

# DATASHEET APSYN140-X Specification V1.20

Multi-Channel 8 kHz to 40 GHz Wideband Synthesizer System



**Document size:**

1 (one) title page  
15 (fifteen) content pages

## DEFINITIONS

The specifications in the following pages describe the warranted performance of the instrument for  $23 \pm 5$  °C after a 30-minute warm-up period

**Typical:** Expected mean values, not warranted performance

**Min and max:** Parameter range that is guaranteed by product design, and/or production tested. Warranted performance specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

## INTRODUCTION

### Multi-Output ultra-low Phase Noise Wideband Frequency Synthesizer with USB & LAN Interface

The APSYN140-X is a multi-channel wideband low phase-noise synthesizer settable from 100 kHz (8 kHz with option 8K) to 40 GHz.

The product is available with 1, 2, 3 or 4 fully independently configurable outputs. For each output channel, frequency, output power, phase and modulation can be set.

The settable output power range is from -5 to +25 dBm.

The APSYN140-X has a milli-Hz frequency resolution and uses a high-stability OCXO internal reference. The reference can be phase-locked to a 10 or 10 MHz external reference. With option VREF, a user-settable range from 1 to 250 MHz is available.

For highest phase coherence, multiple APSYN140-X can be cascaded with just one master reference clock.

When ordered with option FILT, the APSYN140-X provides excellent harmonic rejection even a full output power.

The APSYN140-X offers dedicated sweeping capabilities with switching speeds of only 500  $\mu$ s (20  $\mu$ s with option FS) and internal phase and narrow pulse modulation.

The module has USB and LAN interfaces (optionally also GPIB) and can be controlled using the SCPI 1999 command set.

# FACTS, FIGURES & SPECIFICATIONS

## Signal Specifications

| PARAMETER                        | MIN              | TYPICAL            | MAX                | NOTE                                    |
|----------------------------------|------------------|--------------------|--------------------|---|
| <b>Frequency Range</b>           | 100 kHz<br>8 kHz |                    | 40 GHz             | Settable to 43.5 GHz<br>Option 8K       |
| Resolution                       |                  | 0.001 Hz           |                    |   |
| <b>Phase Resolution</b>          |                  | 0.01 deg           |                    |   |
| <b>Switching Speed</b>           |                  | 1.5 ms             |                    | after SCPI command received             |
| CW Mode                          |                  | 500 µs             |                    |   |
| Sweep / List Mode                |                  | 500 µs<br>20 µs    |                    | Option FS                               |
| <b>SSB Phase noise at 1 GHz</b>  |                  |                    |                    | (see also plot)                         |
| at 1 kHz from carrier            |                  | -140 dBc/Hz        |                    |   |
| at 100 kHz from carrier          |                  | -150 dBc/Hz        |                    |   |
| Wideband noise                   |                  | -160 dBc/Hz        |                    |   |
| <b>SSB Phase noise at 10 GHz</b> |                  |                    |                    |   |
| at 1 kHz from carrier            |                  | -120 dBc/Hz        |                    |   |
| at 100 kHz from carrier          |                  | -130 dBc/Hz        |                    |   |
| Wideband noise                   |                  | -160 dBc/Hz        |                    |   |
| <b>Output power range</b>        |                  |                    |                    | (see also plots)                        |
| 8 kHz to 10 MHz                  | -10 dBm          |                    | +20 dBm            | (option 8K)                             |
| 10 MHz to 5 GHz                  | -10 dBm          |                    | +20 dBm            |   |
| 5 to 20 GHz                      | -5 dBm           |                    | +20 dBm            |   |
| 18 to 33 GHz                     | 10 dBm           |                    | +19 dBm            |   |
| 33 to 40 GHz                     | 0 dBm            |                    | +18 dBm            |   |
| 10 MHz to 5 GHz                  | -10 dBm          |                    | +15 dBm            | Option FILT                             |
| 5 to 26 GHz                      | -10 dBm          |                    | +12 dBm            | Option FILT                             |
| 26 to 40 GHz                     | -10 dBm          |                    | +10 dBm            | Option FILT                             |
| <b>Resolution</b>                |                  | 0.5 dB             |                    |   |
| <b>Reverse Power Protection</b>  |                  |                    |                    |   |
| DC Voltage                       |                  | 7 V                |                    |   |
| RF Power                         |                  |                    | 20 dBm             |   |
| <b>Output impedance</b>          |                  | 50 Ohms            |                    |   |
| VSWR                             |                  | 1.8                |                    |   |
| <b>Spectral purity</b>           |                  |                    |                    |   |
| Output harmonics                 |                  | -15 dBc<br>-55 dBc |                    | (see also plots)<br>>1 GHz, Option FILT |
| Sub-harmonics                    |                  | -75 dBc<br>-50 dBc | -50 dBc<br>-30 dBc | < 20 GHz<br>>20 GHz                     |
| <b>Non-harmonic spurious</b>     |                  | -75 dBc            | -60 dBc            |   |



## Modulation Capabilities

| PARAMETER                                   | MIN                        | TYPICAL               | MAX           | NOTE  |
|---|----------------------------|-----------------------|---------------|---|
| <b>Pulse Modulation</b>                     |                            |                       |               |   |
| Modulation source                           |                            | Internal/<br>External |               |   |
| External input amplitude                    | TTL                        |                       |               |   |
| Pulse rise/fall time                        |                            | 10 ns                 |               |   |
| On/off ratio                                |                            | 40 dB                 |               | Pout > +10 dBm, see plot  |
| Pulse overshoot                             |                            |                       | 10%           |   |
| Pulse delay                                 |                            | 20 ns                 |               |   |
| Pulse polarity                              |                            | Normal,<br>inverse    |               | selectable  |
| <b>Internal pulse generator</b>             |                            |                       |               |   |
| Repetition frequency (PRF)                  | 0.1 Hz                     |                       | 100 MHz       | = 1/T   |
| Duty cycle                                  | 1 % to 99 %<br>in 1% steps |                       |               | within specified minimum pulse<br>width   |
| Minimum pulse settling range                | 30 ns                      |                       | 20 s          |   |
| Pulse Pattern Modulation & Staggered<br>PRF |                            |                       |               | Using internal pattern generator  |
| Pulse width                                 | 30 ns                      |                       | 5 s           |   |
| Programmable pattern length                 | 2                          |                       | 65536         |   |
| Duty cycle                                  | 0.05%                      |                       | 99.95%        |   |
| Pulse width resolution                      |                            | 5 ns                  |               |   |
| Pulse period (T) accuracy                   |                            | 0.00005xT+<br>3ns     |               |   |
| Pulse width accuracy                        |                            | 0.00005xT+<br>5ns     |               |   |
| Pulse width resolution                      |                            | 5 ns                  |               |   |
| Pulse jitter                                |                            | 2 ns                  | 5 ns          |   |
| Polarity                                    |                            | selectable            |               |   |
| <b>Frequency Modulation</b>                 |                            |                       |               |   |
| Modulation source                           |                            | Internal              |               |   |
| Maximum Frequency deviation (peak)          | N · 400 MHz                |                       |               | < 1.25 GHz (N=1)<br>1.25 GHz to 2.5 GHz (N=0.125)<br>2.5 GHz to 5 GHz (N=0.25)<br>5 GHz to 10 GHz (N=0.5)<br>10 GHz to 20 GHz (N=1)<br>20 GHz to 40 GHz (N=2) |
| Deviation accuracy                          |                            | 0.50%                 | 2%            |   |
| Distortion (THD)                            |                            | < 1 %                 |               | 1 kHz rate, 10 kHz deviation  |
| Modulation rate                             | 0.1 Hz                     |                       | 80 kHz        |   |
| Modulation waveforms                        | Sine                       |                       |               |   |
| <b>Phase Modulation</b>                     |                            |                       |               |   |
| Modulation source                           |                            | Internal              |               |   |
| Phase deviation (peak)                      | 0                          |                       | 300 · N · rad |   |
| Deviation accuracy                          |                            | 0.50%                 | 2%            |   |
| Modulation rate                             | 0.1 Hz                     |                       | 80 kHz        |   |
| Modulation waveforms                        | Sine                       |                       |               |   |
| Distortion (THD)                            |                            | < 1%                  |               | 1 kHz rate & N x rad deviation  |

## Sweeping Capability, Sweep type: linear, logarithmic, random

| PARAMETER                  | MIN                       | TYPICAL | MAX | NOTE      |
|----------------------------|---------------------------|---------|-----|-----------|
| <b>Frequency Sweep</b>     |                           |         |     |           |
| Step time ( $t_{step}$ )   | 500 $\mu$ s<br>20 $\mu$ s |         |     | Option FS |
| Dwell time ( $t_{dwell}$ ) | 15 $\mu$ s                |         |     |           |

## Frequency Reference

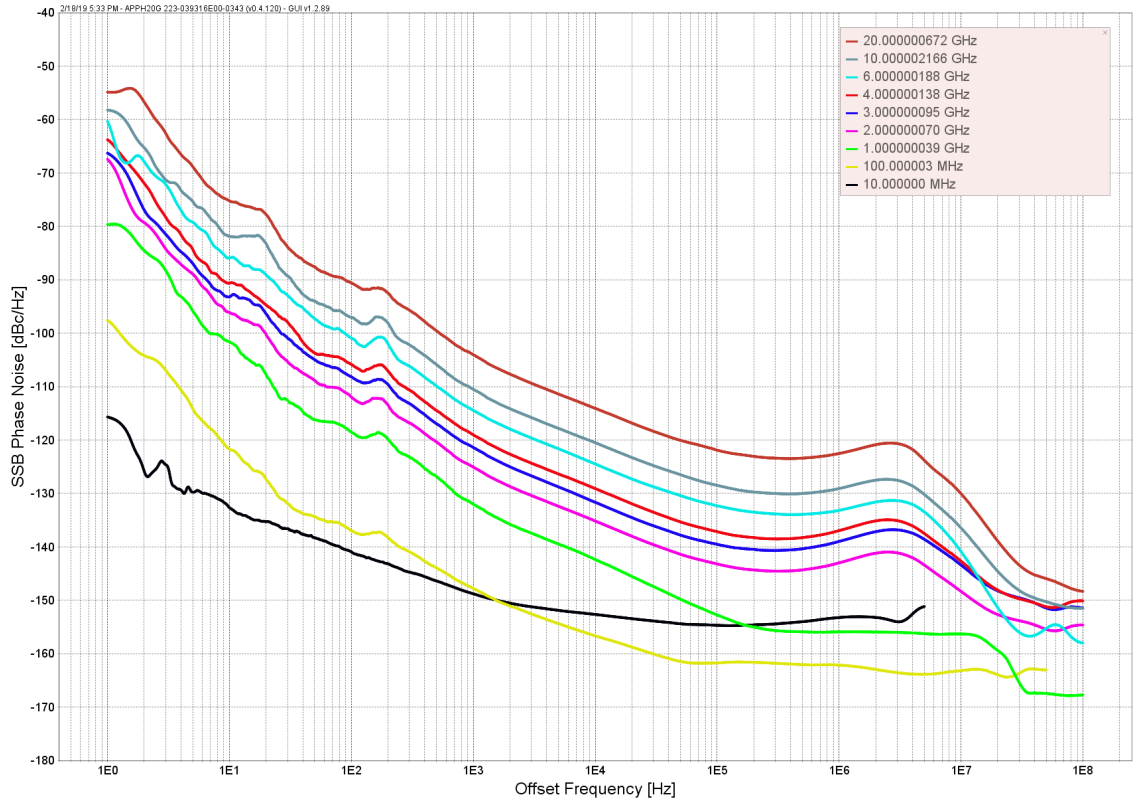
| PARAMETER                                  | MIN    | TYPICAL               | MAX              | NOTE                                  |
|--|--------|-----------------------|------------------|---------------------------------------|
| <b>Internal reference frequency</b>        |        | 100 MHz<br>10 MHz     |                  | Option LN                             |
| <b>Internal Reference Output Frequency</b> |        |                       |                  |                                       |
| Temperature stability                      |        |                       | $\pm$ 100 ppb    | 0 to 50 degC                          |
| Aging 1st year                             |        |                       | 1 ppm<br>0.3 ppm | Option LN                             |
| Aging per day                              |        |                       | 5 ppb<br>0.5 ppb | after 30 days operations<br>Option LN |
| Warm-up time                               |        | 5 min                 |                  |                                       |
| Output of internal reference               |        | 100 MHz               |                  |                                       |
|  |        | 10/100 MHz            |                  | Option LN                             |
| Output power                               |        | 0 dBm                 |                  |                                       |
| Output impedance                           |        | 50 Ohms               |                  |                                       |
| <b>Bypass Internal reference Input</b>     |        | 100 MHz               |                  | High phase synchronous mode           |
| <b>Phase Lock to External Reference</b>    | 1 MHz  | 10 MHz<br>integer MHz | 250 MHz          | Option VREF                           |
| <b>Reference input level</b>               |        |                       |                  |                                       |
| 10 MHz or 1-250 MHz                        | -5 dBm | 0 dBm                 | +13 dBm          |                                       |
| Bypass 100 MHz                             | 5 dBm  |                       | +15 dBm          |                                       |
| <b>Reference input impedance</b>           |        | 50 Ohms               |                  |                                       |
| <b>Lock Range</b>                          |        |                       |                  |                                       |
| 10 MHz or 1-250 MHz                        |        |                       | $\pm$ 1.5 ppm    |                                       |
| Bypass 100 MHz                             |        |                       | >100 ppm         |                                       |

## Trigger (TRIG IN): Input is TRIG IN at front panel

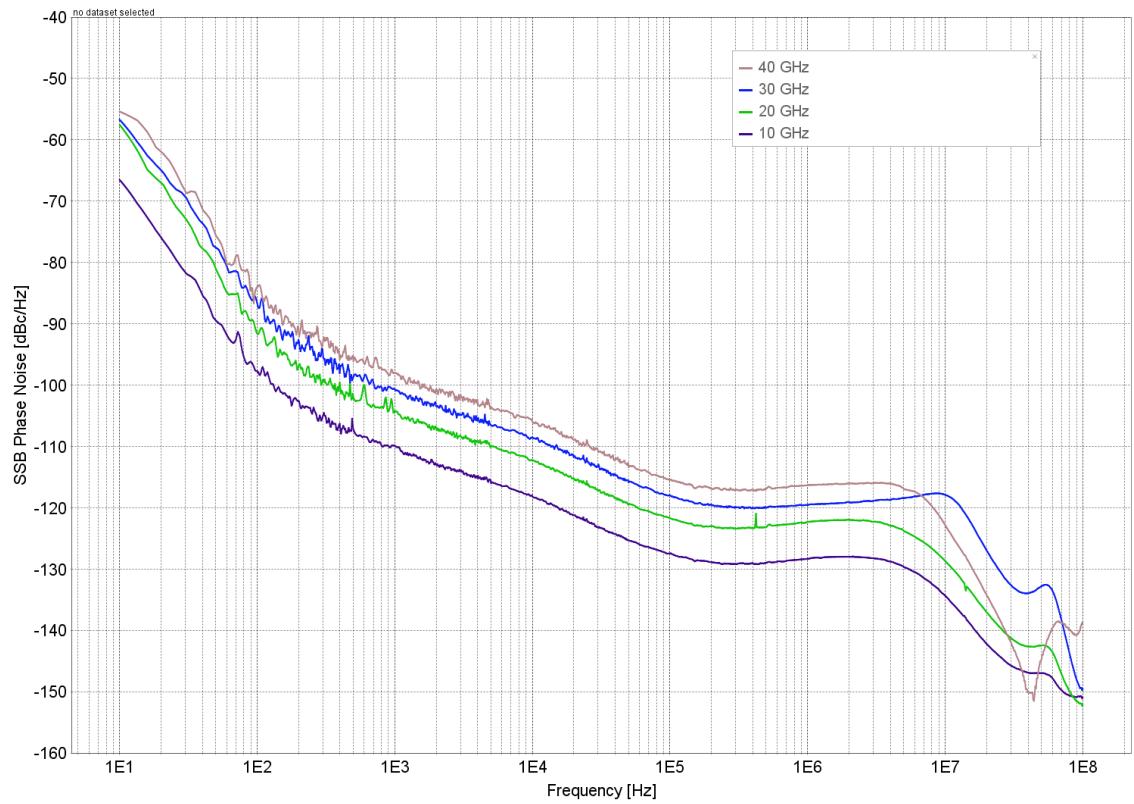
| PARAMETER                 | MIN   | TYPICAL | MAX  | NOTE                              |
|---------------------------|---|---------|------|-----------------------------------|
| <b>Trigger Types</b>      | Continuous, single (point), gated, gated direction  |         |      |                                   |
| <b>Trigger Source</b>     | external, bus (LAN, USB)                            |         |      |                                   |
| <b>Trigger Modes</b>      | Continuous free run, trigger and run, reset and run |         |      |                                   |
| Trigger latency           |   | 5 ns    |      |                                   |
| Trigger uncertainty       |   | 10 ns   |      |                                   |
| External Trigger delay    | 50 ns   |         | 40 s |                                   |
| External Delay Resolution |   | 5 ns    |      |                                   |
| <b>Trigger Modulo</b>     | 1   |         | 255  | Execute only on Nth trigger event |
| <b>Trigger Polarity</b>   | Rising, falling                                     |         |      |                                   |

# TYPICAL PERFORMANCE CURVES

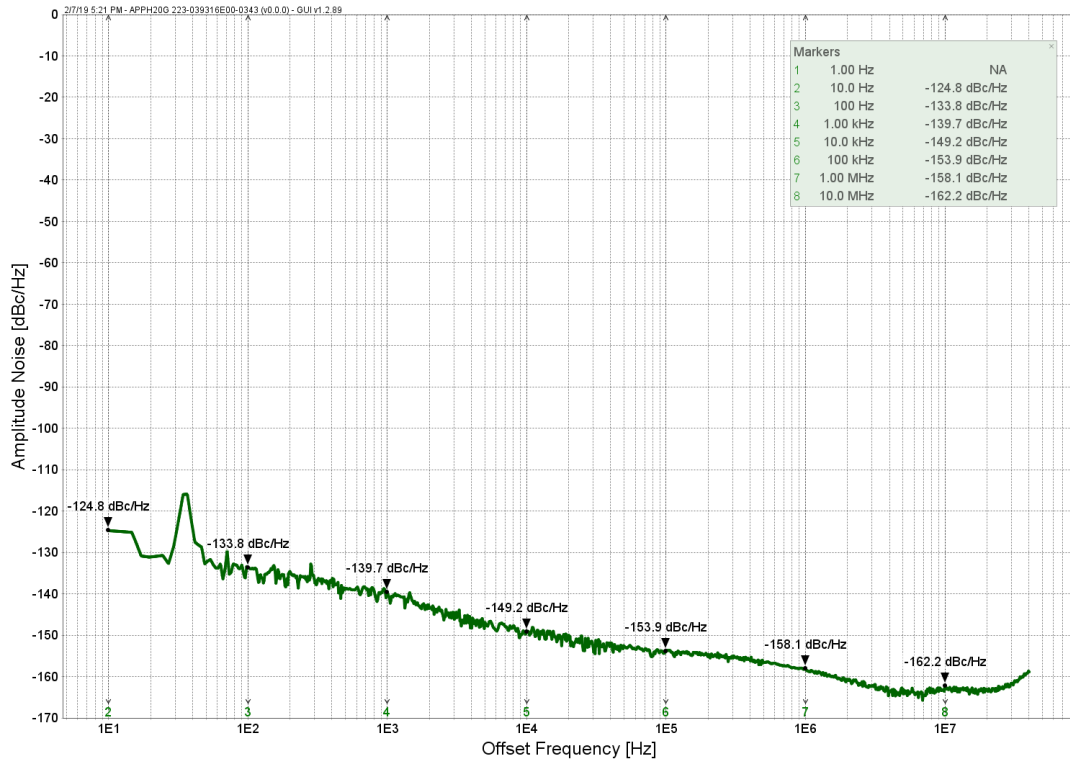
## Phase Noise Performance with option LN



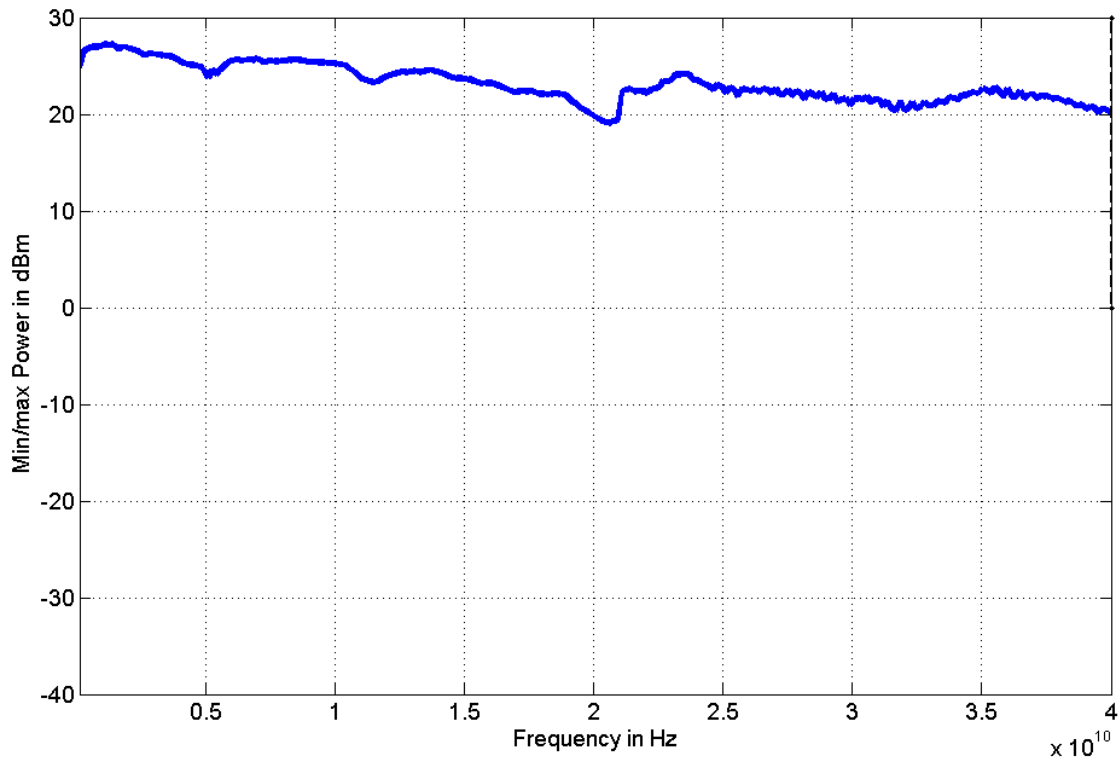
## Phase Noise Performance without option LN



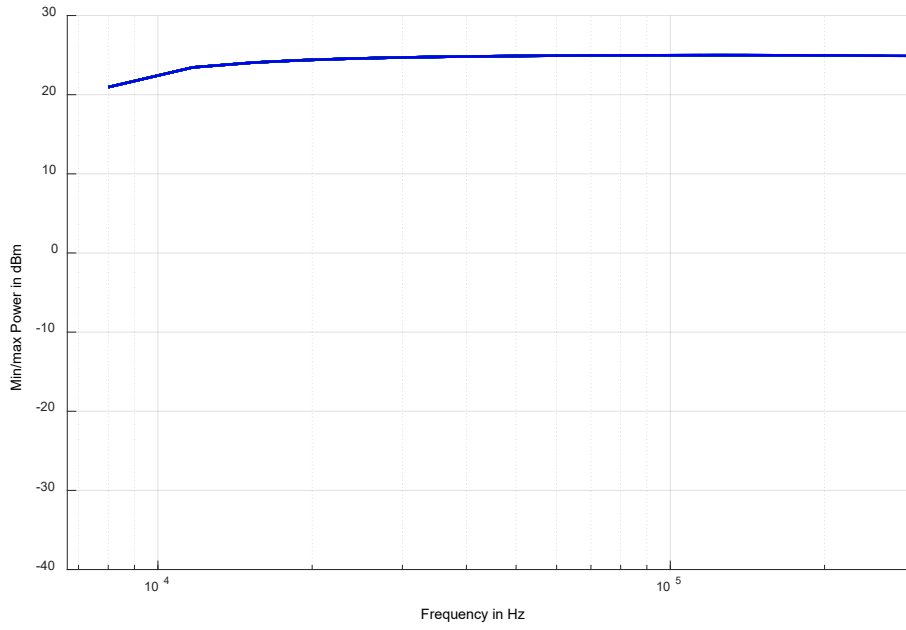
## Amplitude Noise at 10 GHz



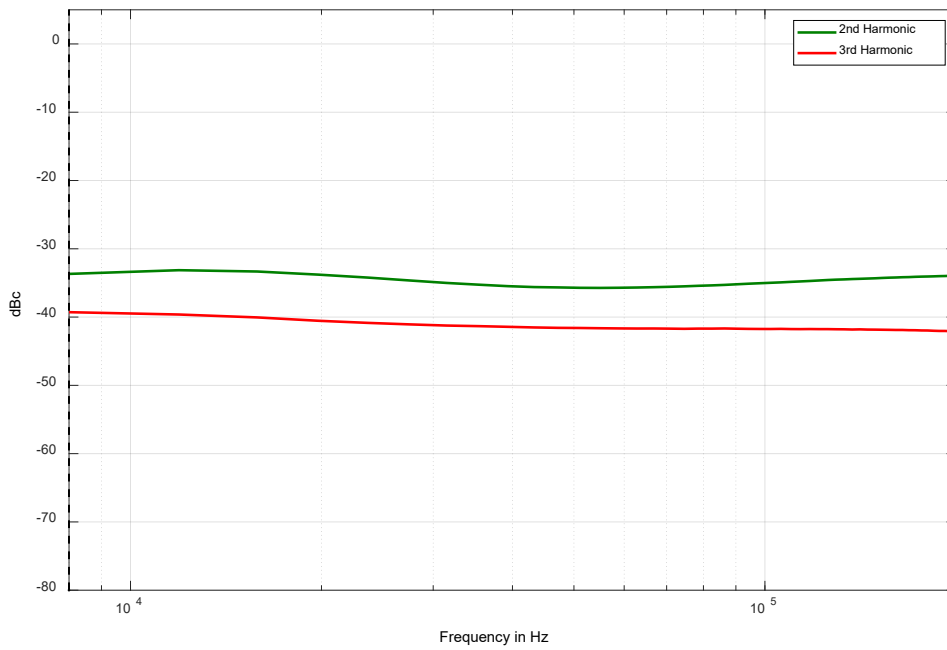
## Maximum Output Power (without option FILT)



## Maximum Output Power at 8 to 250 kHz (option 9K)

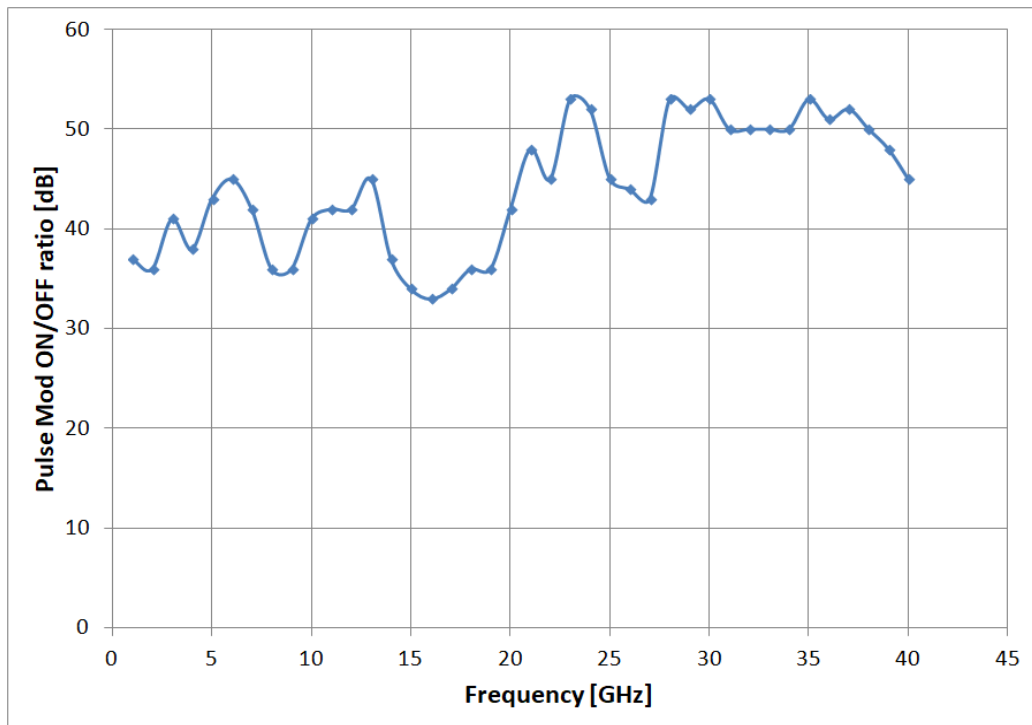


## Harmonics at lower frequencies and 0 dBm (with option 9K)

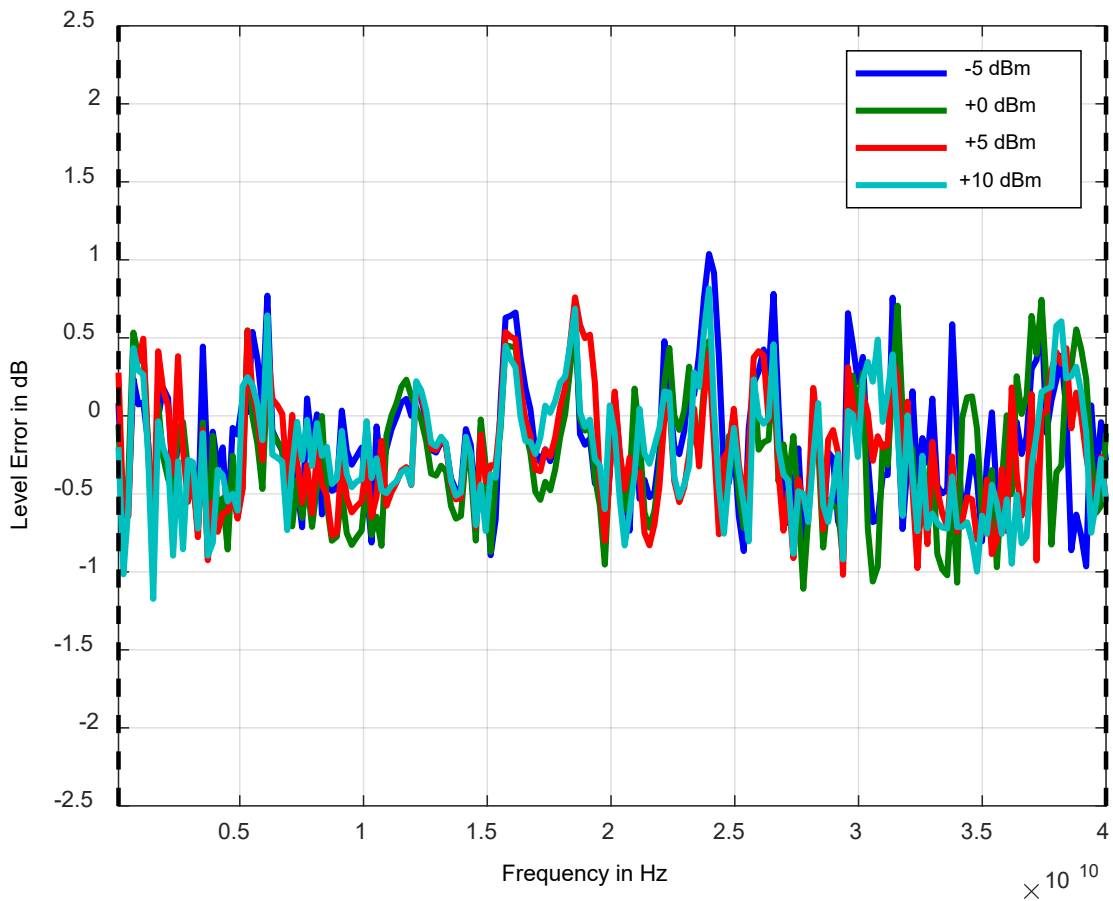




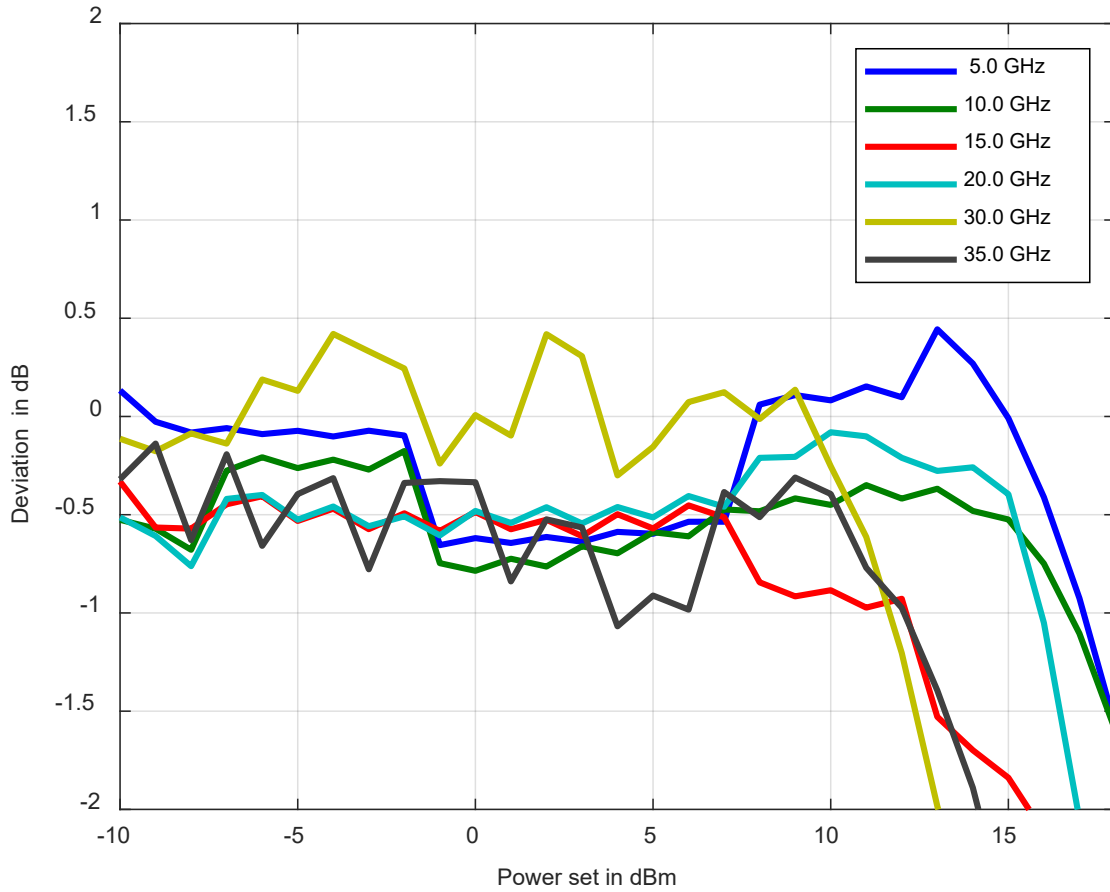
## Pulse Modulation on-off ratio



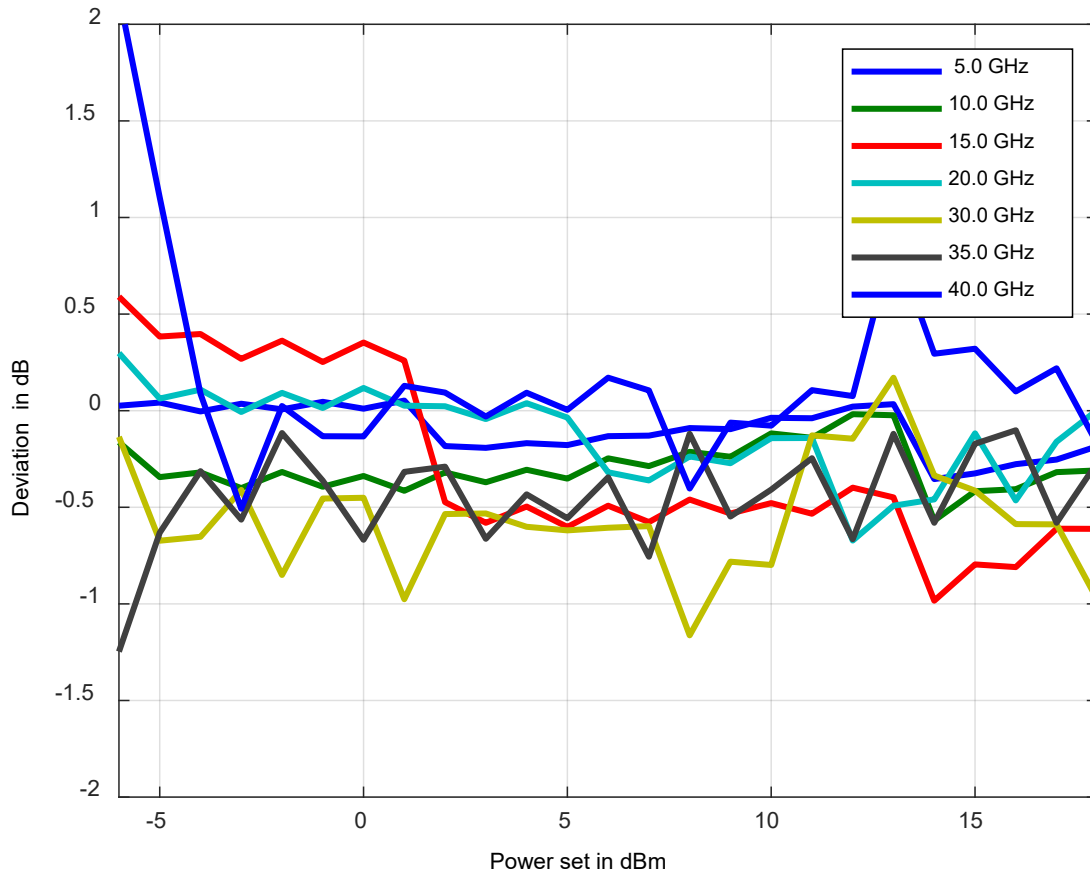
## Power level accuracy (with option FILT)



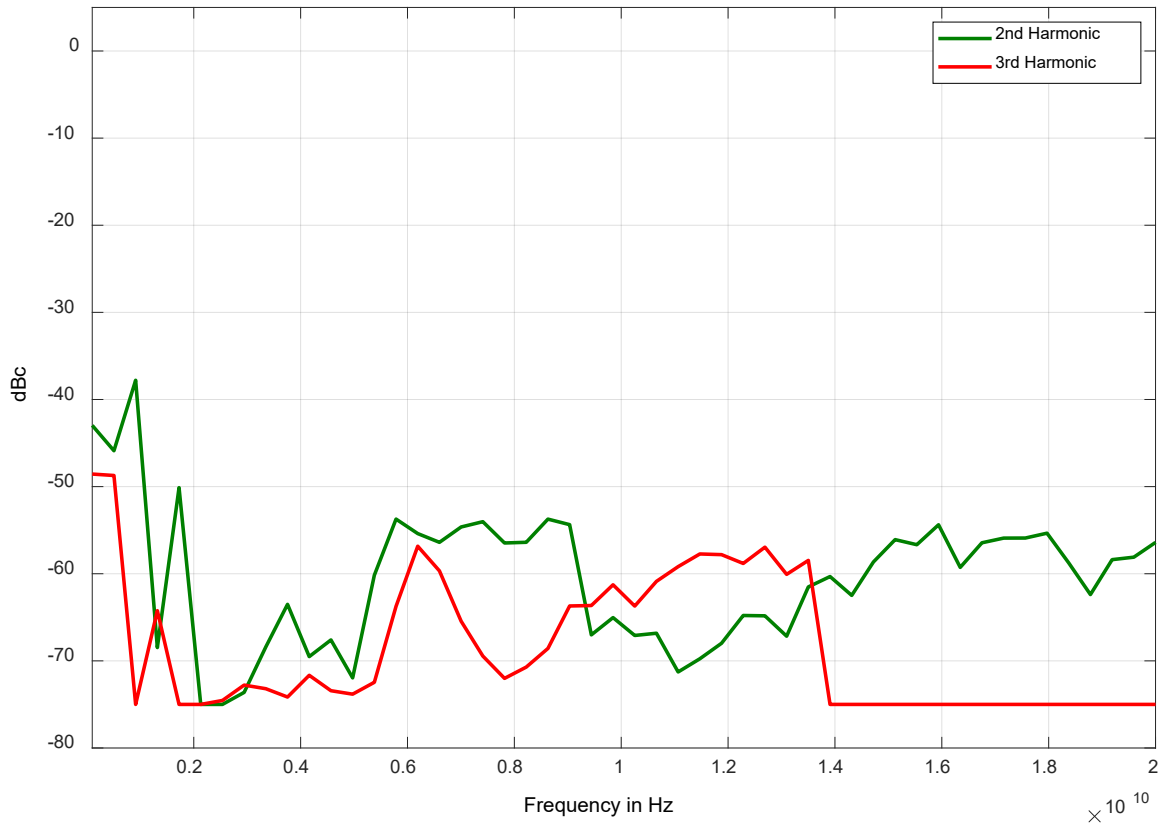
**Power level linearity (with option FILT)**



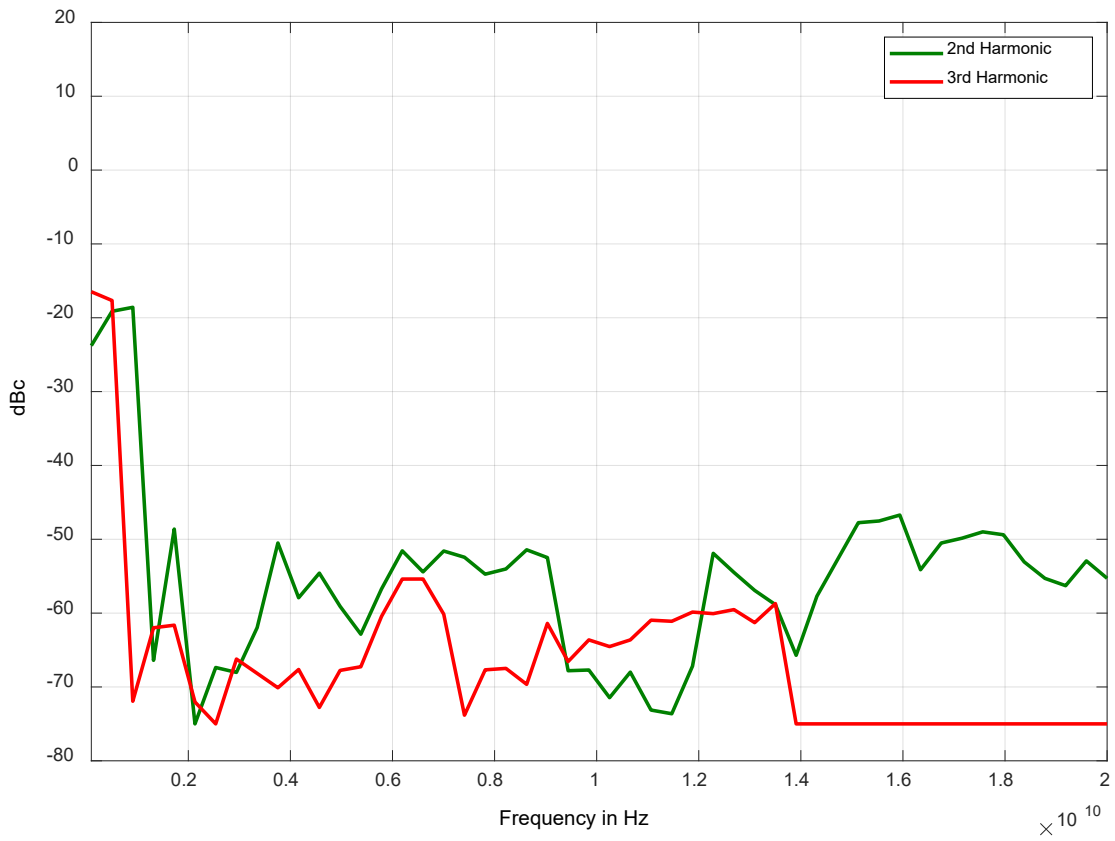
**Power level linearity**



### Harmonics @ 0 dBm (with option FILT)



### Harmonics +15 dBm (with option FILT)



## ORDERING INFORMATION



| HOST MODEL | PRODUCT     | DESCRIPTION   |
|------------|-------------|---|
| APSYN140-X | APSYN140-1  | Single output, 19" 1HU rack-mount module            |
| APSYN140-X | APSYN140-2  | Dual-Output, 19" 1HU rack-mount module              |
| APSYN140-X | APSYN140-3  | Triple-Output, 19" 1HU rack-mount module            |
| APSYN140-X | APSYN140-4  | Quad-Output, 19" 1HU rack-mount module              |
| APSYN140-X | Option LN   | Enhanced close in phase noise & frequency stability |
| APSYN140-X | Option FS   | Ultra-fast switching speed                          |
| APSYN140-X | Option VREF | Variable external reference                         |
| APSYN140-X | Option GPIB | GPIB interface                                      |
| APSYN140-X | Option FILT | Enhanced harmonic rejection                         |
| APSYN140-X | Option 8K   | Frequency range extension to 8 kHz                  |

# GENERAL CHARACTERISTICS

## Remote programming interfaces

Ethernet 100BaseT LAN interface, USB 2.0 host & device, GPIB (IEEE-488.2,1987) with listen and talk (optional), Control language SCPI Version 1999.0

## Power requirements 24V ± 3.0 VDC; 25 W maximum

**Mains adapter supplied:** 100-240 VAC in/ 24 V 4.0 A DC out

**Environmental** (Levels similar to MIL-PRF-28800F Class 3/4)

**Operating temperature range** 0 to 45 °C

**Storage temperature range** –40 to 70 °C

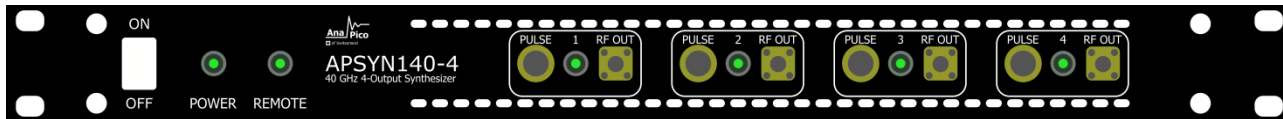
**Operating and storage altitude** up to 15,000 feet (4600 m)



Safety/EMC complies with applicable Safety and EMC regulations and directives.

Weight ≤ 10.0 kg (22 lbs) net

Dimensions: 19" 1HE enclosure: 43 mm H x 426 mm W x 460 mm L [1.7 in H x 16.8 in W x 18.1 in L]



### Front view

1. RF outputs: K (2.92 mm) female (1 to 4)
2. External pulse modulation inputs: BNC female (1 to 4)
3. DC power switch



### Rear view

1. Internal reference output (SYSREF OUT): BNC female
2. External reference input (SYSREF IN): BNC female
3. Trigger output: BNC female
4. Trigger input: BNC female
5. Internal reference output (REF OUT): BNC female
6. External reference input (REF IN): BNC female
7. GPIB: IEEE-488.2, 1987 with listen and talk (optional)
- 8.
9. USB 2.0 host and device
10. LAN connection: RJ-45
11. FUSE (3.15 A)
12. AC Power plug





## Document History

| Version/Status | Date       | Author | Notes                         |
|----------------|------------|--------|-------------------------------|
| V10            | 2019-02-20 | jk     | first release                 |
| V110           | 2020-01-26 | jk     | Added option FILT & option 8K |
| V120           | 2020-4-30  | jk     | Added plots for 8K and FILT   |
|                |            |        |                               |
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