



# Product Manual – Waveguide Amplifiers



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# Safety and Operational Guidelines



Read all instructions and information in this product manual before connecting a module to its power supply or a signal generator. Operational procedures must be followed for proper function. If you have questions, contact VDI before supplying power to or otherwise operating any VDI module.



VDI assumes the customer is familiar with microwave, millimeter wave and VDI products in general. The user and customer are expected to understand all safety guidelines, health hazards and general advisories that may exist and are associated with the use of this device. VDI is not responsible for any human hazards that may exist or may occur while using this device.



Disassembly of any VDI components is prohibited and will void the product's warranty. VDI is not responsible for the warranty or guarantee of products that are damaged as a result of improper handling, testing, biasing, or use by the user.

## Safety Guidelines

- VDI accepts no liability for damage or injury resulting from or caused by:
  - Improper use, disassembly or use for other purposes than for which the product was designed.
  - Use outside common safety, health or general advisories pertaining to microwave, millimeter-wave and VDI products.
  - Repairs carried out by persons other than VDI or its assigned agents.
  - Tampering with or altering power cords or other cabling.

## Waveguide Test Port Care

- Inspect waveguide flanges for damage or debris prior to making connections.
- Torque waveguide screws in the range of 20-50cNm when making waveguide flange connections. Greater torque can damage the interface.
- Making a connection with metal debris between the waveguide flanges can damage the waveguide interface and prevent repeatable connections.
- If debris is present, clean the flange with pre-dampened TexWipe wipes or swabs (e.g. Part Number TX1065).
- If these are not available, TexWipe cloths lightly dampened with ethanol may be used (e.g. Part Number TX604).
- Cover test ports with dust caps when the system is idle.

## General Operating Practices and Recommendations

- Check with VDI before any measurement connection is attempted beyond those described in this manual or if it may exceed commonly accepted standards of practice.
- VDI does not recommend the use of liquid or paste for either thermal grounding of VDI components or for locking screws. Liquids/pastes wicking into the VDI components can damage the internal devices and worsen performance.



# Waveguide Amplifiers Overview

## Waveguide Amplifiers

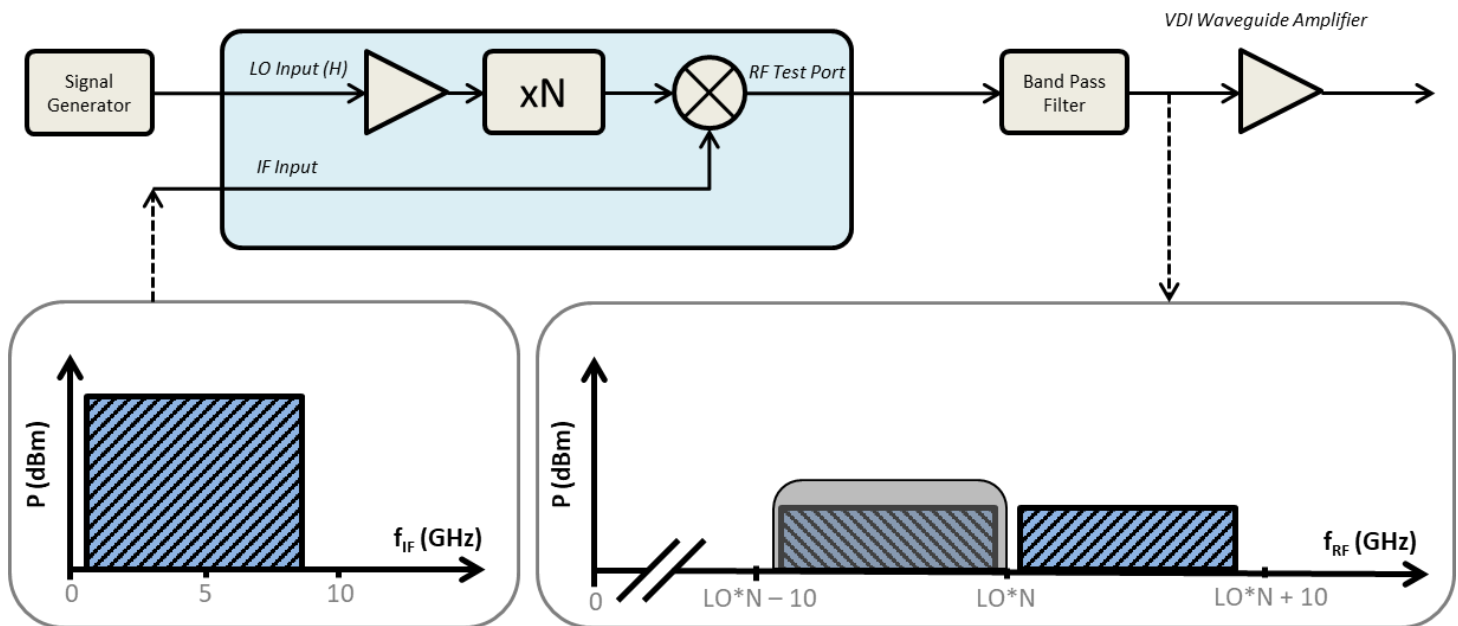
Amplifiers are able to boost a small input RF signal to a large output RF signal. VDI offers amplifiers up to ~260 GHz with additional amplifiers under development. Higher frequency or narrowband higher power amplifiers may be available upon request.



## Amplifiers with VDI SAX and CCU / CCD Modules

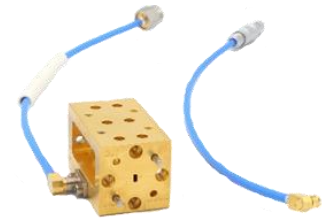
VDI amplifiers can be used with VDI Spectrum Analyzer Extension (SAX or SAX-M) Modules and Compact Converter (CC) Modules, configured for block up-conversion mode. In block up-conversion mode, the module up-converts a block of IF signals in the microwave to millimeter-wave frequencies. VDI amplifiers are available to boost the output power and overcome significant conversion and transmission losses.

The figure below shows how an SAX module can be used with a band pass filter and an amplifier to enhance the performance of the module when configured for block up-conversion. Refer to the SAX Operational Manual for details on how to operate an SAX module.



# Product Specifications – Broadband Power Amplifiers

| General Specifications for VDI Waveguide Amplifiers |               |
|-----------------------------------------------------|---------------|
| Description                                         | Specification |
| DC Bias Voltage (V)* †                              | +9 ± 1        |
| Maximum Weight (lbs.)                               | 0.1           |
| Maximum Case Temperature**                          | < 45°C        |
| Fan Supply Voltage / Current Draw**                 | +5V / ~20mA   |



\*Amplifiers use SMP(m) bias connectors and include SMP(f) to LEMO and SMP(f) to SMA(m) cables. The SMP to LEMO 00 cable is for use with an SAX-UP or CCU module. The SMP to SMA cable is for general use.

\*\*Waveguide amplifiers must be connected to thermally grounded waveguide prior to biasing.

\*\*\*Heatsink + Fan Assembly only included on select amplifiers. Can be removed, but user must provide sufficient heatsinking to stay below the maximum case temperature.

† 64AMP requires +5V ± 0.1V bias voltage. Applying +9V to this amplifier may damage the device.

| VDI Broadband Power Amplifier Specifications |                      |                     |                         |                                       |                              |                                     |                                      |                              |                                      |
|----------------------------------------------|----------------------|---------------------|-------------------------|---------------------------------------|------------------------------|-------------------------------------|--------------------------------------|------------------------------|--------------------------------------|
| VDI Part Number                              | Amplifier Band (GHz) | Waveguide Interface | Gain, S21 (dB, typical) | Saturated Output Power (dBm, typical) | Output P1dB†† (dBm, typical) | Input Reflection, S11 (dB, typical) | Output Reflection, S22 (dB, typical) | Maximum RF Input Power (dBm) | Current Draw (Typical / Maximum, mA) |
| WR19AMP                                      | 40-60                | WR-19               | 16                      | 20                                    | 17                           | -10                                 | -10                                  | 7                            | 400 / 500                            |
| WR15AMP                                      | 50-75                | WR-15               | 20                      | 19                                    | 11                           | -10                                 | -10                                  | 7                            | 450 / 1200                           |
| WR12AMP                                      | 60-90                | WR-12               | 18                      | 20                                    | 16                           | -10                                 | -10                                  | 7                            | 150 / 500                            |
| WR12AMP-S2                                   | 60-90                | WR-12               | 18                      | 22                                    | 18                           | -10                                 | -10                                  | 10                           | 300 / 1000                           |
| WR12AMP-S4                                   | 60-90                | WR-12               | 18                      | 24.5                                  | 20                           | -10                                 | -10                                  | 13                           | 600 / 2000                           |
| WR10AMP                                      | 75-110               | WR-10               | 17                      | 20                                    | 16                           | -8                                  | -8                                   | 7                            | 150 / 500                            |
| WR10AMP-S2                                   | 75-110               | WR-10               | 17                      | 22                                    | 18                           | -8                                  | -8                                   | 10                           | 300 / 1000                           |
| WR10AMP-S4                                   | 75-110               | WR-10               | 17                      | 24.5                                  | 21                           | -8                                  | -8                                   | 13                           | 600 / 2000                           |
| WR8.0AMP                                     | 90-140               | WR-8.0              | 21                      | 19                                    | 13                           | -6                                  | -10                                  | 7                            | 300 / 800                            |
| WR8.0AMP-M1                                  | 90-140               | WR-8.0              | 21                      | 21.5                                  | 15                           | -5                                  | -5                                   | 7                            | 350 / 1050                           |
| WR8.0AMP-M2                                  | 90-140               | WR-8.0              | 21                      | 24.5                                  | 18                           | -10                                 | -10                                  | 10                           | 700 / 2100                           |
| WR8.0AMP-M4                                  | 90-140               | WR-8.0              | 21                      | 27.5                                  | 21                           | -10                                 | -10                                  | 13                           | 1400 / 4200                          |
| WR8.0AMP-M8                                  | 90-140               | WR-8.0              | 21                      | 30                                    | 24                           | -10                                 | -10                                  | 16                           | 2800 / 8400                          |
| WR6.5AMP                                     | 110-170              | WR-6.5              | 20                      | 18                                    | 11                           | -9                                  | -10                                  | 7                            | 200 / 600                            |
| WR6.5AMP-S2                                  | 110-170              | WR-6.5              | 20                      | 20                                    | 13                           | -9                                  | -10                                  | 10                           | 400 / 1200                           |
| WR6.5AMP-S4                                  | 110-170              | WR-6.5              | 20                      | 22.5                                  | 16                           | -9                                  | -10                                  | 13                           | 800 / 2400                           |
| WR6.5AMP-S8                                  | 110-170              | WR-6.5              | 20                      | 25                                    | 18                           | -10                                 | -10                                  | 16                           | 1600 / 4800                          |
| WR5.1AMP                                     | 140-220              | WR-5.1              | 22                      | 13                                    | 7                            | -8                                  | -10                                  | 7                            | 150 / 350                            |
| WR4.3AMP                                     | 170-260              | WR-4.3              | 24                      | 16                                    | 9                            | -7                                  | -2                                   | 3                            | 300 / 800                            |
| WR4.3AMP-M2                                  | 170-260              | WR-4.3              | 22                      | 18.5                                  | 12                           | -7                                  | -2                                   | 6                            | 600 / 1600                           |
| WR4.3AMP-M4                                  | 170-260              | WR-4.3              | 20                      | 21                                    | 15                           | -7                                  | -2                                   | 9                            | 1200 / 3200                          |
| WR4.3AMP-M8                                  | 170-260              | WR-4.3              | 20                      | 23                                    | 18                           | -10                                 | -10                                  | 12                           | 2400 / 6400                          |
| WR3.4AMP†                                    | 220-330              | WR-3.4              | 22                      | 5                                     | -1                           | -8                                  | -6                                   | 0                            | 60 / 120                             |

†WR-3.4 amplifier specifications are goal specifications. Contact VDI for more information

††All amplifiers will meet P1dB specification listed above. P1dB data will not be provided with each amplifier.



## Product Specifications – Narrowband Power Amplifiers

| VDI Narrowband Power Amplifier† Specifications |                      |                     |                         |                                       |                              |                                     |                                      |                              |                                      |
|------------------------------------------------|----------------------|---------------------|-------------------------|---------------------------------------|------------------------------|-------------------------------------|--------------------------------------|------------------------------|--------------------------------------|
| VDI Part Number                                | Amplifier Band (GHz) | Waveguide Interface | Gain, S21 (dB, typical) | Saturated Output Power (dBm, typical) | Output P1dB†† (dBm, typical) | Input Reflection, S11 (dB, typical) | Output Reflection, S22 (dB, typical) | Maximum RF Input Power (dBm) | Current Draw (Typical / Maximum, mA) |
| <b>64AMP</b>                                   | 56-72                | WR-15               | 12                      | 27                                    | 23                           | -8                                  | -8                                   | 23                           | 1300 / - **                          |
| <b>130AMP</b>                                  | 120-140              | WR-6.5              | 24                      | 21.5                                  | 15                           | -5                                  | -5                                   | 7                            | 500 / 1000                           |
| <b>130AMP-M2</b>                               | 120-140              | WR-6.5              | 24                      | 24.5                                  | 18                           | -5                                  | -5                                   | 10                           | 1000 / 2000                          |
| <b>130AMP-M4</b>                               | 120-140              | WR-6.5              | 24                      | 27.5                                  | 21                           | -5                                  | -5                                   | 13                           | 2000 / 4000                          |
| <b>160AMP</b>                                  | 150-180              | WR-5.1              | 23                      | 21                                    | 14                           | -5                                  | -10                                  | 10                           | 600 / 1200                           |
| <b>160AMP-M2</b>                               | 150-180              | WR-5.1              | 22                      | 24                                    | 16                           | -10                                 | -10                                  | 13                           | 1200 / 2400                          |
| <b>160AMP-M4</b>                               | 150-180              | WR-5.1              | 22                      | 26.5                                  | 18                           | -10                                 | -10                                  | 16                           | 2400 / 4800                          |
| <b>160AMP-M8</b>                               | 150-180              | WR-5.1              | 22                      | 29                                    | 20                           | -10                                 | -10                                  | 19                           | 4800 / 9600                          |
| <b>195AMP</b>                                  | 180-200              | WR-5.1              | 18                      | 19                                    | 13 (est.)                    | -6                                  | -6                                   | 10                           | 700 / 1300                           |
| <b>195AMP-M2</b>                               | 180-200              | WR-5.1              | 17                      | 21.5                                  | -                            | -8                                  | -6                                   | 13                           | 1400 / 2600                          |

†Higher Power Narrowband Amplifiers are under development. Contact VDI for more information.

††All amplifiers will meet P1dB specification listed above. Sample P1dB performance as shown in Appendix 1. P1dB data will not be provided with each amplifier.

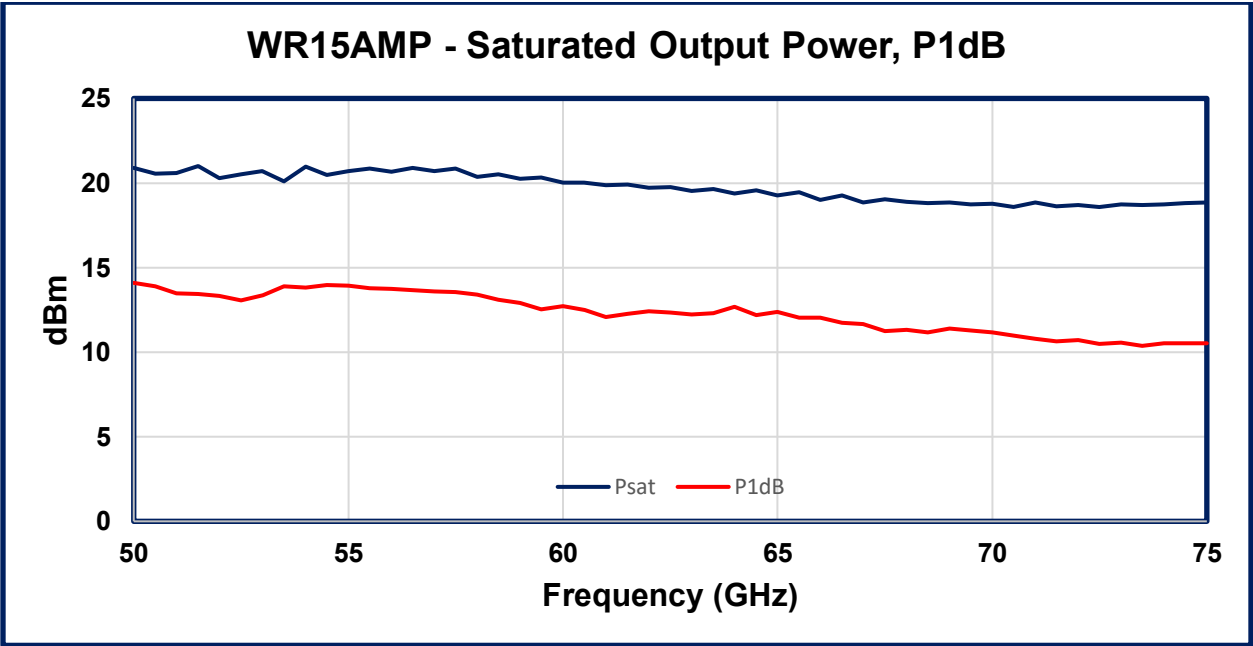
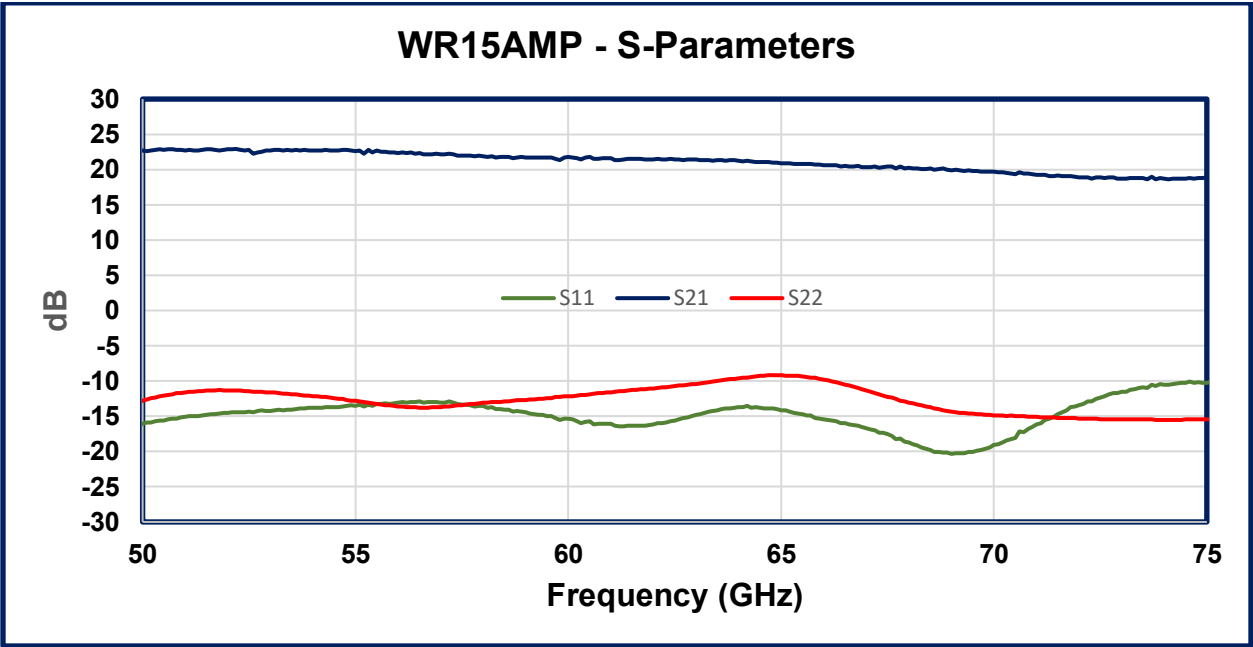
\*\*64AMP requires +5V ± 0.1V bias voltage. Applying +9V may damage the device.



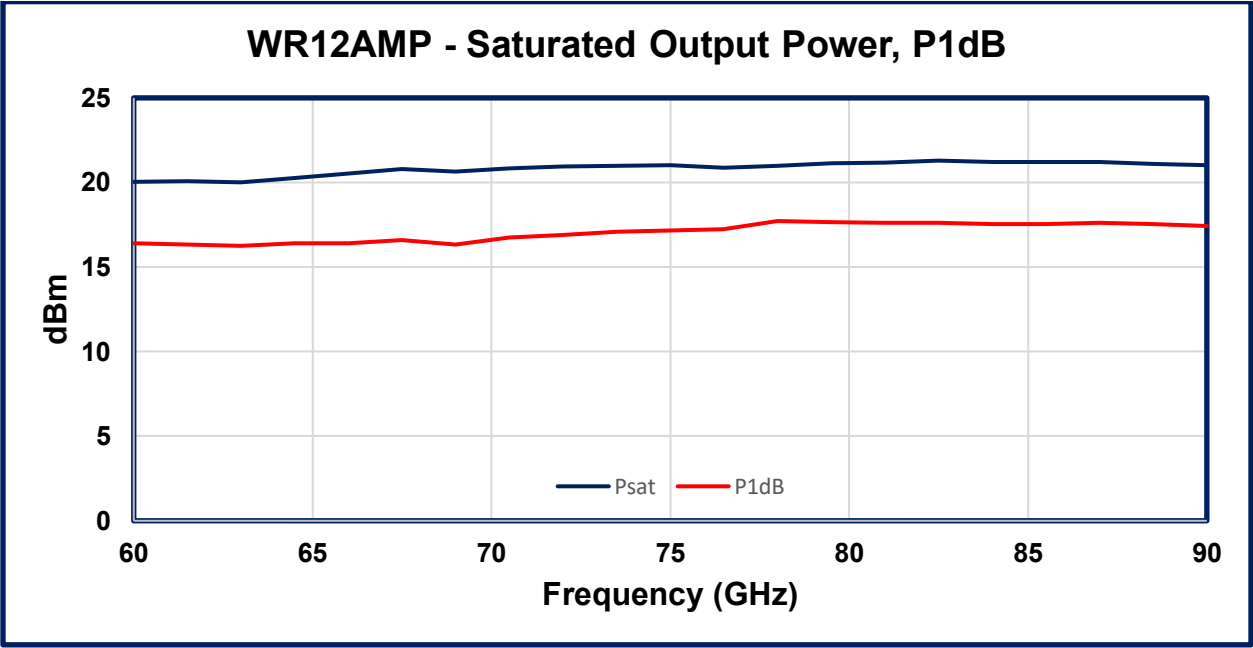
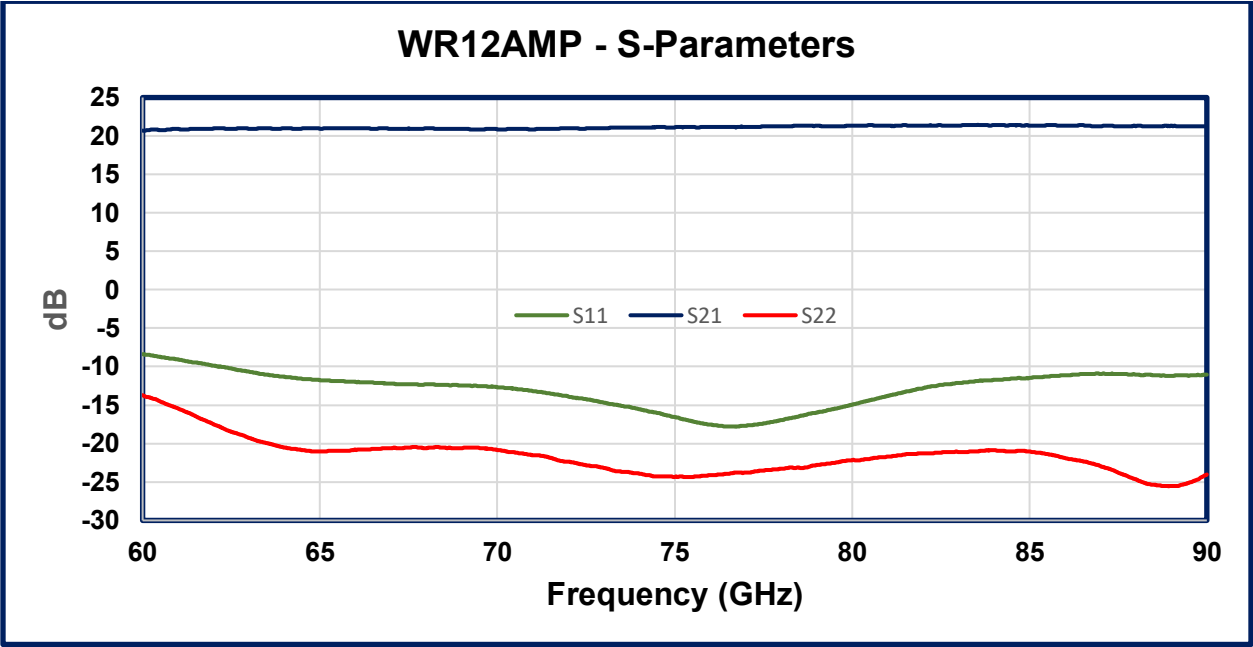
# Amplifier Performance

Typical amplifier performance plots are provided below.

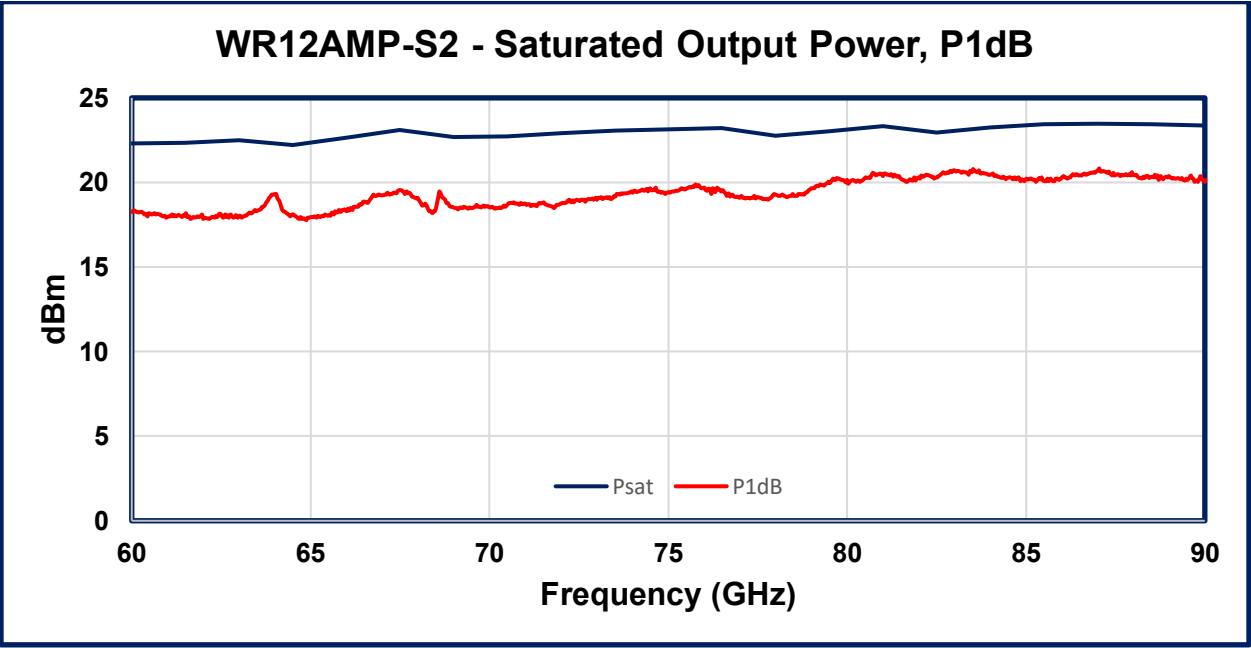
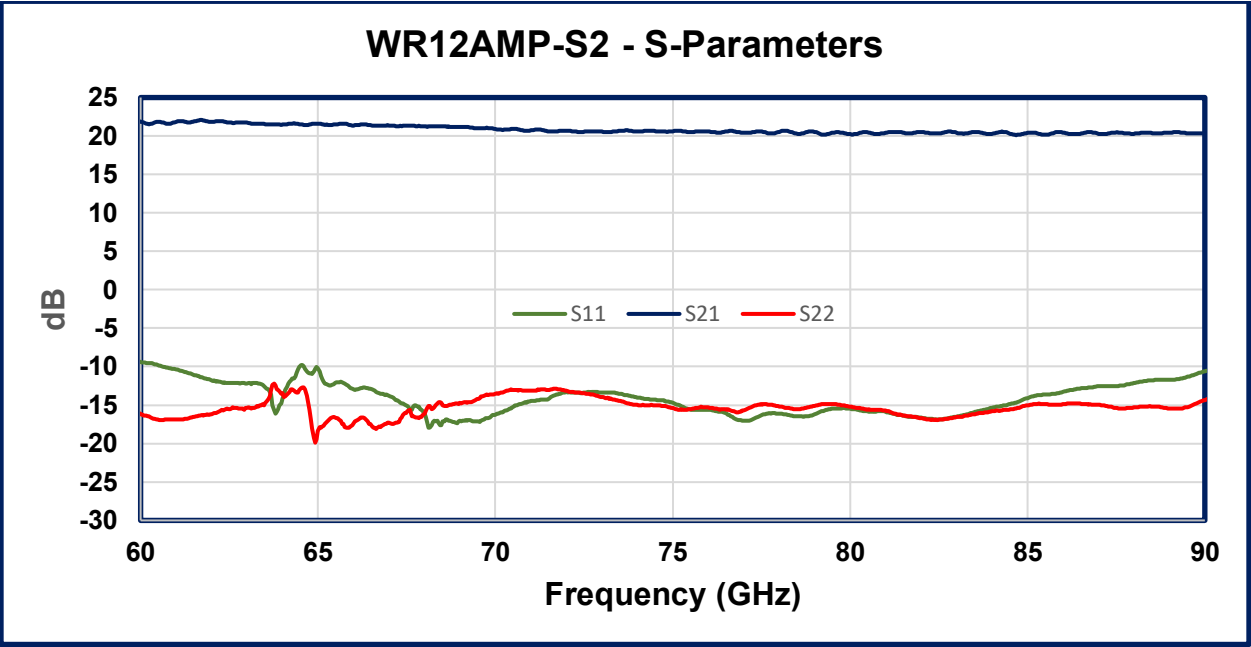
## WR15AMP – S-Parameters and Saturated Output Power, P1dB



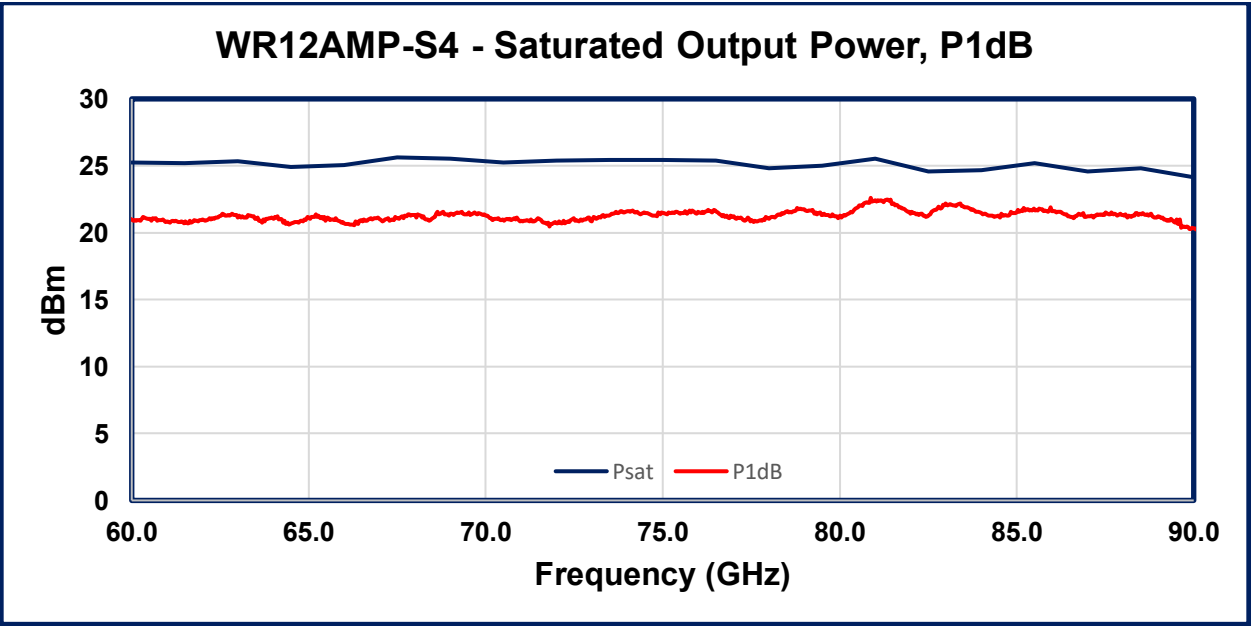
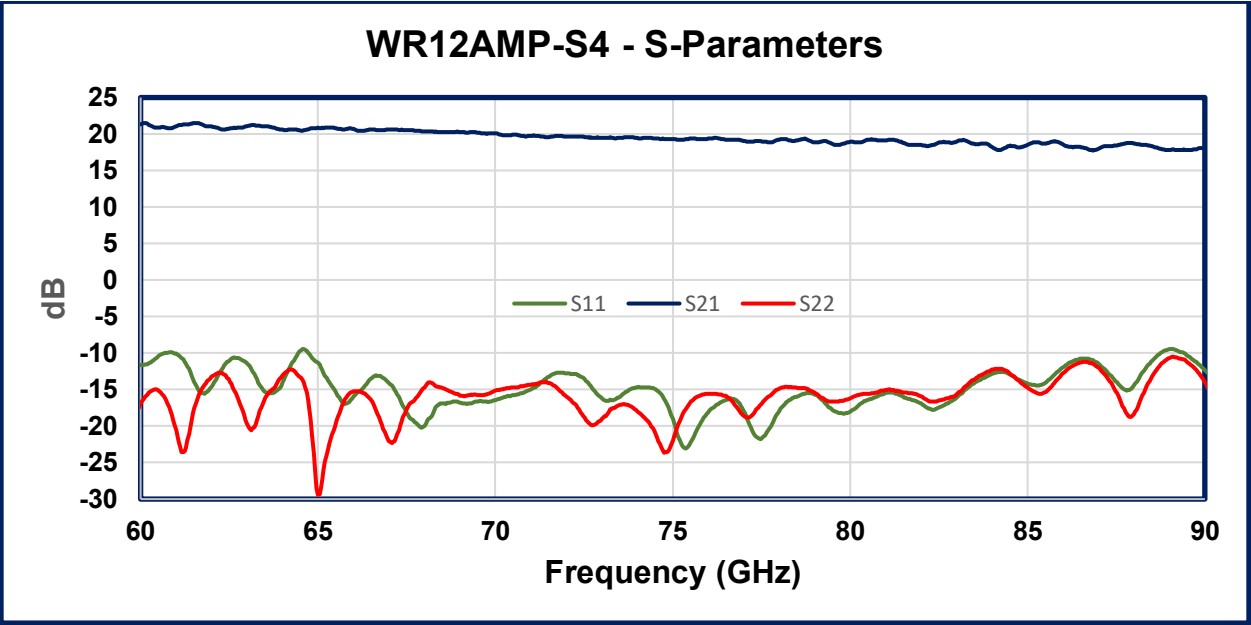
WR12AMP – S-Parameters and Saturated Output Power, P1dB



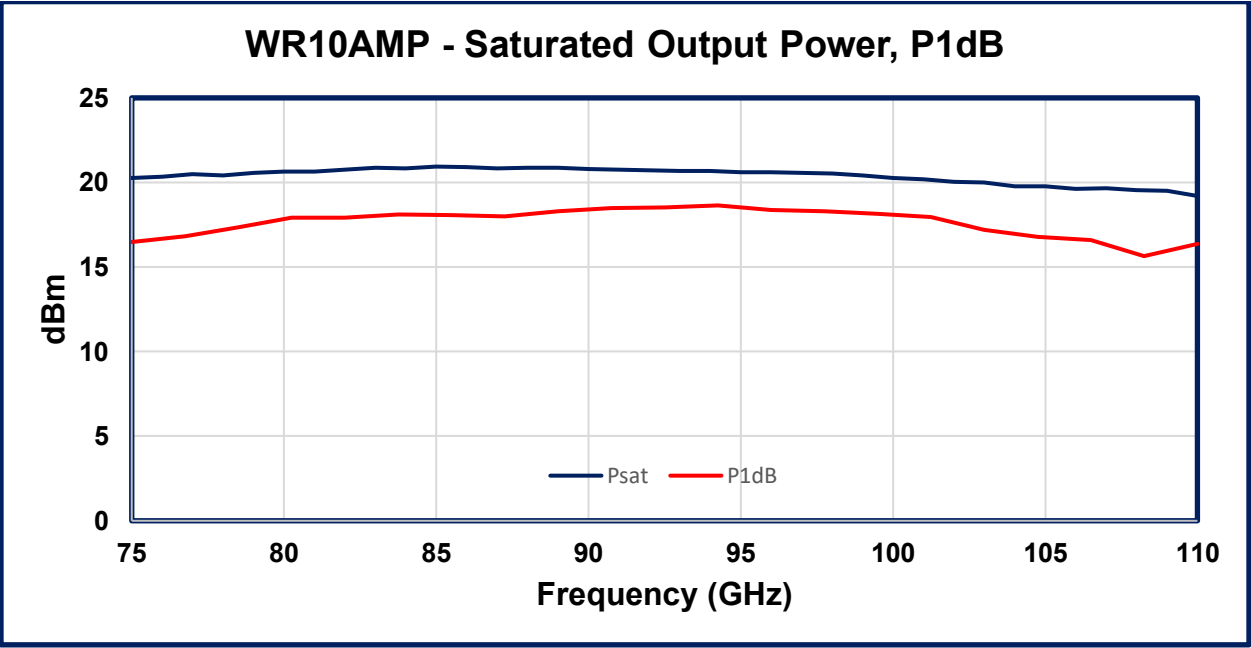
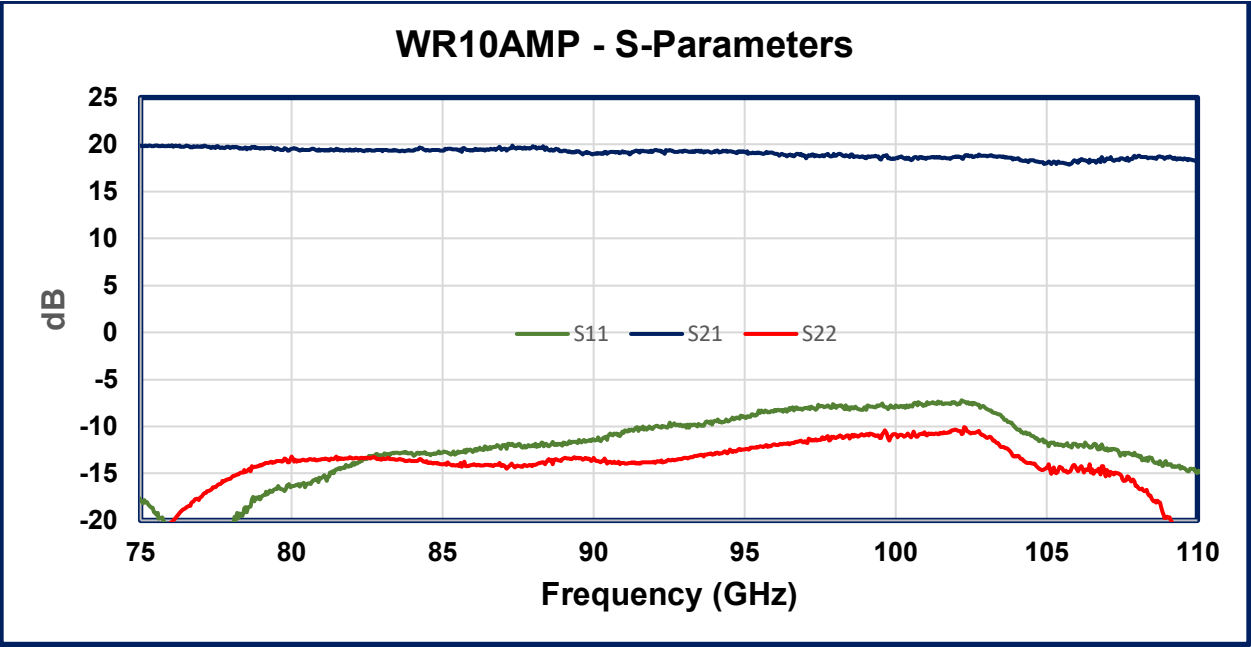
WR12AMP-S2 – S-Parameters and Saturated Output Power, P1dB



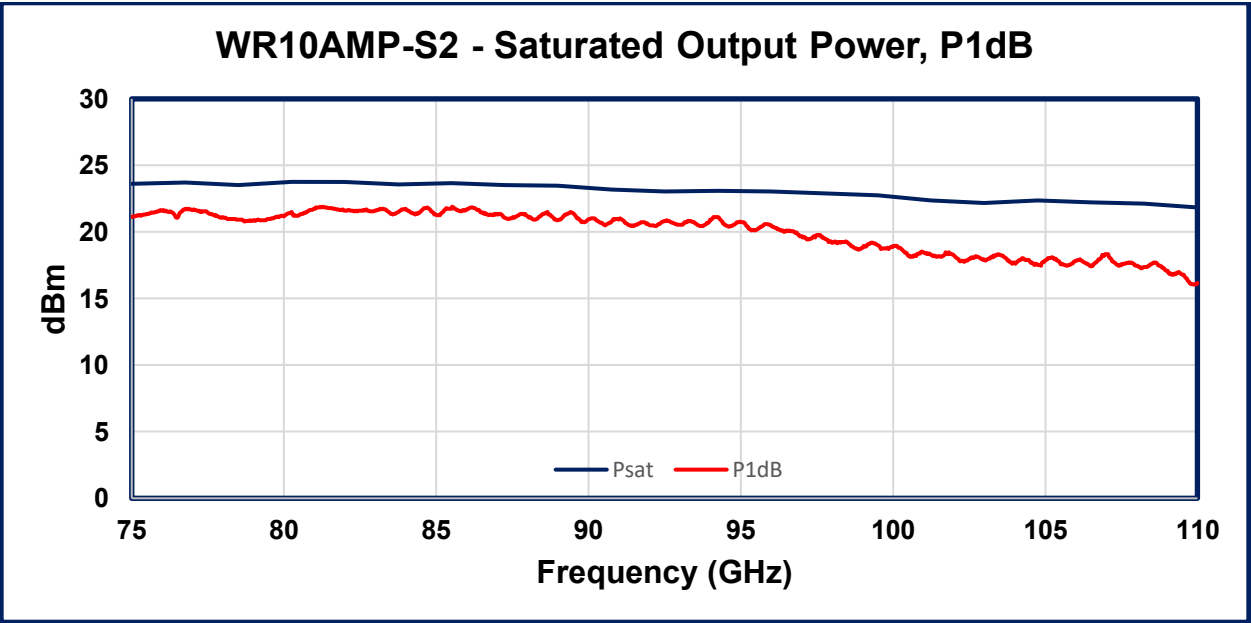
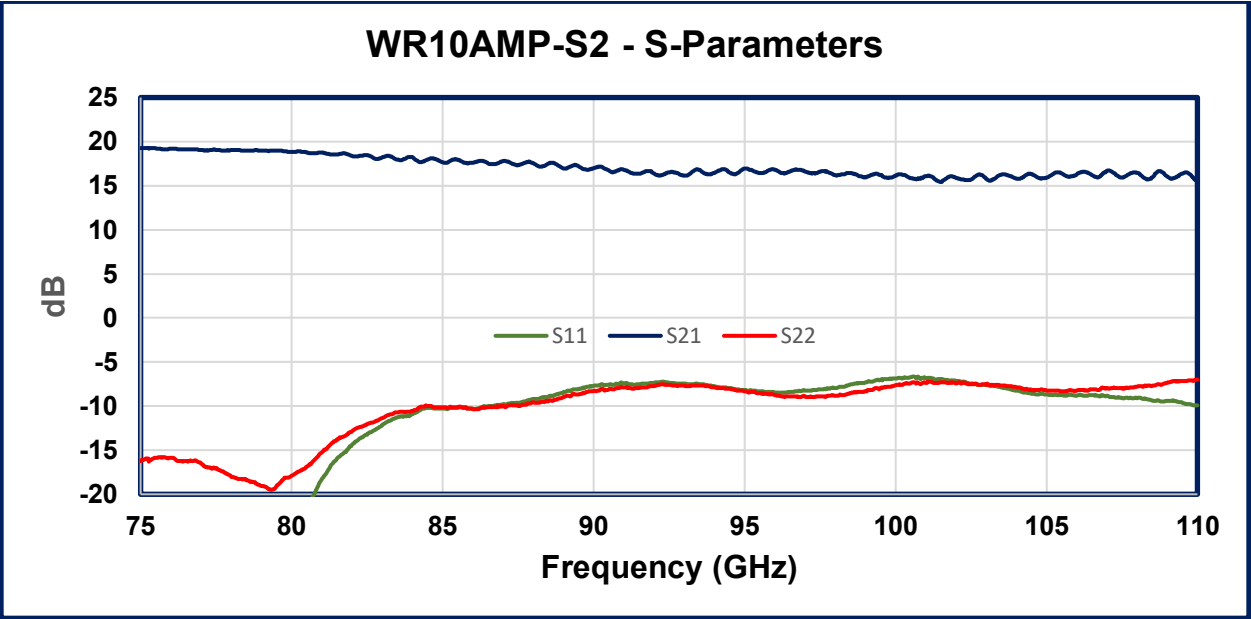
WR12AMP-S4 – S-Parameters and Saturated Output Power, P1dB



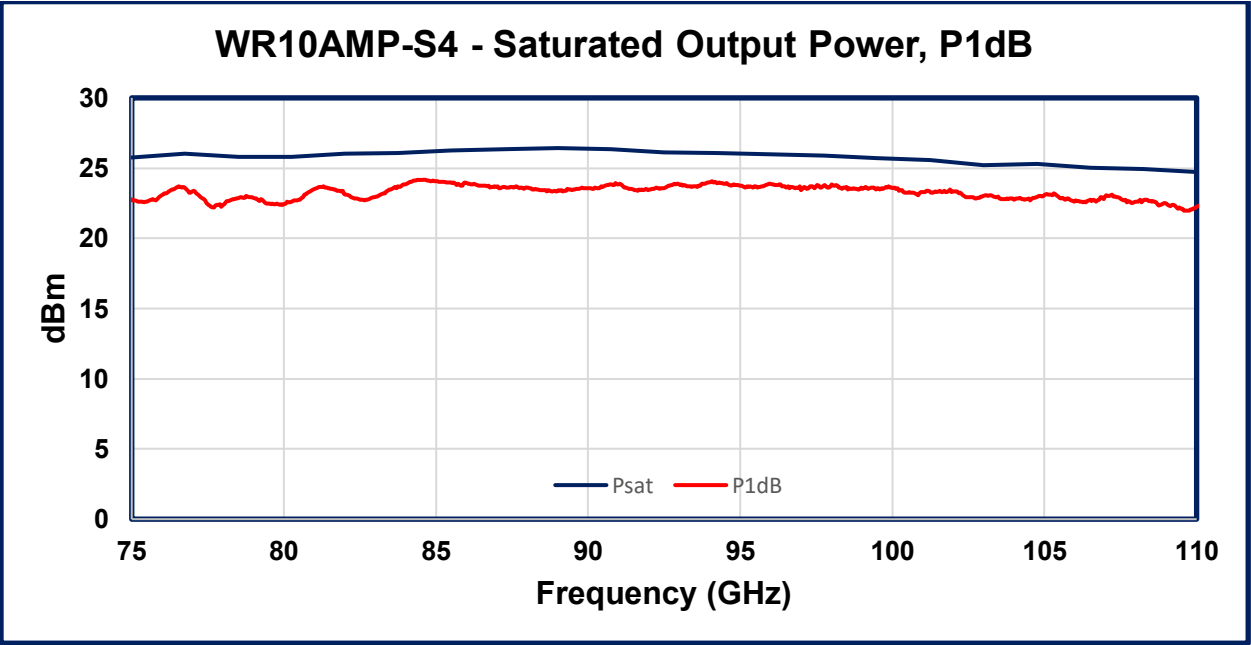
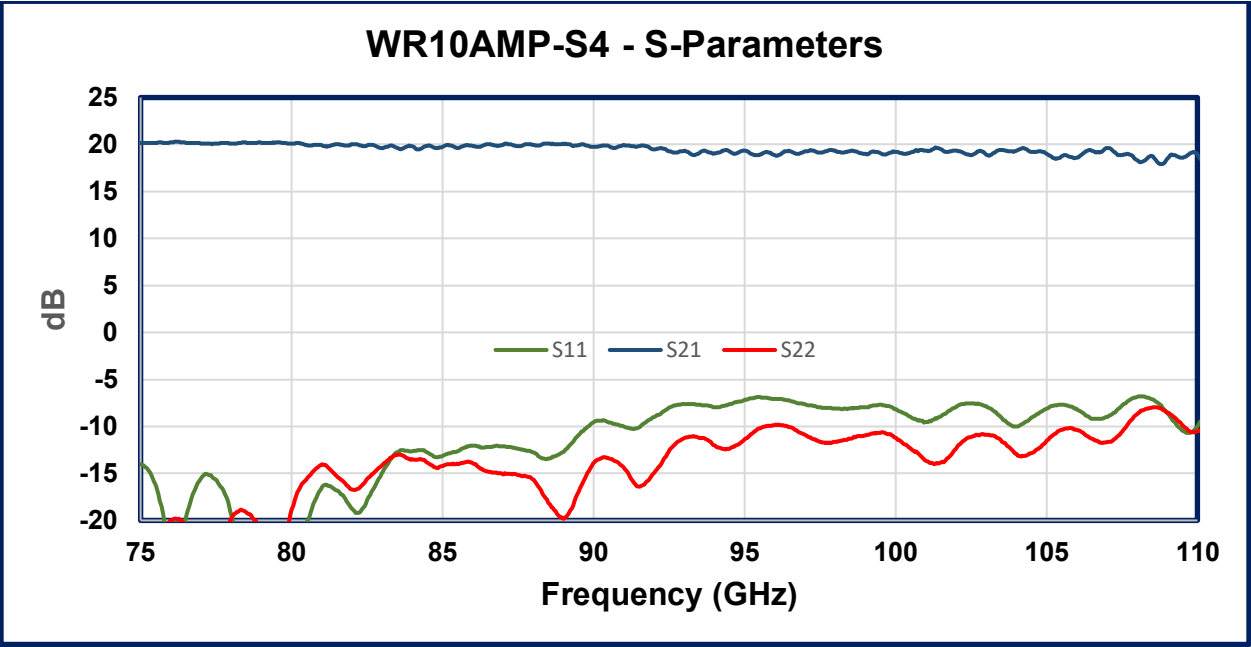
WR10AMP – S-Parameters and Saturated Output Power, P1dB



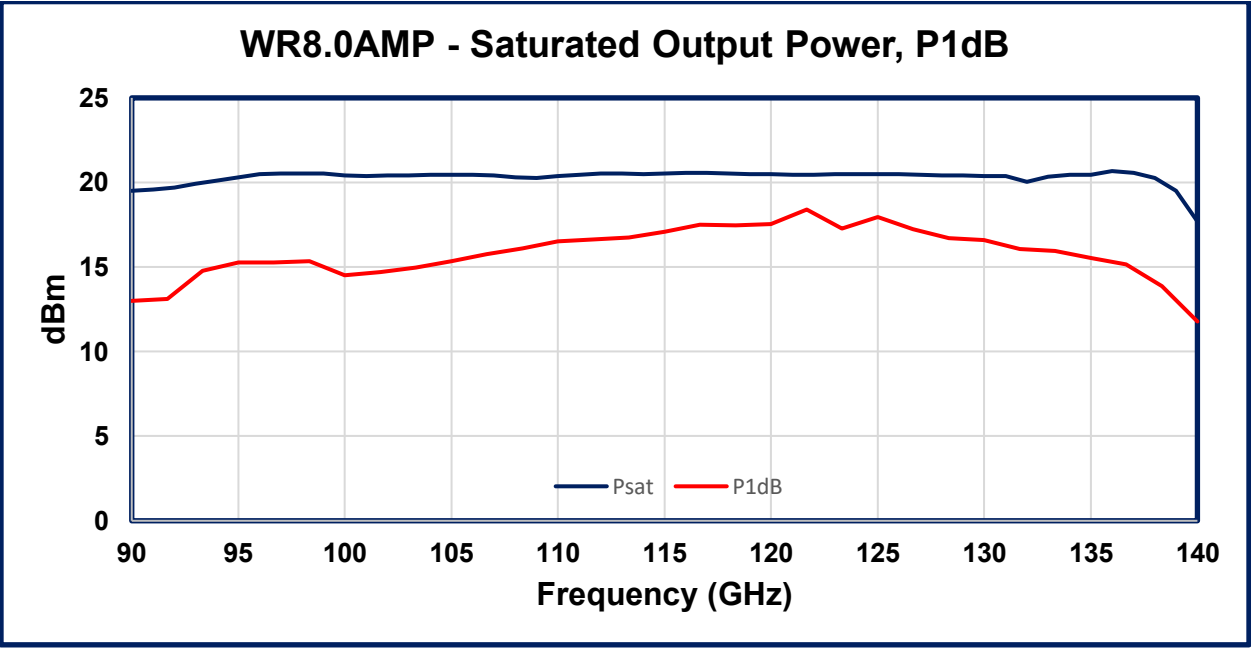
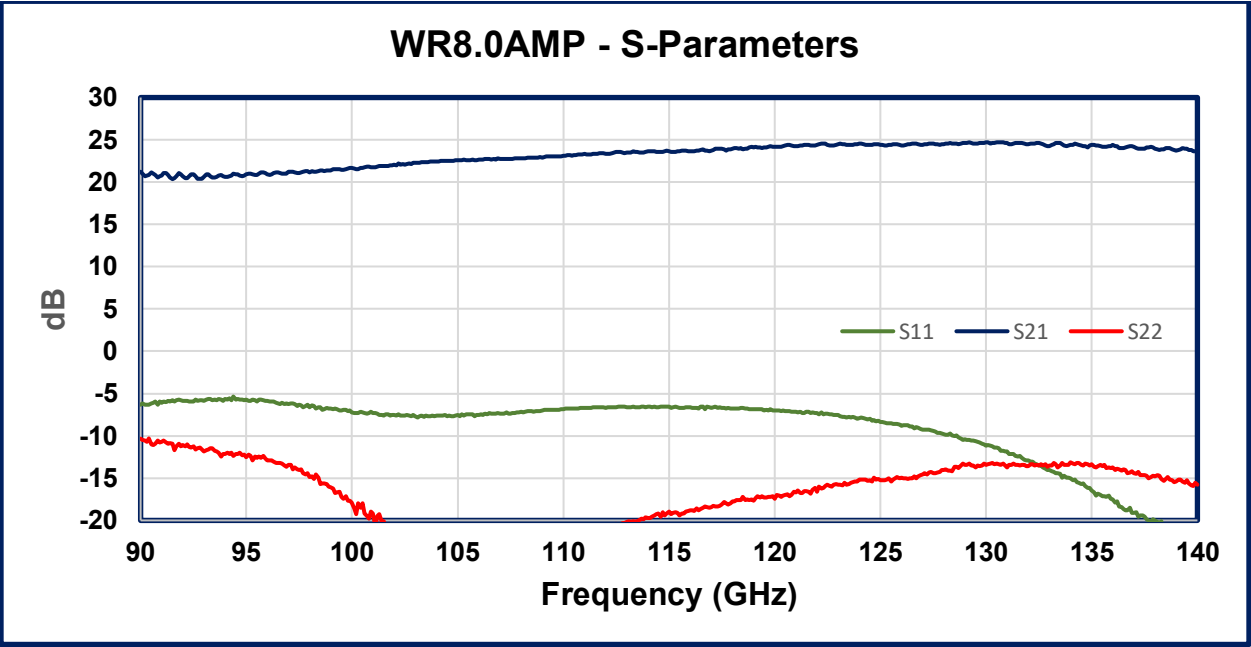
WR10AMP-S2 – S-Parameters and Saturated Output Power, P1dB



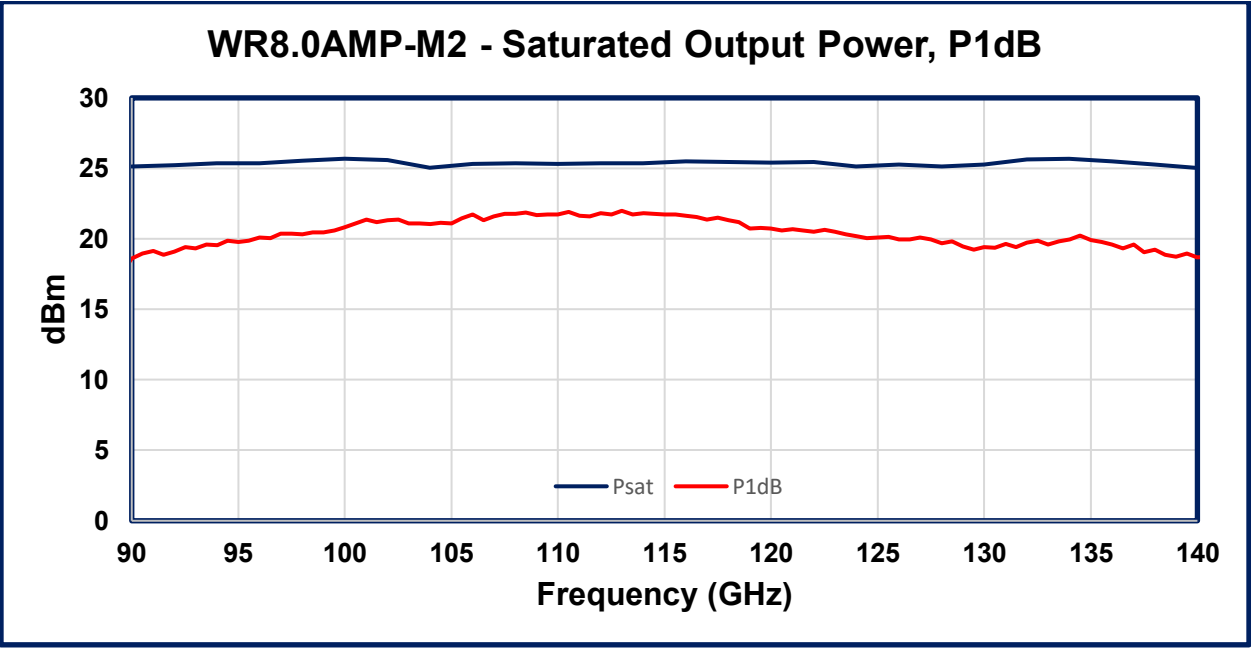
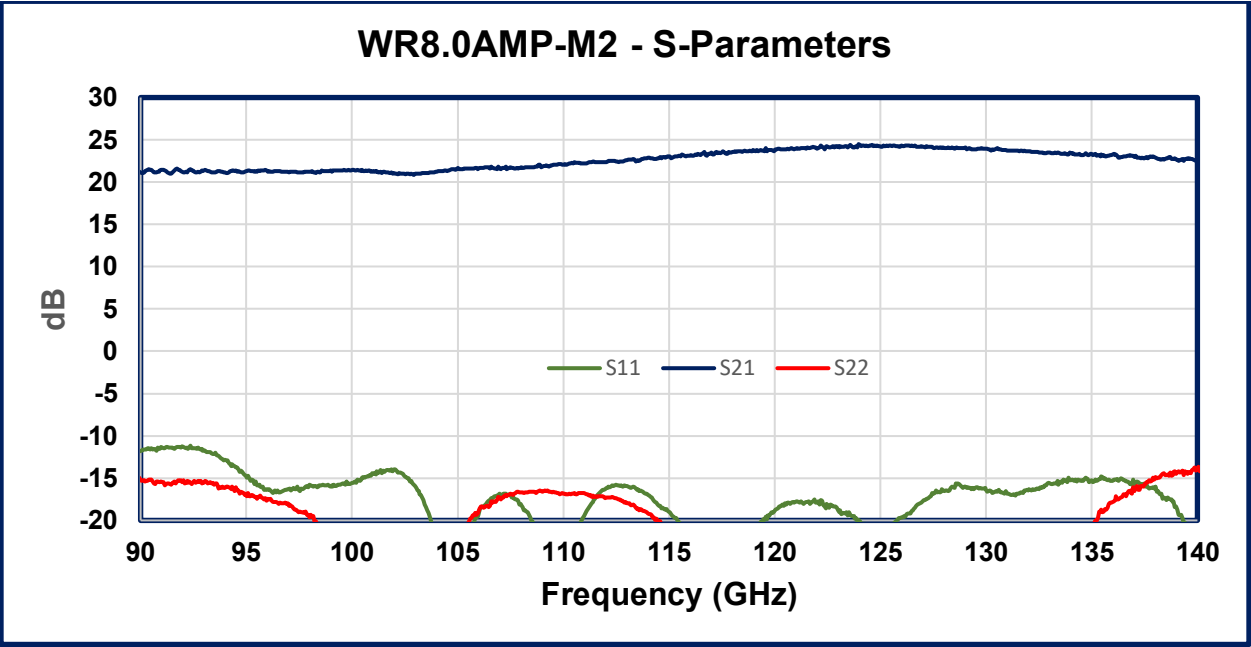
WR10AMP-S4 – S-Parameters and Saturated Output Power, P1dB



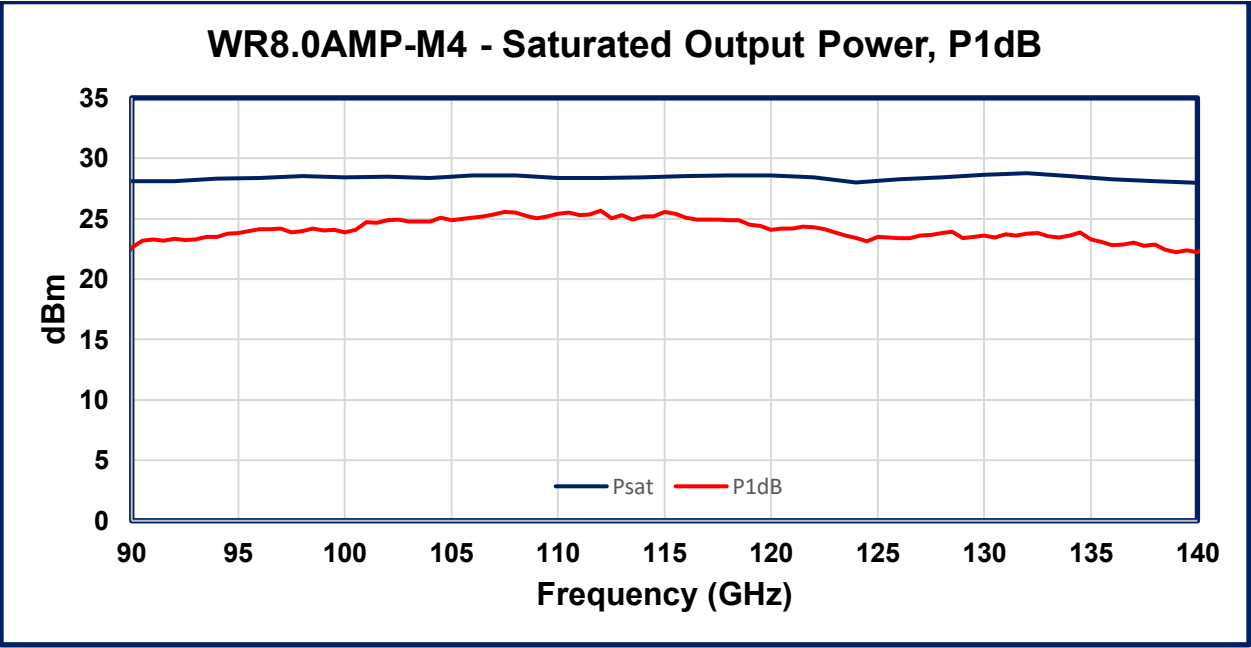
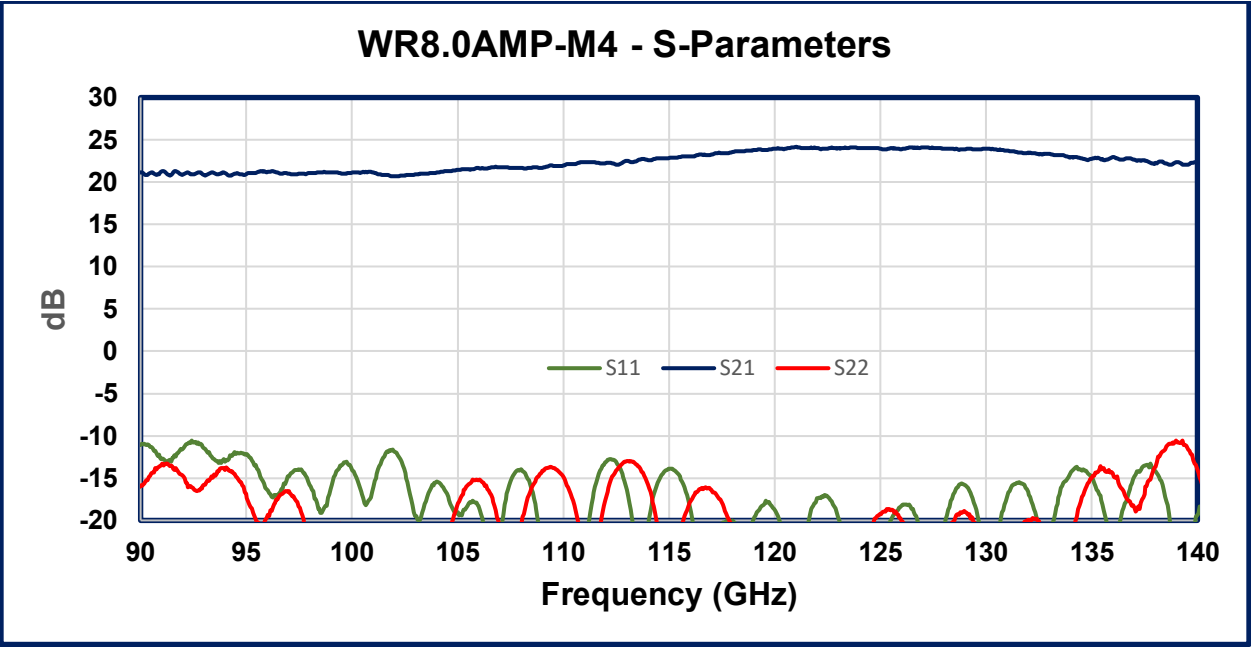
WR8.0AMP – S-Parameters and Saturated Output Power, P1dB



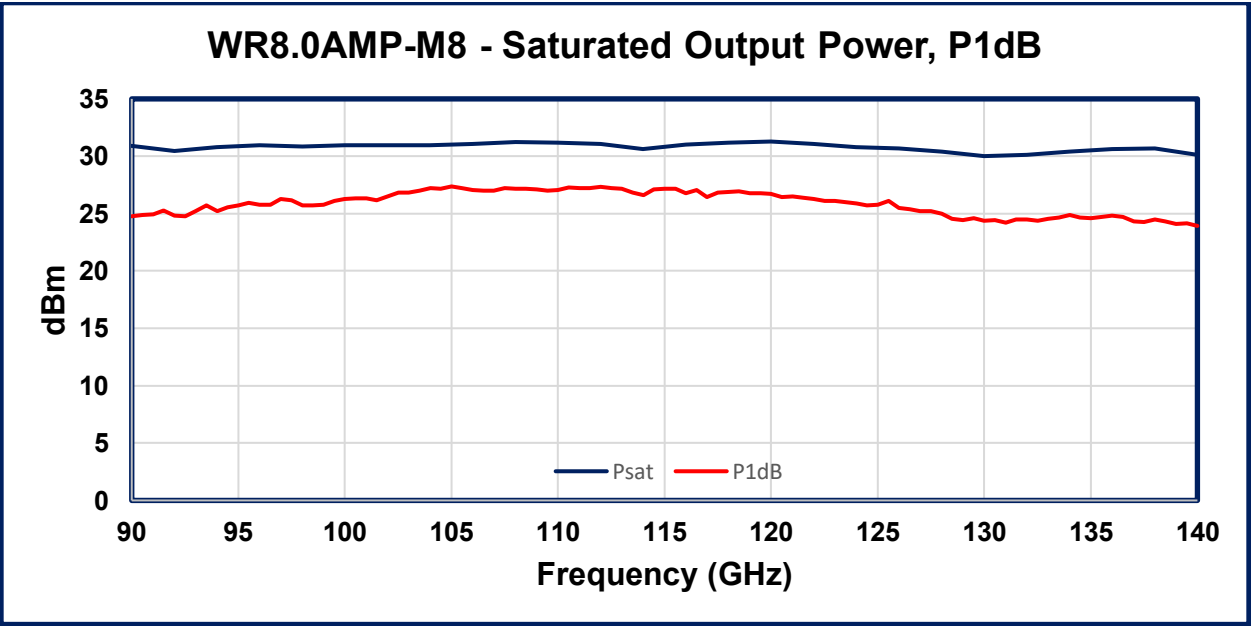
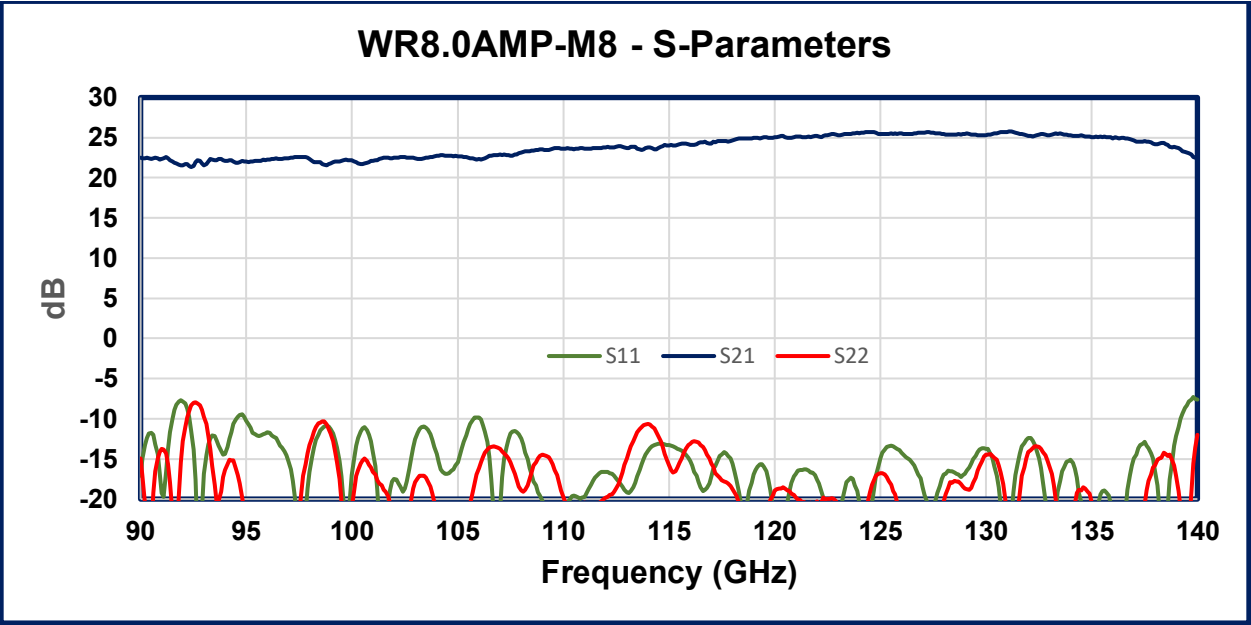
WR8.0AMP-M2 – S-Parameters and Saturated Output Power, P1dB



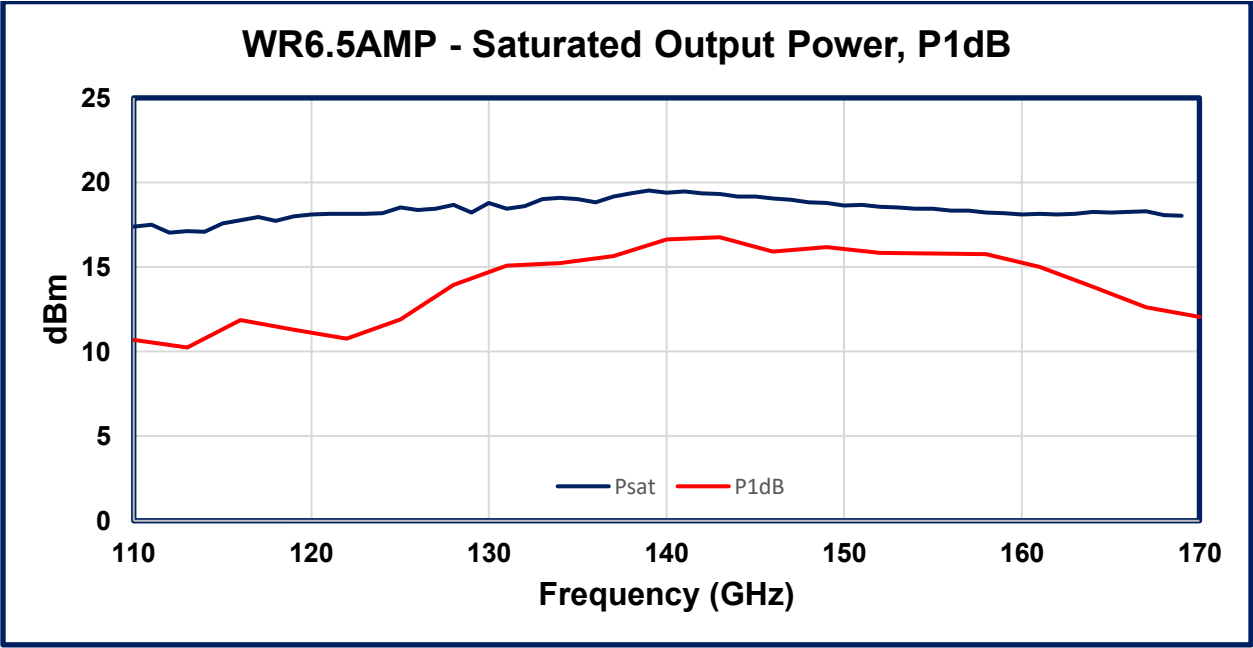
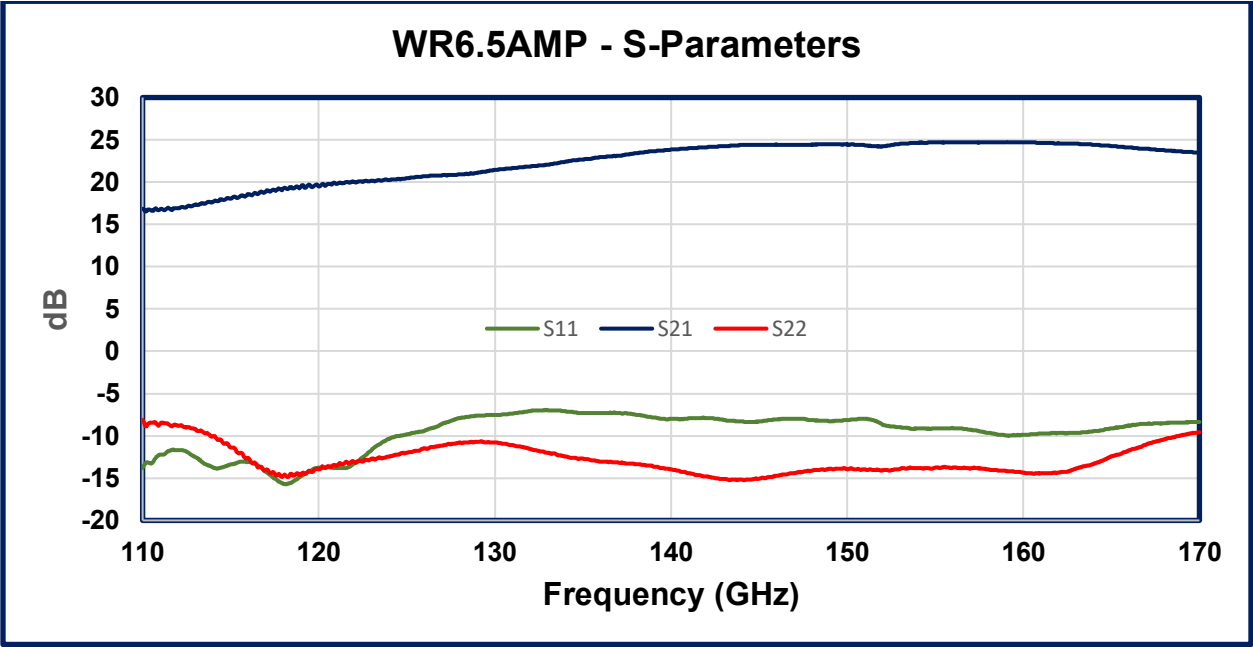
WR8.0AMP-M4 – S-Parameters and Saturated Output Power, P1dB



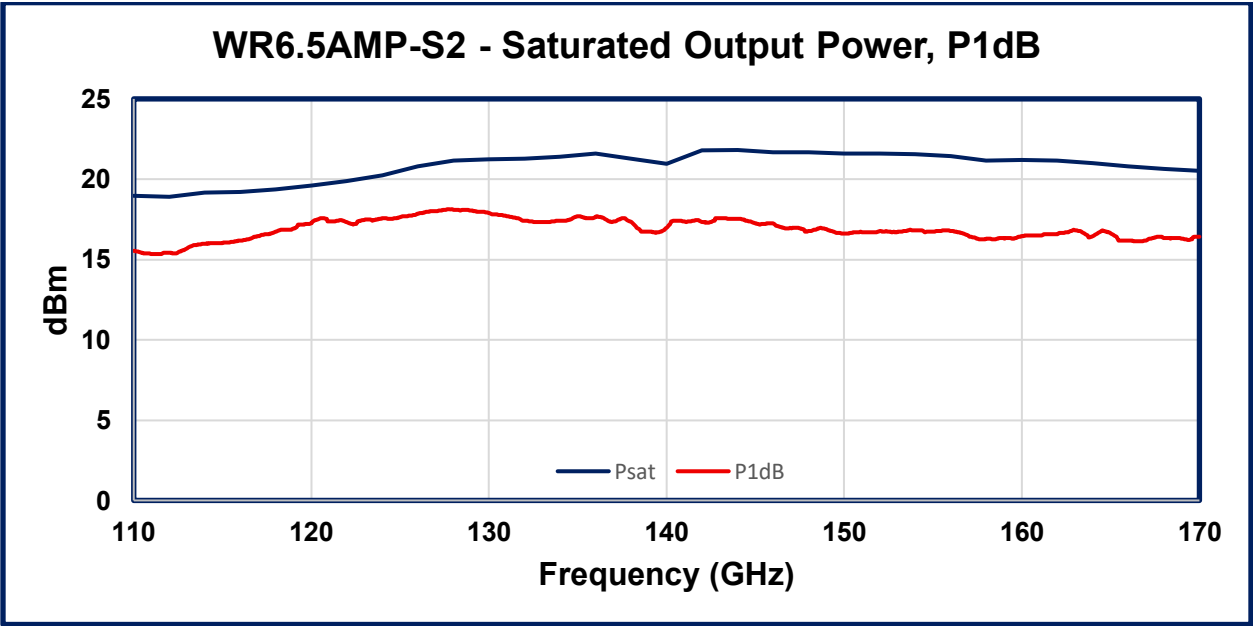
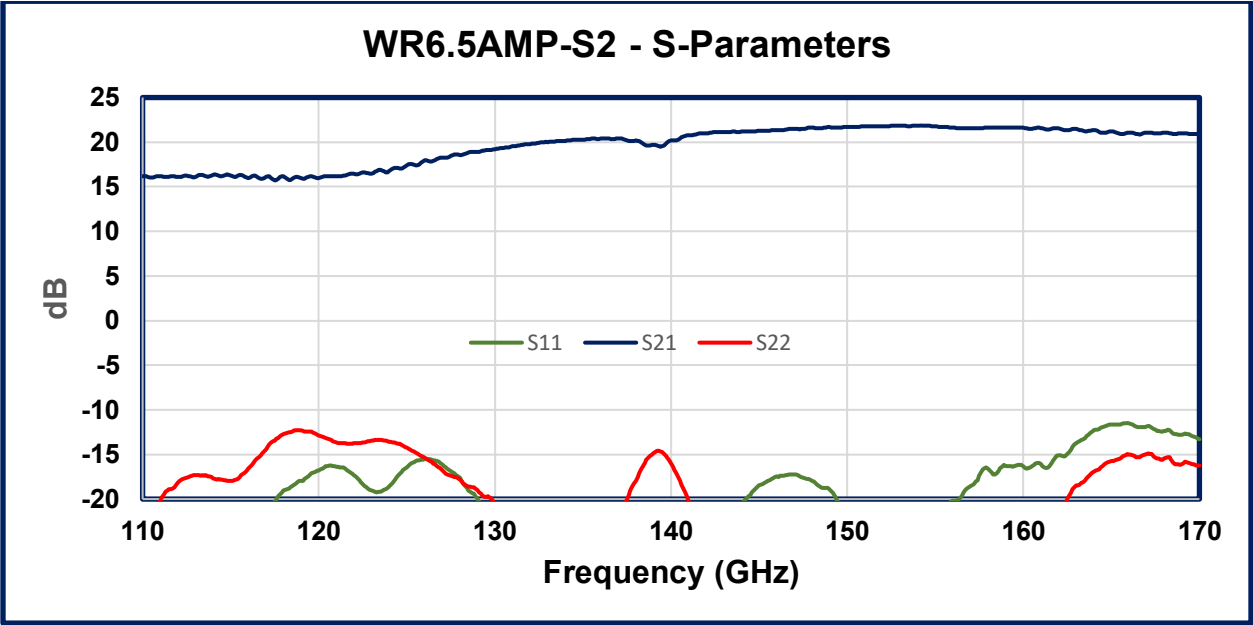
WR8.0AMP-M8 – S-Parameters and Saturated Output Power, P1dB



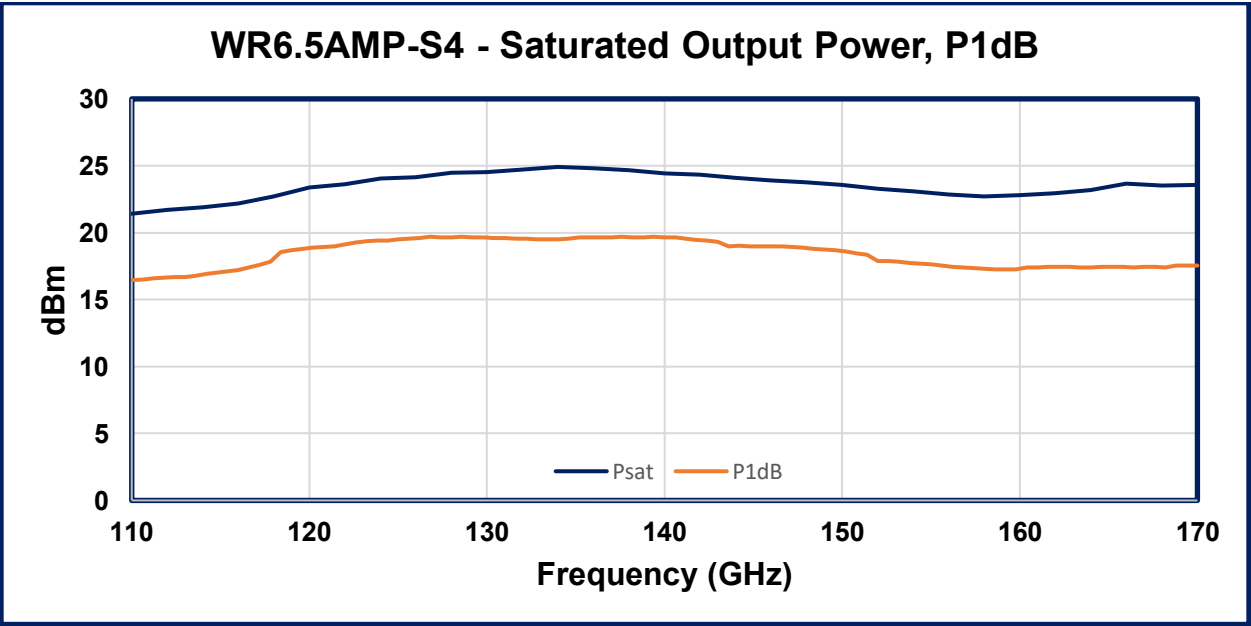
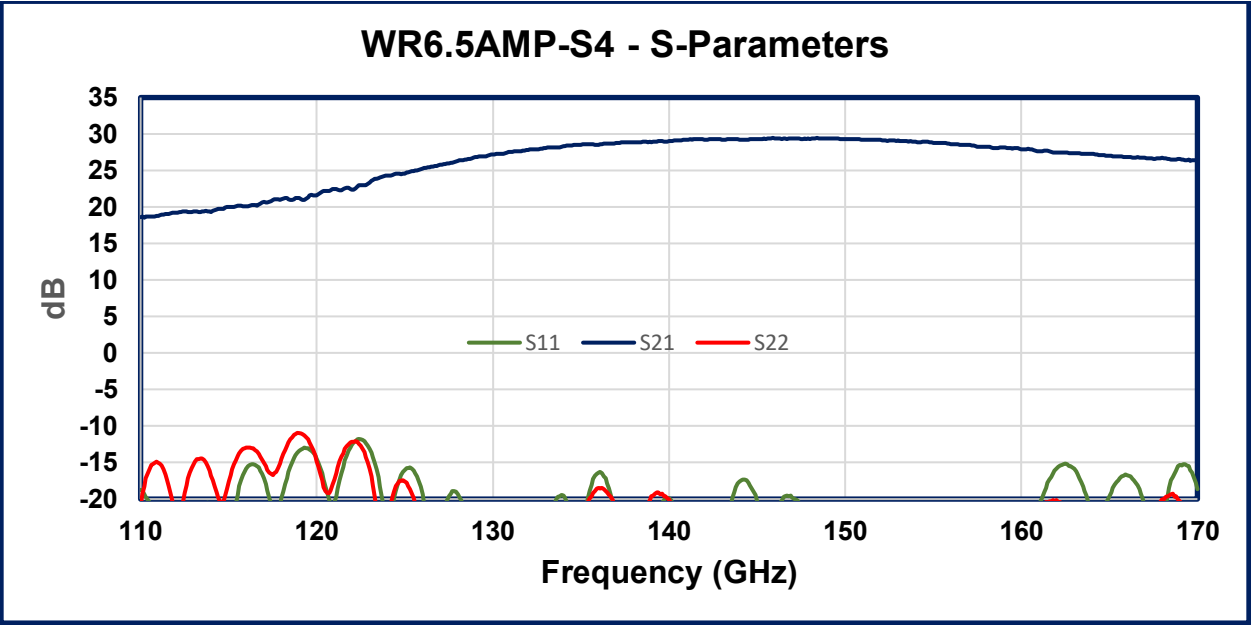
WR6.5AMP – S-Parameters and Saturated Output Power, P1dB



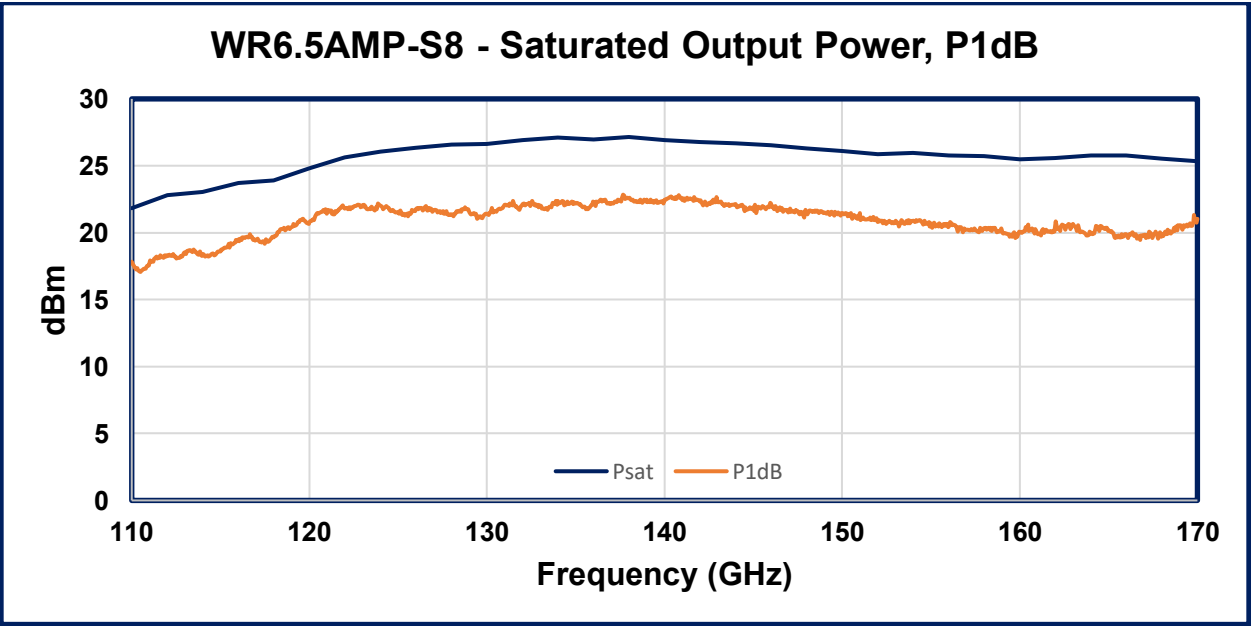
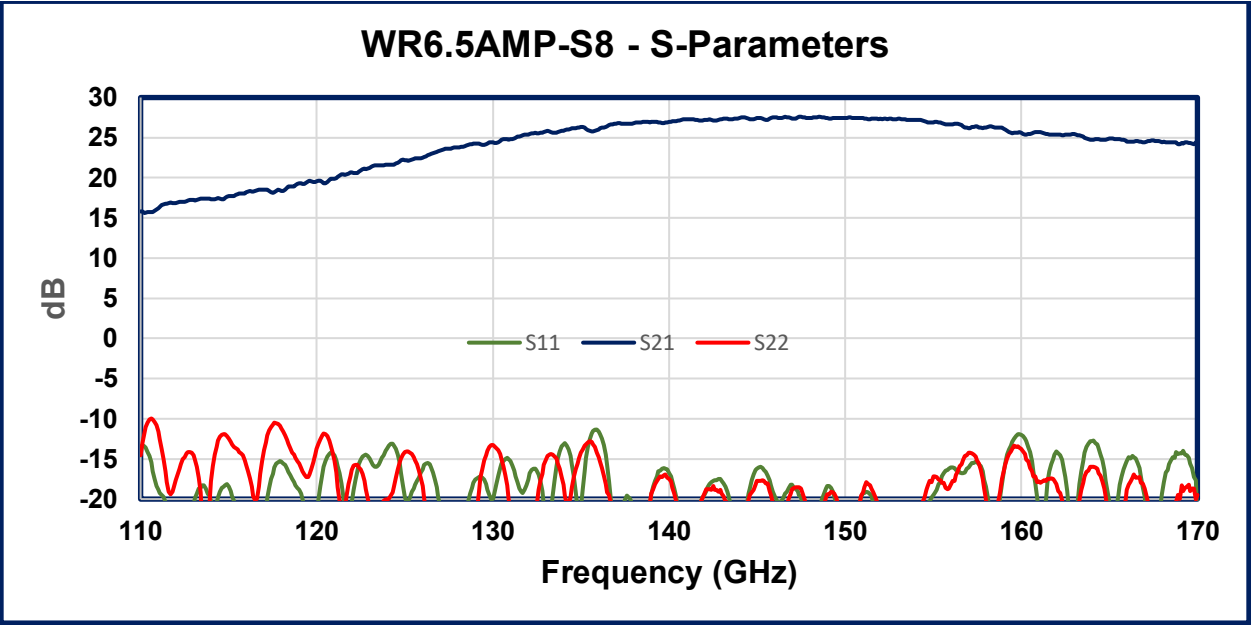
WR6.5AMP-S2 – S-Parameters and Saturated Output Power, P1dB



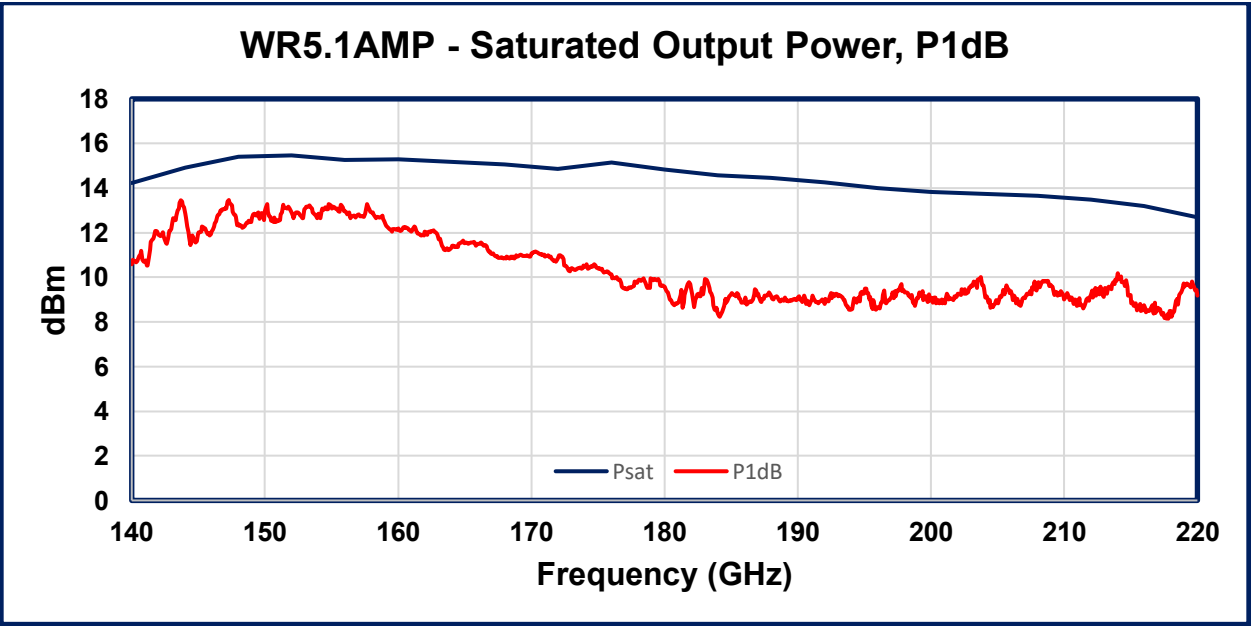
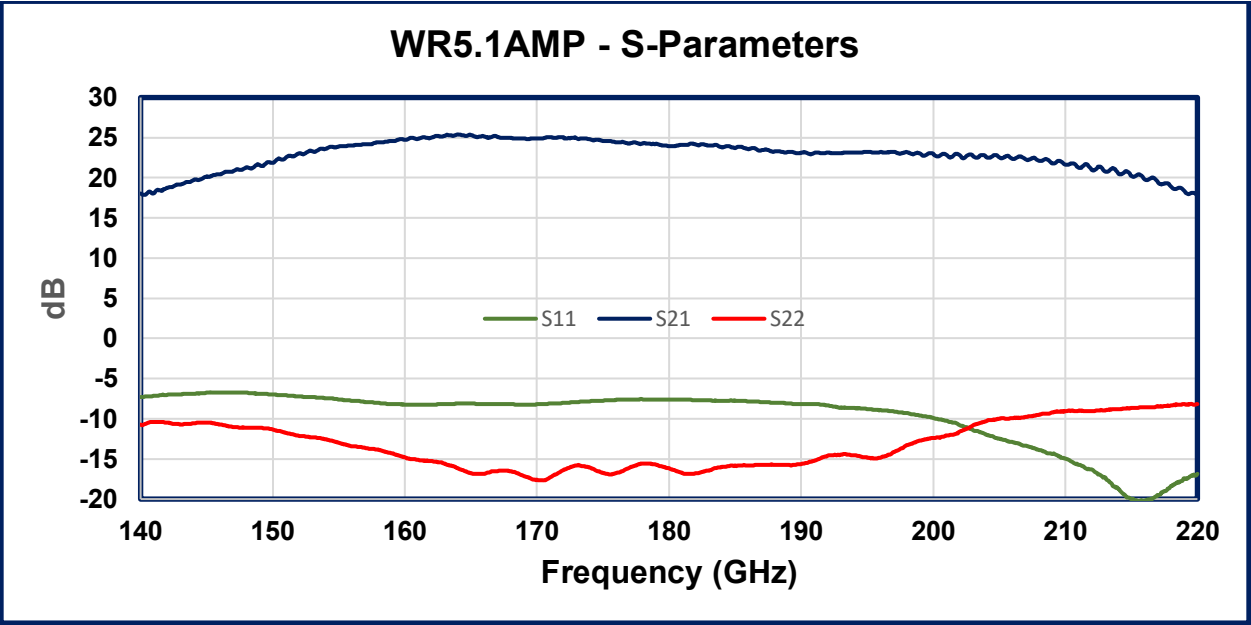
WR6.5AMP-S4 – S-Parameters and Saturated Output Power, P1dB



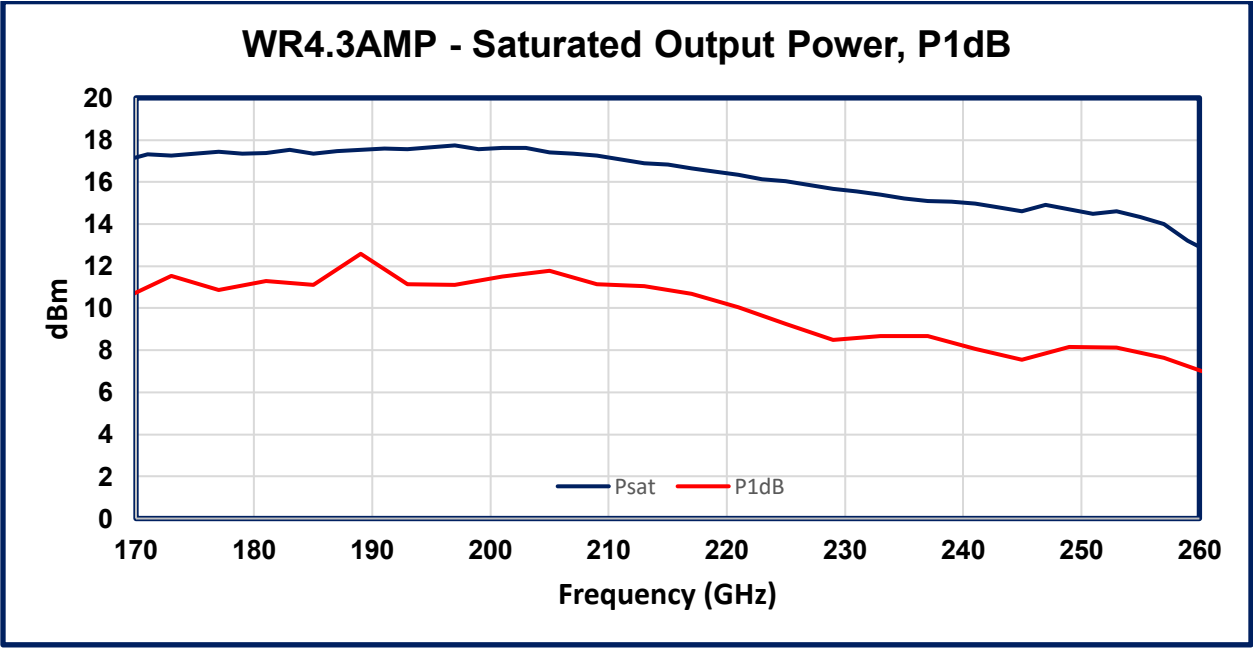
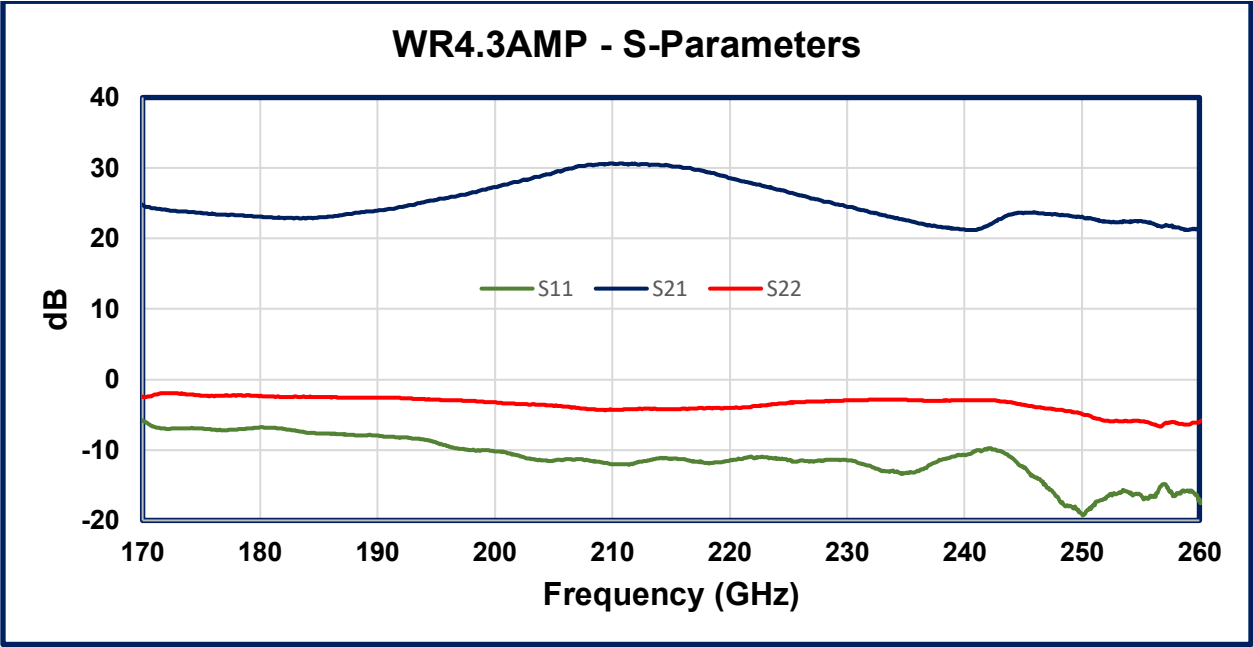
WR6.5AMP-S8 – S-Parameters and Saturated Output Power, P1dB



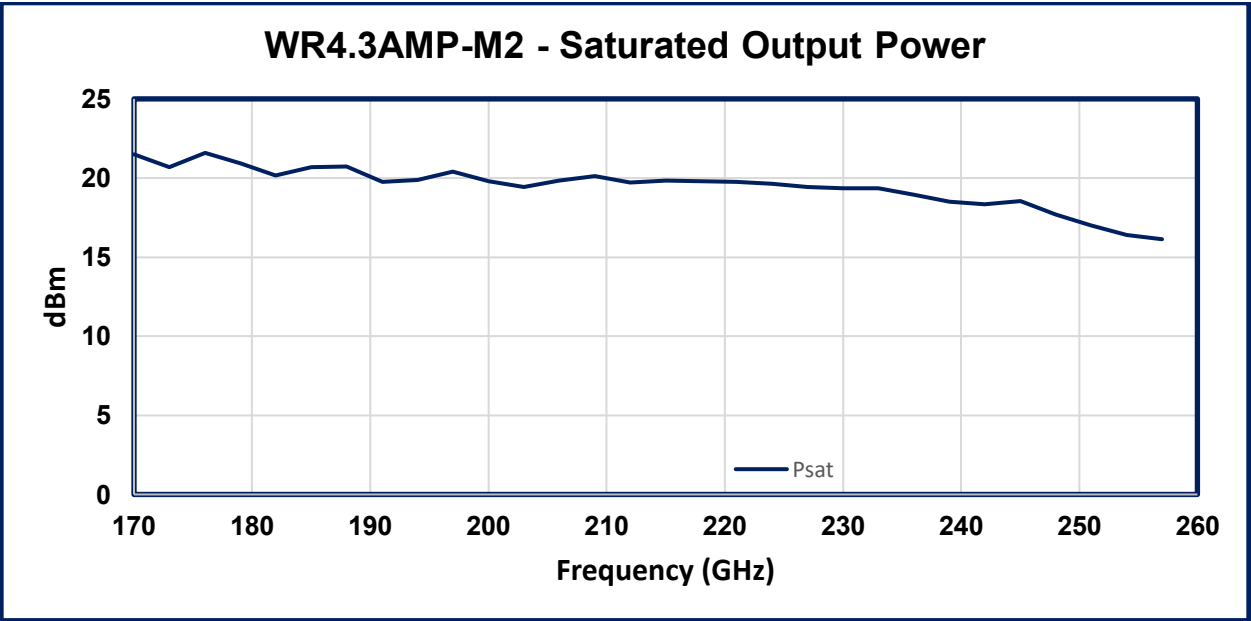
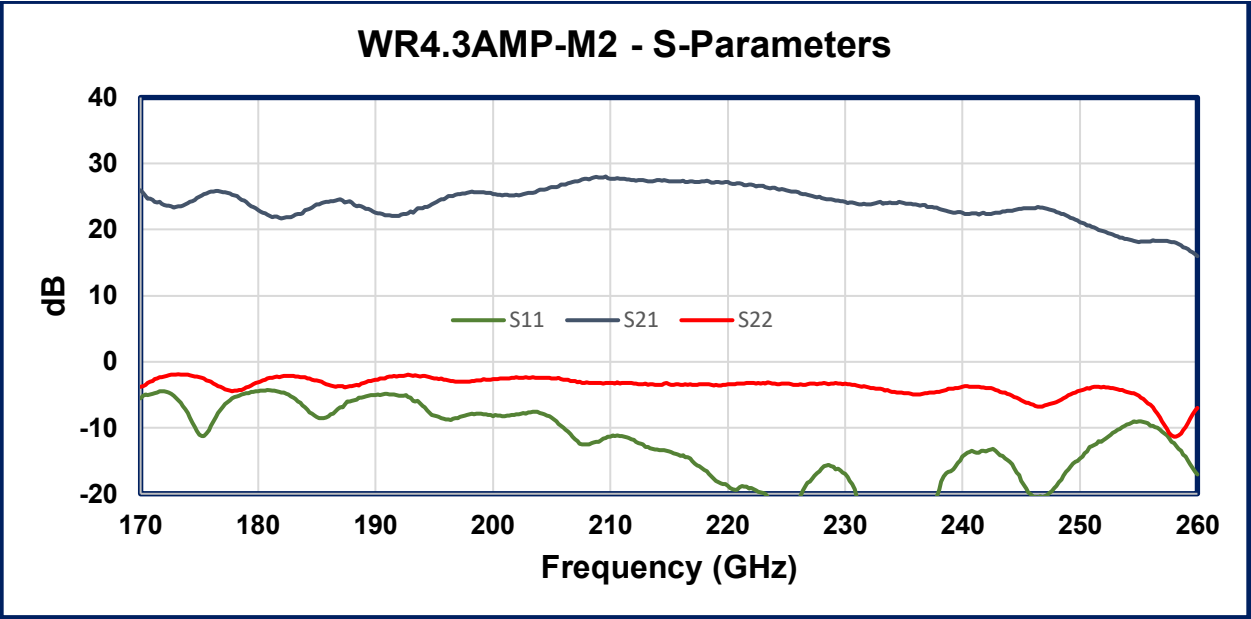
WR5.1AMP – S-Parameters and Saturated Output Power, P1dB



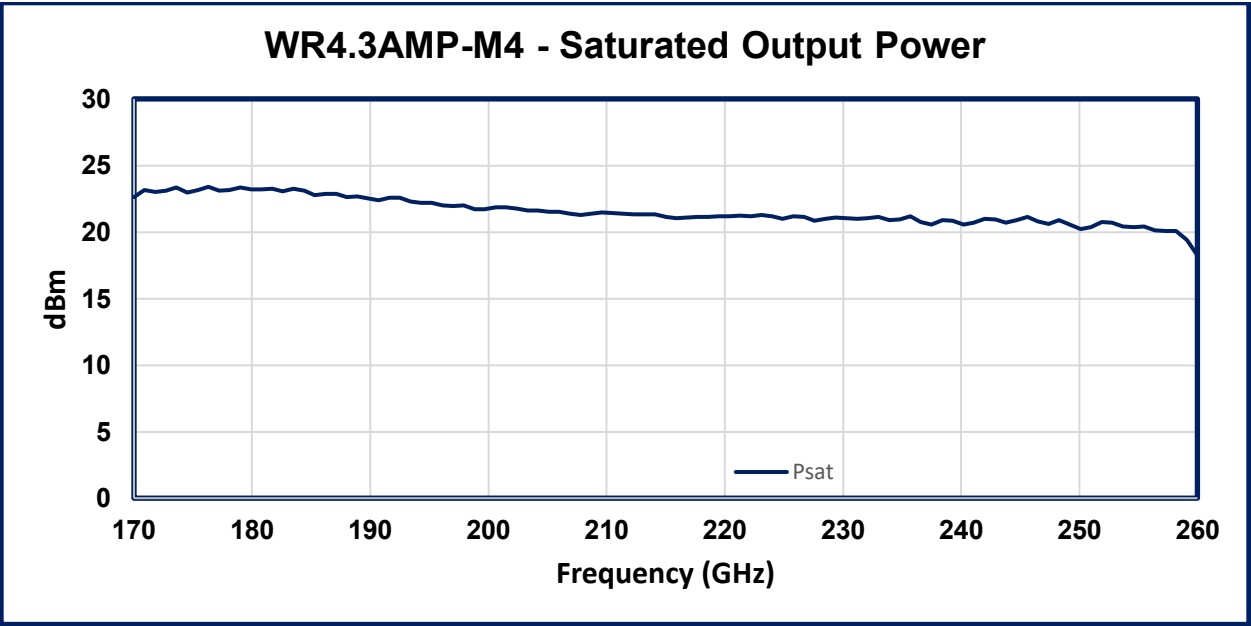
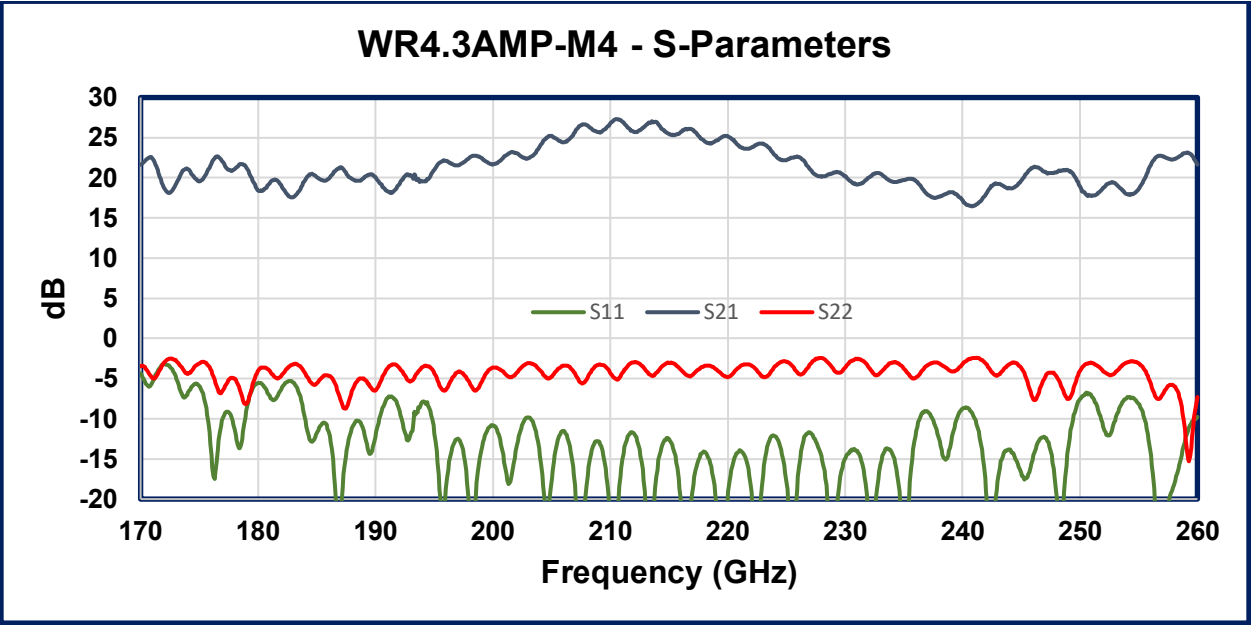
WR4.3AMP – S-Parameters and Saturated Output Power, P1dB



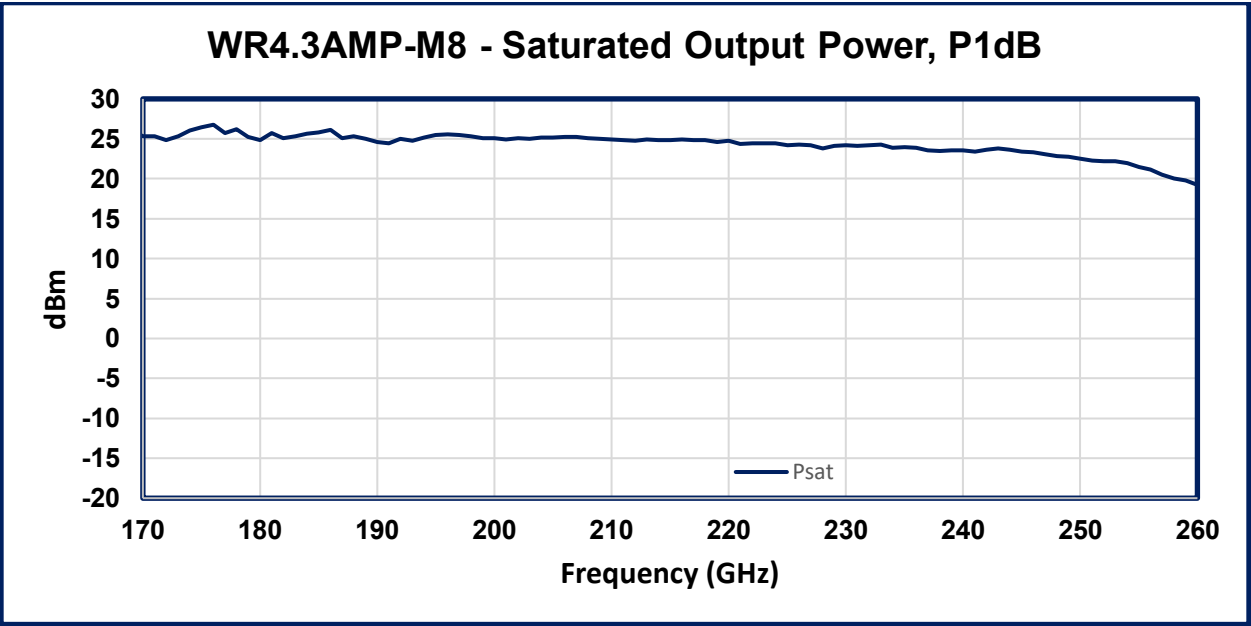
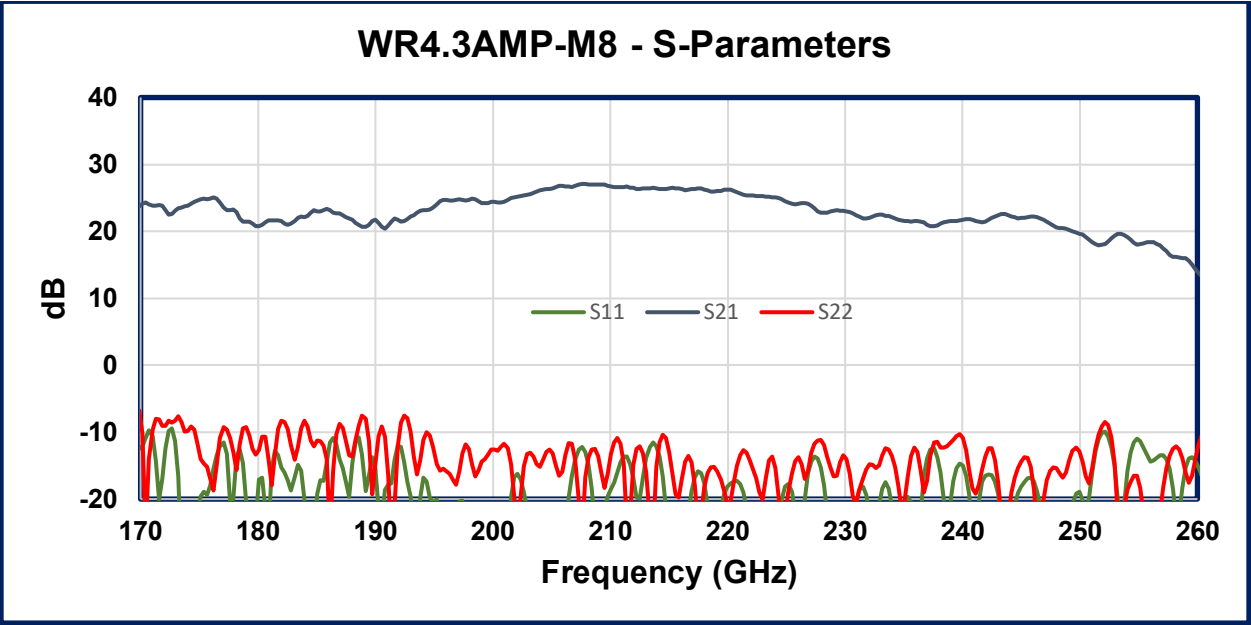
WR4.3AMP-M2 – S-Parameters and Saturated Output Power, P1dB



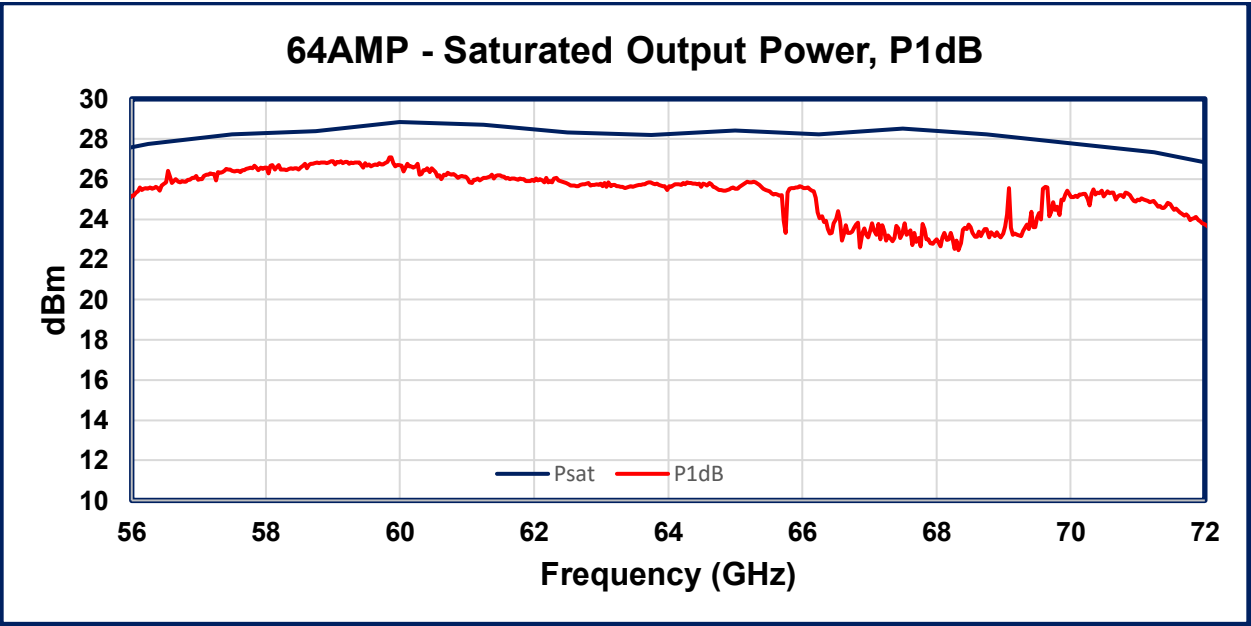
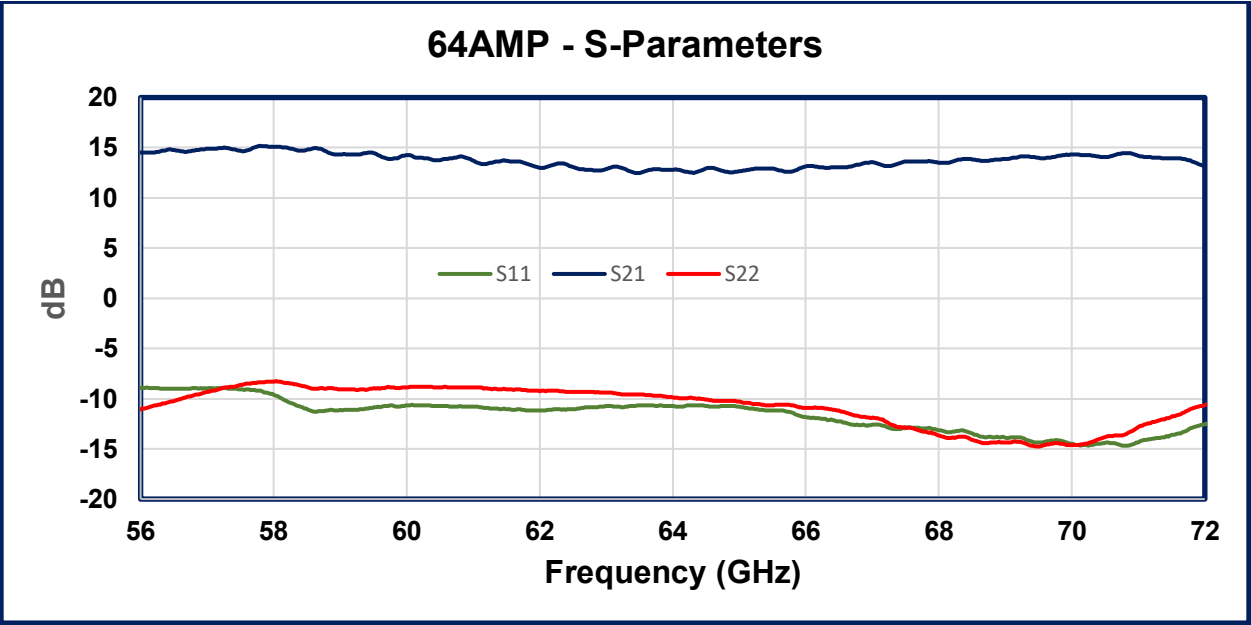
WR4.3AMP-M4 – S-Parameters and Saturated Output Power, P1dB



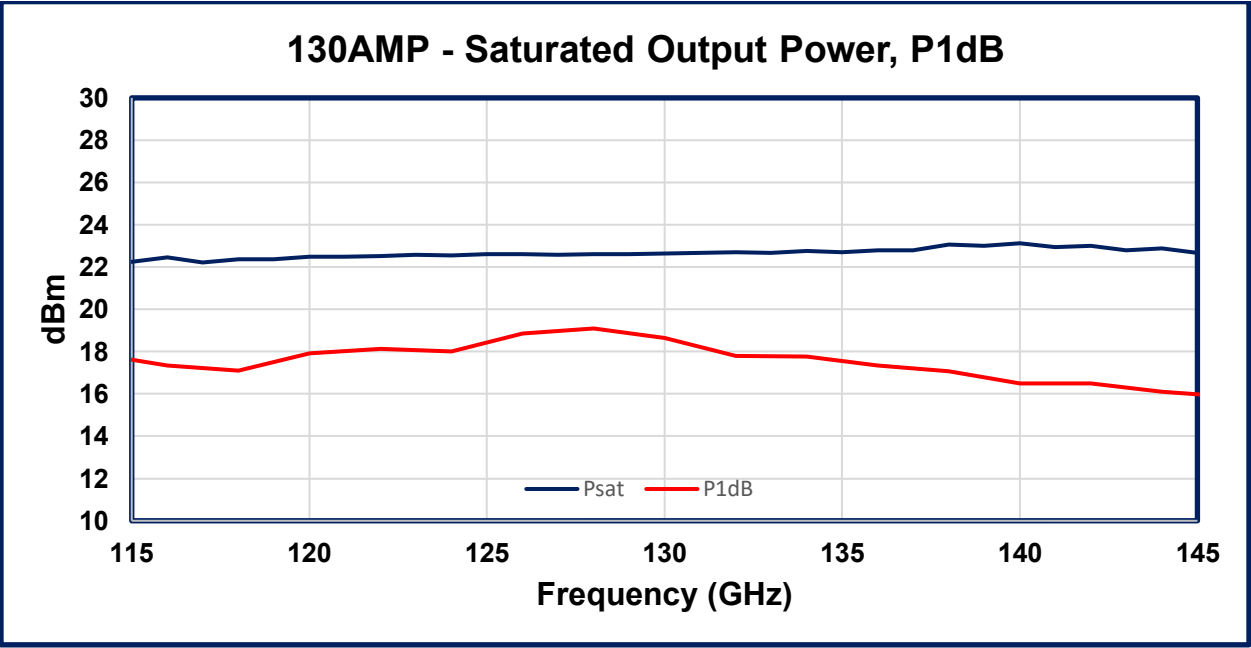
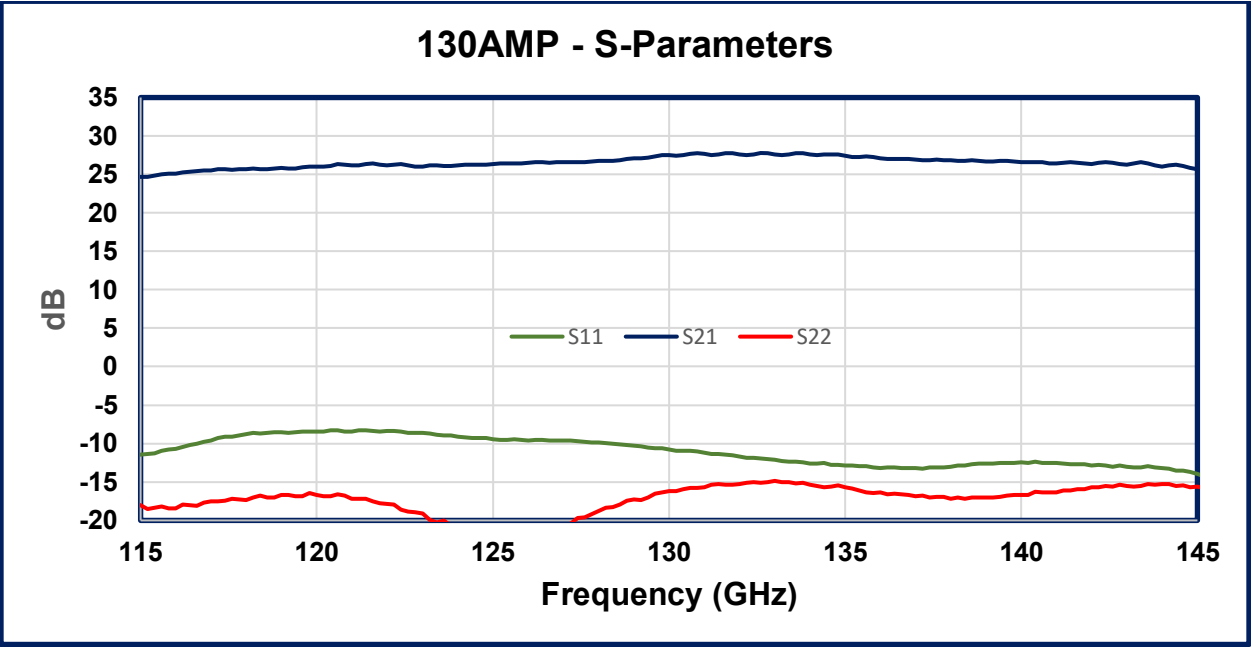
WR4.3AMP-M8 – S-Parameters and Saturated Output Power, P1dB



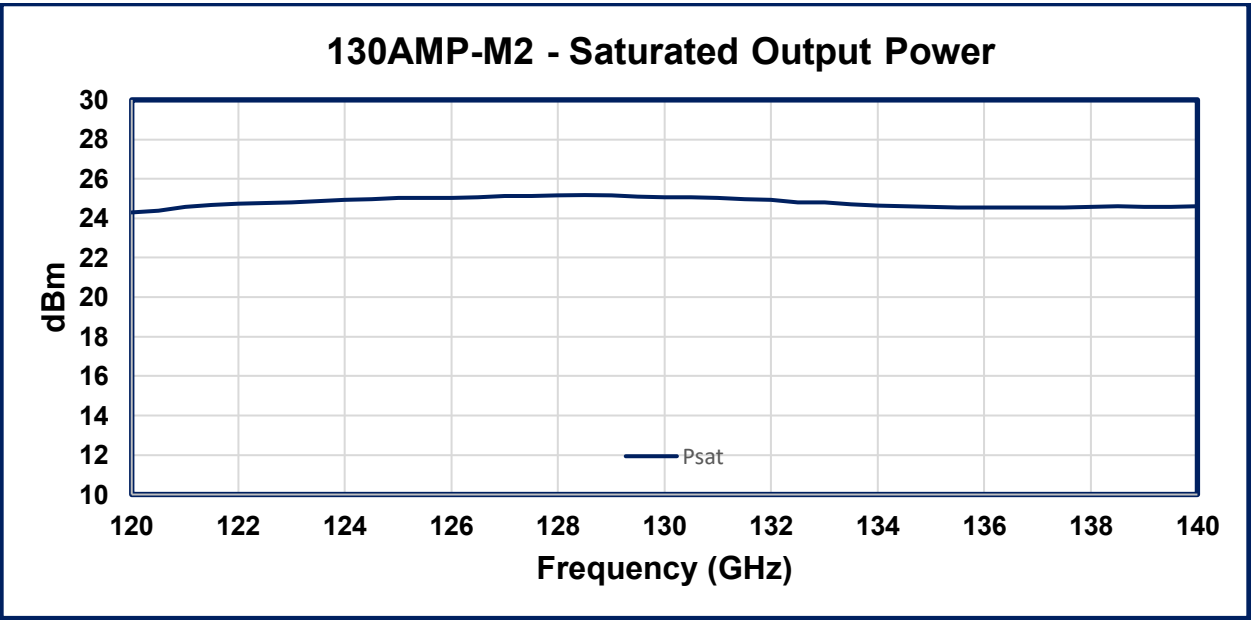
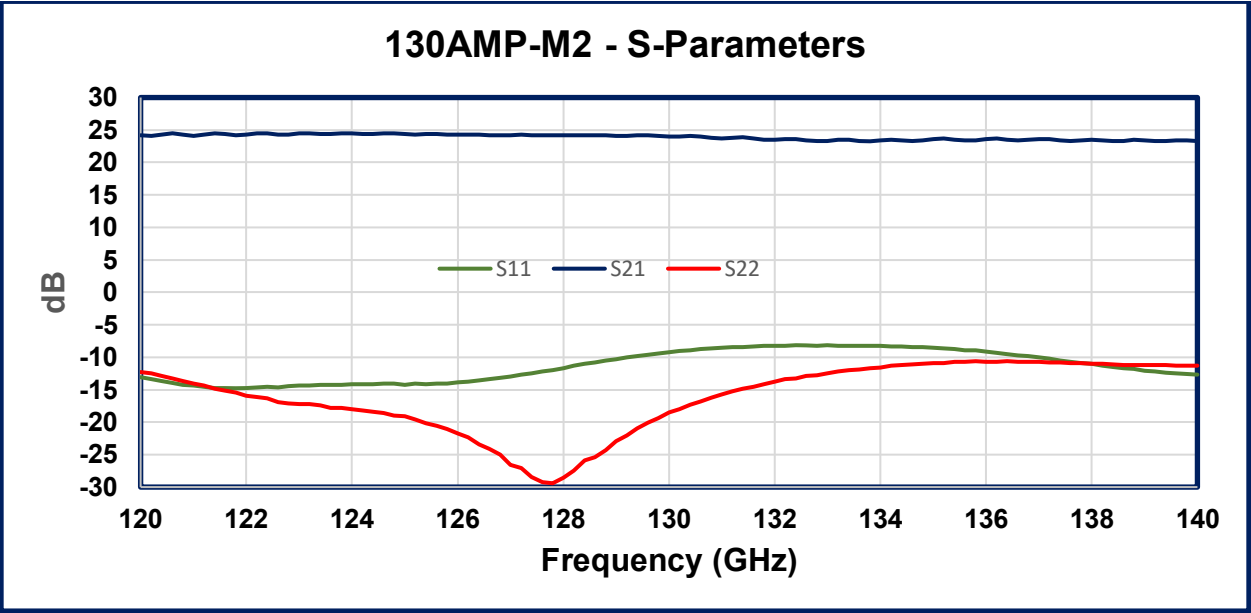
64AMP – S-Parameters and Saturated Output Power, P1dB



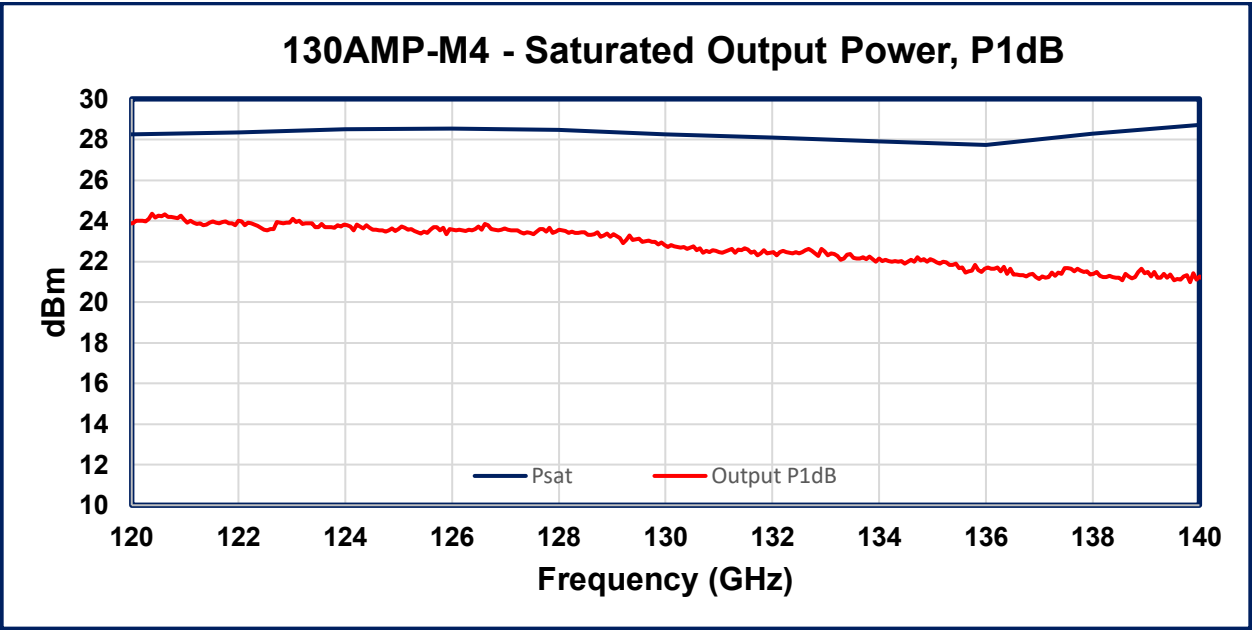
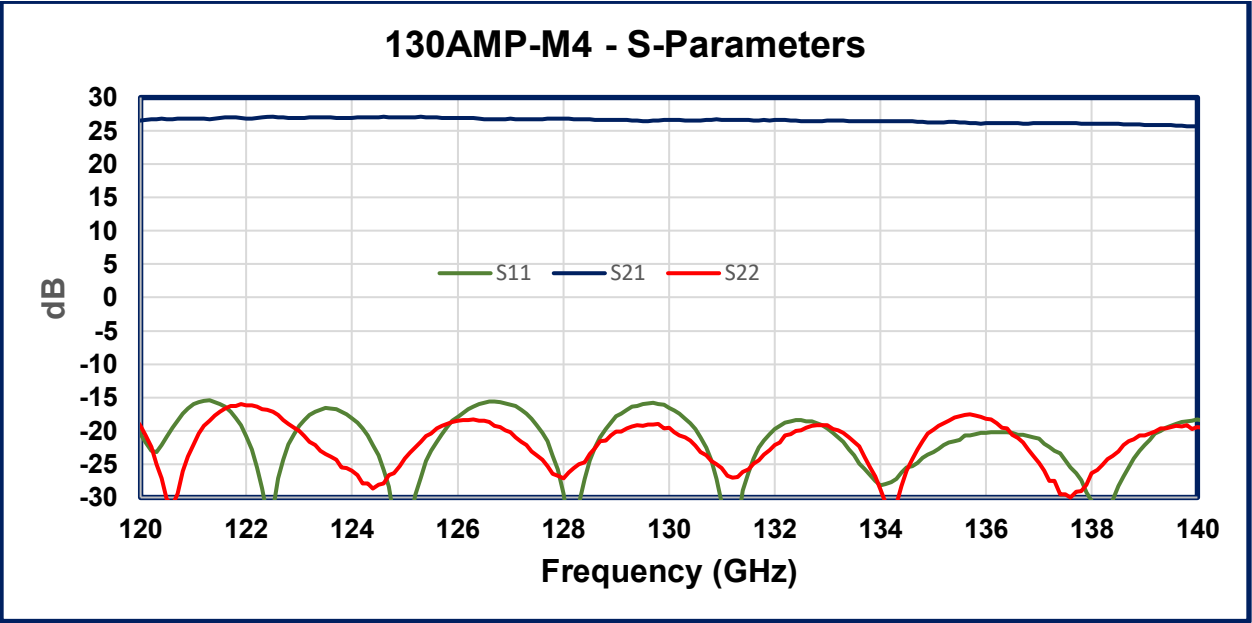
130AMP – S-Parameters and Saturated Output Power, P1dB



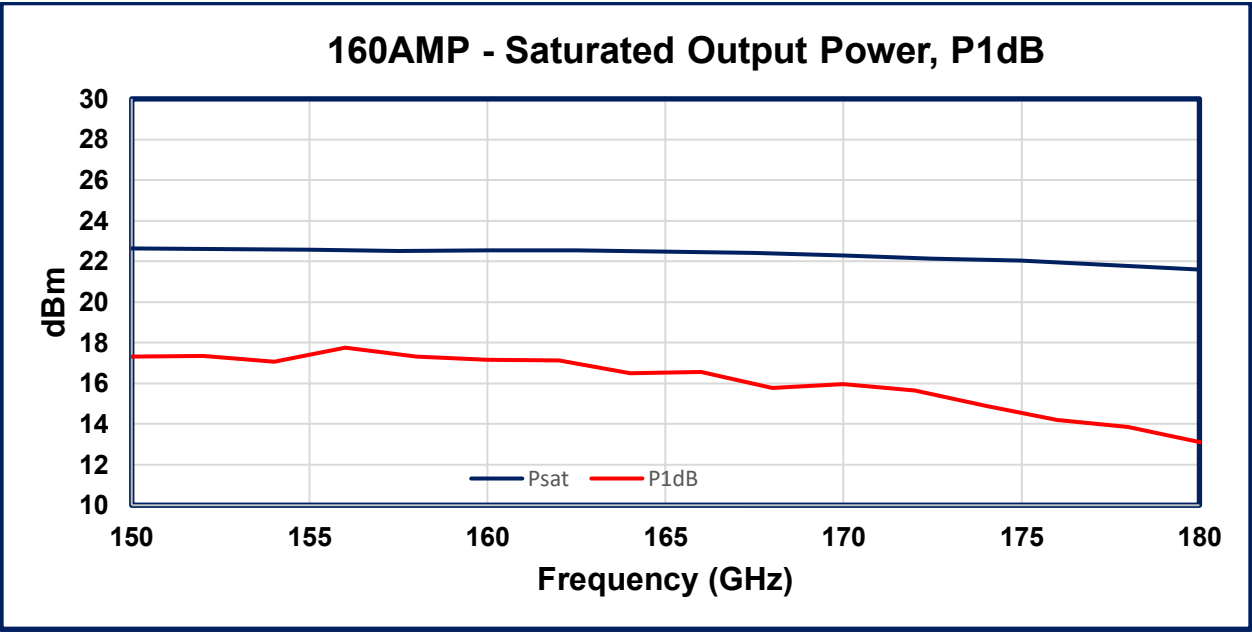
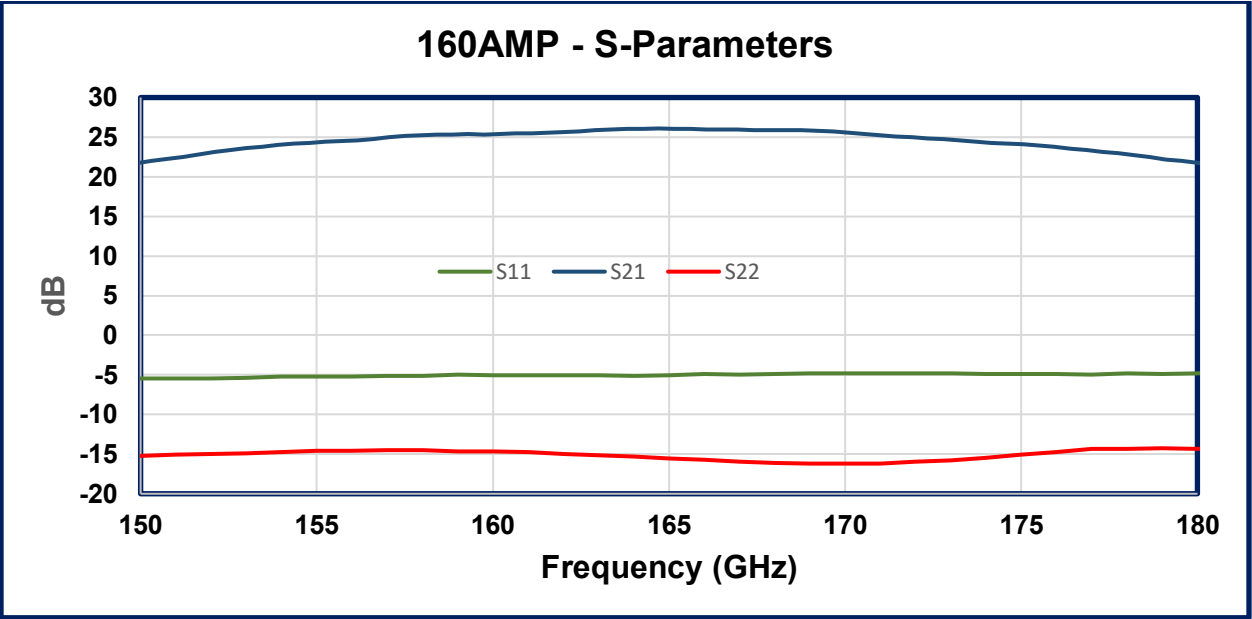
130AMP-M2 – S-Parameters and Saturated Output Power, P1dB



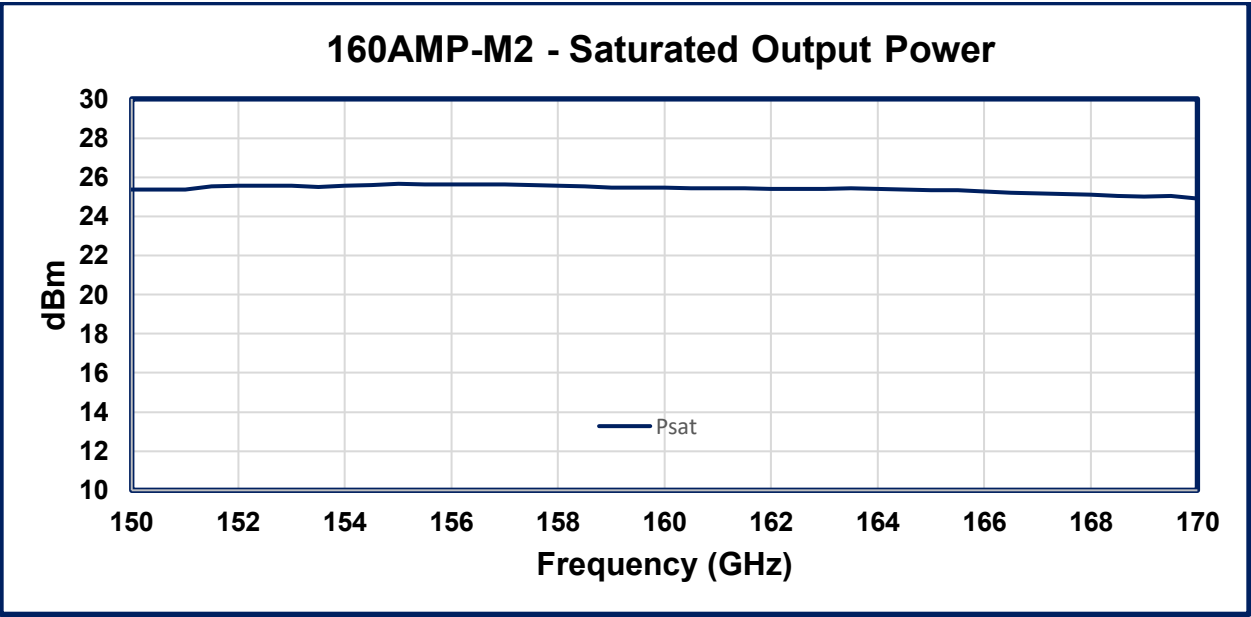
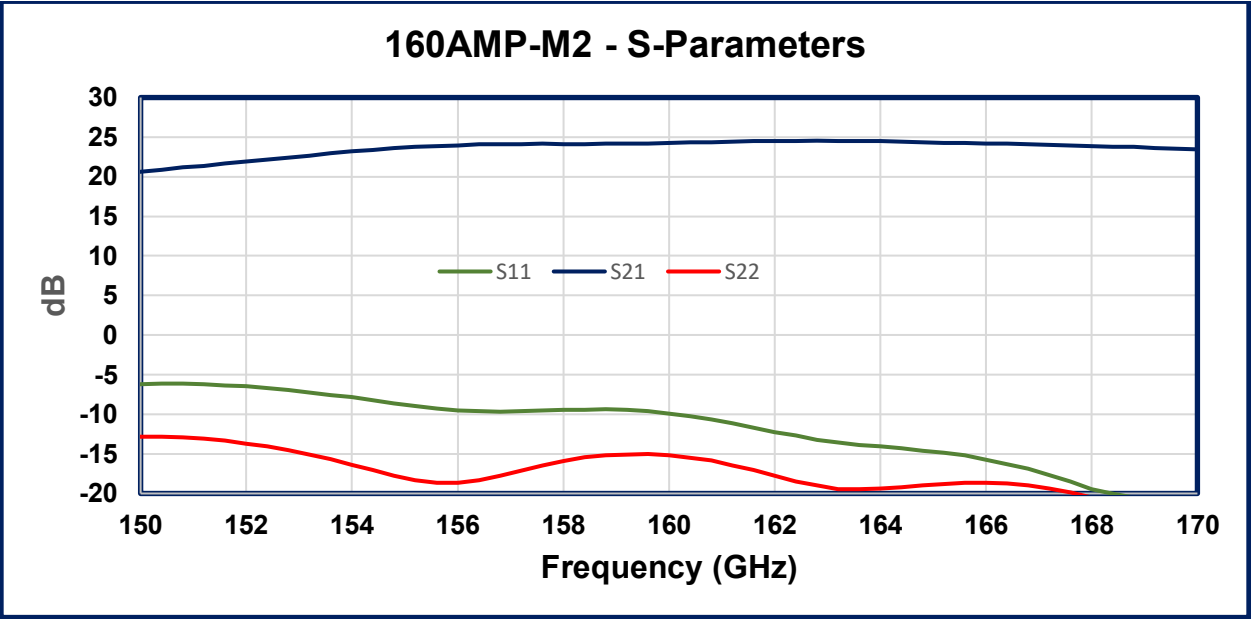
130AMP-M4 – S-Parameters and Saturated Output Power, P1dB



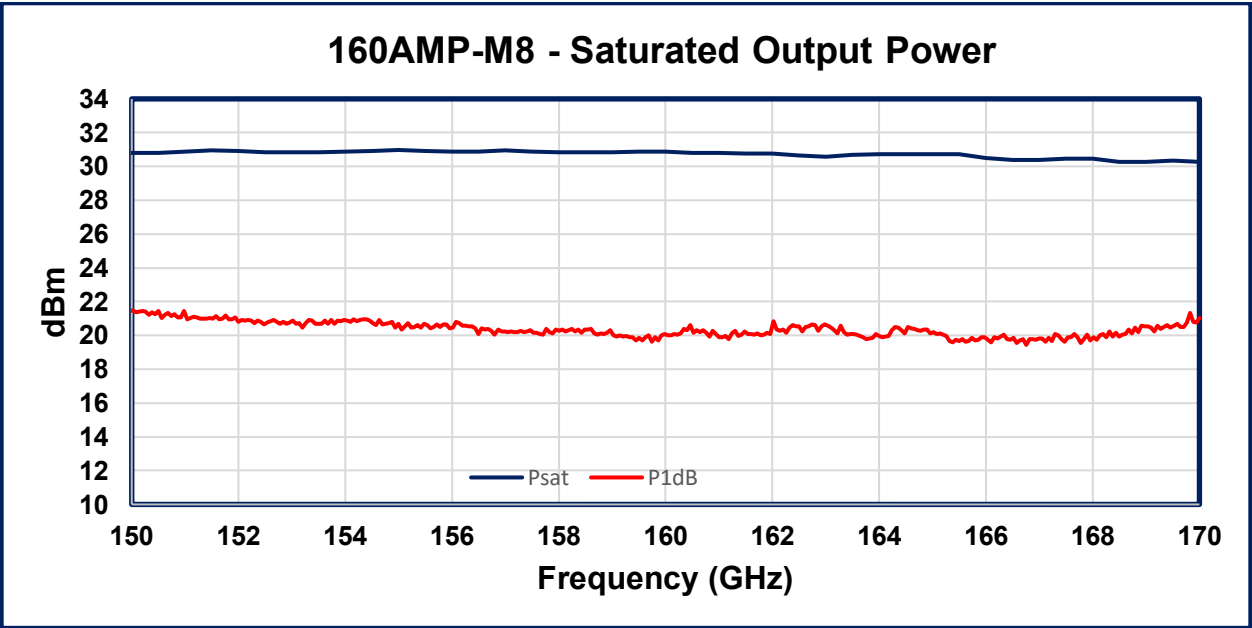
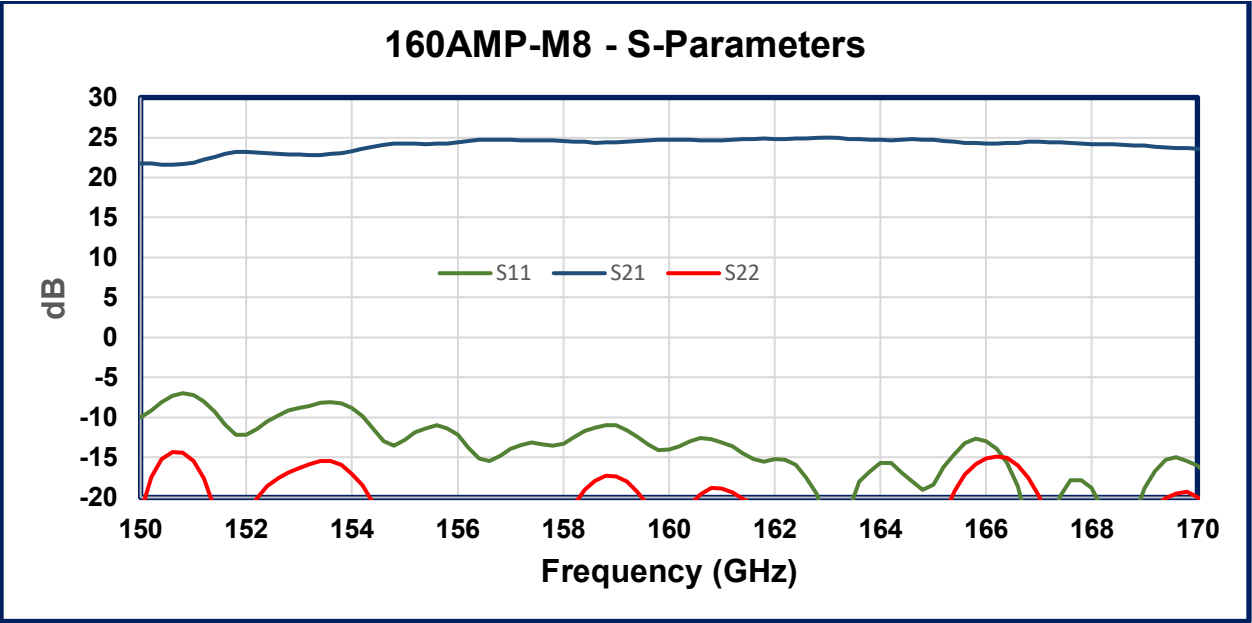
160AMP – S-Parameters and Saturated Output Power, P1dB



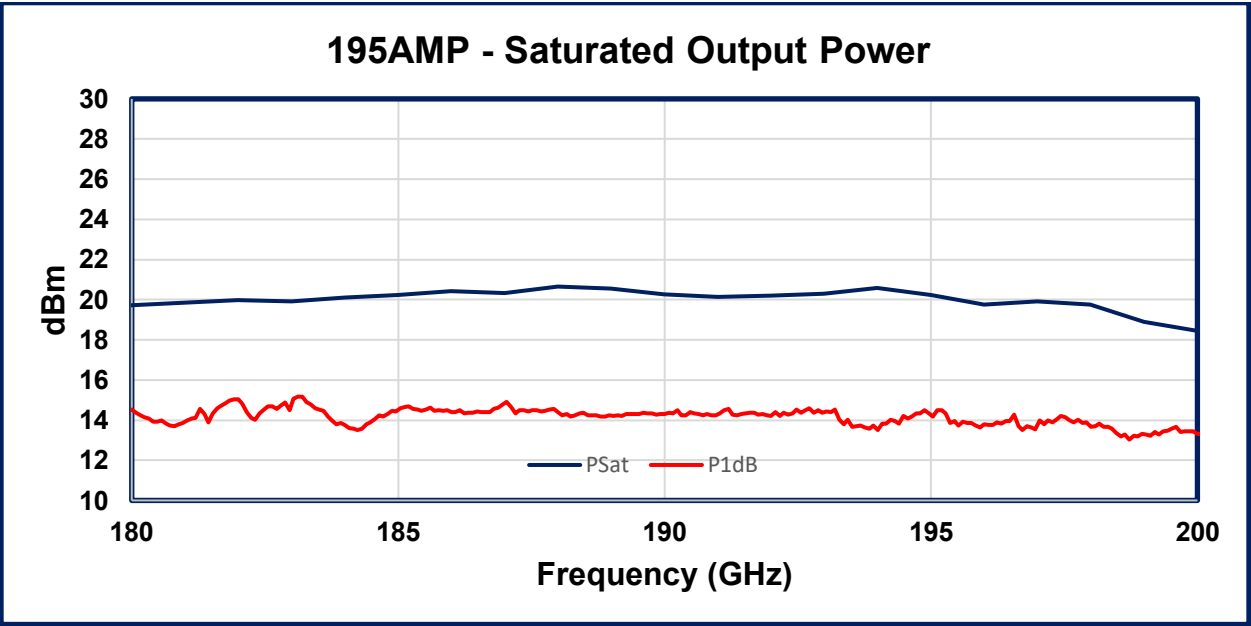
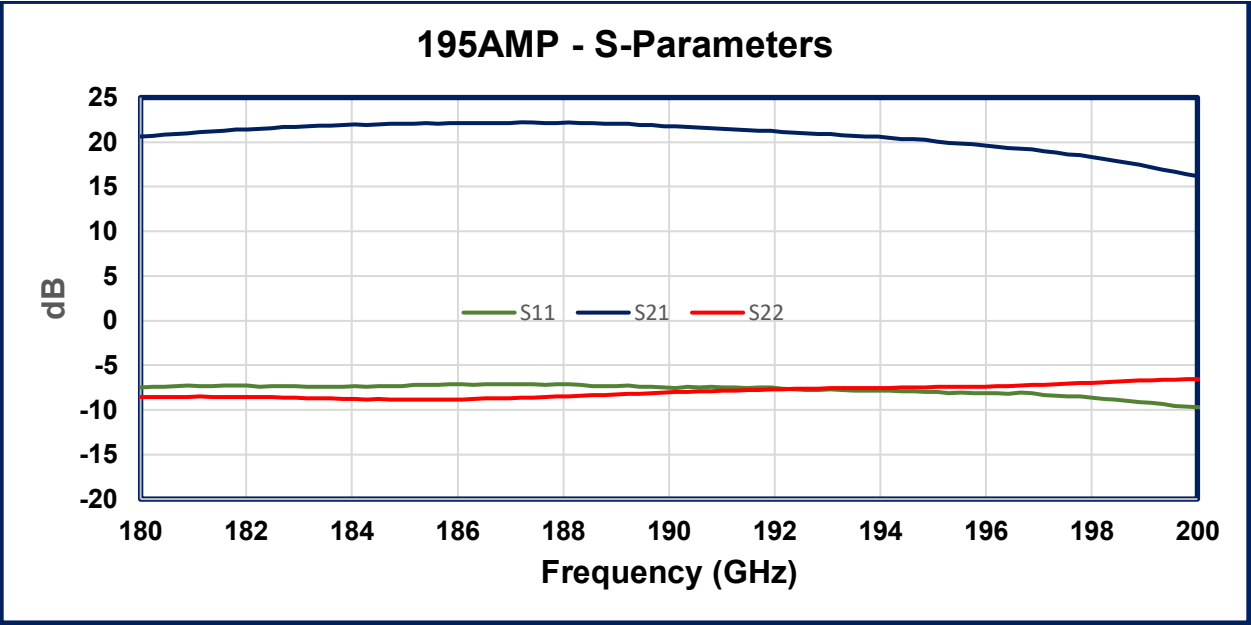
160AMP-M2 – S-Parameters and Saturated Output Power, P1dB



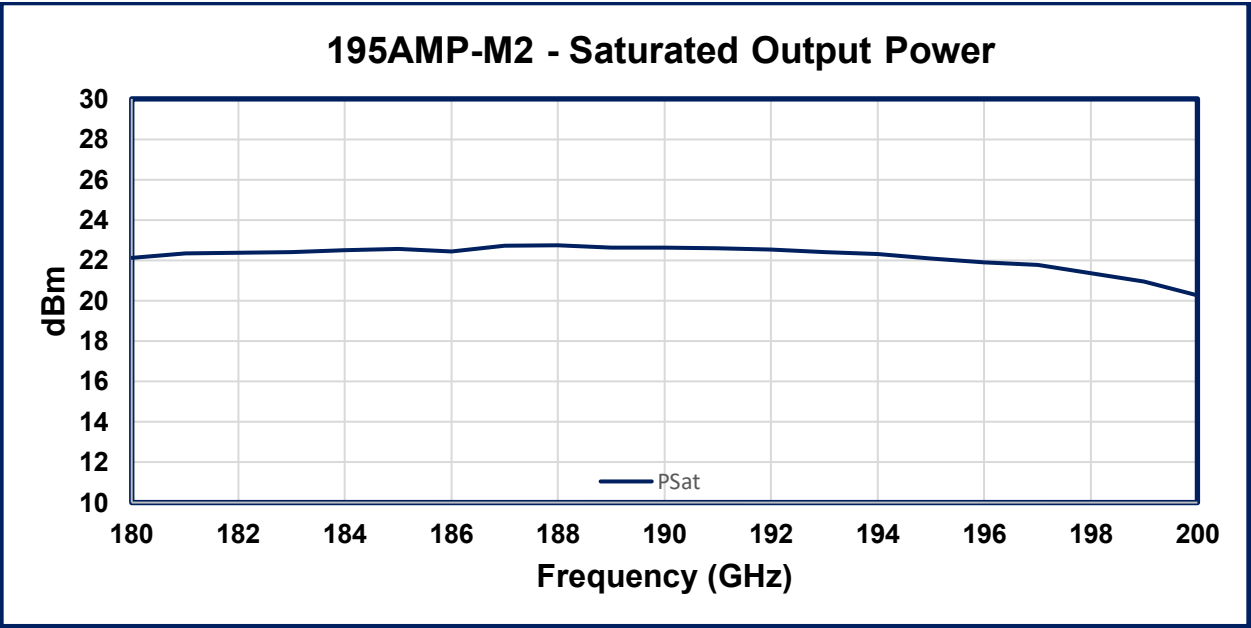
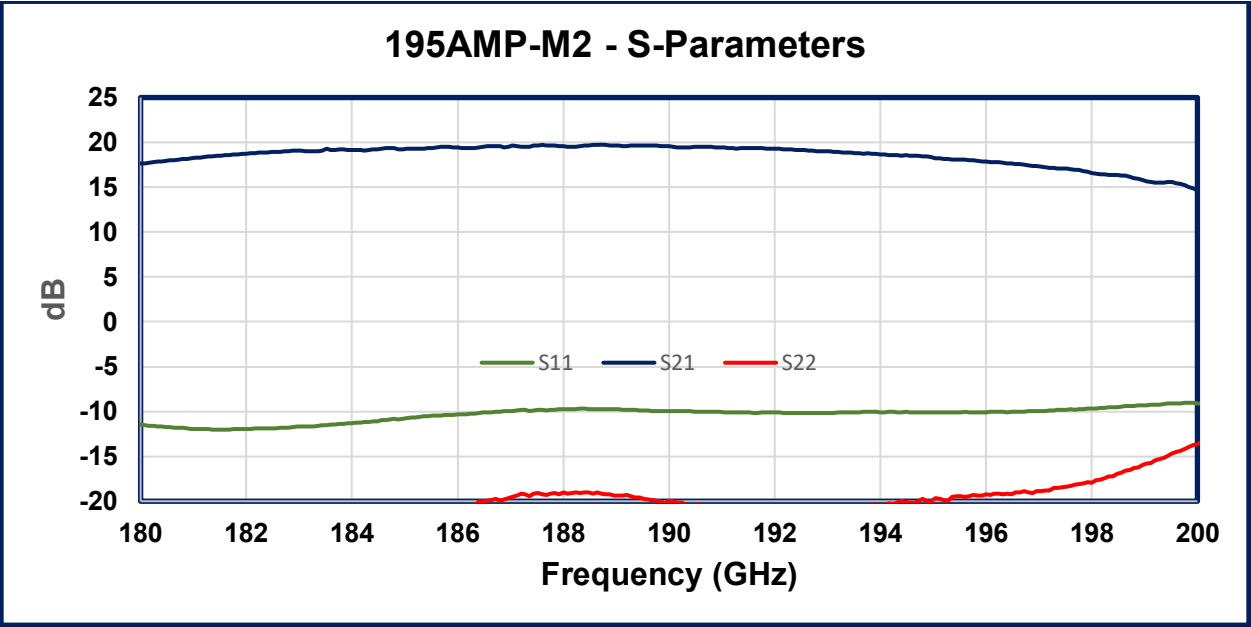
160AMP-M8 – S-Parameters and Saturated Output Power, P1dB



195AMP – S-Parameters and Saturated Output Power, P1dB

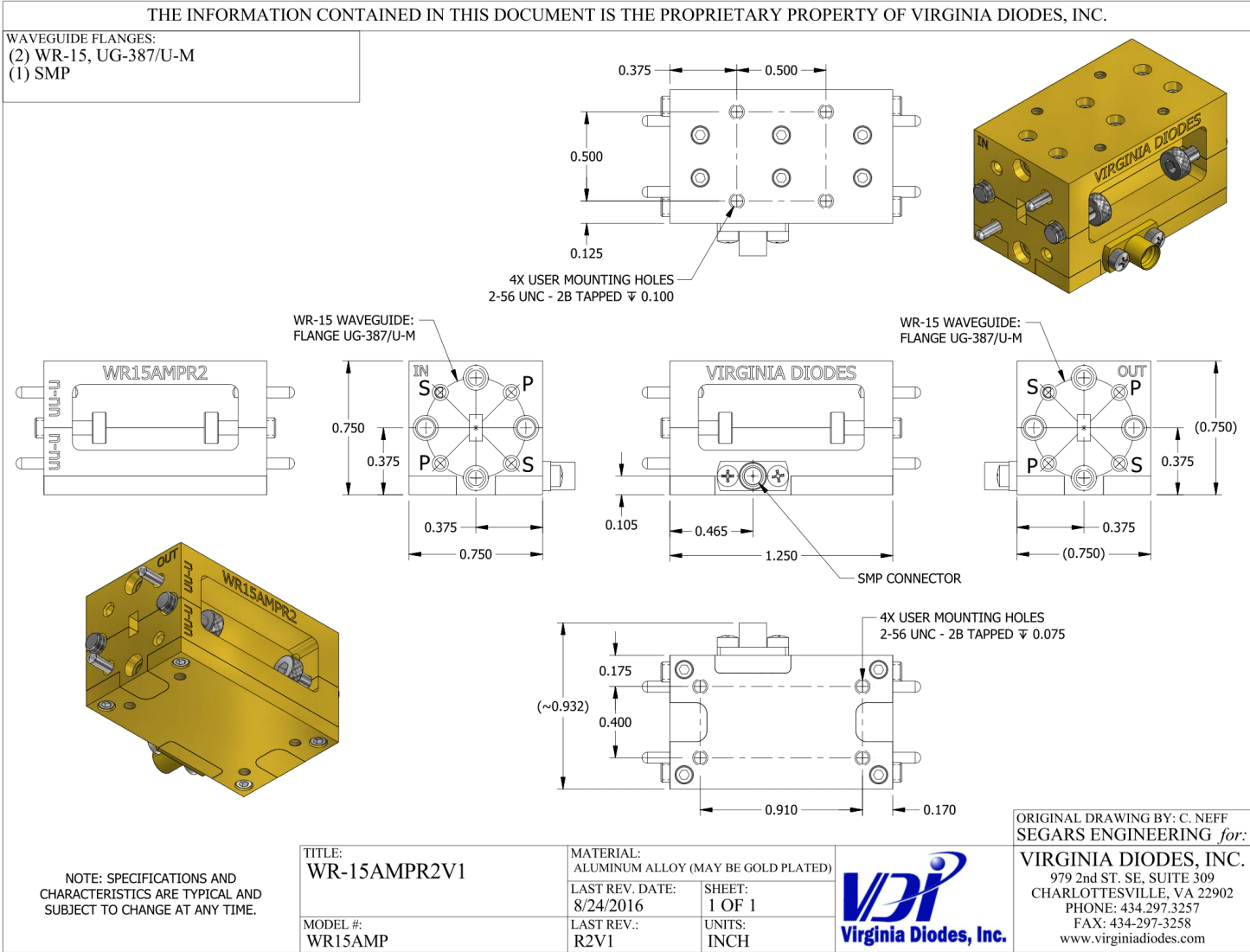


195AMP-M2 – S-Parameters and Saturated Output Power, P1dB

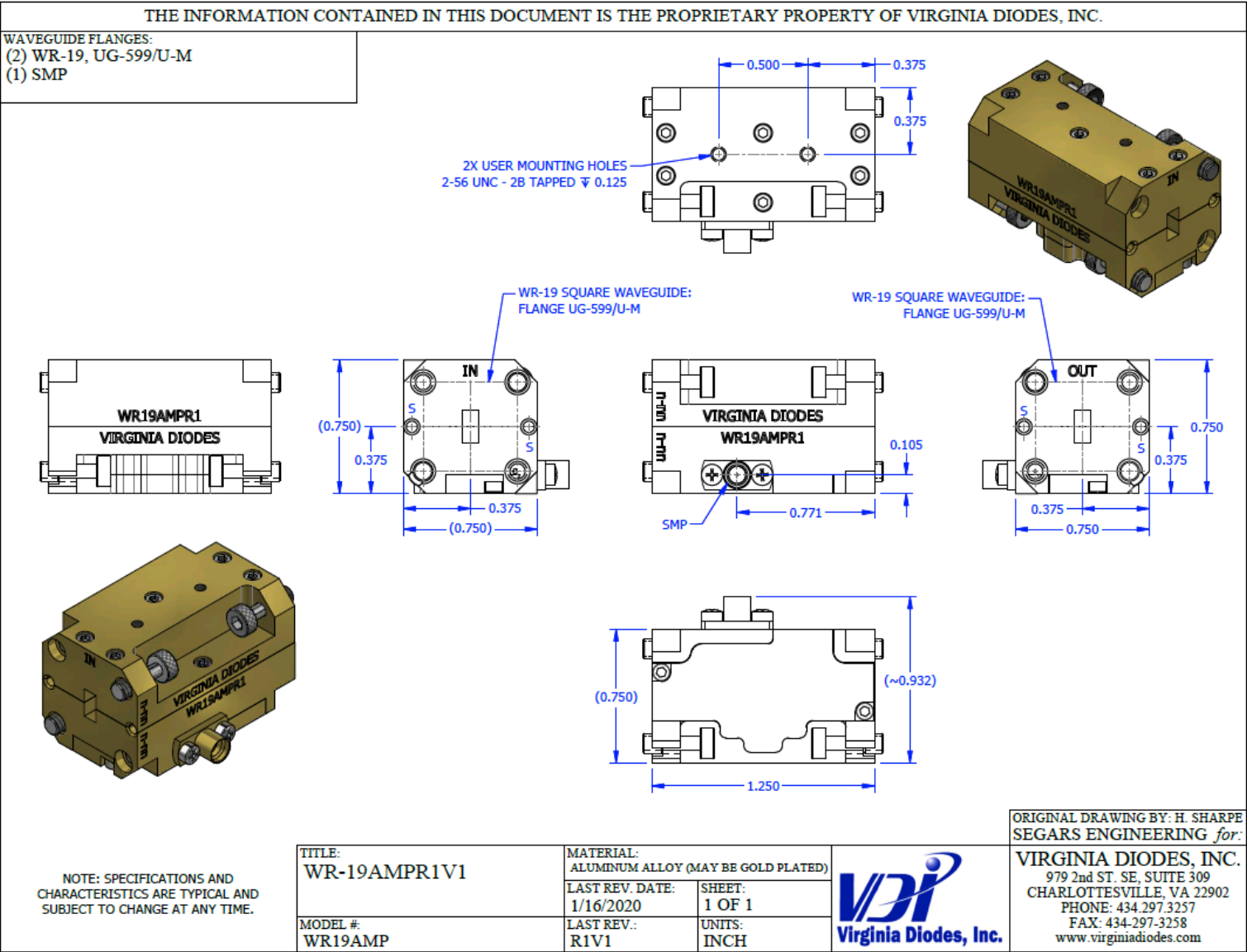


# Mechanical Drawing – WR15 to WR3.4 Amplifiers

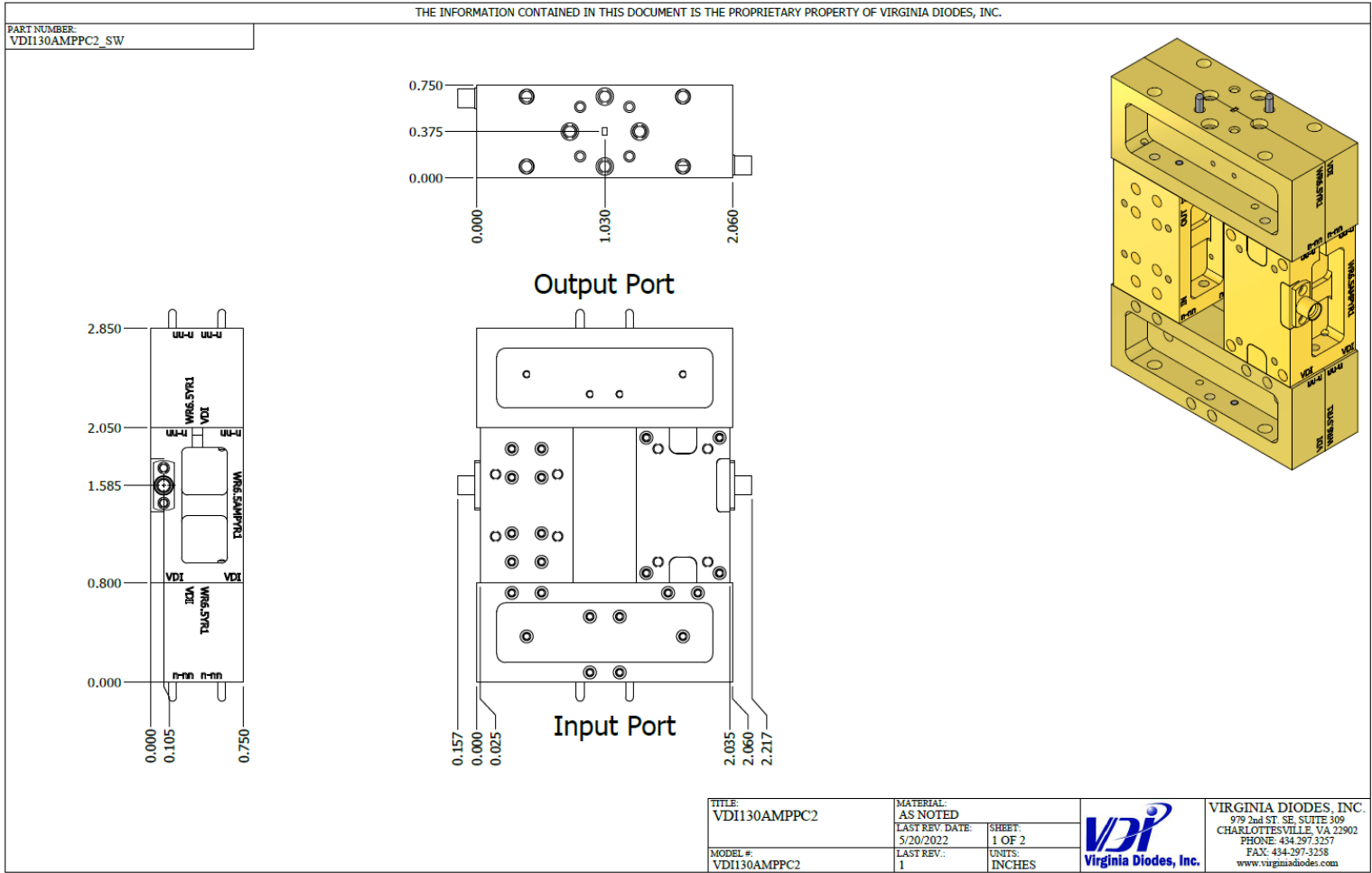
Mechanical Drawing (WR15, WR12, WR10, WR8.0, WR6.5, WR5.1, WR4.3, WR3.4, 64AMP, 130AMP, 160AMP, and 195AMP Amplifiers)



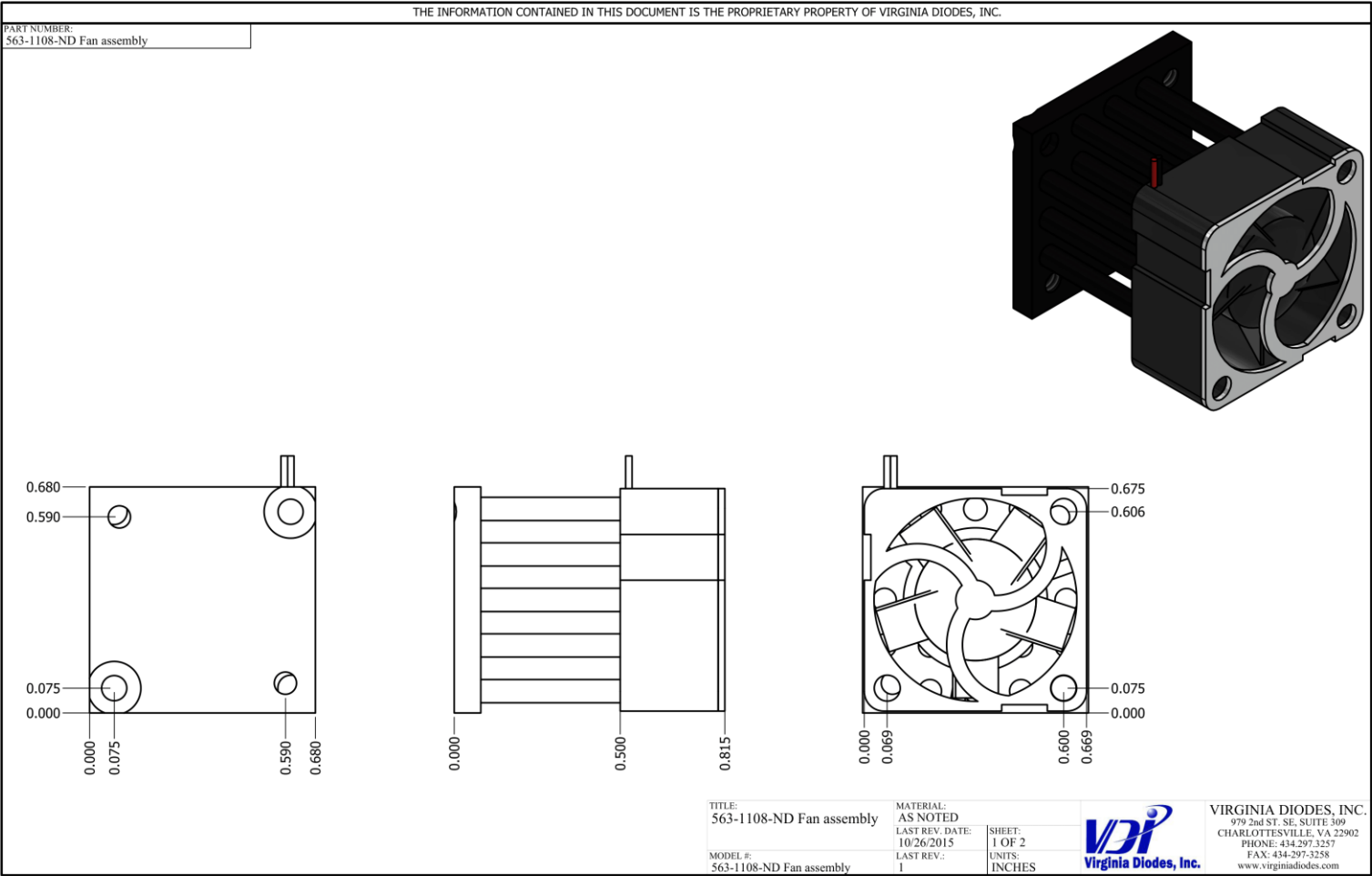
Mechanical Drawing (WR19AMP Only)



Mechanical Drawing (XXXAMP-M4)



Heatsink + Fan Assembly drawing is shown below. The Heatsink + Fan Assembly is included for select Narrowband Amplifiers.



## Addendum – Product Updates and Company Contacts

The Virginia Diodes staff of engineering and physical science professionals work to continually improve our products. We also depend upon feedback from colleagues and customers. Ideas to simplify extension module operations, improve performance or add capabilities are always welcome. Be certain that Virginia Diodes has your latest contact details, including a phone number and an email address, to receive update advisories.

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