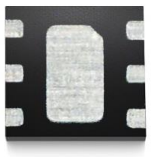
DATA SHEET

RELEASE Ø DATA SHEET



# GRF2076

## Ultra-Low Noise Amplifier with Bypass 600 to 7125 MHz

### FEATURES

- Flexible Bias Voltage and Current
- Process: GaAs pHEMT
- Single Control Logic Input
- Internally Matched to 50 Ω
- Compact 1.5 x 1.5 mm DFN-6 Package

**Reference: 5 V / 70 mA / 3.6 GHz**

- Gain: 17.2 dB
- OP1dB: 22 dBm
- OIP3: 38 dBm
- Evaluation Board Noise Figure: 1.1 dB
- Bypass Mode Gain: -2 dB
- Bypass Mode OP1dB: 21 dBm
- Bypass Mode OIP3: 46 dBm

### APPLICATIONS

- Cellular Repeaters and Signal Boosters
- Cellular Infrastructure
- CBRS

### DESCRIPTION

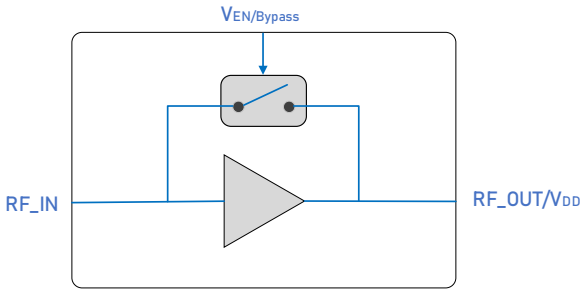
The GRF2076 is an ultra-low noise amplifier with bypass for small cell, wireless infrastructure, and other high-performance applications. It exhibits high gain, outstanding noise figure (NF), and linearity from 600 to 6000 MHz using band-specific matching, and fractional bandwidths of up to 45%.

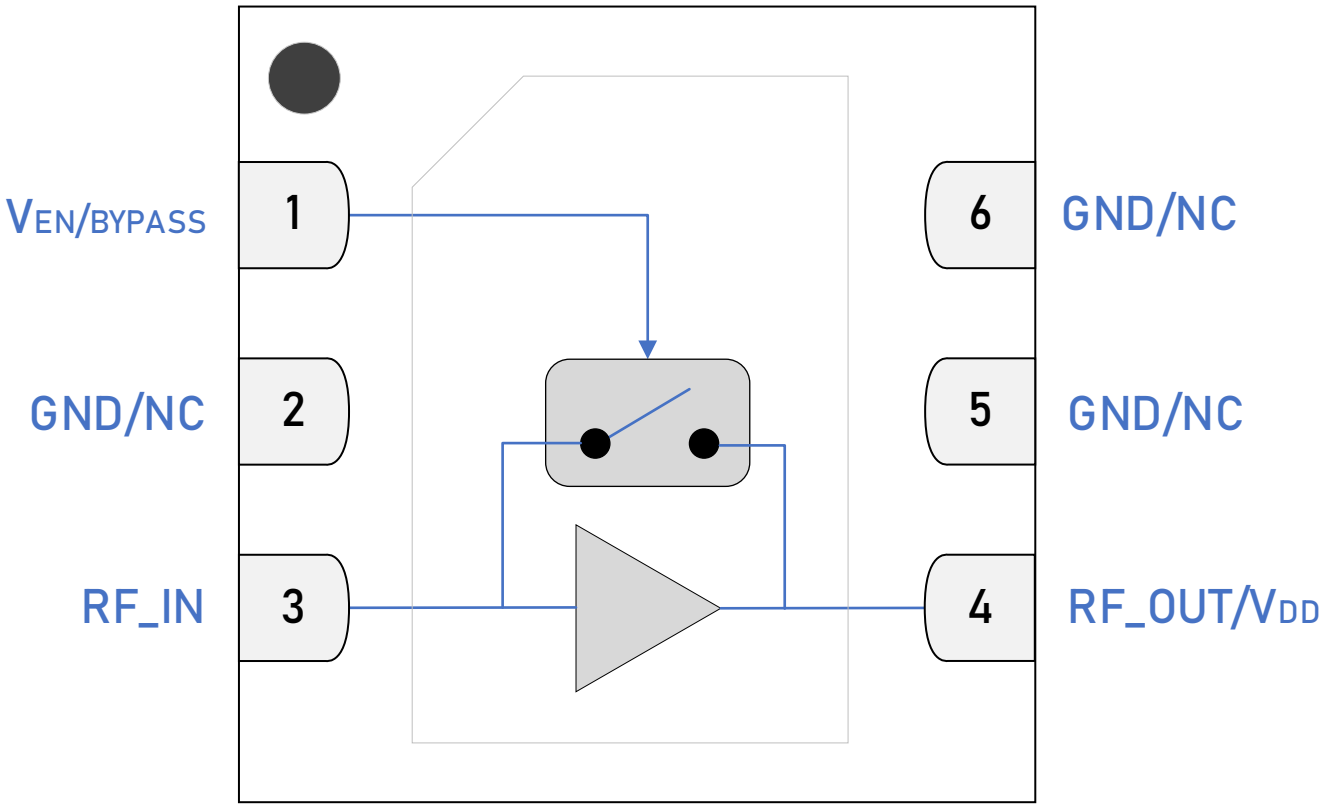
The device can be operated from a supply voltage of 2.7 to 6 V with a selectable $I_{DDQ}$ range of 20 to 100 mA for optimal efficiency and linearity.

Please consult with the GRF applications engineering team for custom tuning/evaluation board data and device S-parameters.

Additional tunes can be found on the GRF2076 "Custom Tunes" product page: [GRF2076 Custom Tunes]

### BLOCK DIAGRAM






**1.5 x 1.5 mm DFN-6 Pin Out (Top View)**



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## Pin Assignments

| Pin | Name | Description | Note |
|---|---|---|---|
| 1 | $V_{ENABLE/BYPASS}$ | $V_{EN/BYPASS}$ Voltage Input | $V_{EN/BYPASS} \leq 0.2$ volts sets Bypass Mode. $V_{EN/BYPASS}$ and external series resistor control the device $I_{DDQ}$ when $V_{EN/BYPASS}$ is high. |
| 2, 5, 6 | GND/NC | Ground or No Connect | No internal connection to die. We recommend connecting these pins to ground. |
| 3 | RF_IN | RF Input | Internally matched to 50 Ω. An external DC blocking capacitor must be used. |
| 4 | RF_OUT/ $V_{DD}$ | RF Output | Internally matched to 50 Ω. $V_{DD}$ must be applied through a choke to this pin. |
| PKG BASE | GND | Ground | Provides DC and RF ground for device, as well as thermal heat sink. Recommend multiple 8 mil vias beneath the package for optimal RF and thermal performance. Refer to evaluation board top layer graphic on schematic page. |

## Control Logic Truth Table

| Mode | Description | $V_{DD}$ | $V_{EN/BYPASS}$ |
|---|---|---|---|
| High Gain | High Gain | 1 | 1 |
| Bypass | Linear Bypass Mode | 1 | 0 |
| Logic Level "0" | Logic Low | 0 V to 0.2 V | 0 V to 0.2 V |
| Logic Level "1" | Logic High | 1.8 V to 5 V | 1.5 V to $V_{DD}$ |

## Absolute Ratings

| Parameter | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | 0 | 6 | V |
| RF Input Power: Load VSWR < 2:1, $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 5 V (Gain Mode) | $P_{IN\ MAX}$ | | 27 | dBm |
| RF Input Power: Load VSWR < 2:1, $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 0 V (Bypass Mode) | $P_{IN\ MAX}$ | | 27 | dBm |
| Operating Temperature (Package Base) | $T_{PKG\ BASE}$ | -40 | 115 | °C |
| Maximum Channel Temperature (MTTF > $10^6$ hours) | $T_{MAX}$ | | 170 | °C |
| Maximum Dissipated Power | $P_{DISS\ MAX}$ | | 330 | mW |

**Electrostatic Discharge**

| | | | | |
|---|---|---|---|---|
| Human Body Model | HBM | 1000 | | V |

**Storage**

| | | | | |
|---|---|---|---|---|
| Storage Temperature | $T_{STG}$ | -65 | 150 | °C |
| Moisture Sensitivity Level | MSL | | 1 | -- |

**Caution! ESD Sensitive Device.**

**Exceeding Absolute Maximum Rating conditions may cause permanent damage.**

Note: For additional information, please refer to *Package Manufacturing Information | Guerrilla RF (guerrilla-rf.com)*

RoHS compliant

All Guerrilla RF products are provided in RoHS compliant lead (Pb)-free packaging requiring no exemptions. Additional information for this topic can be found at this link - *Environmental and Restricted Substance Statement Library*



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## Recommended Operating Conditions

| Parameter | Symbol | Specification | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply Voltage | $V_{DD}$ | 2.7 | 5 | 6 | V | |
| Operating Temperature (Package Base) | $T_{PKG\ BASE}$ | -40 | | 115 | °C | |
| RF Frequency Range | $F_{RF}$ | 600 | 3.6 | 7125 | MHz | Typical Application Schematic with external matching components **(notes 1 & 2)**. |
| RF_IN Port Impedance | $Z_{RFIN}$ | | 50 | | Ω | Single-ended with 2-element match. |
| RF_OUT Port Impedance | $Z_{RFOUT}$ | | 50 | | Ω | Single-ended with 2-element match. |

**Note 1:** Operation outside of this range is supported by using different custom tunes. Examples of other optimized tunes can be found here: GRF2076 Custom Tunes

**Note 2:** Contact the Guerrilla RF Applications team for guidance on optimizing the tuning of the device for alternative bands.

## Nominal Operating Parameters – General

The following conditions apply unless noted otherwise: Typical Application Schematic using the 3.3 to 3.8 GHz tuning set. $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 5 V, $I_{DDQ}$ = 70 mA. $F_{TEST}$ = 3.6 GHz. M5 = 600 Ω. $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

| Parameter | Symbol | Specification | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply Current | $I_{DDQ}$ | | 70 | | mA | $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 5 V |
| Enable Current | $I_{ENABLE}$ | | 3 | 10 | mA | $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 5 V |
| Switching Rise Time | $T_{RISE}$ | | 200 | | ns | Bypass Mode to Gain Mode. Pin = +5.8 dBm **(note 3).** |
| Switching Fall Time | $T_{FALL}$ | | 50 | | ns | Gain Mode to Bypass Mode. Pin = +5.8 dBm **(note 4).** |
| **Disabled Mode** | | | | | | |
| Leakage Current | $I_{LEAKAGE}$ | | 600 | *1000* | µA | $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 0 V |
| **Thermal Data** | | | | | | |
| Thermal Resistance: (Infrared Scan) | $\Theta_{JC}$ | | 66 | | °C/W | On Standard Evaluation Board **(note 5).** |

**Note 3:** Switching Time: 50% of $V_{EN/BYPASS}$ to 90% of Pout.

**Note 4:** Switching Time: 50% of $V_{EN/BYPASS}$ to 10% of Pout.

**Note 5:** MTTF > 10^6 hours for $T_{CHANNEL}$ ≤170 °C.



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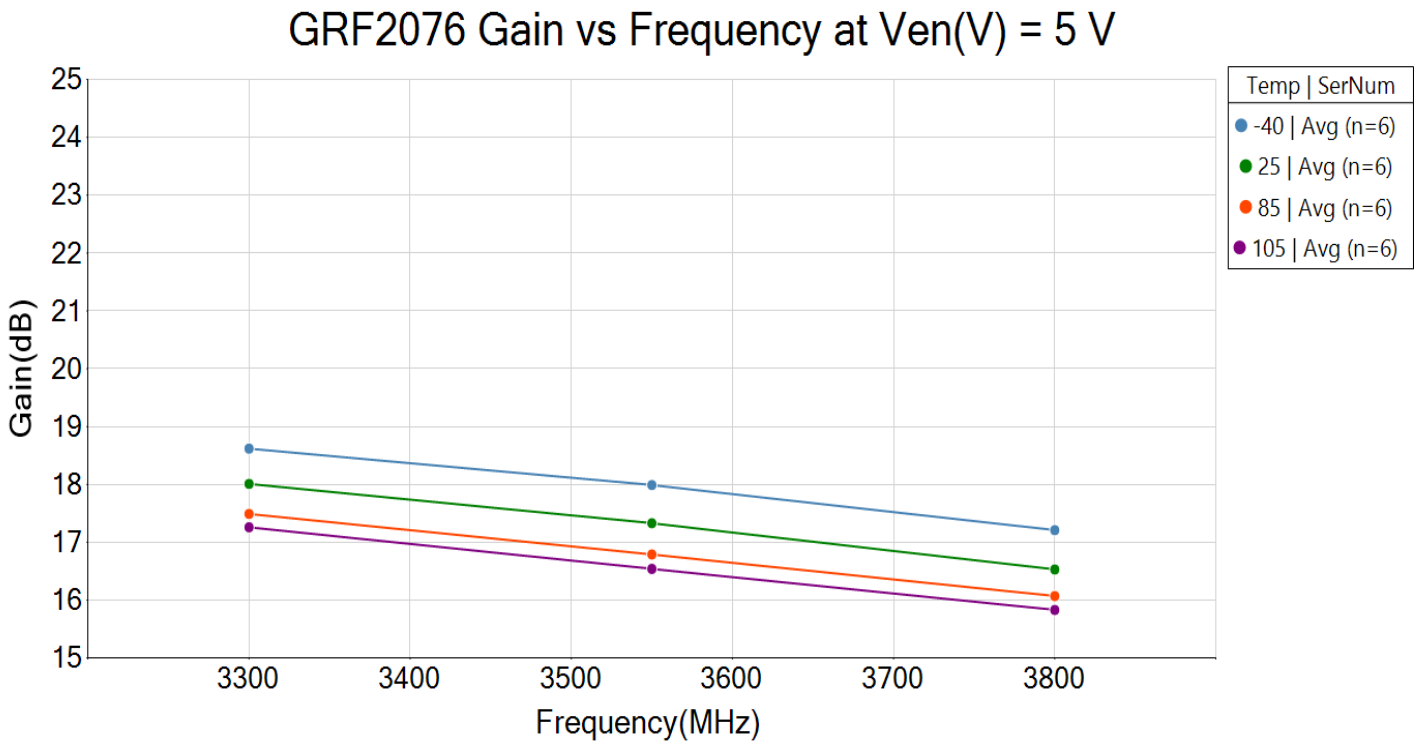
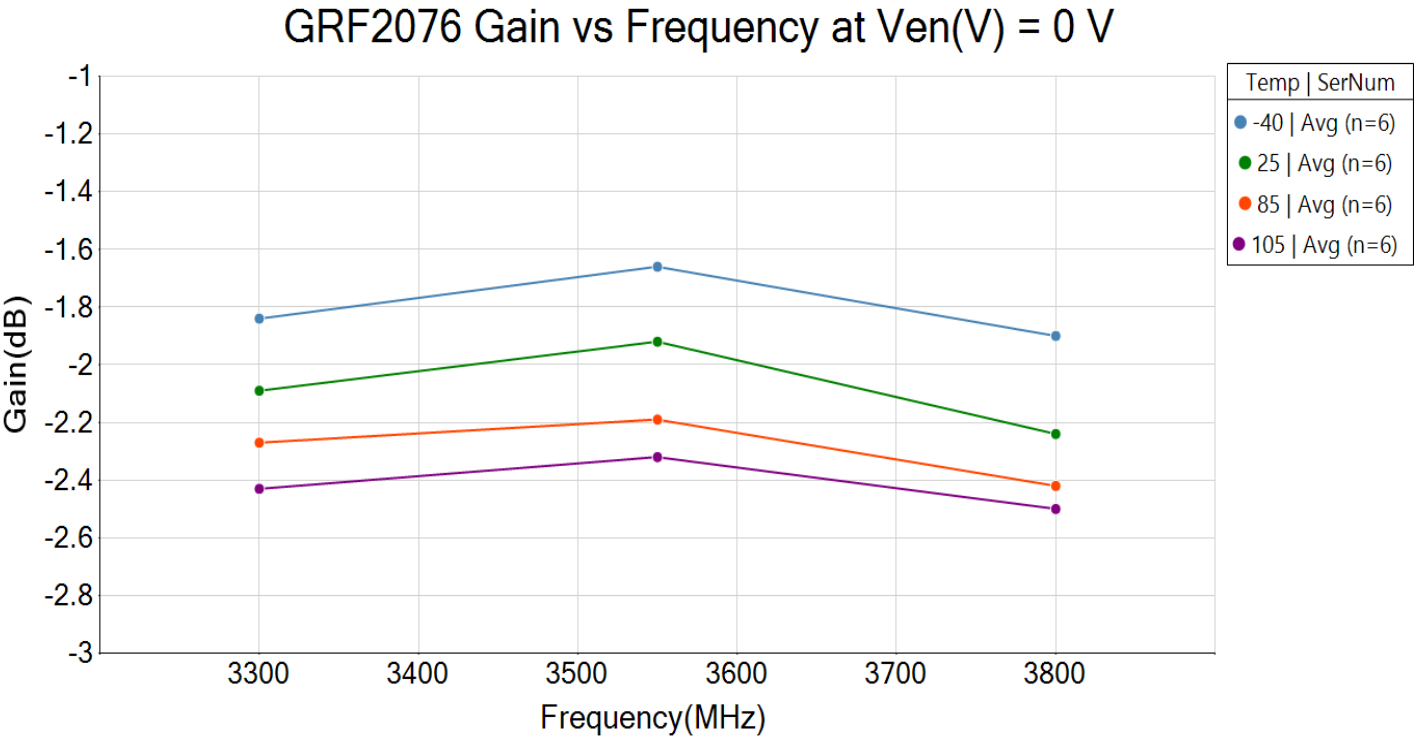
## Nominal Operating Parameters – RF

The following conditions apply unless noted otherwise: Typical Application Schematic using the 3.3 to 3.8 GHz tuning set. $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 5 V, $I_{DDQ}$ = 70 mA. $F_{TEST}$ = 3.6 GHz. M5 = 600 Ω. $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

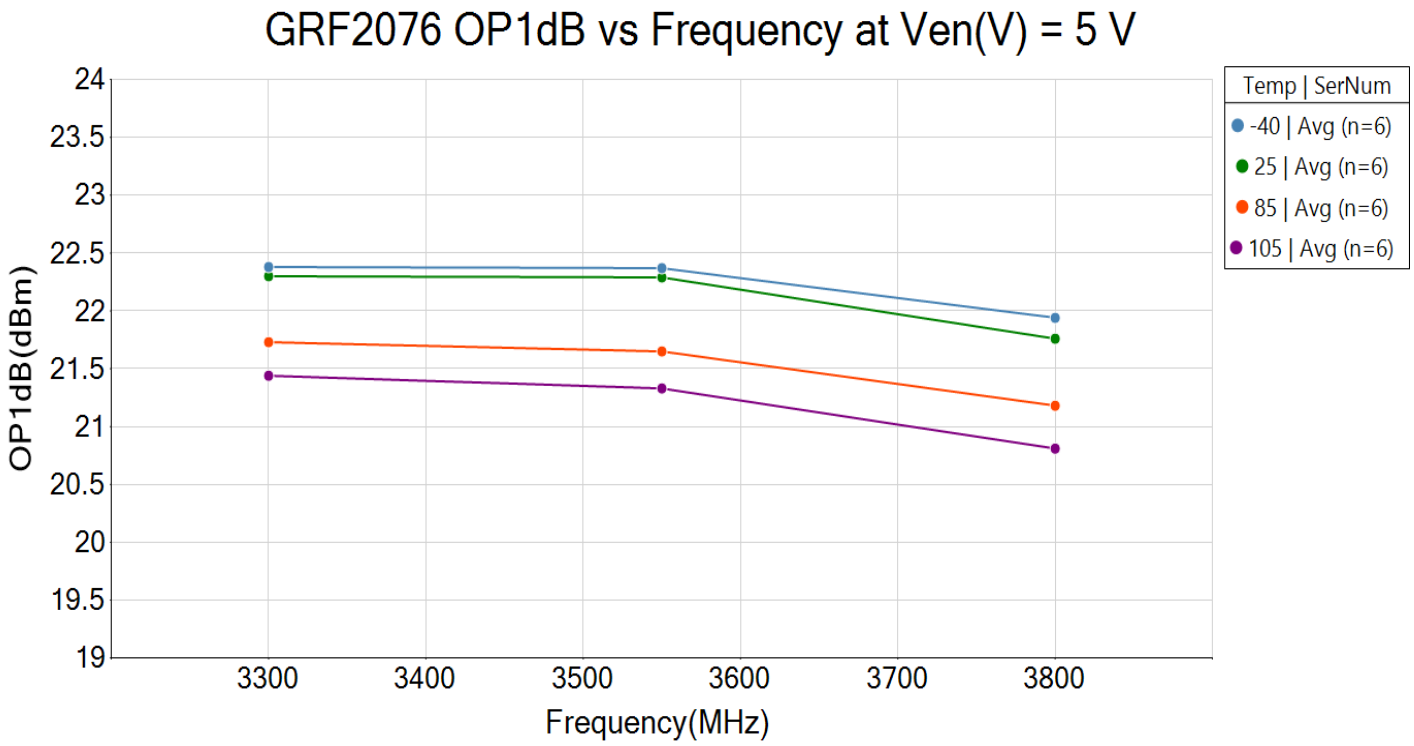
| Parameter | Symbol | Specification | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| **High Gain Mode** | | | | | | $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 5 V |
| Gain | S21 | 16 | 17.2 | | dB | |
| Output 3rd Order Intercept Point | OIP3 | | 38 | | dBm | +2 dBm $P_{OUT}$ per tone at 2 MHz spacing (3599 and 3601 MHz). |
| Output 1 dB Compression Power | OP1dB | 19.5 | 22 | | dBm | |
| Noise Figure | NF | | 1.1 | | dB | On standard evaluation board. |
| **Bypass Mode** | | | | | | $V_{DD}$ = 5 V, $V_{EN/BYPASS}$ = 0 V |
| Gain | S21 | -3.6 | -2 | | dB | |
| Output 3rd Order Intercept Point | OIP3 | | 46 | | dBm | +8 dBm $P_{OUT}$ per tone at 2 MHz spacing (3599 and 3601 MHz). |
| Output 1 dB Compression Power | OP1dB | | 21 | | dBm | |

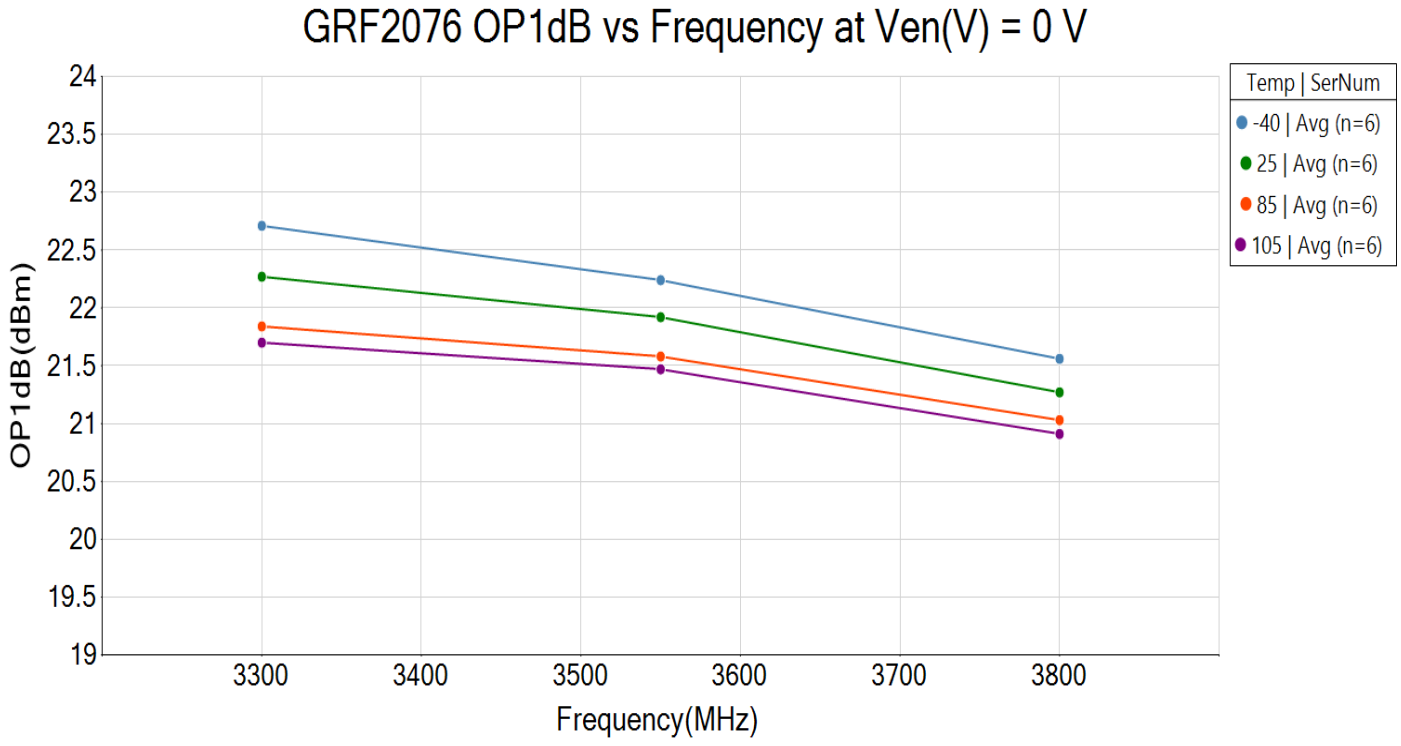
## GRF2076 Evaluation Board Data: 3.3 to 3.8 GHz Tune



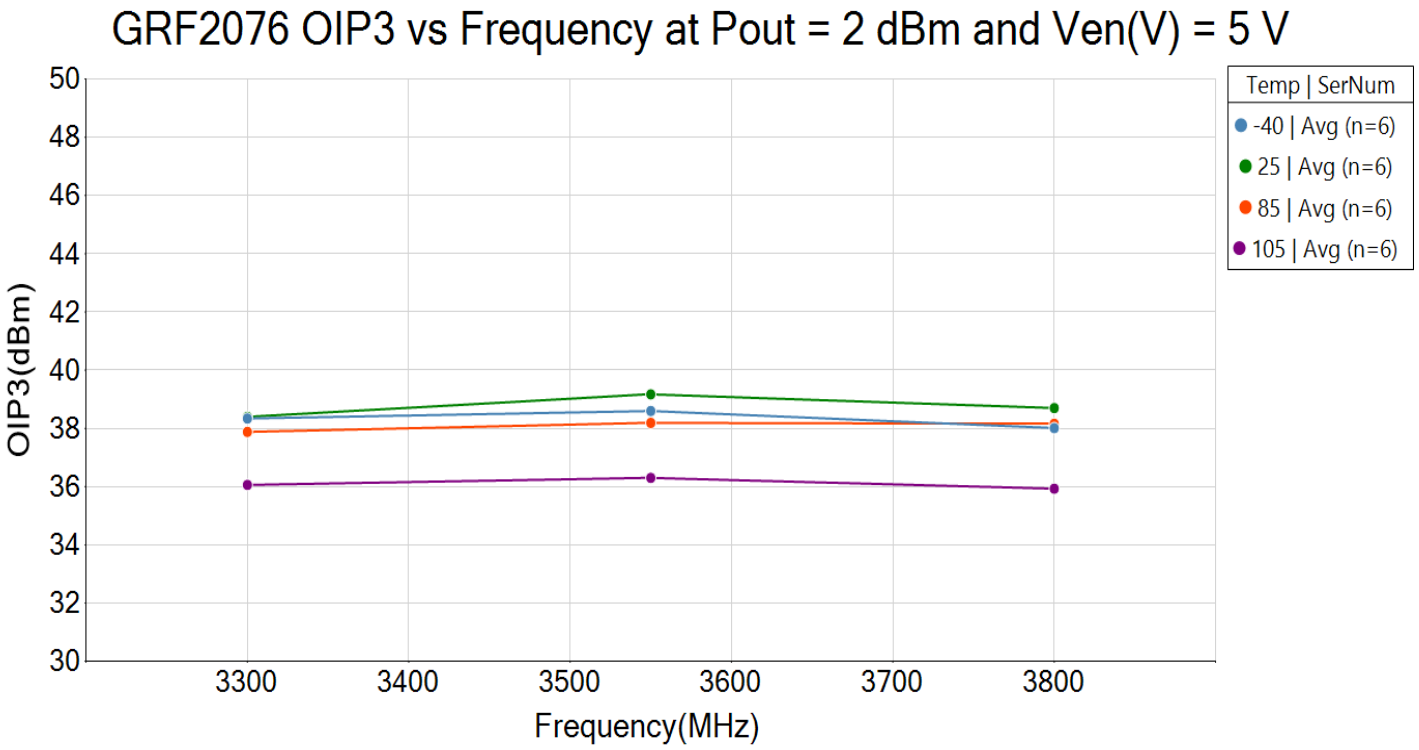



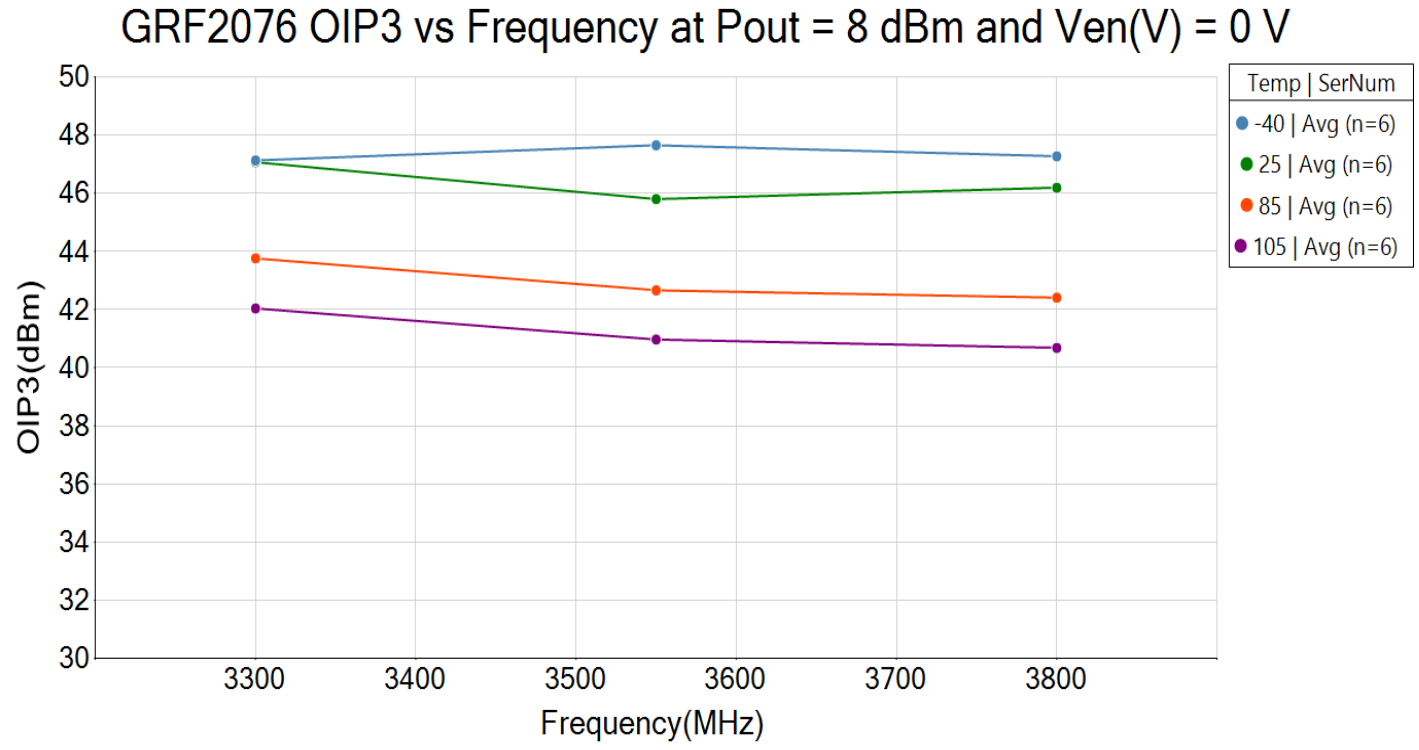
## GRF2076 Evaluation Board Data: 3.3 to 3.8 GHz Tune



## GRF2076 Evaluation Board Data: 3.3 to 3.8 GHz Tune



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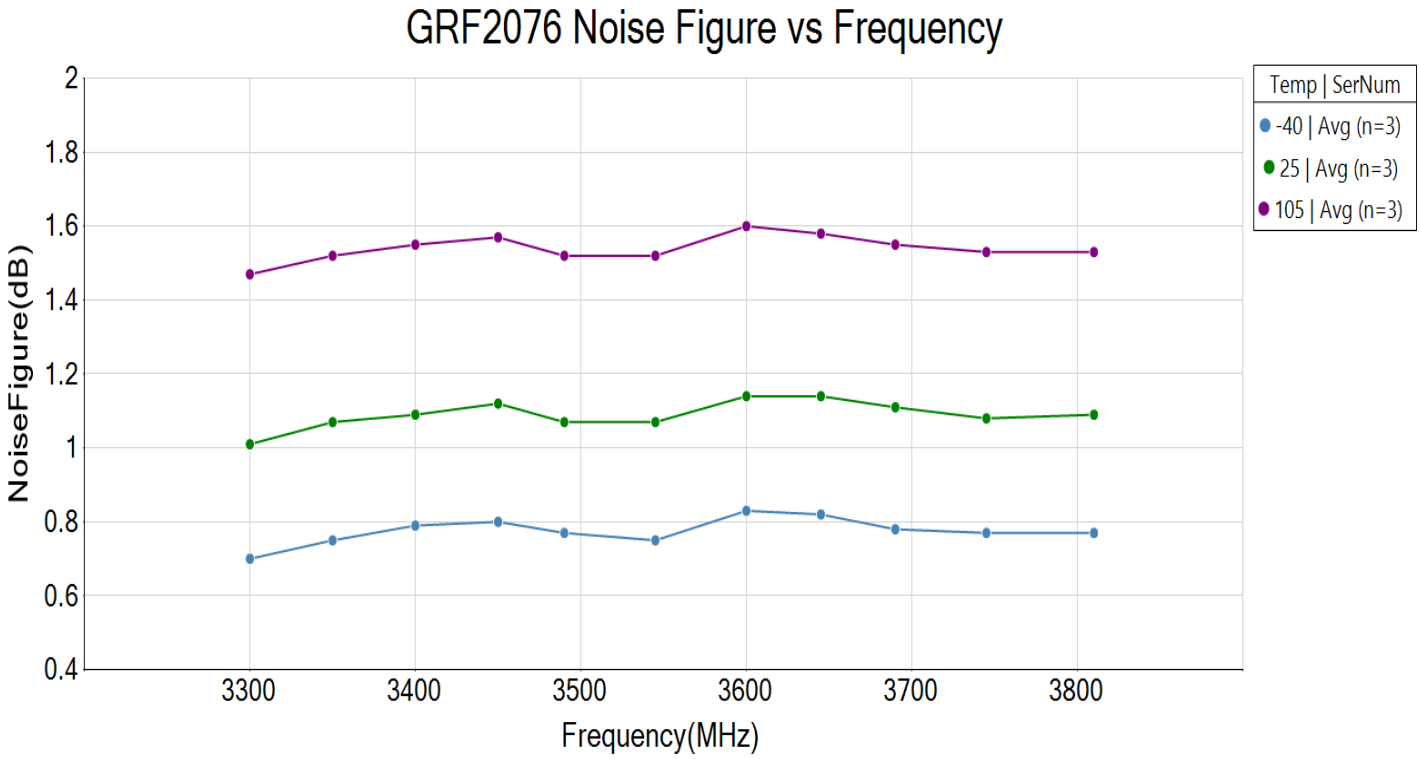
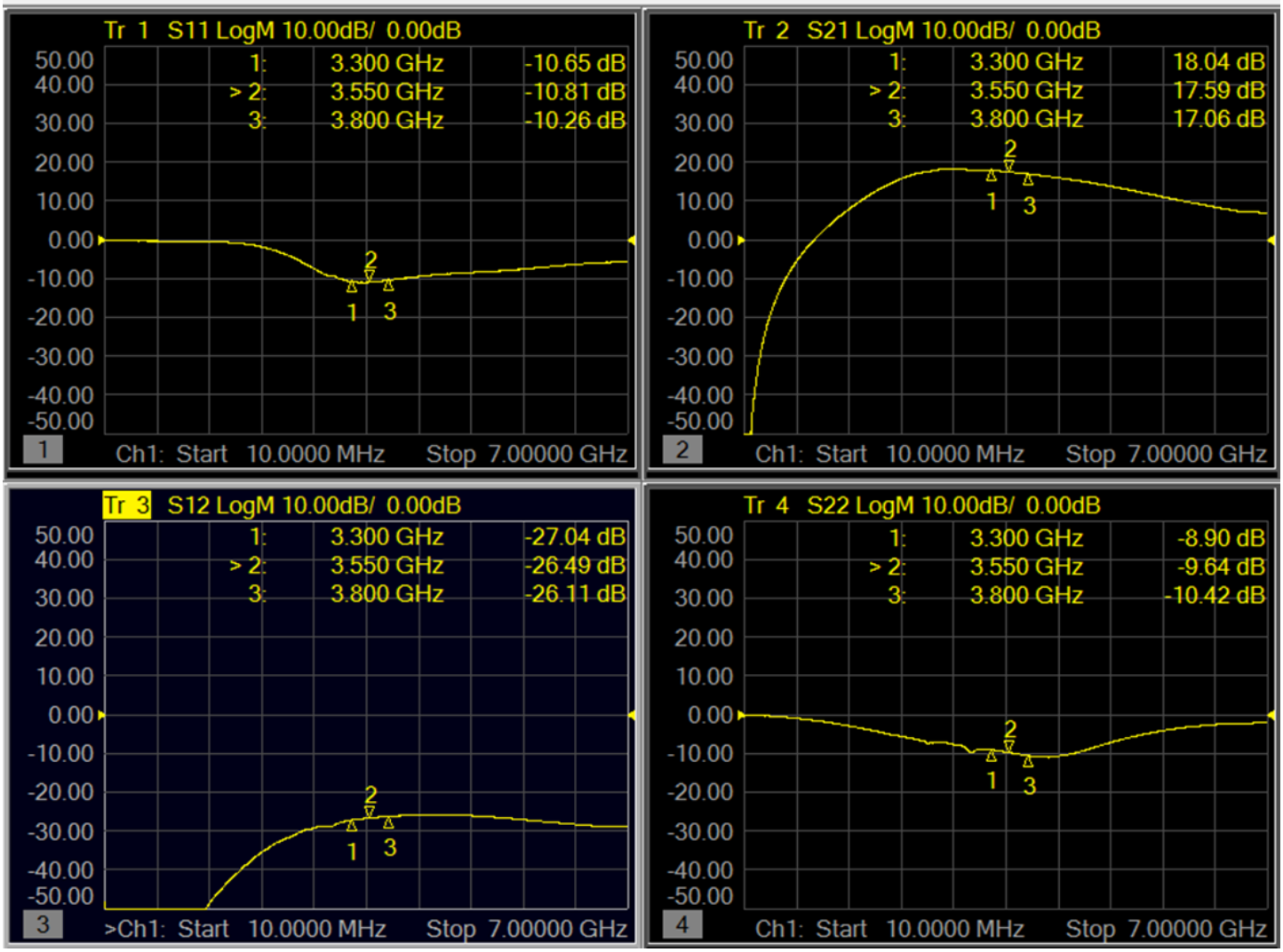
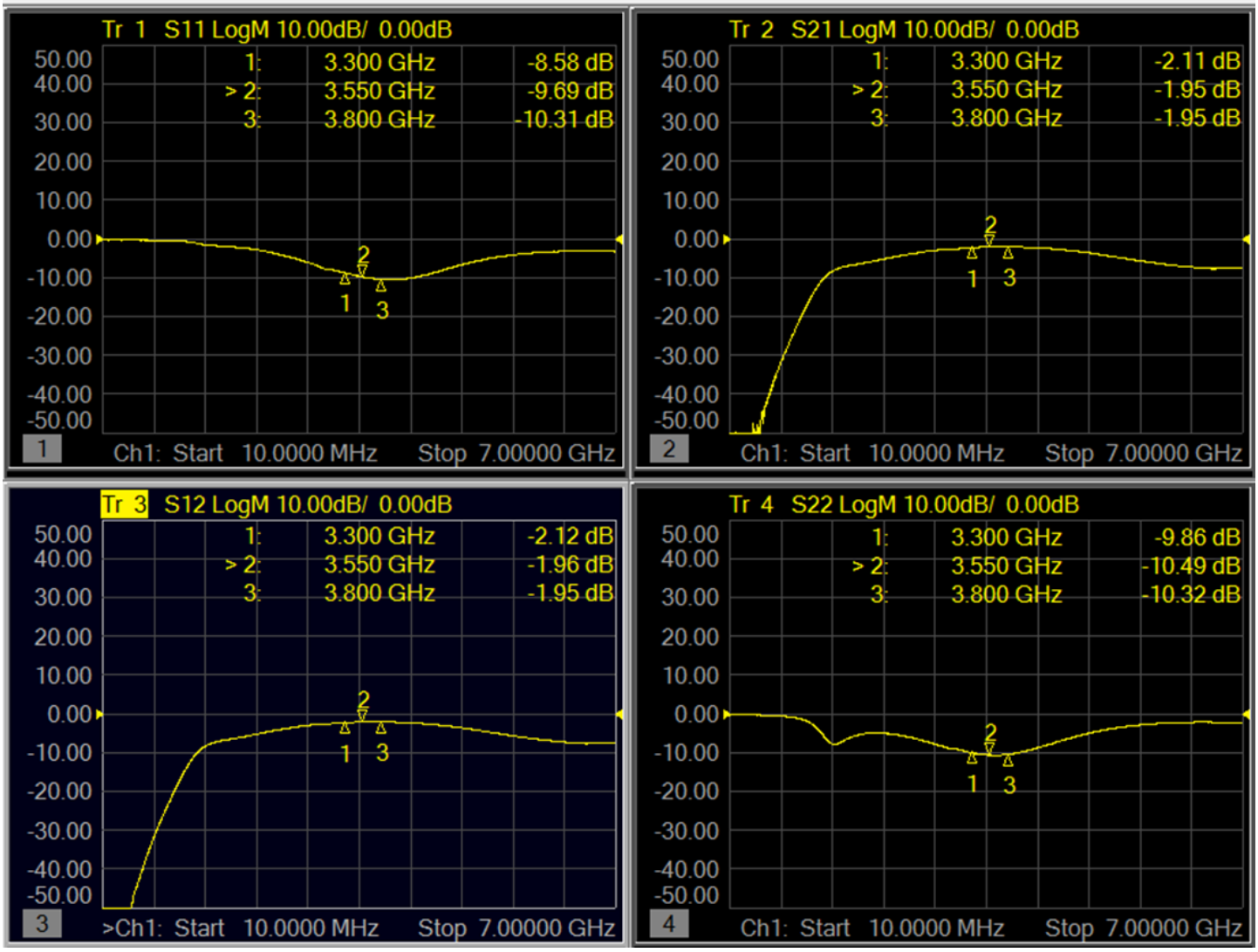
## GRF2076 Evaluation Board Data: 5 V, 3.3 to 3.8 GHz Tune



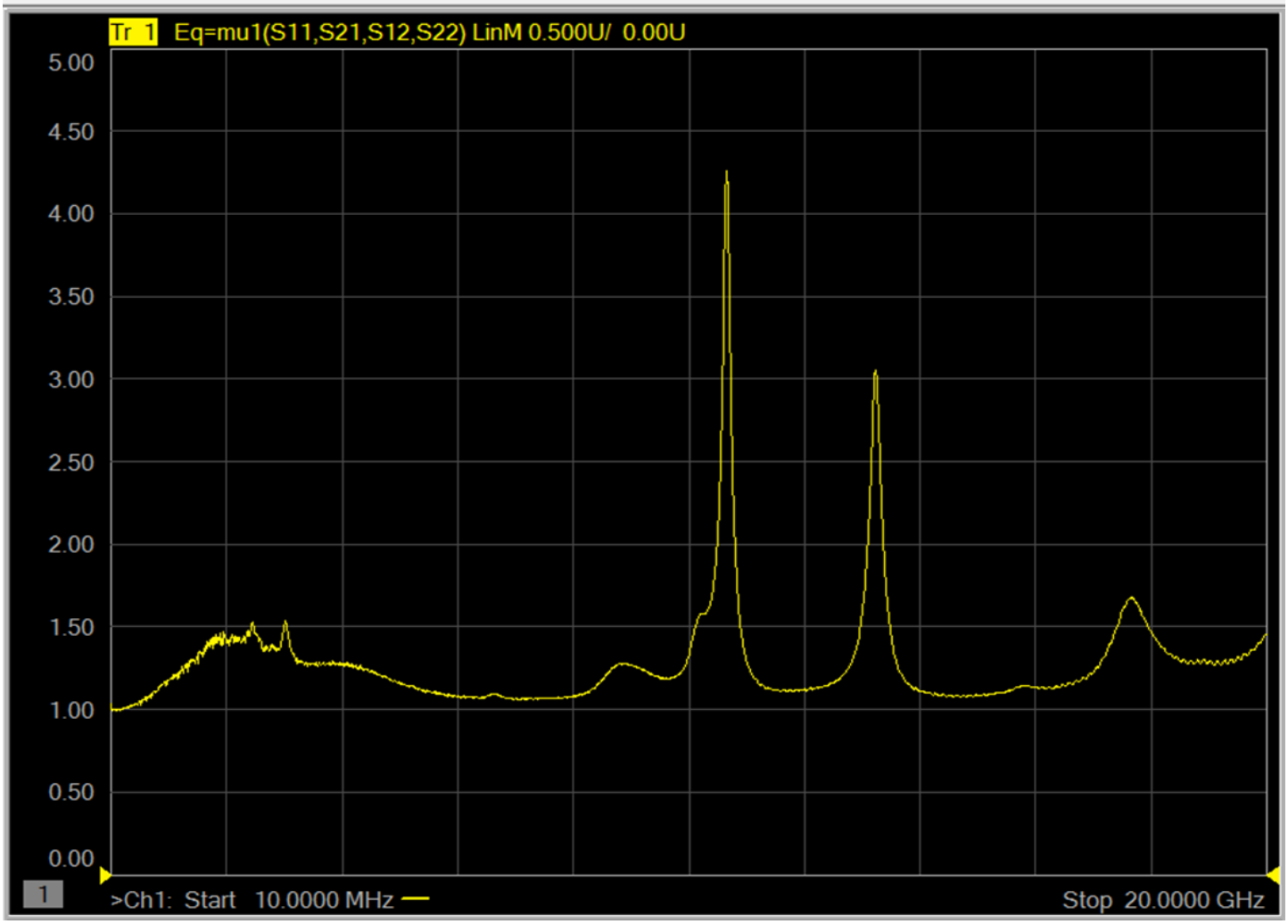
## GRF2076 Evaluation Board S-Parameters: Gain Mode (3.3 to 3.8 GHz Tune)



## GRF2076 Evaluation Board S-Parameters: Bypass Mode (3.3 to 3.8 GHz Tune)



## GRF2076 Evaluation Board Stability Mu Factor (10 MHz to 20 GHz)




**Note: Mu factor >= 1.0 implies unconditional stability.**



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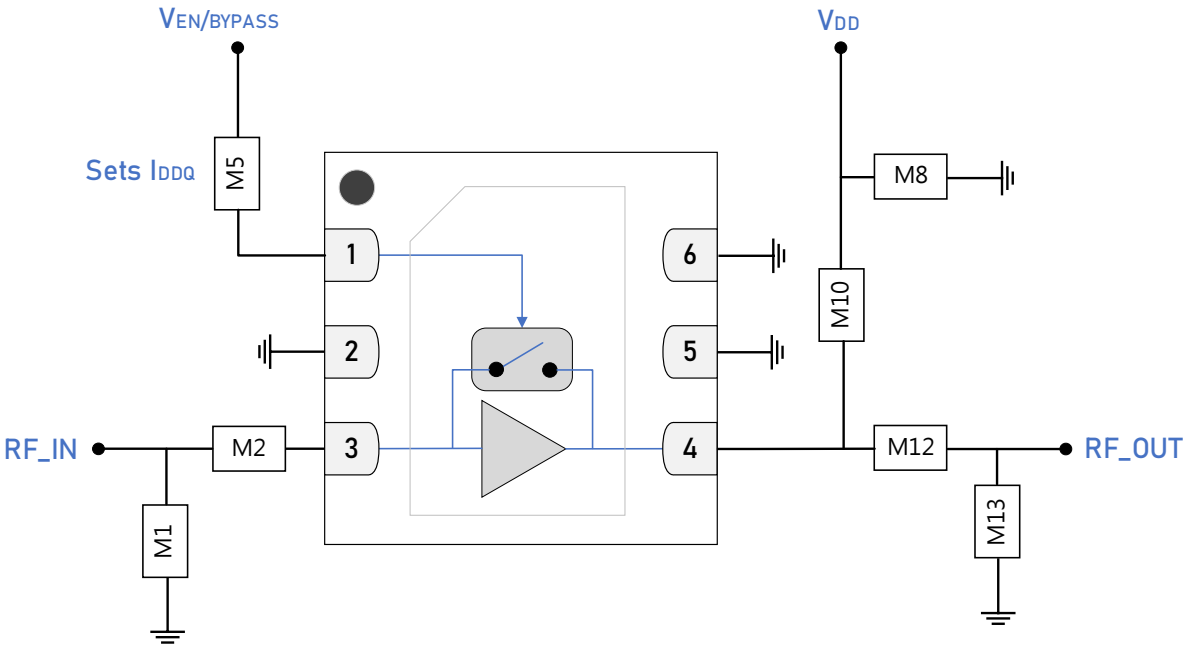
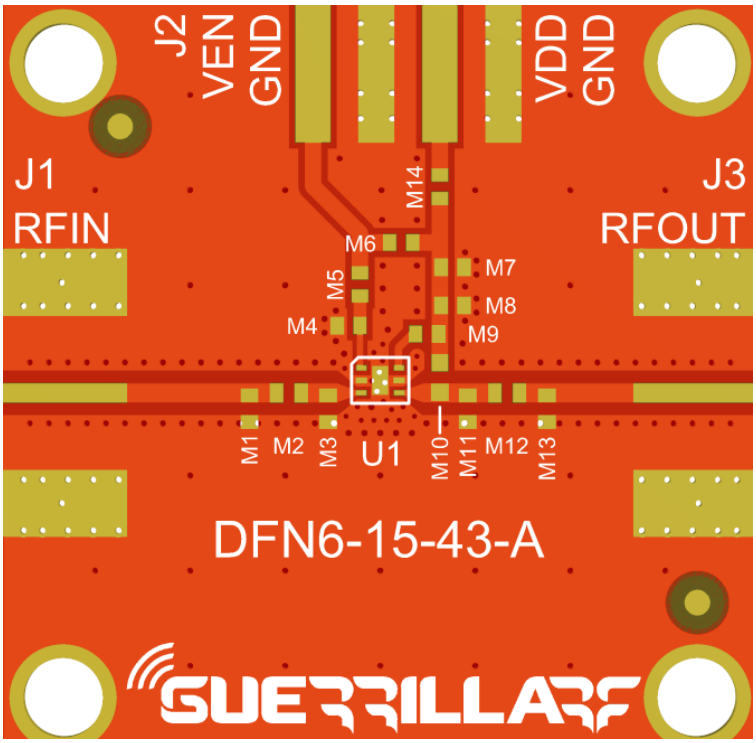



**GRF2076 Standard Evaluation Board Schematic**




**GRF2076 Evaluation Board Assembly Diagram**

## GRF2076 Evaluation Board Assembly Diagram Reference: 3.3 to 3.8 GHz Tune

| Component | Type | Manufacturer | Family | Value | Package Size | Substitution |
|---|---|---|---|---|---|---|
| M3, M4, M6, M7, M9, M11 | DNP | | | | | |
| M1 | Inductor | Murata | LQG | 2.0 nH | 0402 | ok |
| M2 | Capacitor | Murata | GJM | 1.0 pF | 0402 | ok |
| M5 (sets $I_{DDQ}$) | Resistor | Various | 5% | See Curves | 0402 | ok |
| M8 | Capacitor | Murata | GRM | 0.1 µF | 0402 | ok |
| M10 | Inductor | Murata | LQG | 1.8 nH | 0402 | ok |
| M12 | Capacitor | Murata | GRM | 10.0 pF | 0402 | ok |
| M13 | Capacitor | Murata | GRM | 0.2 pF | 0402 | ok |
| Evaluation Board | DFN6-15-43-A | | | | | |



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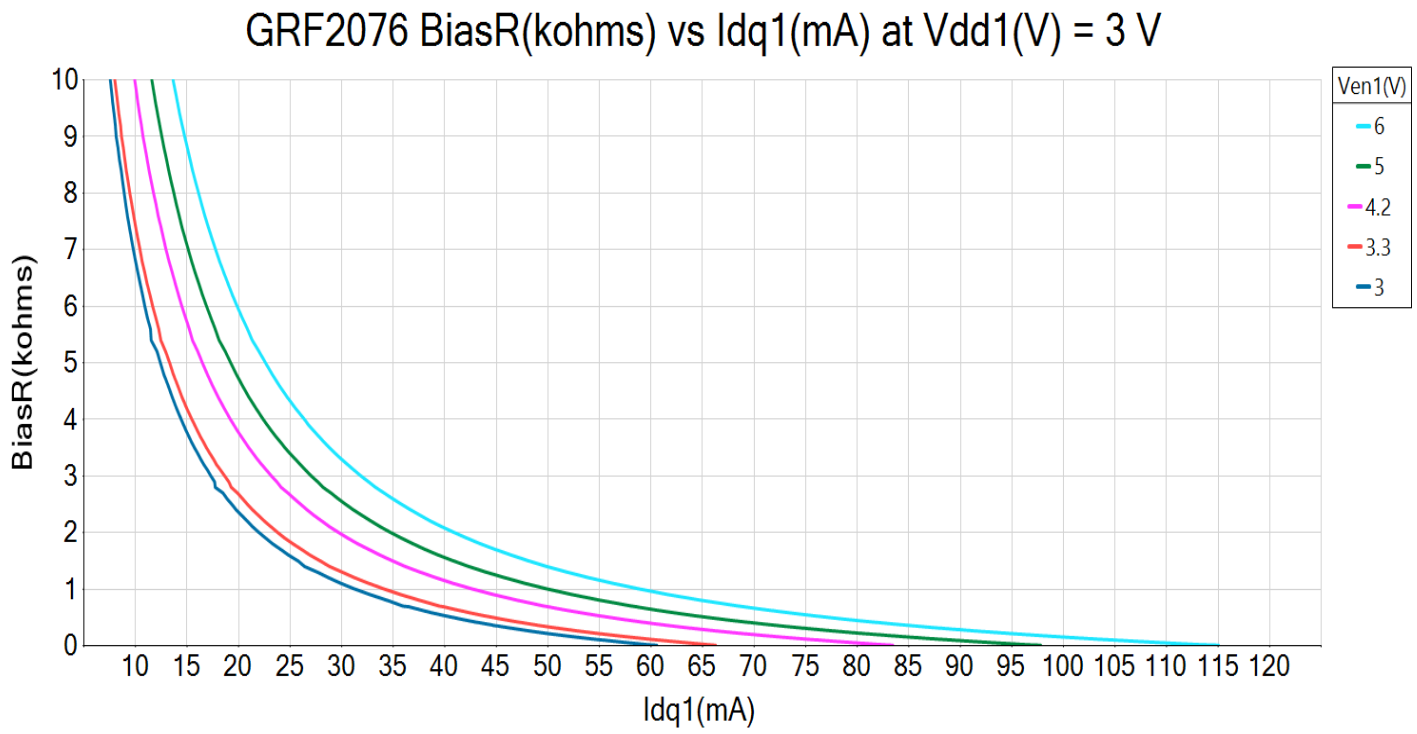
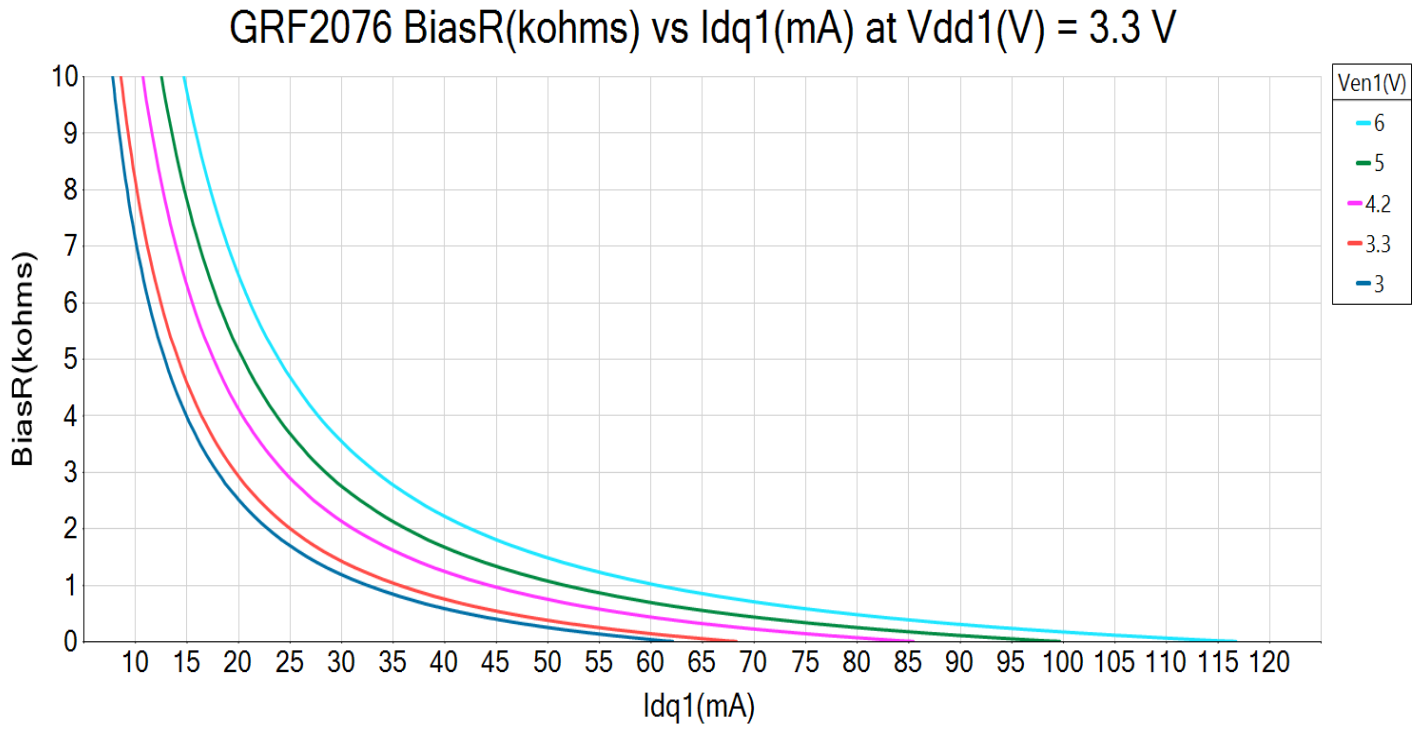
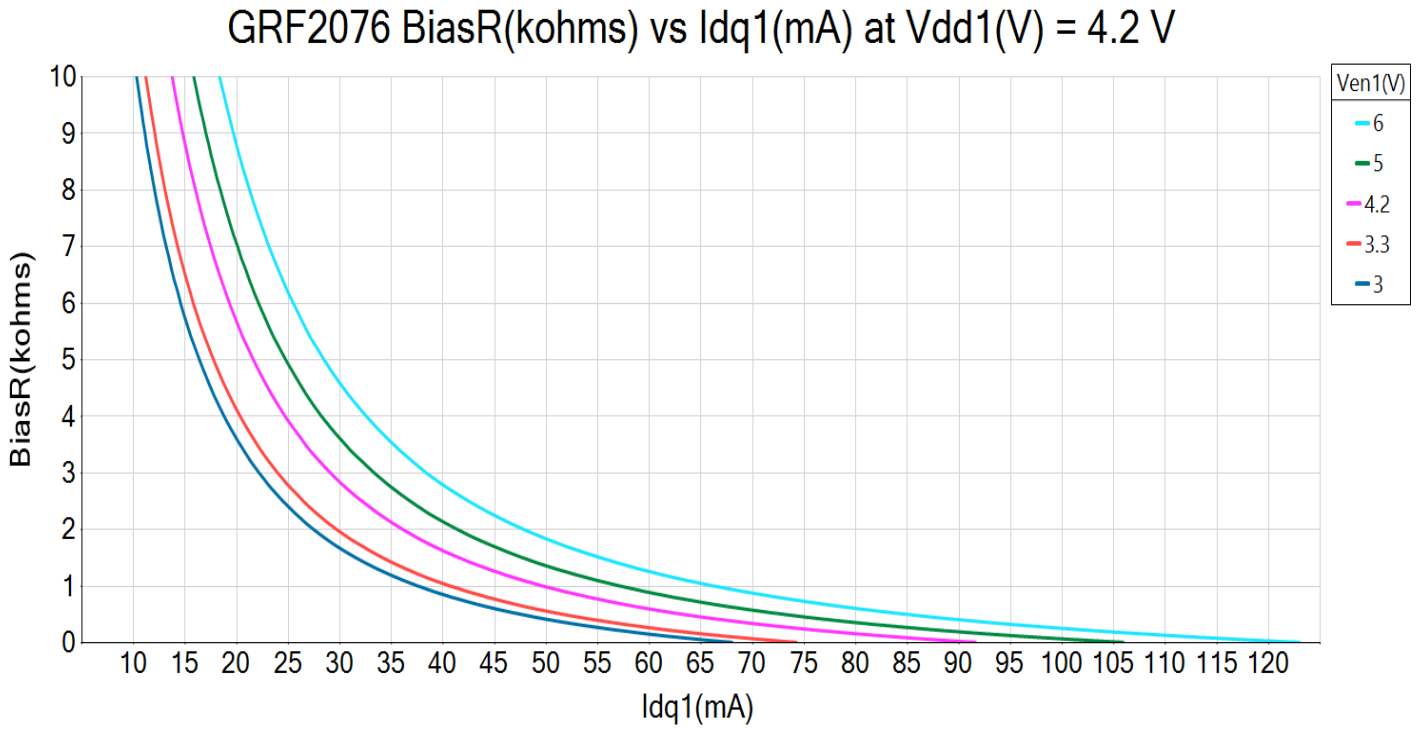
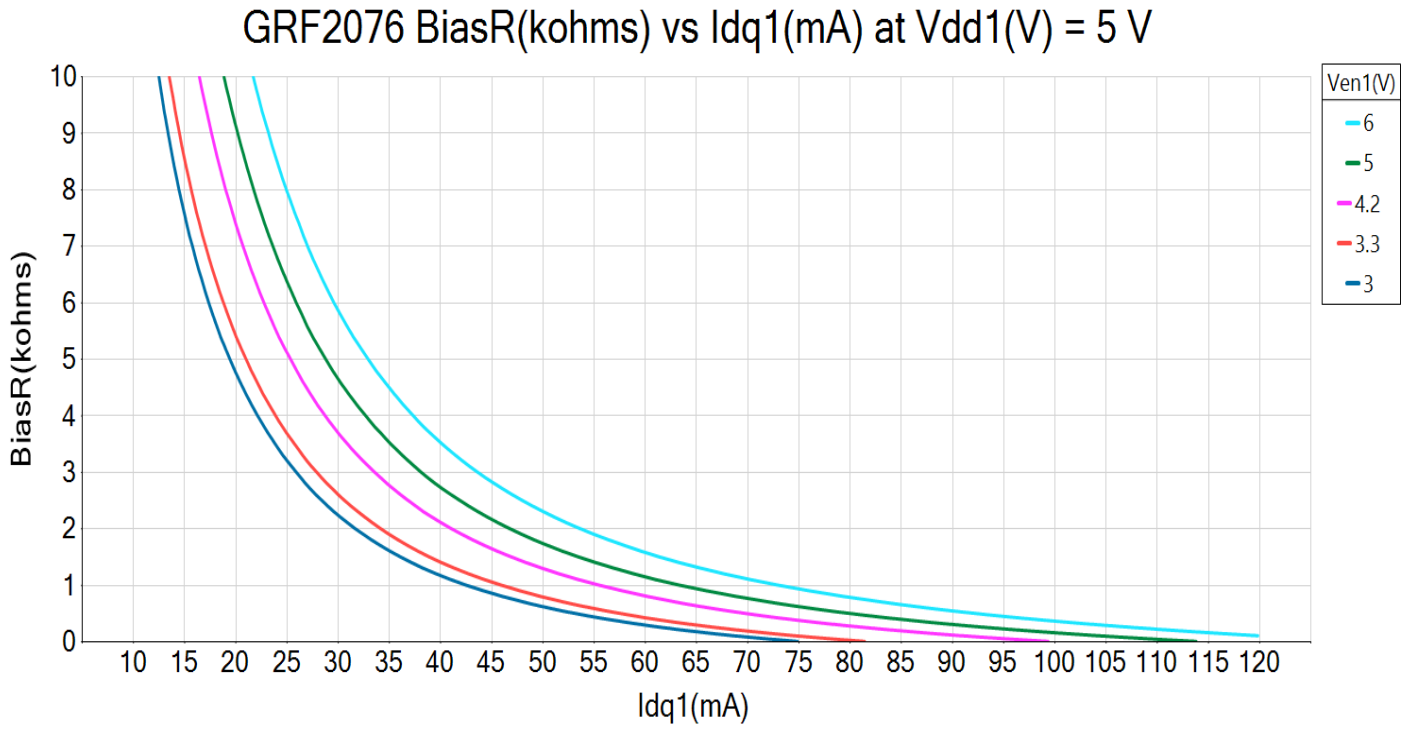
## GRF2076 Bias Resistor Selection Curves



## GRF2076 Bias Resistor Selection Curves



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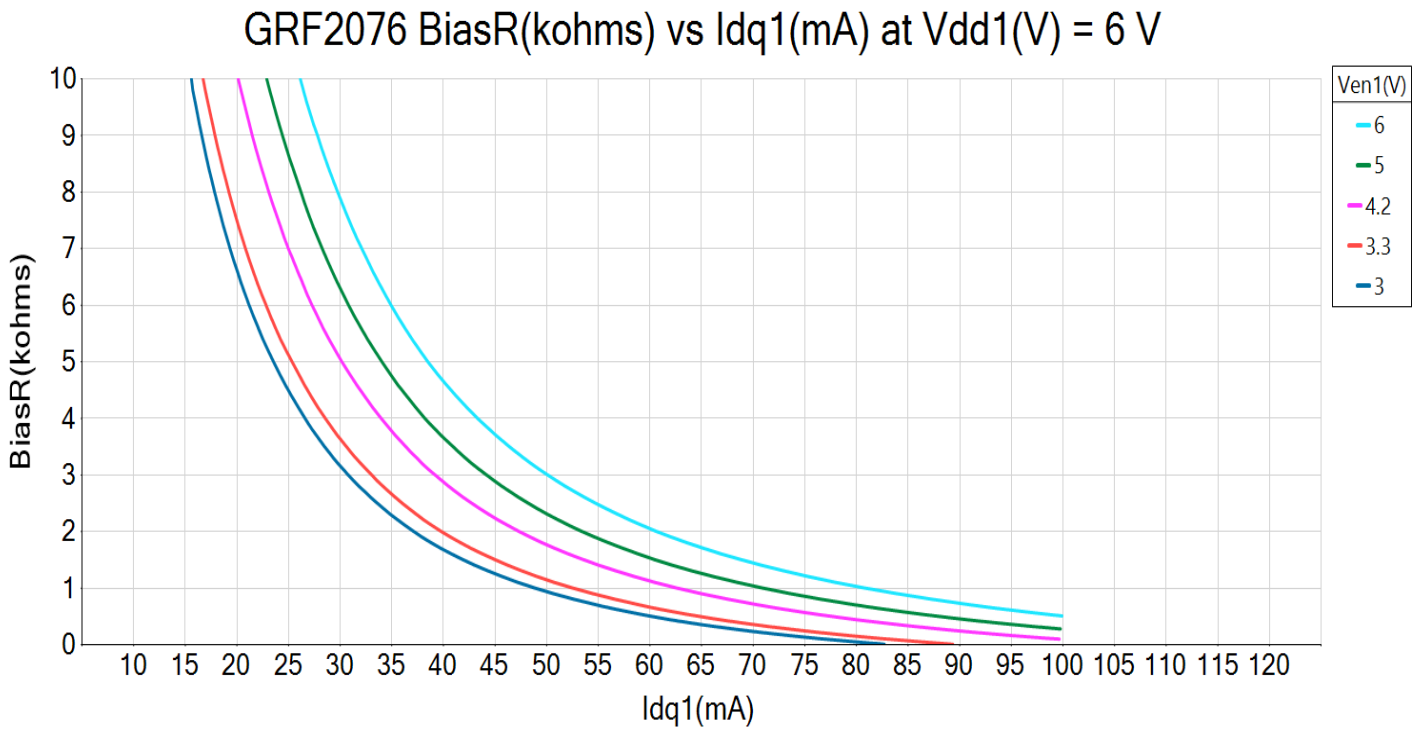
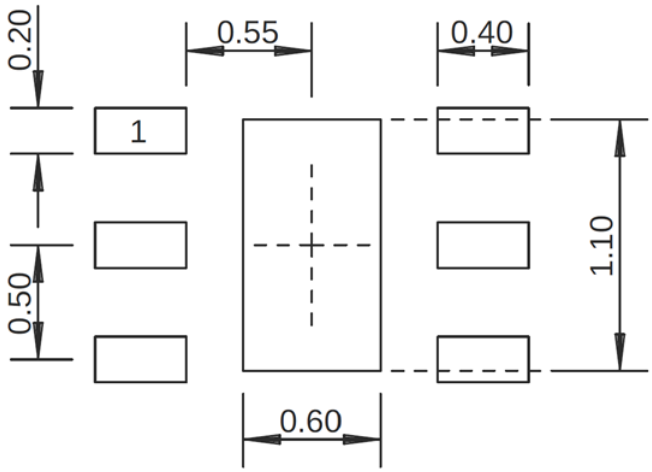
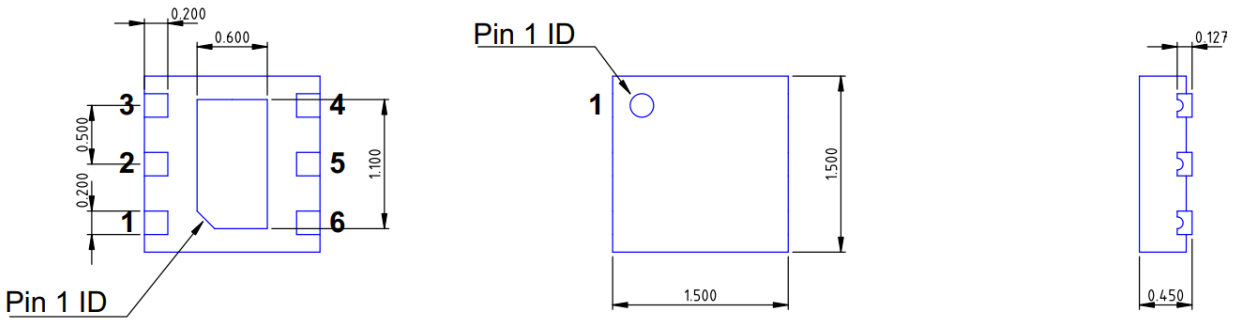
## GRF2076 Bias Resistor Selection Curves






**1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)**

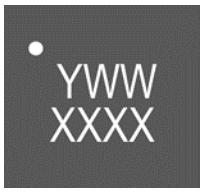



**Bottom View** **Top View** **Side View**

**DFN6 1.5x1.5mm**
**Dimensions in millimeters**
**Dimensional Tolerance: ±0.05**

**1.5 x 1.5 mm DFN-6 Package Dimensions**

## Package Marking Diagram



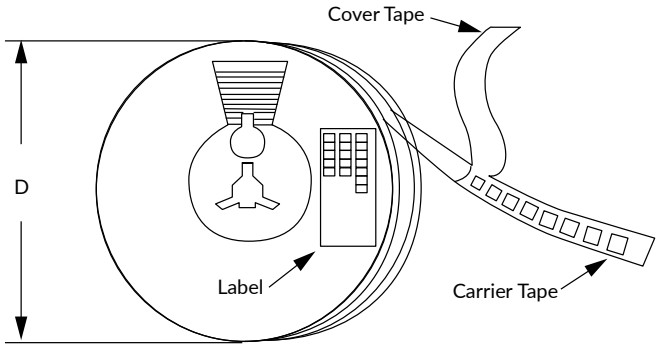

- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the Device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

## Tape and Reel Information

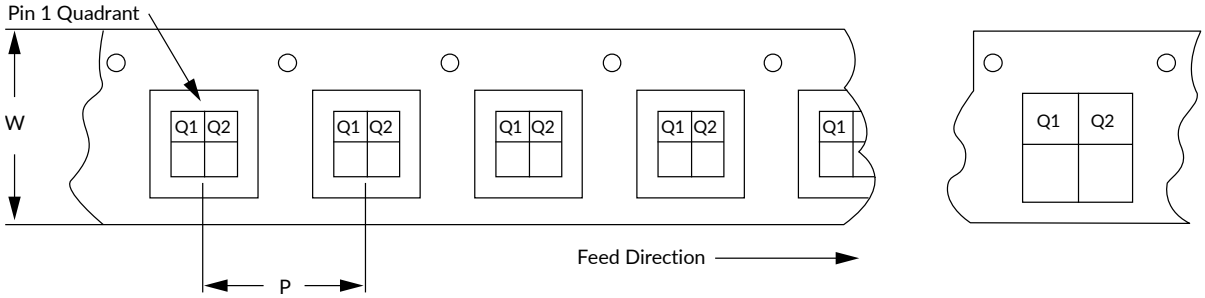
Guerrilla RF's tape and reel specification complies with Electronics Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, which includes units per reel.

Devices are loaded with pins down into the carrier pocket with protective cover tape and reeled onto a plastic reel. Each reel is packaged in a cardboard box. There are product labels on the reel, the protective ESD bag and the outside surface of the box.

For the Tape and Reel Reference Table, please refer to: *Package Manufacturing Information | Guerrilla RF (guerrilla-rf.com)*




**Tape and Reel Packaging with Reel Diameter Noted (D)**




**Carrier Tape Width (W), Pitch (P), Feed Direction and Pin 1 Quadrant Information**

## Revision History

| Revision Date | Description of Change |
|---|---|
| April 13, 2020 | Preliminary Data Sheet. |
| November 8, 2022 | Release Ø Data Sheet. Upgraded Data Sheet to new format. Added new characterization plots. Added new bias resistor selection curves. Lowered OP1dB lower limit from 21.5 to 19.5 dBm. |
| December 20, 2022 | Raised RF input power ($P_{IN\ MAX}$) from 22 to 27 dBm in Gain mode. Added RF input power ($P_{IN\ MAX}$) in Bypass mode. |
| April 29, 2025 | Raised Maximum Operating Temperature from 105 to 115 °C. |
| May 9, 2025 | Extended upper frequency range from 6000 MHz to 7125 MHz. |



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## Data Sheet Classifications

| Data Sheet Status | Notes |
|---|---|
| Advance | S-parameter and NF data based on EM simulations for the fully packaged device using foundry-supplied transistor S-parameters. Linearity estimates based on device size, bias condition and experience with related devices. |
| Preliminary | All data based on limited evaluation board measurements taken within the Guerrilla RF Applications Lab. All parametric values are subject to change pending the collection of additional data. |
| Release Ø | All data based on measurements taken with *production-released* material. TYP values are based on a combination of ATE and bench-level measurements, with MIN/MAX limits defined using *modelled estimates* that account for part-to-part variations and expected process spreads. Although unlikely, future refinements to the TYP/MIN/MAX values may be in order as multiple lots are processed through the factory. |
| Release A-Z | All data based on measurements taken with production-released material *derived from multiple lots which have been fabricated over an extended period of time.* MIN/MAX limits may be refined over previous releases as more statistically significant data is collected to account for process spreads. |