                                                                                |
|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Internal time base reference oscillator aging rate <sup>4</sup> | < $\pm 30 \times 10^{-9}$ /year after 30 days<br>< $\pm 0.5 \times 10^{-9}$ /day after 30 days |
| Initial achievable calibration accuracy                         | $\pm 4 \times 10^{-8}$ or $\pm 40$ ppb                                                         |
| Adjustment resolution                                           | < $1.3 \times 10^{-11}$                                                                        |
| Temperature effects                                             | < $\pm 1 \times 10^{-8}$ , nominal                                                             |
| Line voltage effects                                            | < $\pm 1 \times 10^{-9}$ for $\pm 5\%$ change, nominal                                         |

## Reference output

|           |                                                                                                                                                     |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Frequency | 10 MHz or 100 MHz, user selectable                                                                                                                  |
| Amplitude | $\geq +6$ dBm, nominal into 50 $\Omega$ load at 10 MHz reference output<br>$\geq +8$ dBm, nominal into 50 $\Omega$ load at 100 MHz reference output |

## External reference input

|                           |                                                      |
|---------------------------|------------------------------------------------------|
| Input frequency, standard | 10 MHz                                               |
| Stability                 | Follows stability of external reference input signal |
| Lock range                | $\pm 1$ ppm                                          |
| Amplitude                 | -3 dBm to +20 dBm, nominal                           |
| Impedance                 | 50 $\Omega$ , nominal                                |
| Waveform                  | Sine or square                                       |

## Sweep modes (frequency and amplitude)

|                  |                                                              |                                                                                  |
|------------------|--------------------------------------------------------------|----------------------------------------------------------------------------------|
| Operating modes  | Step sweep                                                   | Equally spaced frequency and amplitude or logarithmically spaced frequency steps |
|                  | List sweep                                                   | Arbitrary list of frequency and amplitude steps                                  |
| Sweep range      | Within instrument frequency range                            |                                                                                  |
| Dwell time       | 100 $\mu$ s to 100 s                                         |                                                                                  |
| Number of points | Step sweep                                                   | 2 to 65535                                                                       |
|                  | List sweep                                                   | 1 to 3201                                                                        |
| Step change      | Linear or logarithmic                                        |                                                                                  |
| Triggering       | Free run, trigger key, external, timer, bus (GPIB, LAN, USB) |                                                                                  |

<sup>4</sup> Not verified by Keysight N78000B ETMS Calibration and Adjustments Software. Daily aging rate may be verified as a supplementary chargeable service, on request.

**Multi-channel baseband synchronization primary/secondary (Option PCH)**

|                                                   |                           |
|---------------------------------------------------|---------------------------|
| Global trigger delay range                        | 0 $\mu$ s to 6.82 $\mu$ s |
| Global trigger delay resolution                   | $\pm$ 1.67 ns             |
| Global trigger jitter                             | $\pm$ 1.67 ns             |
| Channel-to-channel relative trigger repeatability | $< \pm$ 5 ps              |

## Output Power

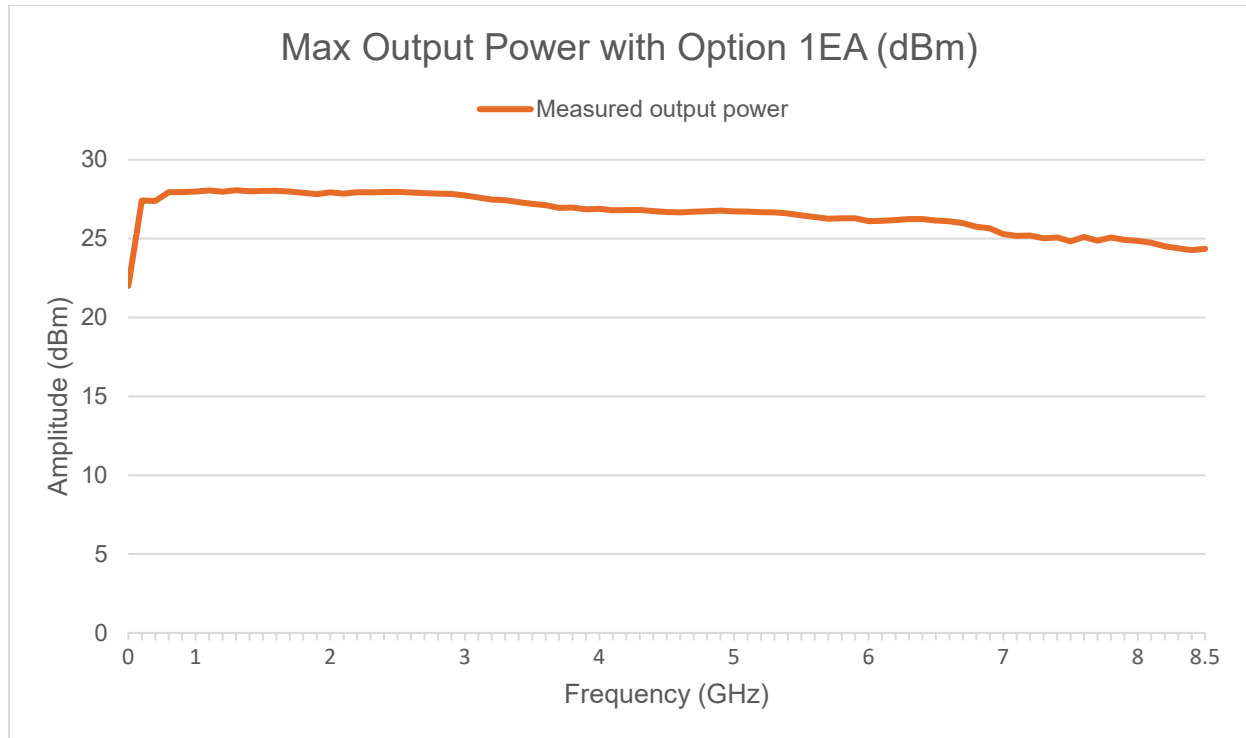
**Output parameters**

|                        |                                                       |
|------------------------|-------------------------------------------------------|
| Settable range         | +20 to -135 dBm (std)<br>+30 to -135 dBm (option 1EA) |
| Resolution             | 0.01 dB                                               |
| Connector <sup>5</sup> | Type N 50 $\Omega$ , nominal                          |
| Maximum reverse power  | 20 W, 50 VDC (nom)                                    |
| Attenuator type        | Electronic                                            |

**Maximum output power, () = typical**

| Frequency range     | Standard | Option 1EA        |
|---------------------|----------|-------------------|
| 9 kHz to < 20 kHz   | +1 dBm   | +1 dBm (+4 dBm)   |
| 20 kHz to < 50 kHz  | +7 dBm   | +7 dBm (+10 dBm)  |
| 50 kHz to < 200 kHz | +12 dBm  | +12 dBm (+14 dBm) |
| 200 kHz to < 10 MHz | +15 dBm  | +15 dBm (+19 dBm) |
| 10 MHz to < 5 GHz   | +18 dBm  | +25 dBm (+26 dBm) |
| 5 GHz to < 8 GHz    | +18 dBm  | +23 dBm (+25 dBm) |
| 8 GHz to < 8.5 GHz  | +18 dBm  | +22 dBm (+24 dBm) |

<sup>5</sup> Connector type for configurations with options 1EM, 001, 002, 003, and 004 is 3.5 mm.

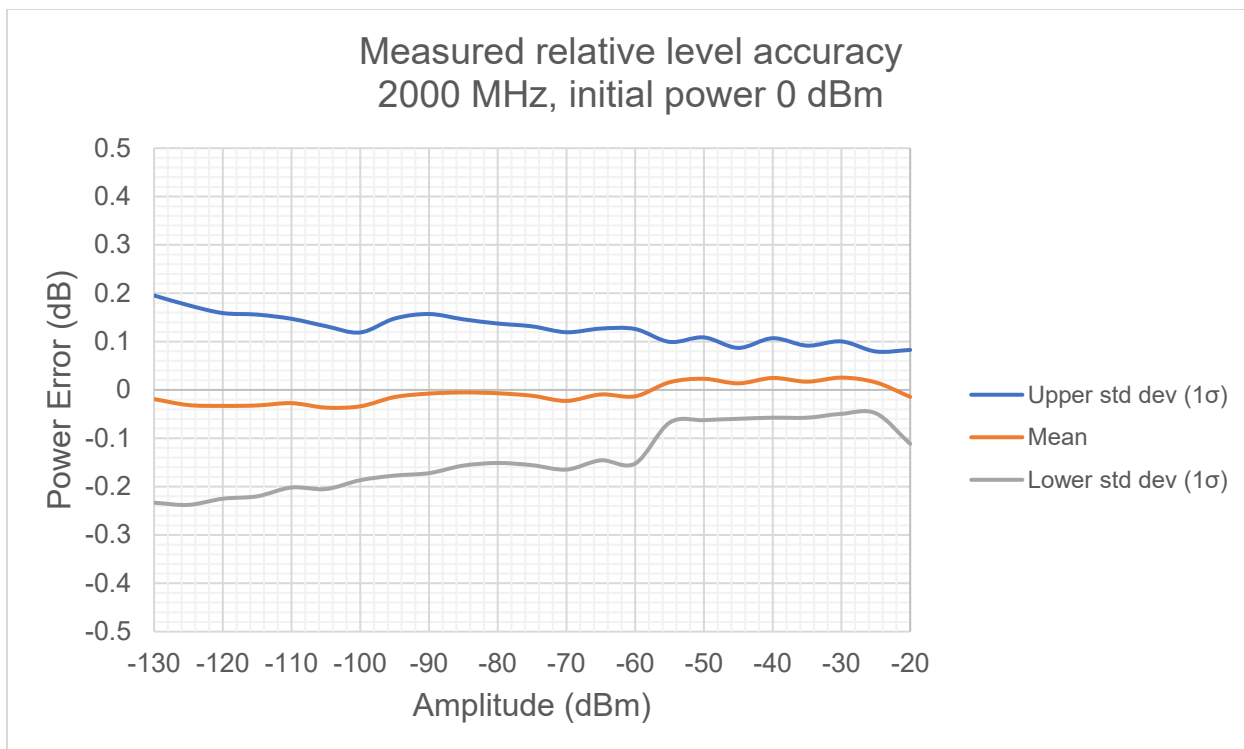


**Absolute level accuracy (CW) <sup>6,7</sup>, temperature range 20 to 30 °C, () = typical**

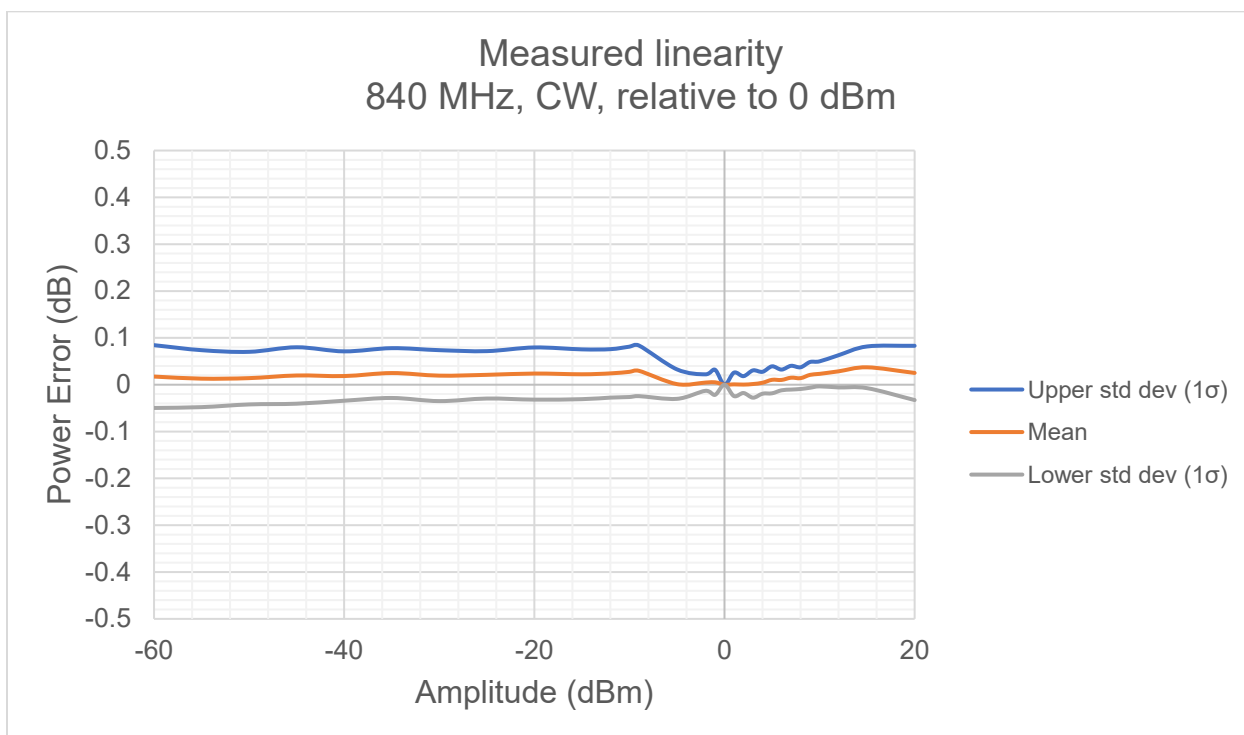
| Frequency range      | +20 dBm to +15 dBm<br>(option 1EA) | < +15 dBm to +5 dBm    | < +5 dBm to -60 dBm    | < -60 dBm to -95 dBm   | < -95 dBm to -110 dBm  | < -110 dBm to -130 dBm<br>(option 1EQ) |
|----------------------|------------------------------------|------------------------|------------------------|------------------------|------------------------|----------------------------------------|
| 9 kHz to < 100 kHz   | -                                  | -                      | ± 3.1 dB<br>(± 1.5 dB) | (± 2.7 dB)             | -                      | -                                      |
| 100 kHz to 10 MHz    | ± 1.1 dB<br>(± 0.5 dB)             | ± 0.8 dB<br>(± 0.2 dB) | ± 1.0 dB<br>(± 0.5 dB) | ± 1.5 dB<br>(± 0.7 dB) | -                      | -                                      |
| >10 MHz to < 270 MHz | ± 2.3 dB<br>(± 1.6 dB)             | ± 1.3 dB<br>(± 0.6 dB) | ± 1.2 dB<br>(± 0.5 dB) | ± 2.0 dB<br>(± 1.2 dB) | ± 2.7 dB<br>(± 1.2 dB) | ± 2.7 dB<br>(± 1.2 dB)                 |
| 270 MHz to < 800 MHz | ± 0.9 dB<br>(± 0.4 dB)             | ± 0.9 dB<br>(± 0.3 dB) | ± 0.8 dB<br>(± 0.3 dB) | ± 0.8 dB<br>(± 0.3 dB) | ± 0.9 dB<br>(± 0.3 dB) | ± 0.9 dB<br>(± 0.3 dB)                 |
| 800 MHz to < 5 GHz   | ± 0.8 dB<br>(± 0.3 dB)             | ± 0.8 dB<br>(± 0.3 dB) | ± 0.8 dB<br>(± 0.3 dB) | ± 0.9 dB<br>(± 0.3 dB) | ± 1.3 dB<br>(± 0.6 dB) | ± 1.3 dB<br>(± 0.6 dB)                 |
| 5 GHz to < 7 GHz     | ± 1.0 dB<br>(± 0.3 dB)             | ± 1.0 dB<br>(± 0.3 dB) | ± 1.0 dB<br>(± 0.4 dB) | ± 1.1 dB<br>(± 0.5 dB) | ± 1.5 dB<br>(± 0.7 dB) | ± 1.5 dB<br>(± 0.7 dB)                 |
| 7 GHz to 8.5 GHz     | ± 1.3 dB<br>(± 0.5 dB)             | ± 1.2 dB<br>(± 0.4 dB) | ± 1.1 dB<br>(± 0.5 dB) | ± 1.4 dB<br>(± 0.6 dB) | ± 1.9 dB<br>(± 0.8 dB) | ± 1.9 dB<br>(± 0.8 dB)                 |

<sup>6</sup> Specifications apply for power alignments > 10 MHz.

<sup>7</sup> Performance operating below 20 kHz frequency is not warranted if the power level is set below -85 dBm.

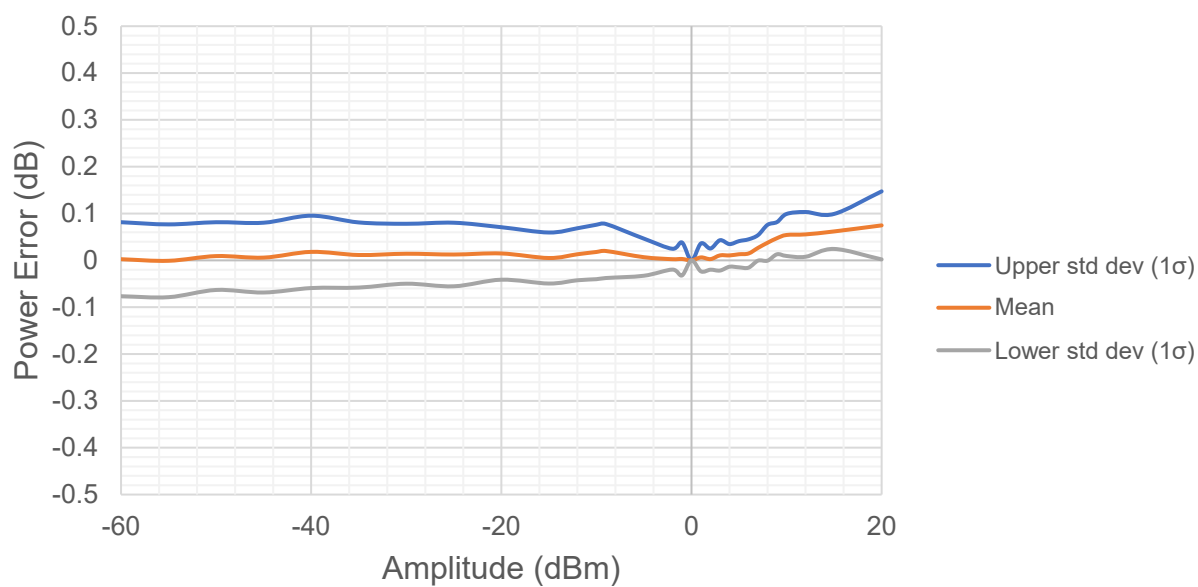


Relative level accuracy measures the accuracy of a step change from any power level to any other power level. This is useful for large changes (such as 5 dB steps).

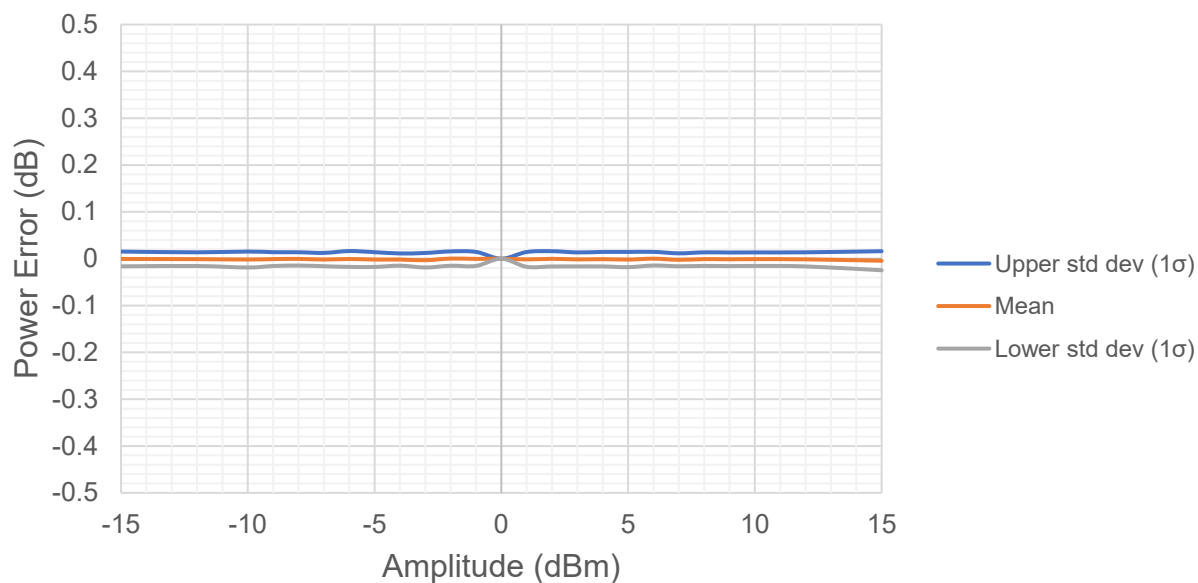




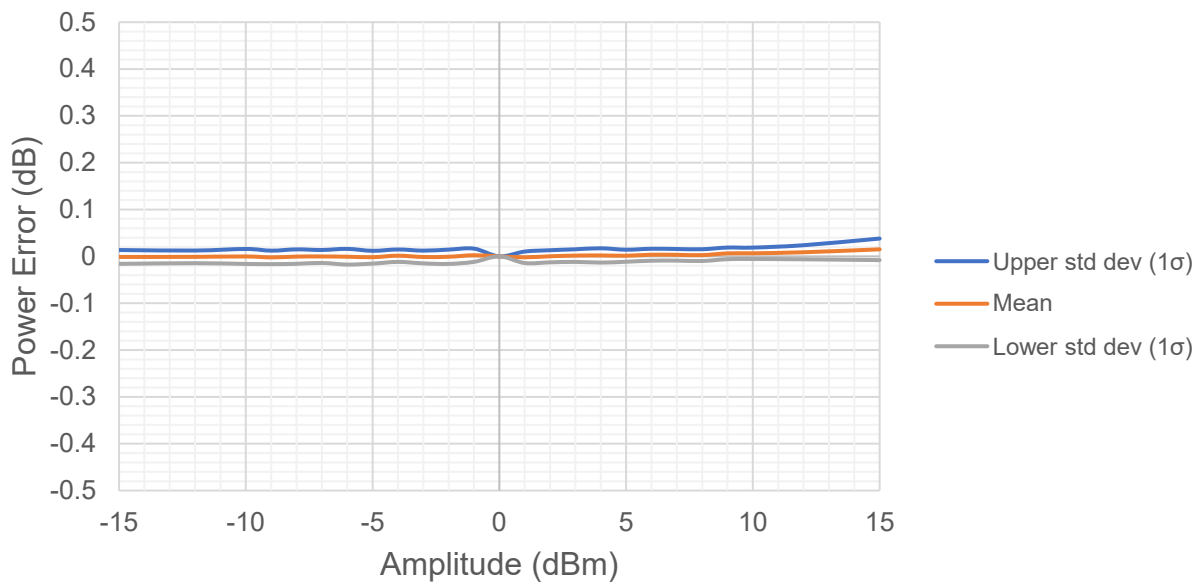
Measured linearity  
2000 MHz, CW, relative to 0 dBm



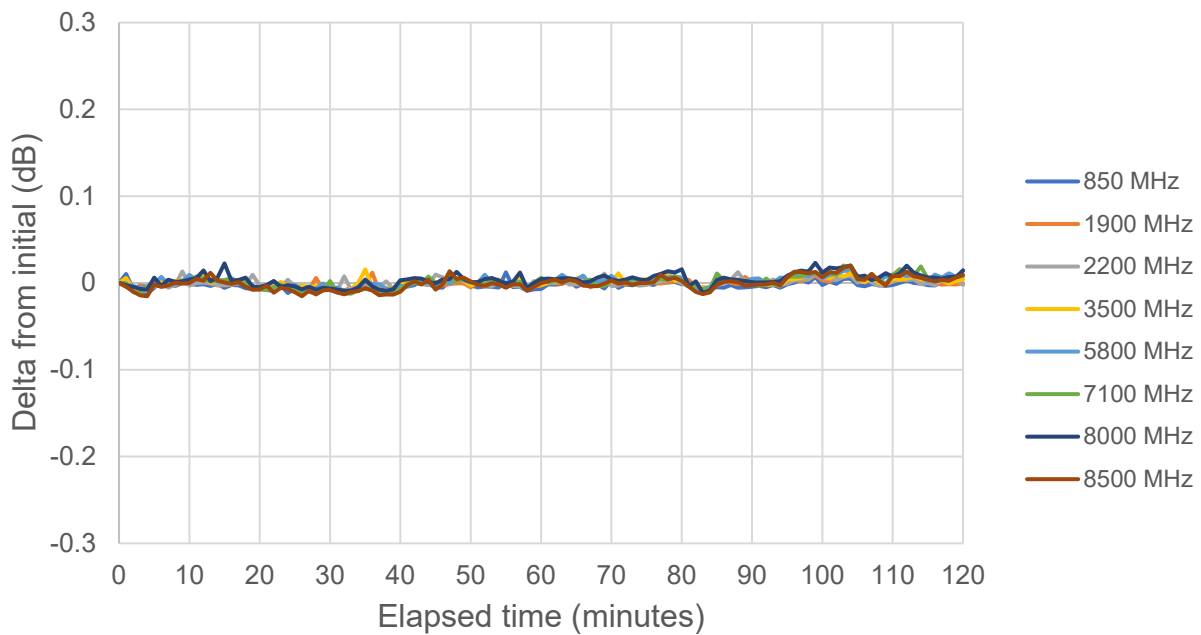
Measured linearity with all attenuator states held  
840 MHz, CW, relative to 0 dBm



Measured linearity with all attenuator states held  
2000 MHz, CW, relative to 0 dBm



Measured amplitude repeatability +5 dBm



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.

**VSWR, measured**

| Frequency range     | Option UNM | Option 1EM |
|---------------------|------------|------------|
| 30 kHz to < 60 kHz  | < 3.0:1    | < 3.0:1    |
| 60 kHz to < 800 kHz | < 2.0:1    | < 2.0:1    |
| 800 kHz to < 1 MHz  | < 1.7:1    | < 1.7:1    |
| 1 MHz to < 10 MHz   | < 1.25:1   | < 1.25:1   |
| 10 MHz to < 30 MHz  | < 2.1:1    | < 2.1:1    |
| 30 MHz to < 6.8 GHz | < 1.5:1    | < 1.5:1    |
| 6.8 GHz to 8.5 GHz  | < 1.9:1    | < 1.7:1    |

**Amplitude switching speed <sup>8</sup>, () = typical**

| CW mode         | Standard | Option UNZ          |
|-----------------|----------|---------------------|
| SCPI mode       | (≤ 8 ms) | n/a                 |
| Step/ list mode | (≤ 5 ms) | ≤ 500 us (≤ 400 us) |

<sup>8</sup> Time from receipt of SCPI command or trigger signal to amplitude settled within 0.2 dB. Switching speed specifications apply when status register updates are off.

# Phase Noise

Absolute SSB phase noise (CW in enhanced SNR mode at +10 dBm) (dBc/Hz), Standard, temperature range 20 to 30 °C, () = typical

| Frequency | 1 Hz  | 10 Hz       | 100 Hz      | 1 kHz       | 10 kHz      | 100 kHz     | 1 MHz       | 10 MHz      | 100 MHz |
|-----------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---------|
| 100 MHz   | (-89) | -103 (-110) | -120 (-126) | -140 (-146) | -143 (-148) | -143 (-148) | -141 (-149) | -141 (-148) | -       |
| 500 MHz   | (-76) | -89 (-96)   | -106 (-113) | -130 (-135) | -136 (-140) | -136 (-140) | -150 (-157) | -150 (-157) | (-157)  |
| 1 GHz     | (-70) | -84 (-90)   | -99 (-106)  | -124 (-129) | -129 (-134) | -129 (-134) | -150 (-157) | -150 (-158) | (-158)  |
| 2 GHz     | (-64) | -77 (-84)   | -93 (-100)  | -117 (-123) | -123 (-128) | -123 (-127) | -146 (-154) | -150 (-158) | (-158)  |
| 3 GHz     | (-60) | -74 (-80)   | -89 (-96)   | -114 (-120) | -119 (-124) | -119 (-124) | -144 (-152) | -152 (-158) | (-158)  |
| 4 GHz     | (-59) | -71 (-77)   | -87 (-94)   | -112 (-117) | -116 (-122) | -116 (-121) | -141 (-150) | -151 (-157) | (-158)  |
| 6 GHz     | (-55) | -68 (-74)   | -84 (-90)   | -108 (-114) | -113 (-118) | -113 (-118) | -137 (-146) | -149 (-155) | (-155)  |
| 8 GHz     | (-53) | -66 (-72)   | -82 (-88)   | -105 (-111) | -111 (-116) | -110 (-115) | -134 (-144) | -146 (-153) | (-153)  |

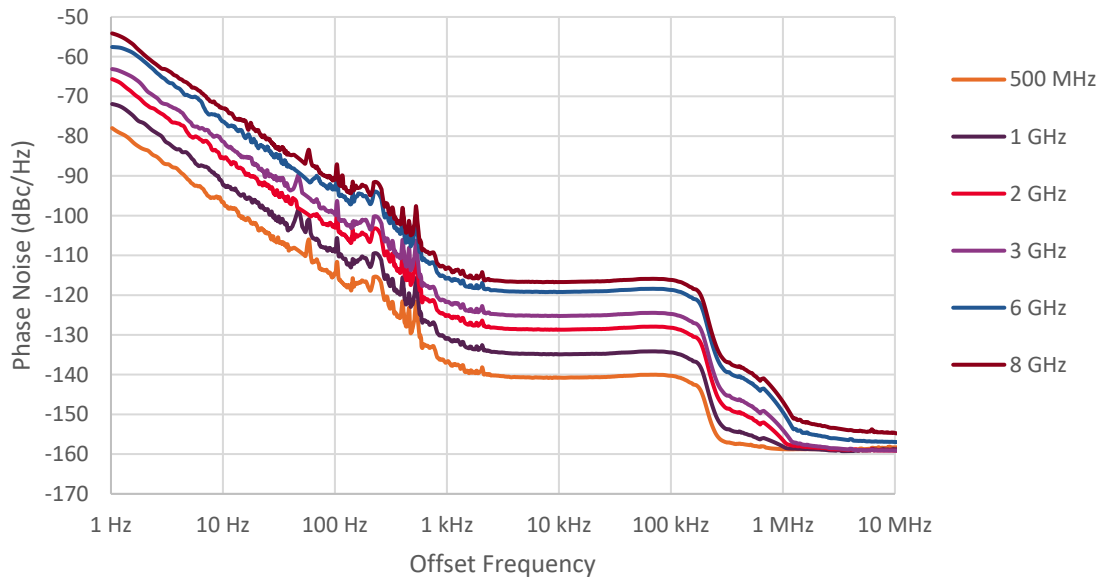
Absolute SSB phase noise (CW in enhanced SNR mode at +10 dBm) (dBc/Hz), Option EP3, temperature range 20 to 30 °C, () = typical

| Frequency | 1 Hz  | 10 Hz       | 100 Hz      | 1 kHz       | 10 kHz      | 100 kHz     | 1 MHz       | 10 MHz      | 100 MHz |
|-----------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---------|
| 100 MHz   | (-90) | -103 (-110) | -120 (-126) | -140 (-146) | -143 (-149) | -143 (-149) | -141 (-149) | -141 (-148) | -       |
| 500 MHz   | (-76) | -89 (-96)   | -106 (-112) | -130 (-136) | -140 (-146) | -140 (-146) | -150 (-157) | -150 (-157) | (-157)  |
| 1 GHz     | (-69) | -84 (-90)   | -99 (-106)  | -123 (-129) | -133 (-139) | -133 (-139) | -149 (-157) | -150 (-158) | (-158)  |
| 2 GHz     | (-64) | -78 (-84)   | -93 (-99)   | -117 (-123) | -126 (-132) | -127 (-132) | -146 (-154) | -150 (-158) | (-158)  |
| 3 GHz     | (-60) | -74 (-80)   | -89 (-96)   | -114 (-120) | -123 (-129) | -123 (-129) | -144 (-152) | -152 (-158) | (-158)  |
| 4 GHz     | (-58) | -72 (-78)   | -87 (-93)   | -111 (-117) | -119 (-125) | -121 (-126) | -141 (-150) | -150 (-157) | (-157)  |
| 6 GHz     | (-55) | -68 (-74)   | -84 (-91)   | -107 (-114) | -117 (-123) | -117 (-123) | -137 (-146) | -149 (-155) | (-156)  |
| 8 GHz     | (-53) | -66 (-72)   | -81 (-88)   | -104 (-111) | -115 (-120) | -115 (-120) | -134 (-144) | -147 (-153) | (-153)  |

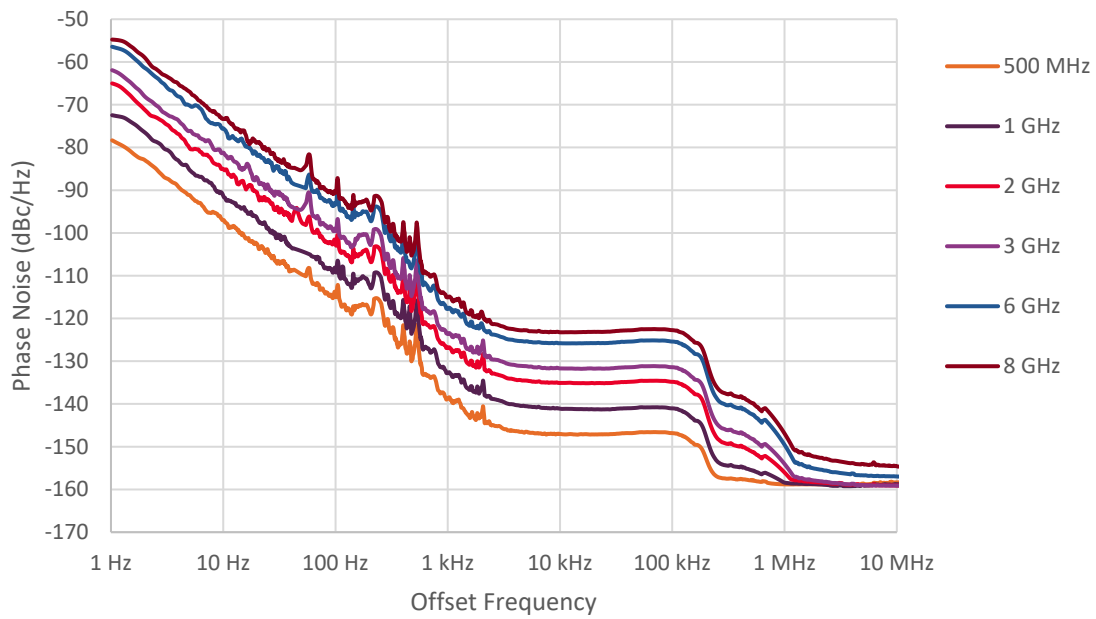
Absolute SSB phase noise (CW in enhanced SNR mode at +10 dBm) (dBc/Hz), Option EP4, temperature range 20 to 30 °C, () = typical

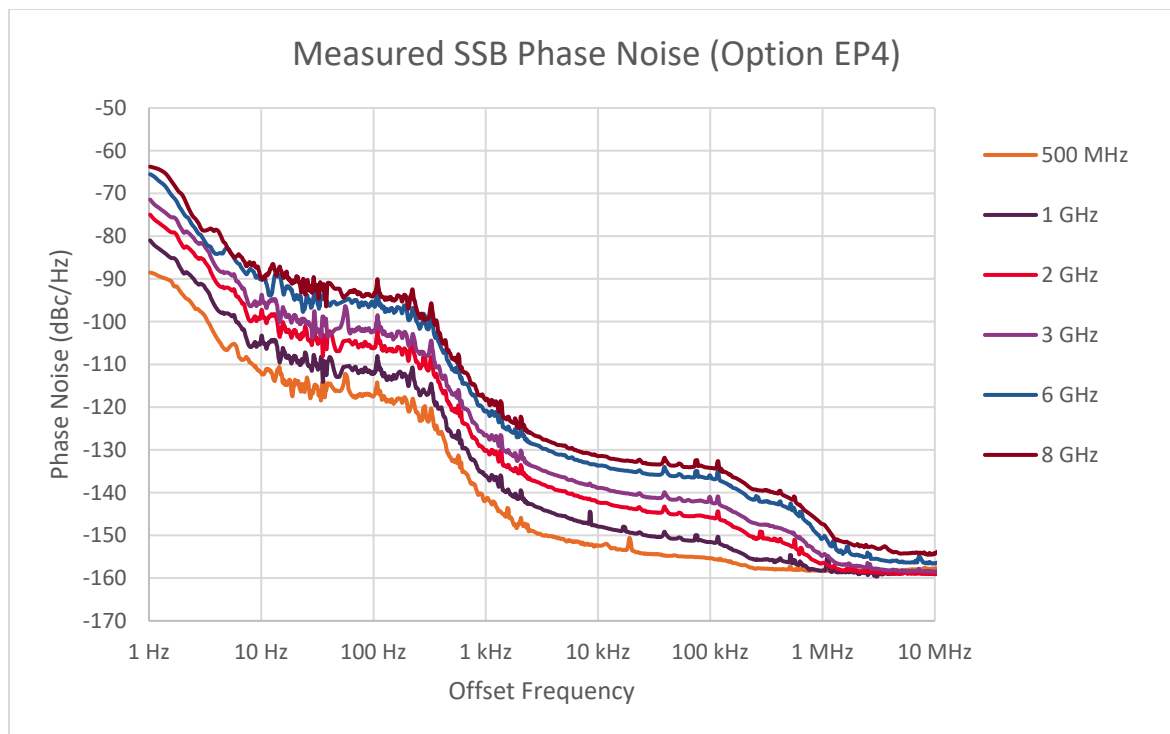
| Frequency | 1 Hz  | 10 Hz       | 100 Hz      | 1 kHz       | 10 kHz      | 100 kHz     | 1 MHz       | 10 MHz      | 100 MHz |
|-----------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---------|
| 100 MHz   | (-92) | -111 (-118) | -121 (-127) | -139 (-146) | -148 (-152) | -148 (-153) | -146 (-153) | -145 (-152) | -       |
| 500 MHz   | (-78) | -95 (-104)  | -106 (-113) | -131 (-138) | -144 (-151) | -149 (-154) | -150 (-157) | -151 (-157) | (-157)  |
| 1 GHz     | (-71) | -88 (-96)   | -100 (-107) | -125 (-132) | -141 (-146) | -146 (-150) | -149 (-157) | -151 (-158) | (-158)  |
| 2 GHz     | (-65) | -83 (-92)   | -93 (-101)  | -120 (-127) | -135 (-141) | -139 (-144) | -149 (-155) | -151 (-158) | (-158)  |
| 3 GHz     | (-63) | -80 (-88)   | -89 (-97)   | -117 (-123) | -133 (-138) | -136 (-141) | -145 (-153) | -151 (-158) | (-158)  |
| 4 GHz     | (-60) | -78 (-86)   | -86 (-94)   | -114 (-121) | -130 (-136) | -132 (-138) | -143 (-151) | -151 (-157) | (-158)  |
| 6 GHz     | (-56) | -73 (-81)   | -84 (-91)   | -111 (-118) | -128 (-133) | -130 (-135) | -140 (-148) | -149 (-156) | (-156)  |
| 8 GHz     | (-53) | -70 (-79)   | -81 (-88)   | -108 (-115) | -125 (-130) | -128 (-132) | -136 (-145) | -147 (-153) | (-154)  |

Measured SSB Phase Noise (Standard)



Measured SSB Phase Noise (Option EP3)





## Spectral Purity

Harmonics (CW), () = typical

| Frequency range       | $\leq +10$ dBm          | $\leq +12$ dBm     |
|-----------------------|-------------------------|--------------------|
| 9 kHz to 100 kHz      | (<-30 dBc) <sup>9</sup> | n/a                |
| > 100 kHz to 3 GHz    | <-35 dBc (-41 dBc)      | <-33 dBc (-39 dBc) |
| > 3 GHz to 4.25 GHz   | <-30 dBc (-34 dBc)      | (<-32 dBc)         |
| > 4.25 GHz to 8.5 GHz | (<-34 dBc)              | (<-32 dBc)         |

Non-harmonics (CW), > 10 kHz offset, +10 dBm, temperature range 20 to 30 °C, () = typical

| Frequency range     | Standard (+10 dBm) | Option EP3 / EP4  |
|---------------------|--------------------|-------------------|
| 9 kHz to < 15 MHz   | -52 dBc            | -52 dBc (-59 dBc) |
| 15 MHz to < 30 MHz  | -60 dBc            | -60 dBc (-68 dBc) |
| 30 MHz to < 8.5 GHz | -75 dBc            | -80 dBc           |

Subharmonics

None

<sup>9</sup> Measured at 0 dBm or maximum specified power, whichever is less.

**Fixed spurs, +10 dBm**

| Frequency range                                   |         |
|---------------------------------------------------|---------|
| 300 MHz                                           | -77 dBc |
| DAC spur ( $19.2 \text{ GHz} - 2f_{\text{out}}$ ) | -67 dBc |
| DAC spur ( $3f_{\text{out}} - 19.2 \text{ GHz}$ ) | -69 dBc |

**Jitter <sup>10</sup>, measured**

| Carrier frequency | RMS jitter |            |            | $\mu\text{UI rms}$ |            |            |
|-------------------|------------|------------|------------|--------------------|------------|------------|
|                   | Standard   | Option EP3 | Option EP4 | Standard           | Option EP3 | Option EP4 |
| 155 MHz           | 30.8 fs    | 26.97 fs   | 26.83 fs   | 4.8                | 4.2        | 4.2        |
| 622 MHz           | 18.95 fs   | 12.8 fs    | 11.51 fs   | 11.8               | 8          | 7.2        |
| 2.488 GHz         | 16.14 fs   | 8.23 fs    | 6.17 fs    | 40.2               | 20.5       | 15.4       |

**Secondary DDS tone generator (Option CW1)**

Enables a secondary DDS tone generator that can reduce the 2nd harmonic tone. Compatible only with harmonic products of CW signals; not compatible with harmonic products of modulated signals.

**Carrier settings**

|                         |                      |
|-------------------------|----------------------|
| Carrier frequency range | 9 kHz to 8.5 GHz     |
| Carrier amplitude range | +10 to -50 dBm (nom) |

**Secondary DDS tone generator settings**

|                                        |                      |
|----------------------------------------|----------------------|
| Frequency range                        | 9 kHz to 8.5 GHz     |
| Amplitude range                        | -10 to -70 dBc (nom) |
| Phase range                            | -180° to +180° (nom) |
| Maximum tone improvement <sup>11</sup> | Up to 15 dB (nom)    |

<sup>10</sup> Calculated from phase noise performance at +10 dBm (CW in enhanced SNR mode)

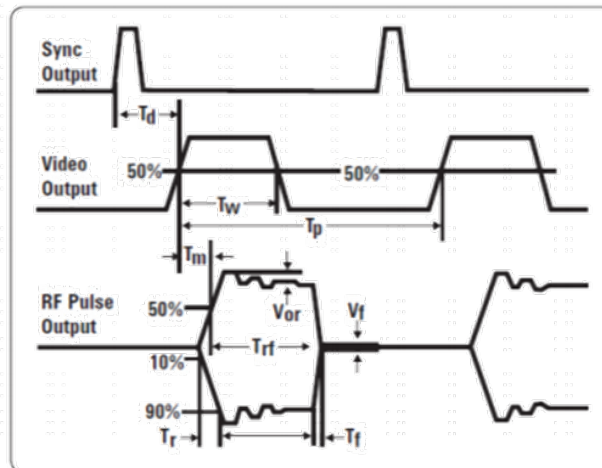
<sup>11</sup> Phase setting of the secondary DDS tone generator varies depending on the phase of the 2<sup>nd</sup> harmonic tone.

# Pulse Modulation (Option PMR)

Pulse modulation <sup>12</sup>, () = typical

|                                  |                              |                  |
|----------------------------------|------------------------------|------------------|
| On/off ratio                     | (105 dB)                     |                  |
| Rise/fall times                  | 10 ns (8 ns)                 |                  |
| Minimum pulse width              | 20 ns                        |                  |
| Level accuracy (relative to CW)  | < $\pm 1$ dB ( $\pm 0.3$ dB) |                  |
| Width compression                | ( $\pm 5$ ns)                |                  |
| Video feed-through <sup>13</sup> | (< 85 mV)                    |                  |
| External video delay             | Internal <sup>14</sup>       | 320 ns, nominal  |
|                                  | External                     | 120 ns, nominal  |
| RF delay                         | 5 ns, nominal                |                  |
| Pulse overshoot                  | (< 15%)                      |                  |
| Input level                      | High-level                   | 0.575 V, nominal |
|                                  | Low-level                    | 0.425 V, nominal |

- $T_d$  video delay (variable)
- $T_w$  video pulse width (variable)
- $T_p$  Pulse period (variable)
- $T_m$  RF delay
- $T_{rf}$  RF pulse width
- $T_f$  RF pulse fall time
- $T_r$  RF pulse rise time
- $V_{or}$  pulse overshoot
- $V_f$  video feedthrough



<sup>12</sup> Specifications apply to center frequencies  $\geq 100$  MHz and powers set to  $\geq -10$  dBm. Operable down to 9 kHz.

<sup>13</sup> Applies to power level < +10 dBm.

<sup>14</sup> Applies to externally triggered internal pulse modulation.



### Internal pulse generator (Option PMR)

|                  |                                                 |                                   |
|------------------|-------------------------------------------------|-----------------------------------|
| Modes            | Square, free run, triggered, adjustable doublet |                                   |
| Square wave rate | 0.1 Hz to 25 MHz                                |                                   |
| Signal routing   | Pulse trigger input                             | Pulse In                          |
|                  | Pulse sync output                               | Event 1                           |
|                  | Pulse video output                              | Event 2                           |
| Pulse period     | 30 ns to 42 s                                   |                                   |
| Pulse width      | 20 ns to (42 s – 10 ns)                         |                                   |
| Resolution       | 10 ns                                           |                                   |
| Settable delay   | Square                                          | (-10 ns + 10 ns) to (5 s – 10 ns) |
|                  | Free run                                        | (-42 s + 10 ns) to (42 s – 30 ns) |
|                  | Triggered                                       | 0 to (42 s – 30 ns)               |
| Pulse doublets   | 1 <sup>st</sup> pulse delay                     | 0 to (42 s – 30 ns)               |
|                  | 1 <sup>st</sup> pulse width                     | 20 ns to (42 s – 10 ns)           |
|                  | 2 <sup>nd</sup> pulse delay                     | 0 to (42 s – 30 ns)               |
|                  | 2 <sup>nd</sup> pulse width                     | 20 ns to (42 s – 10 ns)           |

## Analog Modulation

### Frequency bands

| Band # | Frequency range     |
|--------|---------------------|
| 1      | 9 kHz to < 10 MHz   |
| 2      | 10 MHz to < 8.5 GHz |

### Frequency modulation (option UNT)

|                                                   |                            | Internal                                                                                                        | External                                                               |
|---------------------------------------------------|----------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Max deviation                                     |                            | 1 GHz (nom)                                                                                                     | 1 GHz (nom)                                                            |
| Resolution                                        |                            | 0.1% of deviation or 1 Hz, whichever is larger, nominal<br>0.1% of deviation or 1 Hz, whichever is larger (nom) | 0.1% of deviation or 1 Hz, whichever is larger (nom)                   |
| Deviation accuracy                                | Deviation ≤ 5 MHz          | < 1.5% of setting + 20Hz                                                                                        | < 1.5% of setting + 20Hz (nom)                                         |
|                                                   | 5 MHz < deviation ≤ 10 MHz | < 2% of setting + 20Hz                                                                                          | < 2% of setting + 20Hz (nom)                                           |
|                                                   |                            |                                                                                                                 |                                                                        |
| Modulation frequency response @ 100 kHz deviation | 0.5 dB bandwidth           | DC/5 Hz to 100 kHz (nom)                                                                                        | DC/5 Hz to 100 kHz (nom)                                               |
|                                                   | 1 dB bandwidth             | DC/5 Hz to 3 MHz (nom)                                                                                          | DC/5 Hz to 3 MHz (nom)                                                 |
|                                                   | 3 dB bandwidth             | DC/1 Hz to 7 MHz (nom)                                                                                          | DC/1 Hz to 7 MHz (nom)                                                 |
| Carrier frequency accuracy                        |                            | < ± 0.2% of set deviation                                                                                       | < ± 0.2% of set deviation (nom)                                        |
| Total harmonic distortion                         |                            | < 0.4% [1 kHz rate, deviation is 1 MHz]                                                                         | < 0.4% (nom) [1 kHz rate, deviation is 1 MHz]                          |
| FM using external inputs 1 or 2                   | Sensitivity                | n/a                                                                                                             | +1 V peak for indicated deviation (nom)                                |
|                                                   | Input impedance            | n/a                                                                                                             | 50 Ω/ 600 Ω/ 1 M Ω (nom)                                               |
|                                                   | Paths                      | n/a                                                                                                             | FM path 1 and FM path 2 are summed internally for composite modulation |

### Phase modulation (option UNT)

|                                       |                 | Internal                                                     | External                                                               |
|---------------------------------------|-----------------|--------------------------------------------------------------|------------------------------------------------------------------------|
| Max deviation                         |                 | 600MHz / $\Phi$ M rate or 12 $\pi$ , whichever is less (nom) | 600MHz / $\Phi$ M rate or 12 $\pi$ , whichever is less (nom)           |
| Frequency Response                    | 3 dB bandwidth  | DC / 5 Hz to 10 MHz (nom)                                    | DC / 5 Hz to 10 MHz (nom)                                              |
| Resolution                            |                 | 0.1% of deviation                                            | 0.1% of deviation (nom)                                                |
| Deviation accuracy                    |                 | < + 0.5% + 0.01 rad, typical [1 kHz rate]                    | < + 0.5% + 0.01 rad (nom) [1 kHz rate]                                 |
| Total harmonic distortion             |                 | < 0.2%, typical [1 kHz rate, 1 radian deviation]             | < 0.2% (nom) [1 kHz rate, 1 radian deviation]                          |
| $\Phi$ M using external inputs 1 or 2 | Sensitivity     | n/a                                                          | +1 V peak for indicated deviation (nom)                                |
|                                       | Input impedance | n/a                                                          | 50 $\Omega$ / 600 $\Omega$ / 1 M $\Omega$ (nom)                        |
|                                       | Paths           | n/a                                                          | FM path 1 and FM path 2 are summed internally for composite modulation |

### Amplitude modulation (option UNT)

|                                              |                                               |           | Internal                                                 |                   | External                                                                        |                   |
|----------------------------------------------|-----------------------------------------------|-----------|----------------------------------------------------------|-------------------|---------------------------------------------------------------------------------|-------------------|
|                                              |                                               |           | Linear                                                   | Exponential       | Linear                                                                          | Exponential       |
| Settable depth                               |                                               |           | 0 to 100%                                                | 0 to -40 dB (nom) | 0 to 100% (nom)                                                                 | 0 to -40 dB (nom) |
| Depth resolution                             |                                               |           | 0.1% (nom)                                               | 0.01 dB (nom)     | 0.1% (nom)                                                                      | 0.01 dB (nom)     |
| AM depth accuracy (@ 1 kHz rate, <80% depth) | f < 3 GHz                                     |           | < 1.5% of setting + 1% (typical is 0.5% of setting + 1%) | < 1 dB (nom)      | < 1.5% of setting + 1% (nom)                                                    | < 1 dB (nom)      |
| Total harmonic distortion (@1 kHz rate)      | f < 5 MHz                                     | 30% depth | <0.25% (typical)                                         | <0.25% (nom)      | <0.25% (nom)                                                                    | <0.25% (nom)      |
|                                              |                                               | 80% depth | < 0.5% (typical)                                         | < 0.5% (nom)      | < 0.5% (nom)                                                                    | < 0.5% (nom)      |
|                                              | 5 MHz < f < 2 GHz (2 GHz to 3 GHz is typical) | 30% depth | < 2%                                                     | < 2% (nom)        | < 2% (nom)                                                                      | < 2% (nom)        |
|                                              |                                               | 80% depth | < 2%                                                     | < 2% (nom)        | < 2% (nom)                                                                      | < 2% (nom)        |
| Frequency response                           | 30% depth, 1 dB bandwidth                     |           | DC/10 Hz to 500 kHz (nom)                                |                   | DC/10 Hz to 500 kHz (nom)                                                       |                   |
|                                              | 30% depth, < 5 dB bandwidth                   |           | DC/10 Hz to 1 GHz (nom)                                  |                   | DC/10 Hz to 1 GHz (nom)                                                         |                   |
| AM using external inputs 1 or 2              | Sensitivity                                   |           | n/a                                                      |                   | $\pm$ 1 V peak for indicated depth (Over-range can be 150% or $\pm$ 1.5 V peak) |                   |
|                                              | Input impedance                               |           | n/a                                                      |                   | 50 $\Omega$ / 600 $\Omega$ / 1M $\Omega$<br>Damage level: $\pm$ 5 V max         |                   |
|                                              | Paths                                         |           | n/a                                                      |                   | AM path 1 and AM path 2 are summed internally for composite modulation          |                   |

## Simultaneous and composite modulation

| Simultaneous modulation |     | All modulation types (I/O, FM, AM, $\Phi$ M, and pulse modulation) may be simultaneously enabled except: FM and phase modulation cannot be combined and two modulation types cannot be simultaneously generated using the same modulation source; for example, the baseband generator, AM, and FM can run concurrently and all will modulate the output RF (this is useful for simulating signal impairments). |                    |       |                           |          |
|-------------------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------|---------------------------|----------|
| Composite modulation    |     | AM, FM, and $\Phi$ M each consist of two modulation paths which are summed internally for composite modulation; modulation can be any combination of internal or external sources                                                                                                                                                                                                                              |                    |       |                           |          |
|                         | AM  | FM                                                                                                                                                                                                                                                                                                                                                                                                             | PM                 | Pulse | Internal                  | External |
| AM                      | +   | +                                                                                                                                                                                                                                                                                                                                                                                                              | +                  | +     | n/a                       | n/a      |
| FM                      | +   | +                                                                                                                                                                                                                                                                                                                                                                                                              | -                  | +     | n/a                       | n/a      |
| PM                      | +   | -                                                                                                                                                                                                                                                                                                                                                                                                              | +                  | +     | n/a                       | n/a      |
| Pulse                   | +   | +                                                                                                                                                                                                                                                                                                                                                                                                              | +                  | -     | n/a                       | n/a      |
| Internal                | n/a | n/a                                                                                                                                                                                                                                                                                                                                                                                                            | n/a                | n/a   | n/a                       | n/a      |
| External                | n/a | n/a                                                                                                                                                                                                                                                                                                                                                                                                            | n/a                | n/a   | n/a                       | n/a      |
| + = compatible          |     |                                                                                                                                                                                                                                                                                                                                                                                                                | - = not compatible |       | * = internal and external |          |

## Standard internal analog modulation source

| (Single sine wave generator for use with AM, FM, phase modulation requires Option UNT or 303) |                                                                                            |
|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Waveform                                                                                      | Sine, square, triangle, positive ramp, negative ramp                                       |
| Rate range                                                                                    | 0.1 Hz to 2 MHz (tunable to 3 MHz)                                                         |
| Resolution                                                                                    | 0.1 Hz                                                                                     |
| Frequency accuracy                                                                            | Same as RF reference source, nominal                                                       |
| LF output                                                                                     | 0 to 5 V peak into 50 $\Omega$ , -1V to 5 V offset, nominal. Applicable to channel 1 only. |

## Multifunction generator (option 303)

| The multifunction generator option (Option 303) consists of seven waveform generators that can be set independently with up to five simultaneously using the composite modulation features in AM, FM/PM, and LF out. |                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Function generator 1                                                                                                                                                                                                 | Sine, triangle, square, ramp, pulse                                                                                  |
| Function generator 2                                                                                                                                                                                                 | Sine, triangle, square, ramp, pulse                                                                                  |
| Dual function generator                                                                                                                                                                                              | Sine, triangle, square, ramp, phase offset, and amplitude ratio for Tone 2 relative to Tone 1                        |
| Swept function generator                                                                                                                                                                                             | Sine, triangle, square, ramp<br>Trigger: free run, trigger key, bus, external, internal, global trigger (option PCH) |
| Noise generator 1                                                                                                                                                                                                    | Uniform, Gaussian                                                                                                    |
| Noise generator 2                                                                                                                                                                                                    | Uniform, Gaussian                                                                                                    |
| DC                                                                                                                                                                                                                   | Only for LF output -1 V to +5 V, nominal                                                                             |

## Frequency parameters

|                               |                         |
|-------------------------------|-------------------------|
| Sine wave                     | 0.01 Hz to 100 MHz      |
| Triangle, square, ramp, pulse | 0.01 Hz to 10 MHz (nom) |
| Noise BW                      | 10 MHz (nom)            |
| Resolution                    | 0.01 Hz                 |

# Corrections and De-Embedding (E7653APPC)

User defined automatic channel response correction and S-parameter de-embedding (E7653APPC)

## Methods for fixture error removal

Scatter parameters de-embedding/embedding files generated by a network analyzer or simulation

Automatic channel response correction using a power sensor or spectrum analyzer (amplitude and phase correction)

Scalar user flatness (absolute power correction)

## Scatter parameters

|             |            |
|-------------|------------|
| File format | .s2p, .csv |
|-------------|------------|

|                                     |   |
|-------------------------------------|---|
| Number of cascable calibration sets | 4 |
|-------------------------------------|---|

## User flatness

|             |              |
|-------------|--------------|
| File format | .uflat, .csv |
|-------------|--------------|

|             |                                       |
|-------------|---------------------------------------|
| Entry modes | USB or LAN direct power meter control |
|-------------|---------------------------------------|

# Inputs and Outputs

## Front panel connectors

|           |                                                                                                                                       |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------|
| RF output | Outputs the RF signal via a precision Type-N female connector; see output section for reverse power protection information            |
| USB 2.0   | Type-A connector used with a memory stick for transferring instrument states, licenses and other files into or out of the instrument. |
| USB 3.0   | Outputs 2 A at 15 V.                                                                                                                  |

## Rear panel connectors

| Rear panel inputs and outputs are 3.3 V CMOS, unless indicated otherwise; CMOS inputs will accept 5 V CMOS, 3 V CMOS, or TTL voltage levels. |                                                                                                                                                                                                                                                                                                      |                                                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| RF output (Option 1EM)                                                                                                                       | 1 channel configuration                                                                                                                                                                                                                                                                              | Outputs the RF signal via a precision Type-N female connector                                                                                 |
|                                                                                                                                              | 2 channel configuration                                                                                                                                                                                                                                                                              | Outputs the RF signal via a precision Type-N female connector                                                                                 |
|                                                                                                                                              | 4 channel configuration                                                                                                                                                                                                                                                                              | Outputs the RF signal via a 3.5 mm female connector                                                                                           |
| EXT1/EXT2                                                                                                                                    | Reserved for future use.                                                                                                                                                                                                                                                                             |                                                                                                                                               |
| Event 1-3                                                                                                                                    | Channel 1                                                                                                                                                                                                                                                                                            | BNC connector. The marker signal can also be routed internally to control the RF blanking.                                                    |
|                                                                                                                                              | Channels 2-4                                                                                                                                                                                                                                                                                         | SMB connector; only events 1-2. The marker signal can also be routed internally to control the RF blanking.                                   |
| Trigger 1-5 / STrig In                                                                                                                       | Channel 1                                                                                                                                                                                                                                                                                            | BNC connector. Accepts CMOS signal with minimum pulse width of 10 ns. Damage levels are > +5.5 V and < -2 V.                                  |
|                                                                                                                                              | Channels 2-4                                                                                                                                                                                                                                                                                         | SMB connector, only triggers 1-5. Accepts CMOS signal with minimum pulse width of 10 ns. Damage levels are > +5.5 V and < -2 V.               |
| Pulse In                                                                                                                                     | Channel 1                                                                                                                                                                                                                                                                                            | BNC connector; see Internal Pulse Generator table for more information. Input threshold 0.5 V nominal. Damage levels are > +5 V and < -4.5 V. |
|                                                                                                                                              | Channels 2-4                                                                                                                                                                                                                                                                                         | SMB connector; see Internal Pulse Generator table for more information. Input threshold 0.5 V nominal. Damage levels are > +5 V and < -4.5 V. |
| LF / SWP OUT                                                                                                                                 | Reserved for future use.                                                                                                                                                                                                                                                                             |                                                                                                                                               |
| Reference input                                                                                                                              | BNC connector; accepts a 10 MHz reference signal used to frequency lock the internal timebase. Input damage level is +16 dBm.                                                                                                                                                                        |                                                                                                                                               |
| 10 MHz out (Ref Out)                                                                                                                         | BNC connectors outputs the 10 MHz reference signal used by internal timebase; level nominally +3.9 dBm; nominal output impedance 50 $\Omega$ .                                                                                                                                                       |                                                                                                                                               |
| USB                                                                                                                                          | Type-A                                                                                                                                                                                                                                                                                               | Copy files to and from removable storage devices.                                                                                             |
|                                                                                                                                              | Type-B                                                                                                                                                                                                                                                                                               | Provides remote programming functions via SCPI over USBTMC/USB488.                                                                            |
| LAN (1000 BaseT)                                                                                                                             | The LAN connector provides the same SCPI remote programming functionality as the GPIB connector and is also used to access the internal Web server and FTP server. Supports DHCP, sockets SCPI, VXI-11 SCPI, connection monitoring, dynamic hostname services, TCP keep alive. LXI class C compliant |                                                                                                                                               |
| GPIB                                                                                                                                         | The micro GPIB connector provides remote programming functionality via SCPI.                                                                                                                                                                                                                         |                                                                                                                                               |

# Remote Programming

## Remote programming

|                       |                                                                                                                                                                                                                                                    |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Interfaces            | VXI-11 HiSlip SOCKET USB-488<br>GPIB<br>USB Version-488                                                                                                                                                                                            |
| Control languages     | Control languages SCPI Version 1997.0                                                                                                                                                                                                              |
| Keysight IO libraries | Keysight's IO Library Suite helps you quickly establish an error-free connection between your PC and instruments – regardless of the vendor. It provides robust instrument control and works with the software development environment you choose. |

# General Specifications

## Environmental specifications and regulatory compliance

|                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                  |            |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Temperature                                | Operating                                                                                                                                                                                                                                                                                                                                                                                                                        | 1 channel                                                                                                                                                                                                        | 0 to 55 °C |
|                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2 channel                                                                                                                                                                                                        | 0 to 50 °C |
|                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                  | 4 channel                                                                                                                                                                                                        | 0 to 50 °C |
|                                            | Storage                                                                                                                                                                                                                                                                                                                                                                                                                          | -40 to +70 °C                                                                                                                                                                                                    |            |
| Maximum relative humidity (non-condensing) | 95%RH up to 40 °C, decreases linearly to 45%RH at 55 °C                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                  |            |
| Operating and storage altitude             | Up to 4,600 meters                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                  |            |
| Indoor use                                 | For indoor use only                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                  |            |
| Environmental testing                      | Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of storage, transportation and enduse; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude, and power line conditions; test methods are aligned with IEC 60068-2 and levels are similar to MILPRF28800F Class 3 |                                                                                                                                                                                                                  |            |
| Safety                                     | Complies with European Low Voltage Directive 2006/95/EC                                                                                                                                                                                                                                                                                                                                                                          | IEC/EN 61010-1 <sup>15</sup><br>Canada: CSA C22.2 No. 61010-1<br>USA: UL std no. 61010-1<br>German Acoustic statement                                                                                            |            |
|                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                  | Acoustic noise emission<br>LpA < 77.5 dB<br>Operator position<br>Normal position<br>Per ISO 7779                                                                                                                 |            |
|                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                  | Geraeuschemission<br>LpA < 77.5 dB<br>Am Arbeitsplatz<br>Normaler Betrieb<br>Nach DIN 45635 t.19                                                                                                                 |            |
|                                            | Complies with European EMC Directive 2004/108/EC                                                                                                                                                                                                                                                                                                                                                                                 | IEC/EN 61326-1or IEC/EN 61326-2-1 CISPR Pub 11 Group 1, class A AS/NZS CISPR 11<br>ICES/NMB-001 2This ISM device complies with Canadian ICES-001.<br>Cet appareil ISM est conforme a la norme NMB-001 du Canada. |            |

<sup>15</sup> AC line voltage dropouts (IEC 61000-4-11) of duration greater than 5 ms will cause the RF output to turn off until it is re-enabled by the operator, in order to protect internal hardware.

### Power requirements

| Number of channels              | Maximum frequency                 | Power requirements                                                  | Average power consumption |
|---------------------------------|-----------------------------------|---------------------------------------------------------------------|---------------------------|
| 1 (opt. 001)                    | 3/6/8.5 GHz<br>(opt. 503/506/508) | 100/120 VAC, 50/60/400 Hz<br>220/240 VAC, 50/60/400 Hz<br>650 W Max | 270 W nom.                |
| 2 (opt. 001, 002)               | 3/6/8.5 GHz (opt. 503/506/508)    | 100/120 VAC, 50/60/400 Hz<br>220/240 VAC, 50/60/400 Hz<br>650 W Max | 380 W nom.                |
| 4 (opt. 001, 002, 003, and 004) | 3/6/8.5 GHz (opt. 503/506/508)    | 100/120 VAC, 50/60/400 Hz<br>220/240 VAC, 50/60/400 Hz<br>650 W Max | 550 W nom.                |

### Physical specifications

| Configuration |                                                  | 1 channel (001)         | 2 channel (001/002) | 4 channel (001/002/003/004) |
|---------------|--------------------------------------------------|-------------------------|---------------------|-----------------------------|
| Weight        |                                                  | 16.09 kg (or 35.47 lbs) | 17.9 kg (39.46 lbs) | 21.73 kg (or 47.91 lbs)     |
| Dimensions    | Height                                           | 88.25 mm (without feet) |                     |                             |
|               |                                                  | 102 mm (with feet)      |                     |                             |
|               | Width with handles                               | 474.7 mm                |                     |                             |
|               | Width without handles                            | 425.5 mm                |                     |                             |
|               | Length with handles<br>(including connectors)    | 591.1 mm                |                     |                             |
|               | Length without handles<br>(including connectors) | 501.9 mm                |                     |                             |
| Display       | Resolution                                       | 1280 x 400              |                     |                             |
|               | Size                                             | 190.08 mm x 59.44 mm    |                     |                             |

### Data storage

|          |                                                |
|----------|------------------------------------------------|
| Internal | Removable solid-state drive (256 GB)           |
| External | Supports USB 3.0/2.0 compatible memory devices |

### Self-test

Internal diagnostic routines test most modules in a preset condition; for each module, if its node voltages are within acceptable limits, the module passes the test.

### Recommended calibration cycle

1 year

# Related Literature

| Publication title              | Publication number |
|--------------------------------|--------------------|
| N5185A MXG Configuration Guide | 3124-1731.EN       |

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