



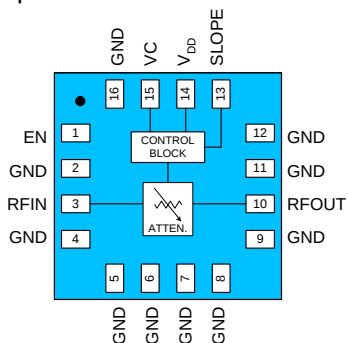
# RFSA2113

## Wide Bandwidth Voltage Controlled Attenuator

### Product Description

The RFSA2113 is a fully monolithic analog voltage controlled attenuator (VCA) featuring exceptional linearity over a typical temperature compensated 30 dB gain control range. The RFSA2113 features a wide bandwidth up to 18 GHz. This VCA incorporates a revolutionary new circuit architecture to solve a long standing industry problem: high IP3, high attenuation range, low DC current, broad bandwidth and temperature compensated linear in dB control voltage characteristic.

The RFSA2113 attenuation level is set by a single positive control voltage with on chip DC conditioning circuitry. The slope polarity of the control voltage versus gain is selectable. The RFSA2113 draws a very low 2 mA current. This attenuator is matched to 50  $\Omega$  over its rated control range and frequency with no external matching components required.

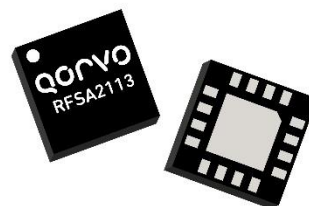


Functional Block Diagram

Typical VCA's in this performance range are based on compound semiconductor GaAs FET MMICs that require 1 to 2 negative voltages for control. This game changing product incorporates the complete solution in a small 3.2 mm x 3.2 mm multi-chip laminate module that reduces the footprint in area and simplifies the control aspects over conventional compound semiconductor attenuator approaches.

### Ordering Information

| Part No.        | Description                                       |
|-----------------|---------------------------------------------------|
| RFSA2113SQ      | Sample bag with 25 pieces                         |
| RFSA2113SR      | 7" Reel with 100 pieces                           |
| RFSA2113TR13    | 13" Reel with 2500 pieces                         |
| RFSA2113PCK-410 | 50 MHz to 18,000 MHz PCBA with 5-piece sample bag |



16 Pin, 3.2 mm x 3.2 mm x 1.175 mm SMT Package

### Product Features

- Patented Circuit Architecture
- Broadband 50 MHz to 18,000 MHz Frequency Range
- 30 dB Attenuation Range
- +45 dBm IIP3 Typical
- +75 dBm IIP2 Typical
- High 1 dB Compression Point +29 dBm
- Low Supply Current 2 mA Typical
- +3 to +5 V Power Supply
- Linear in dB Control Characteristic
- Internal Temperature Compensation
- Class 1C HBM ESD ( $\geq 1000$  V)

### Applications

- Point to Point Radio
- Test Instrumentation
- Microwave Radio
- High Linearity Power Control

## Absolute Maximum Ratings

| Parameter                               | Range / Value | Units |
|-----------------------------------------|---------------|-------|
| Device Voltage (V <sub>DD</sub> )       | -0.5 to +6    | V     |
| SLOPE, VC, EN Pins                      | -0.5 to +6    | V     |
| RF Input Power <sup>(1)</sup>           | +23           | dBm   |
| Storage Temperature                     | -55 to +150   | °C    |
| Junction Temperature ( T <sub>j</sub> ) | +125          | °C    |

Exceeding these absolute maximum ratings during operation of this device may cause permanent damage.

Notes:

1. Peak power of +29 dBm allowable when RMS power does not exceed +23 dBm.

## Recommended Operating Conditions

| Parameter                         | Min  | Typ  | Max  | Units |
|-----------------------------------|------|------|------|-------|
| Device Voltage (V <sub>DD</sub> ) | +3.0 | +5.0 | +5.5 | V     |
| T <sub>CASE</sub>                 | -40  |      | +85  | °C    |

Electrical specifications are measured under bias, signal and temperature conditions as specified. Specifications are not guaranteed over all recommended operating conditions.

## Electrical Specifications

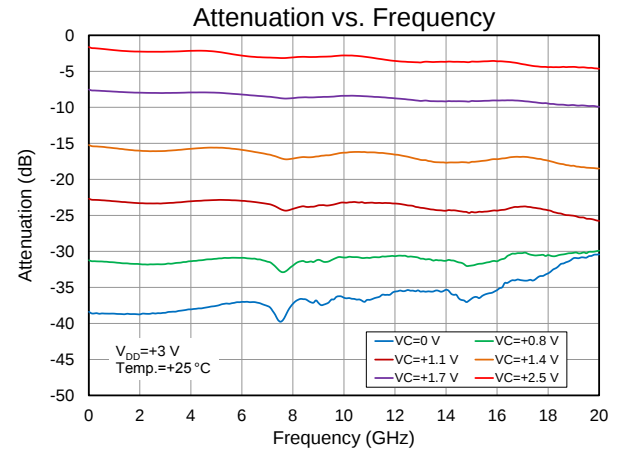
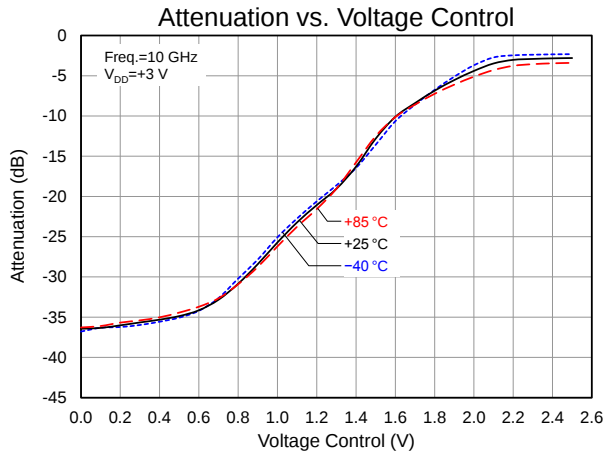
| Parameter                                         | Conditions <sup>(1)</sup>                                                                      | Min | Typ | Max   | Units    |
|---------------------------------------------------|------------------------------------------------------------------------------------------------|-----|-----|-------|----------|
| Operational Frequency Range                       |                                                                                                | 50  |     | 18000 | MHz      |
| Minimum Insertion Loss                            | 1 GHz                                                                                          |     | 2   | 2.8   | dB       |
|                                                   | 10 GHz                                                                                         |     | 3   | 4.5   |          |
|                                                   | 18 GHz                                                                                         |     | 4.5 |       |          |
| Gain Control Range                                | 1 GHz                                                                                          | 32  | 34  |       | dB       |
|                                                   | 10 GHz                                                                                         | 30  | 32  |       |          |
|                                                   | 18 GHz                                                                                         |     | 28  |       |          |
| Gain vs. Temperature                              | Peak to peak gain variation over temperature for fixed control voltage                         |     | 1   |       | dB       |
| Return Loss                                       |                                                                                                |     | 15  |       | dB       |
| Relative Phase                                    | Insertion phase at 15 dB attenuation relative to minimum insertion loss                        |     | 14  |       | °Degrees |
| Input1dB Compression Point                        | Peak power of +29 dBm allowable when RMS power does not exceed +23 dBm. *Not Production Tested | +22 | +29 |       | dBm      |
| Input IP3                                         | P <sub>IN</sub> + (IM3 <sub>dB</sub> C / 2)                                                    | +38 | +45 |       | dBm      |
| Input IP2                                         | P <sub>IN</sub> + IM2 <sub>dB</sub> C, IM2 is F1+F2                                            |     | +75 |       | dBm      |
| Input IH2                                         | P <sub>IN</sub> + H2 <sub>dB</sub> C, H2 is second harmonic                                    |     | +80 |       | dBm      |
| Input IH3                                         | P <sub>IN</sub> + (H3 <sub>dB</sub> C / 2), H3 is third harmonic                               |     | +50 |       | dBm      |
| Device Current, I <sub>DD</sub>                   |                                                                                                |     | 2   | 3.5   | mA       |
| Thermal Resistance, θ <sub>jc</sub>               | Junction to case                                                                               |     |     | 175   | °C/W     |
| Voltage Control Range, Positive Attenuation Slope | +2.5 V control voltage is lowest insertion loss, SLOPE pin logic high                          | 0   |     | +2.5  | V        |
| Voltage Control Range, Negative Attenuation Slope | 0 V control voltage is lowest insertion loss, SLOPE pin logic low                              | 0   |     | +2.5  | V        |
| Voltage Control Pin Current                       | VC pin set to +2.5 V                                                                           |     | 1.2 |       | μA       |
| SLOPE and EN Pins Logic Low                       |                                                                                                |     |     | +0.4  | V        |
| SLOPE and EN Pins Logic High                      |                                                                                                | +1  |     |       | V        |
| Settling Time                                     | 1 dB atten. change settling within 0.1 dB of final value.                                      |     |     | 2     | μsec     |

Notes:

1. Test conditions unless otherwise noted: V<sub>DD</sub>=+5 V, Temp.=+25 °C, 50 Ω system, Freq.=10 GHz.

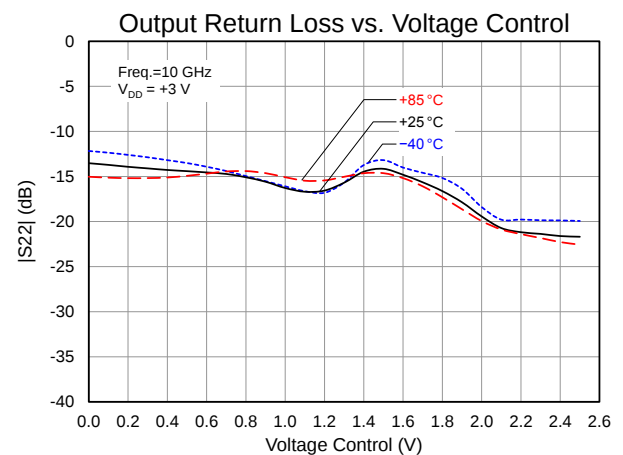
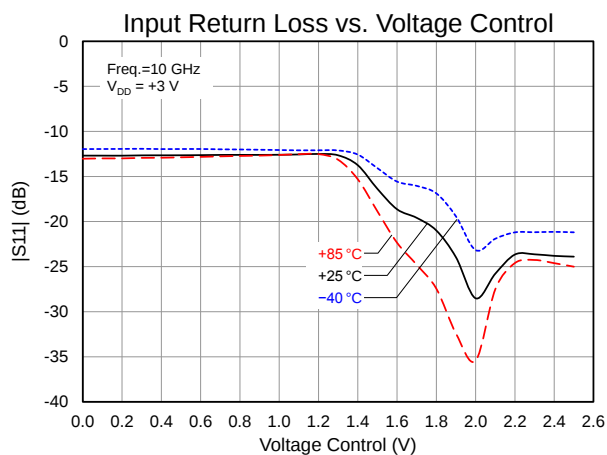
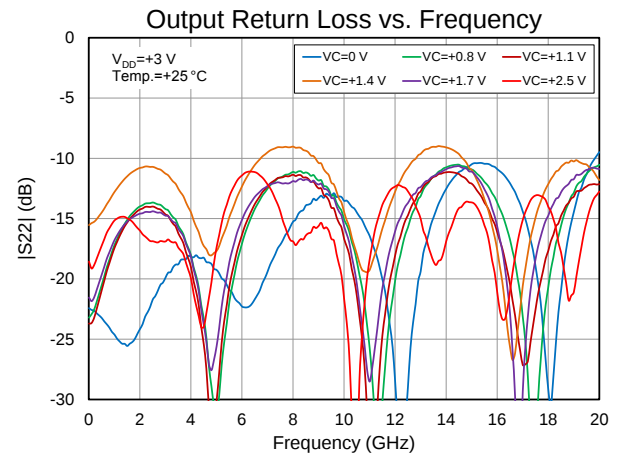
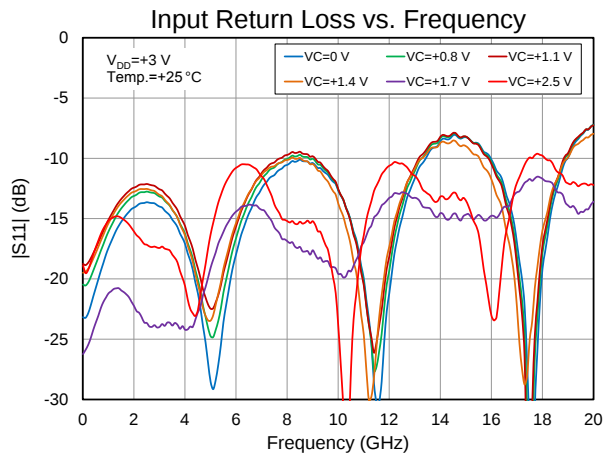
## Measured Positive Attenuation Slope Performance

Test conditions unless otherwise noted:  $V_{DD}=+3\text{ V}$ ,  $\text{Temp}=+25\text{ }^{\circ}\text{C}$ , PCB and connector losses de-embedded.



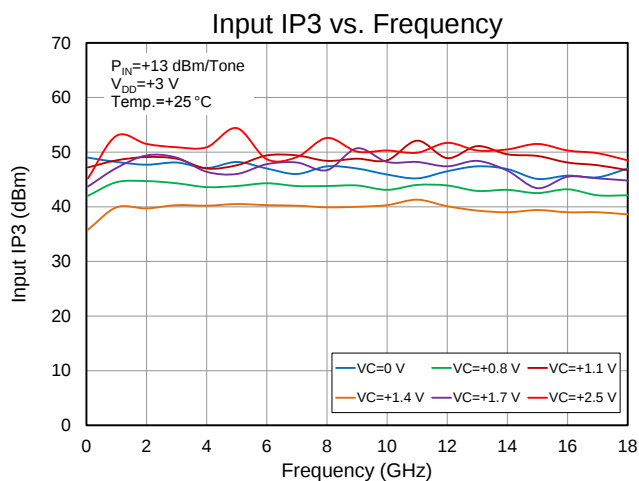
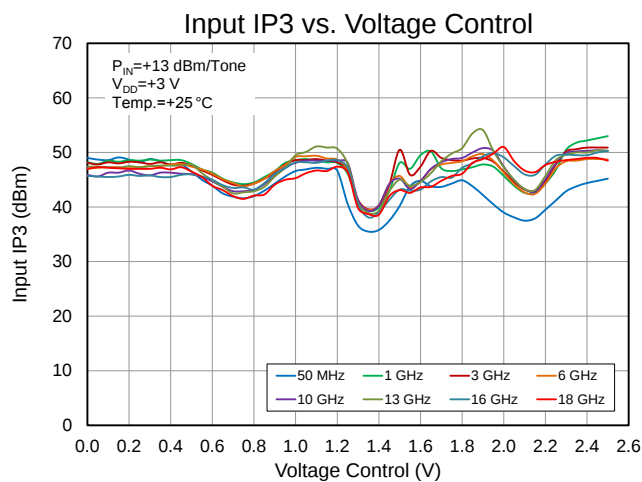
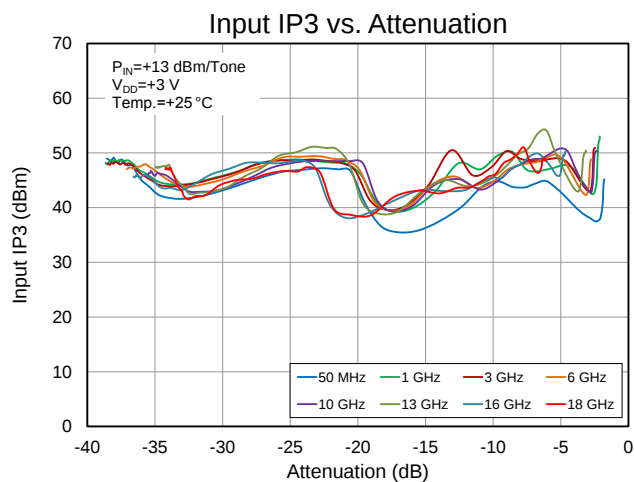
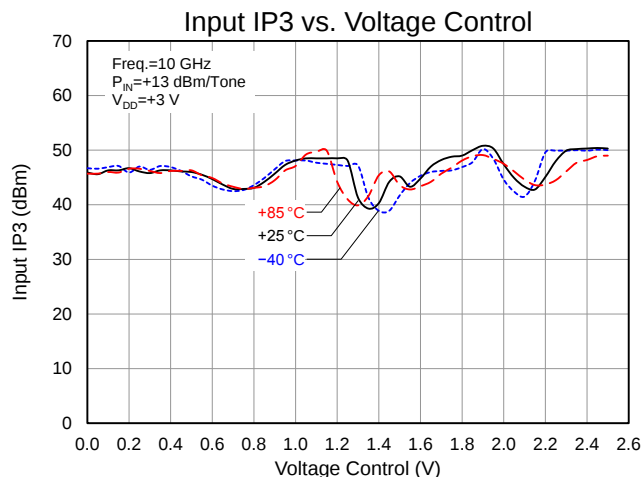
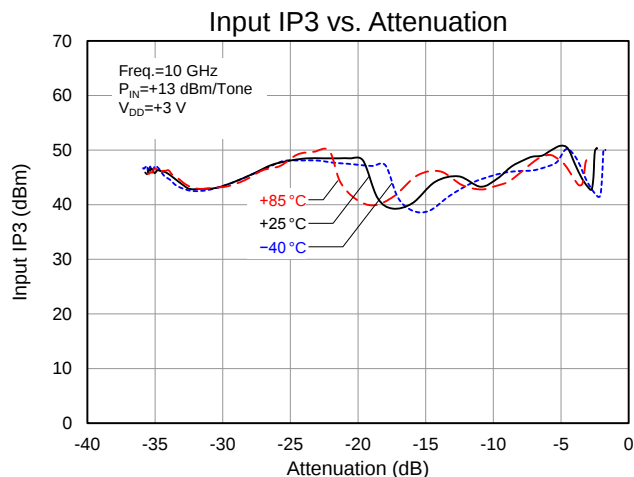
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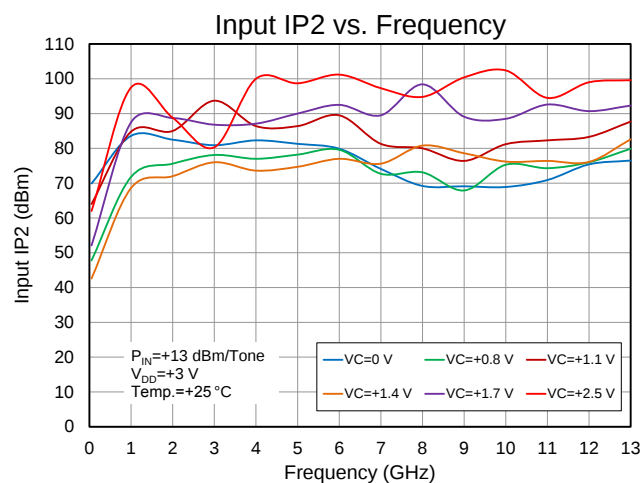
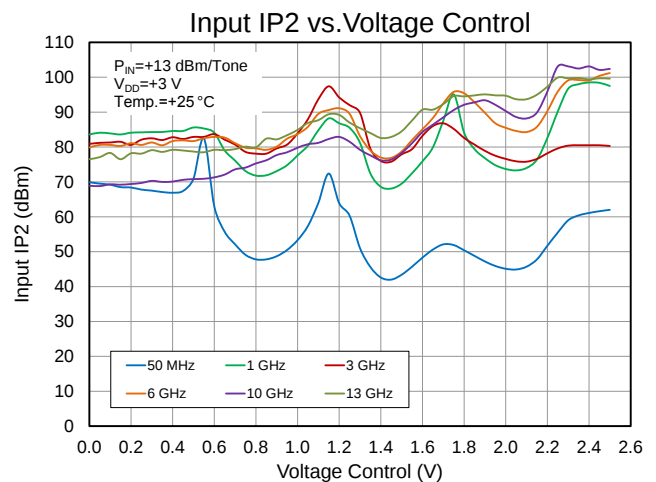
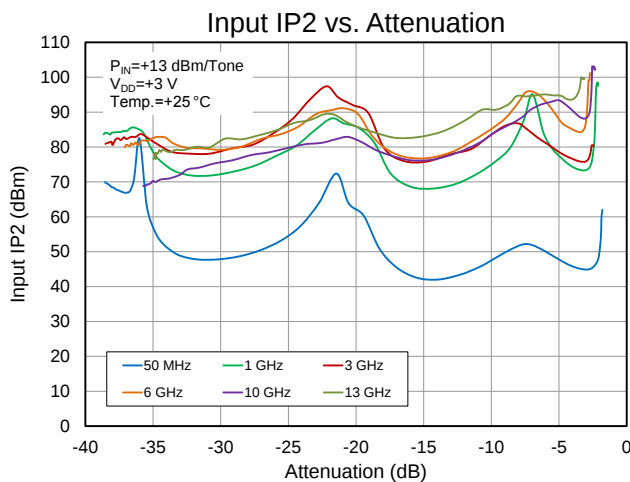
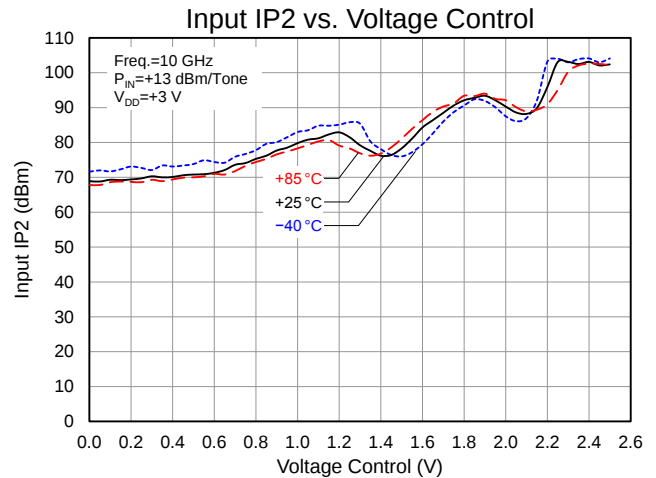
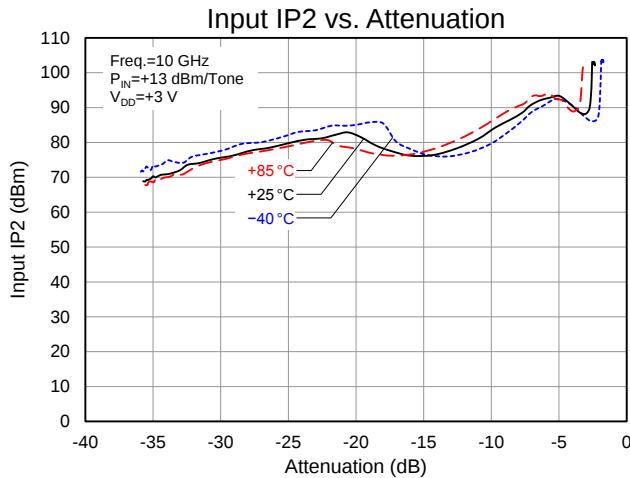
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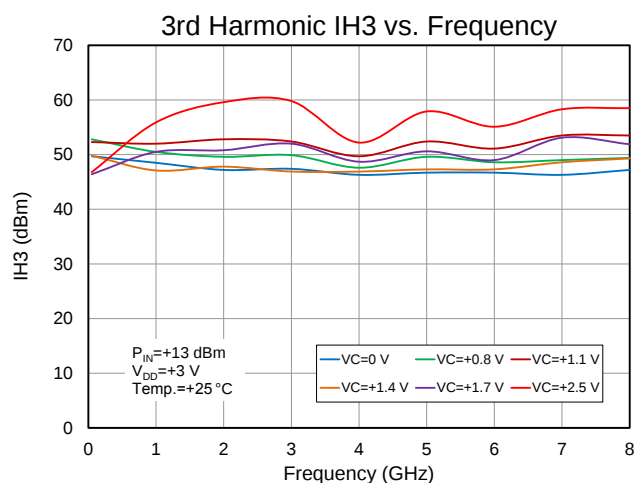
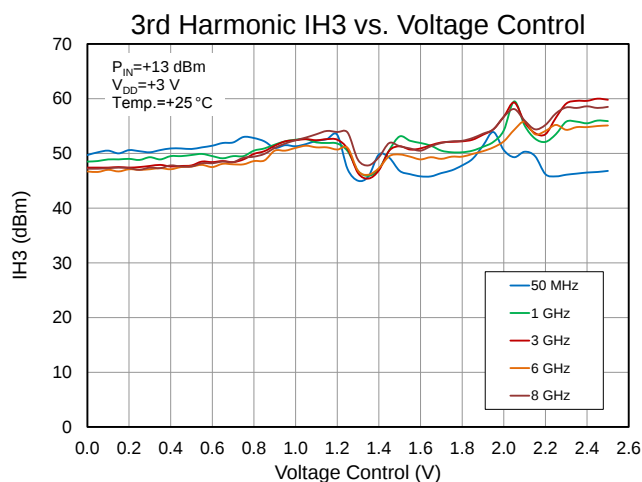
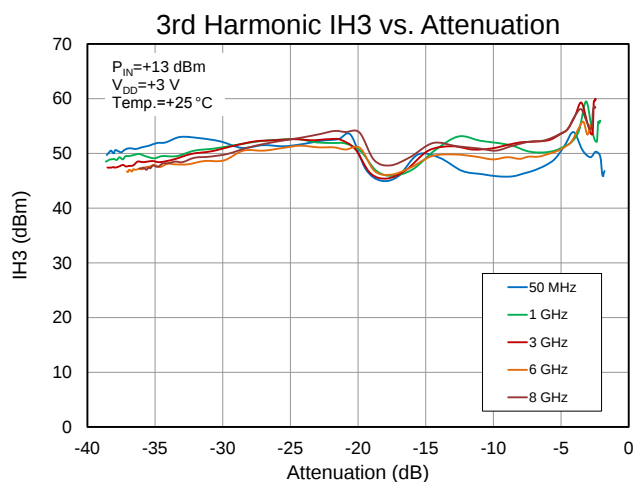
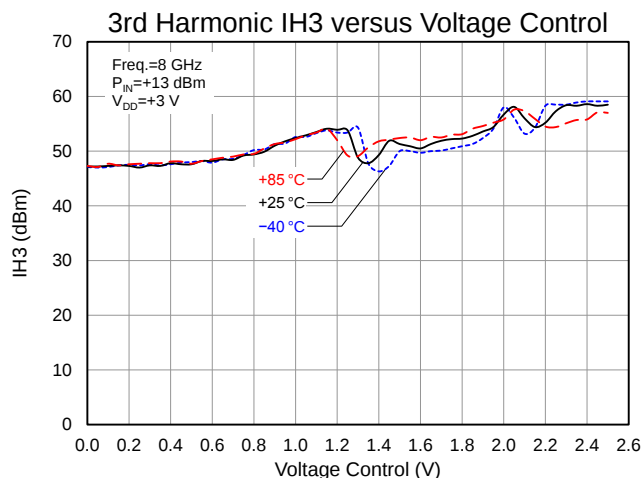
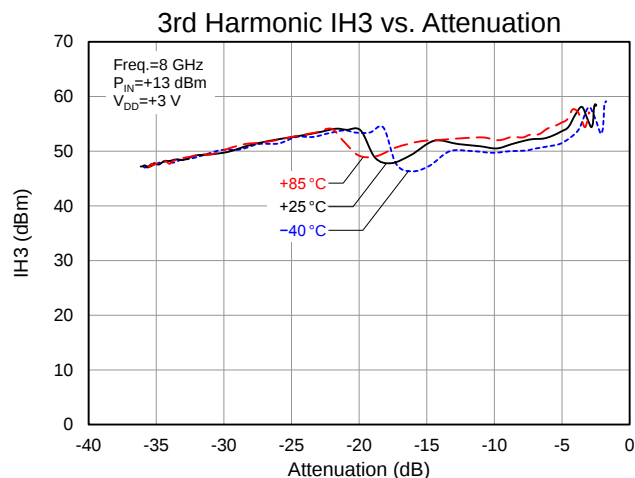
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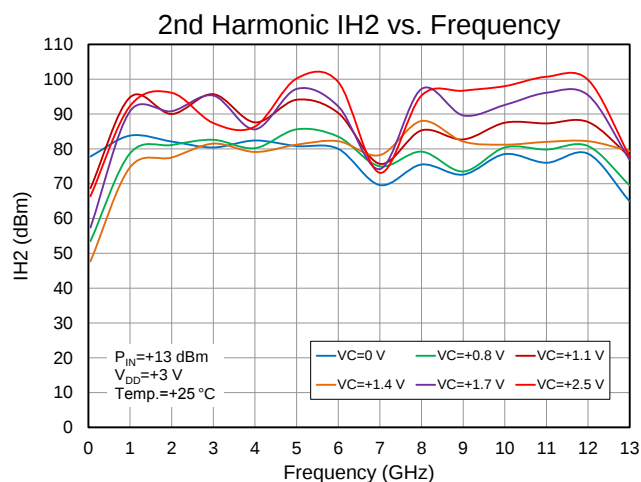
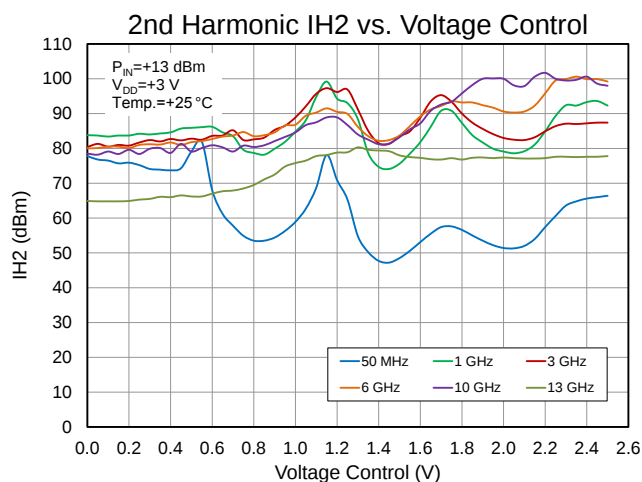
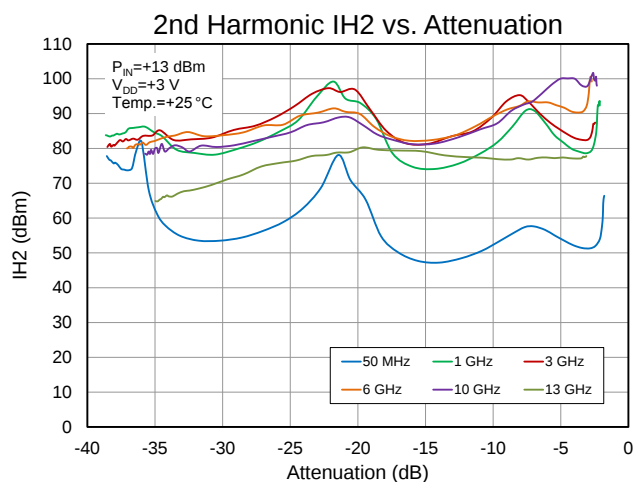
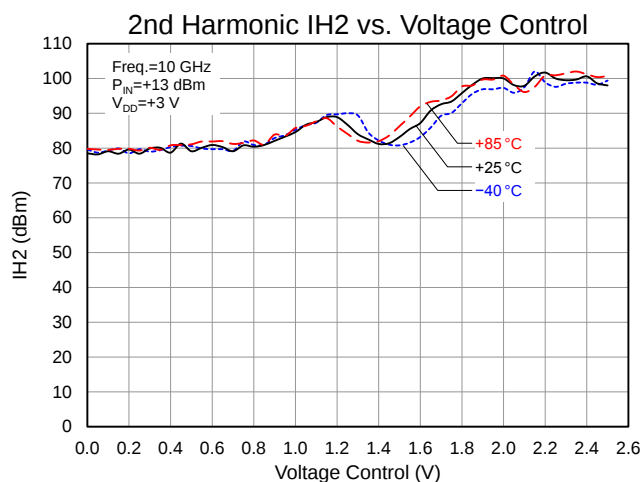
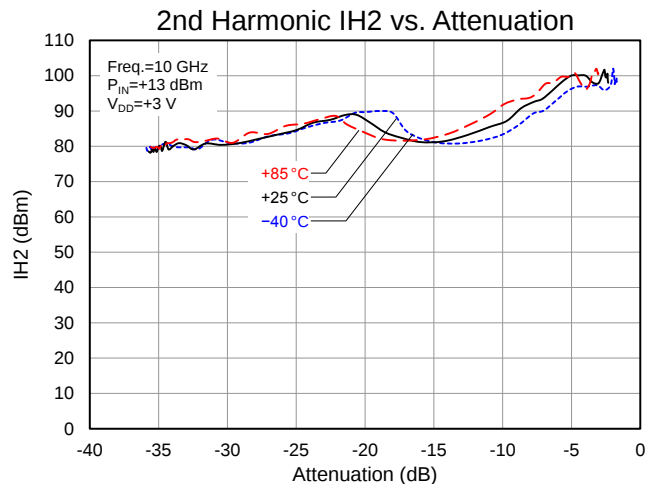
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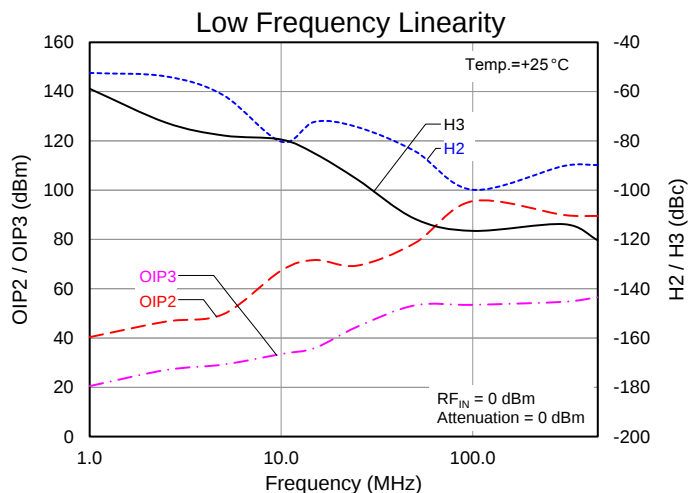
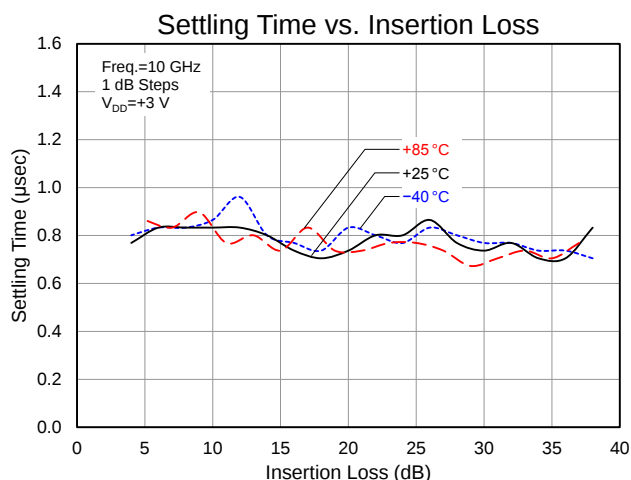
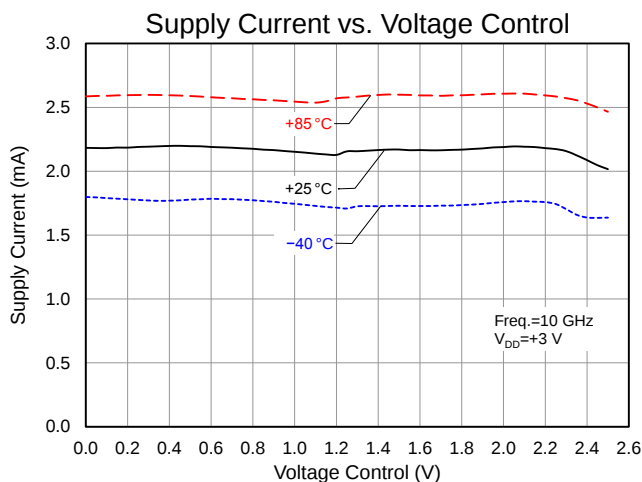
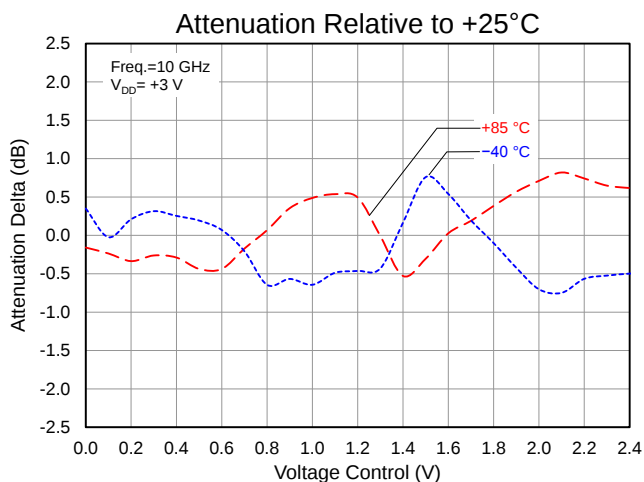
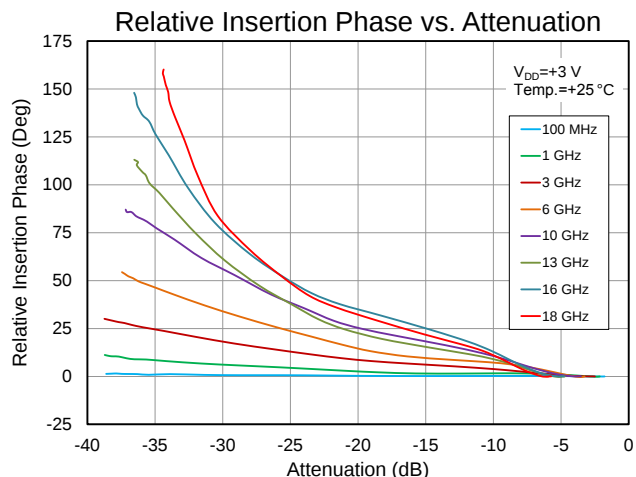
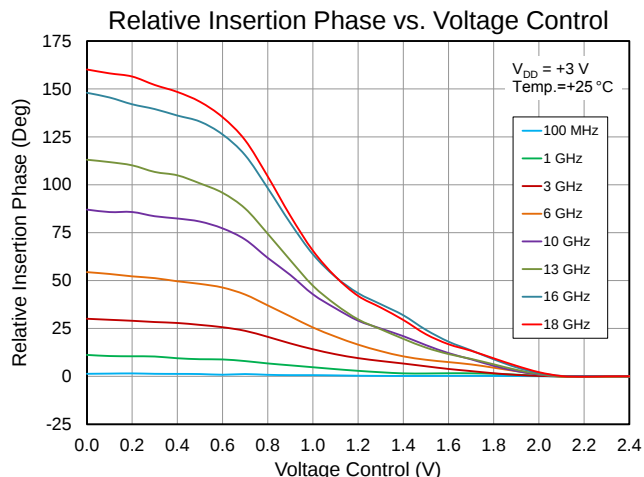
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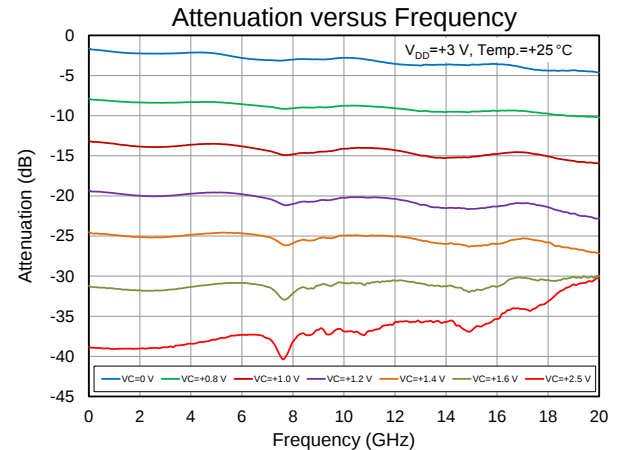
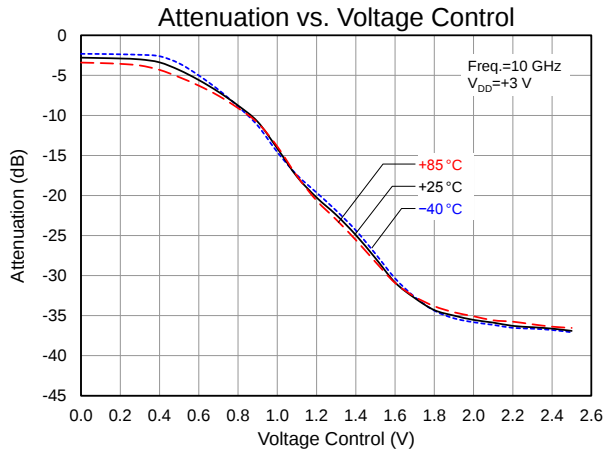
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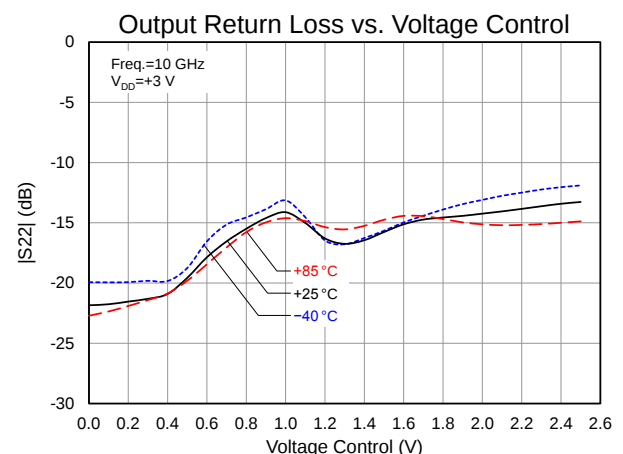
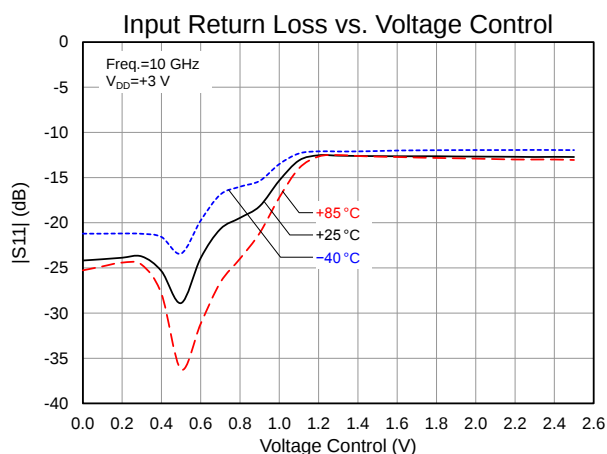
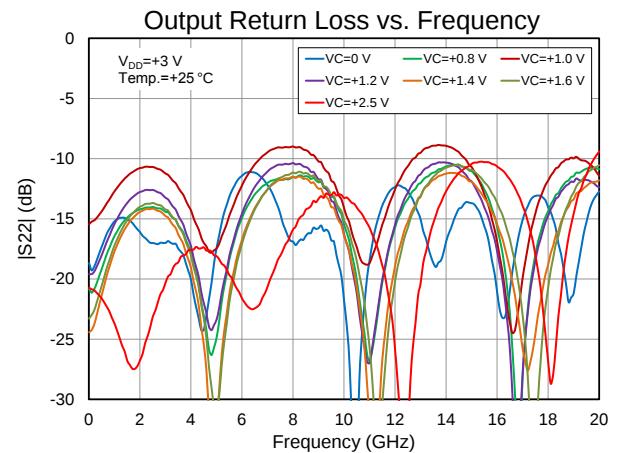
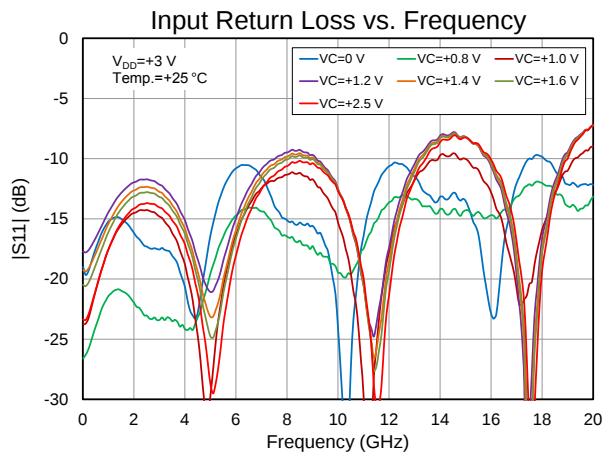
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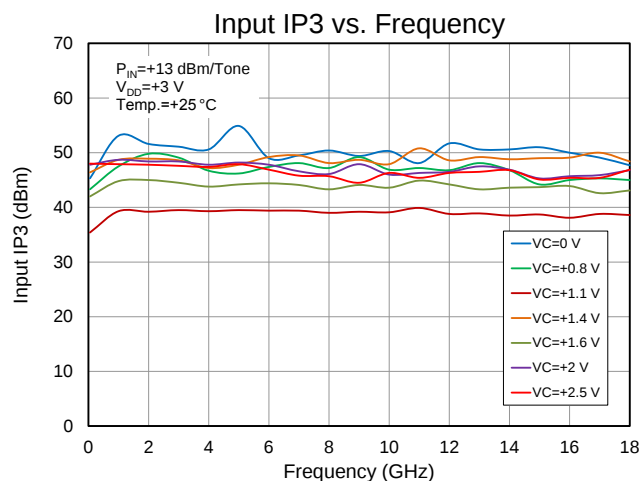
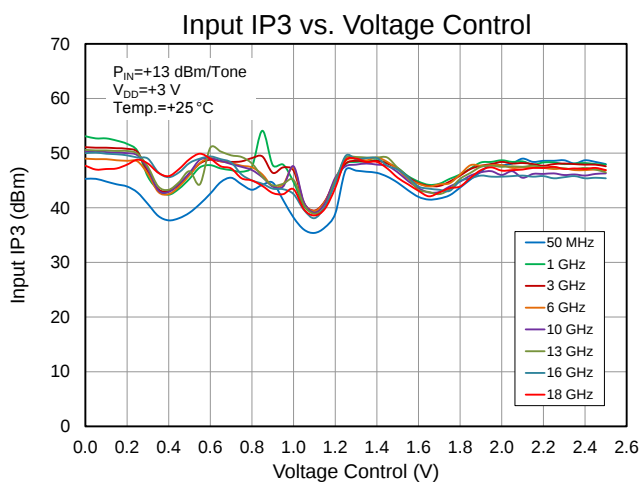
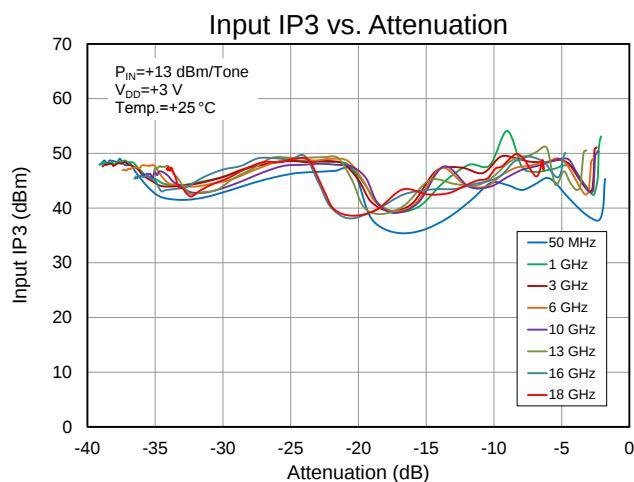
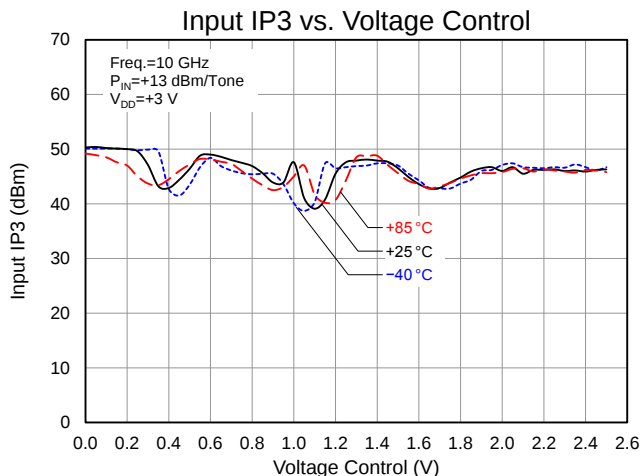
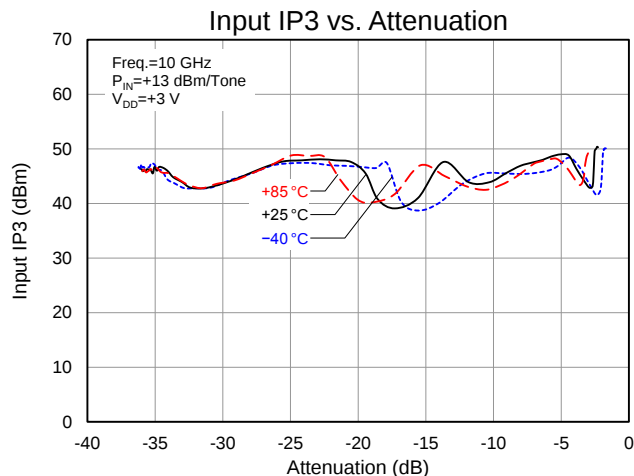
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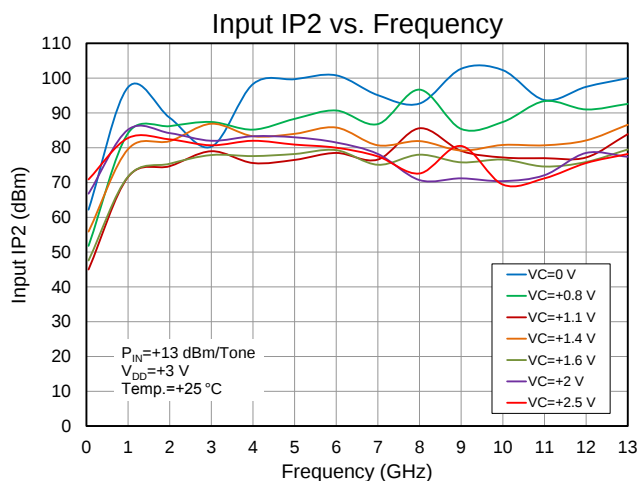
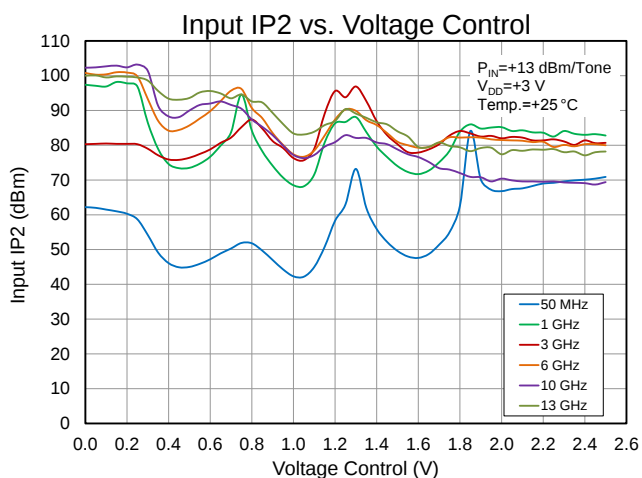
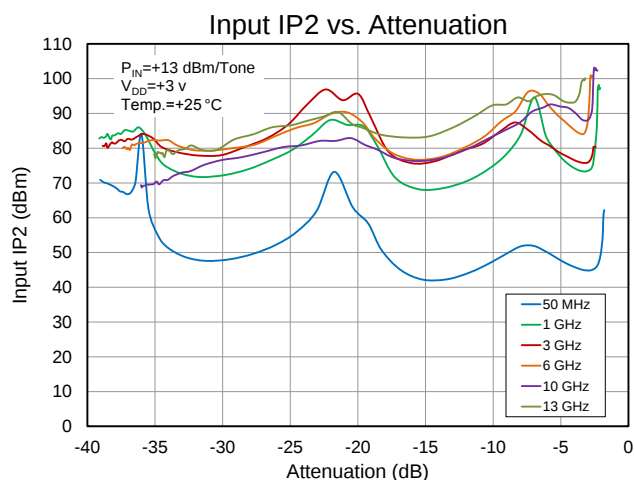
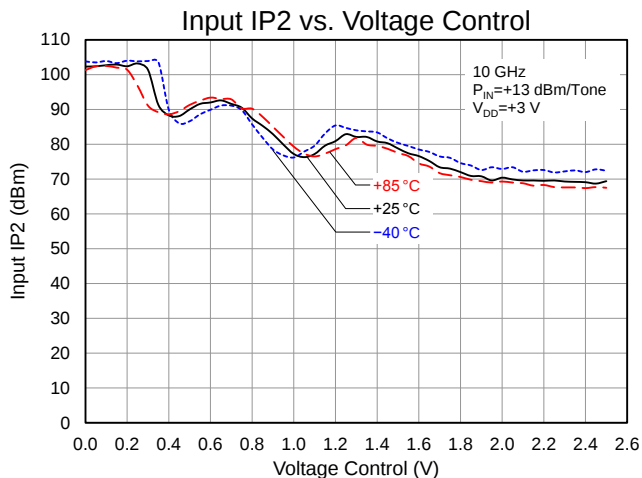
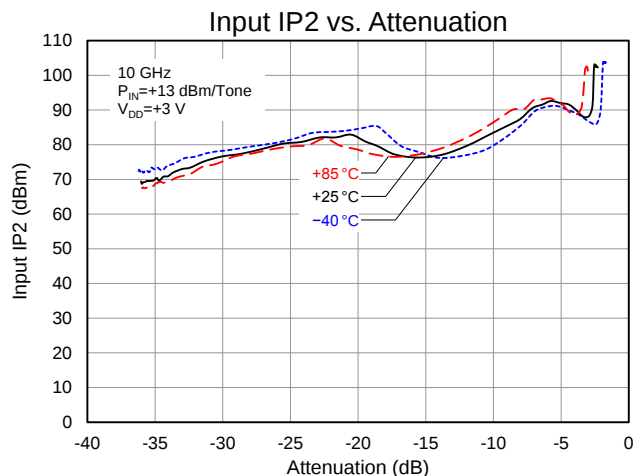
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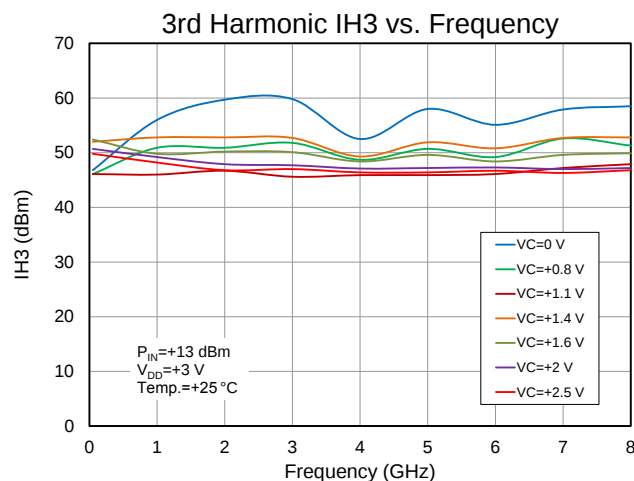
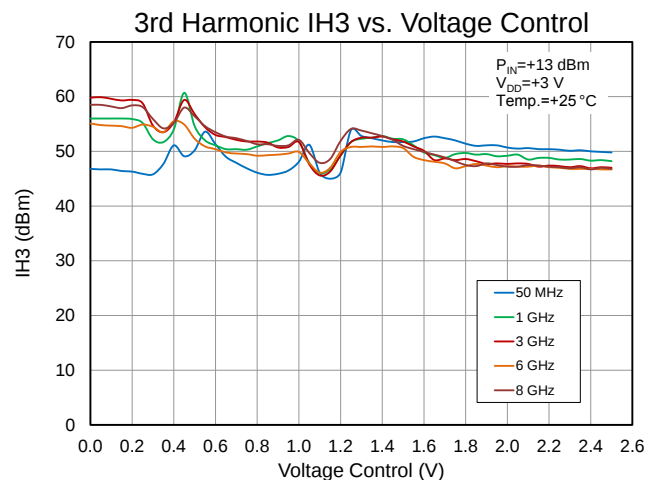
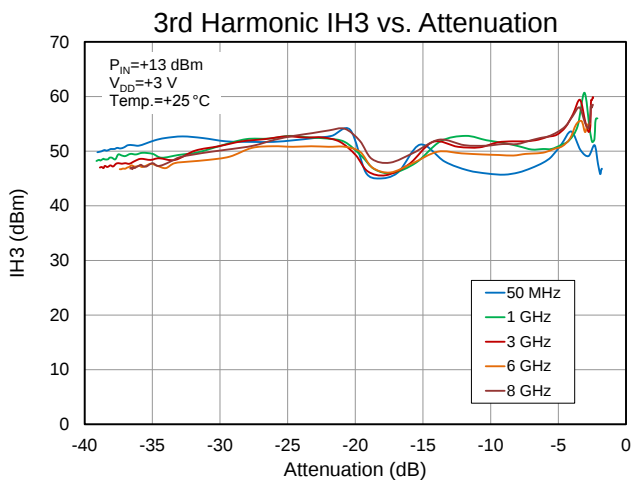
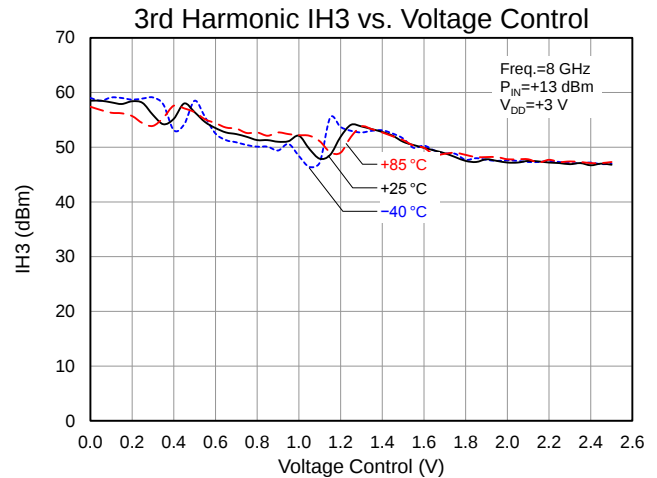
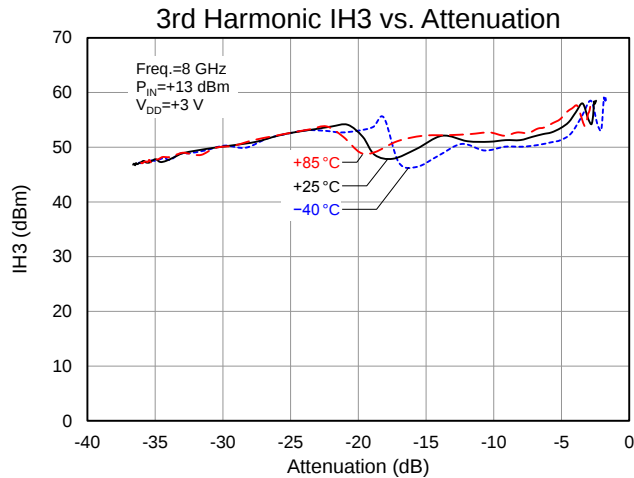
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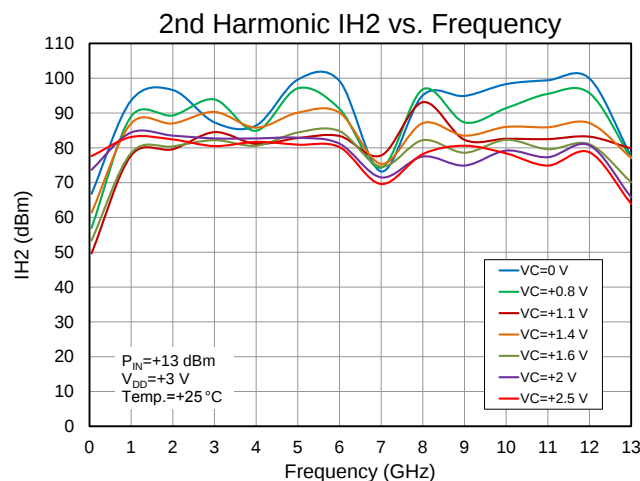
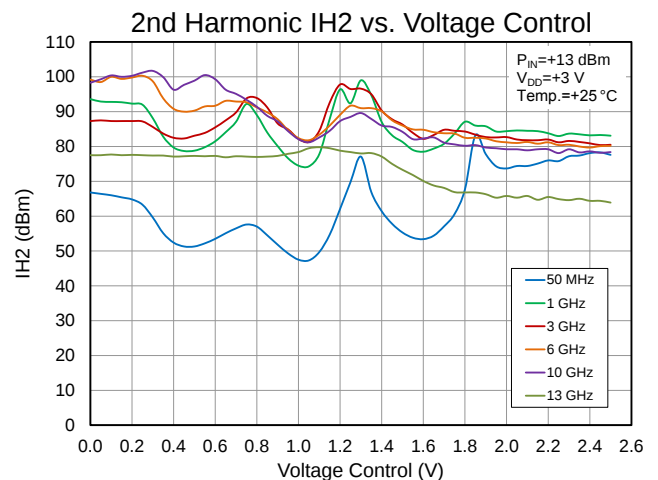
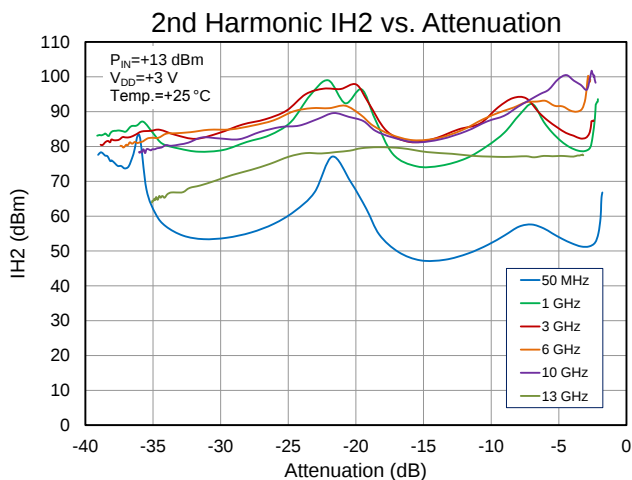
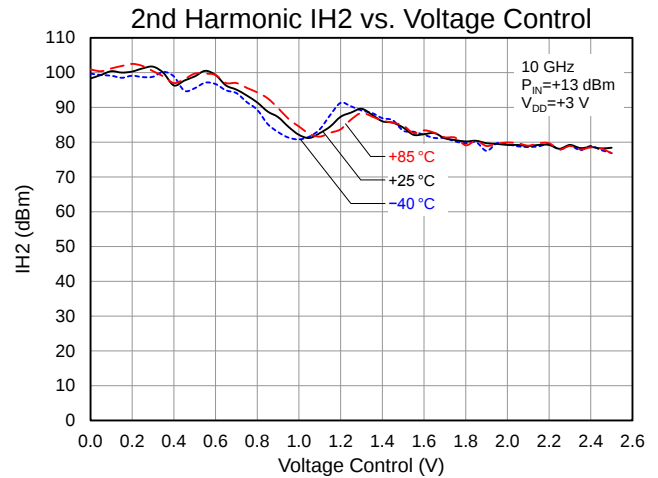
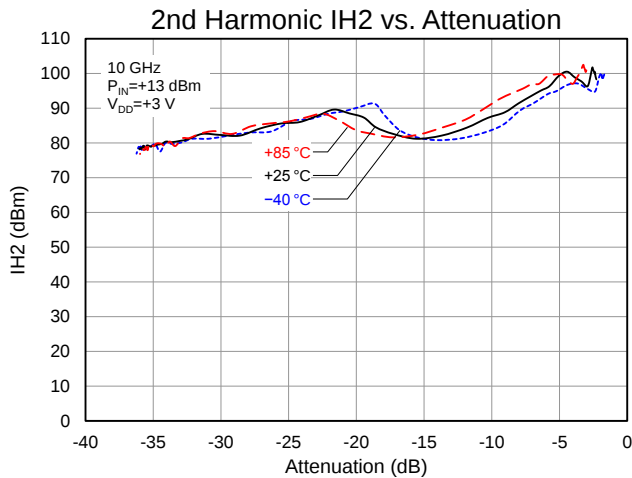
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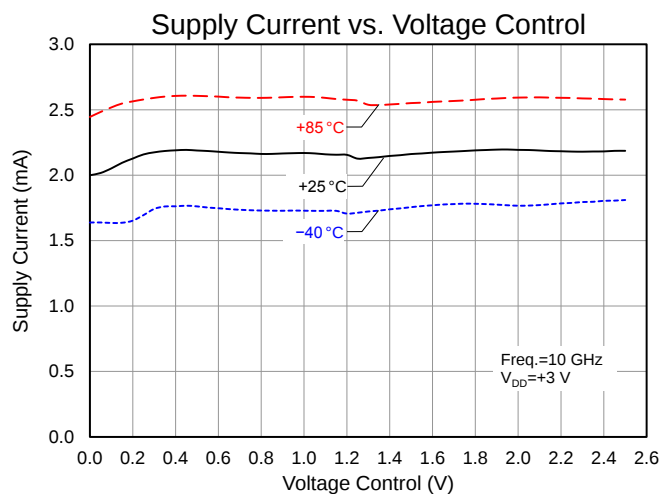
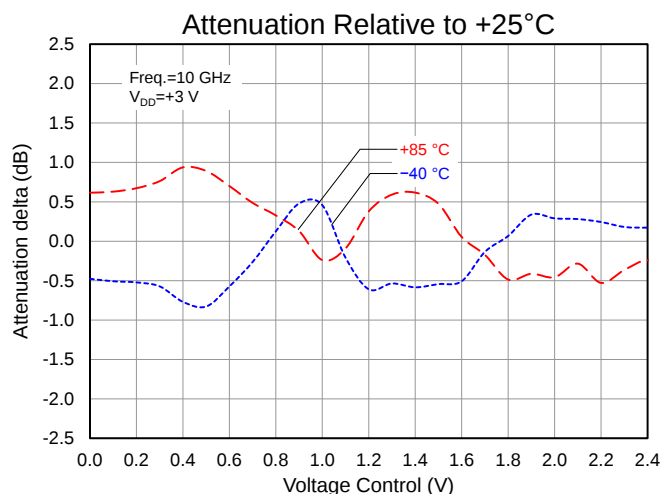
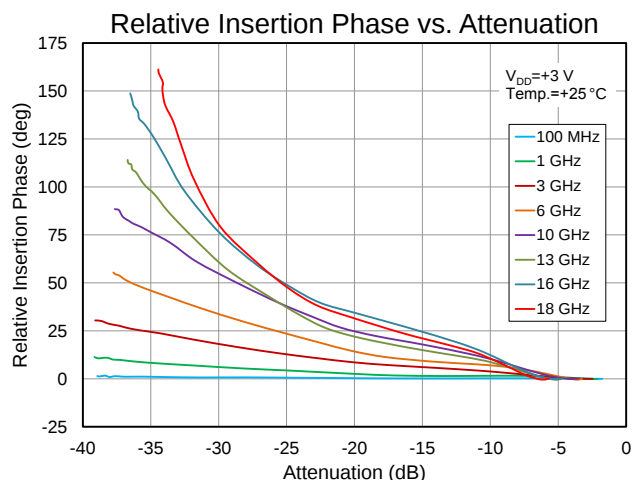
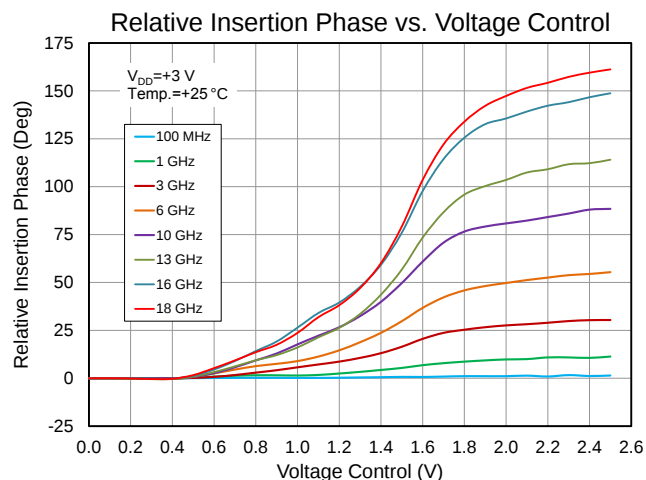
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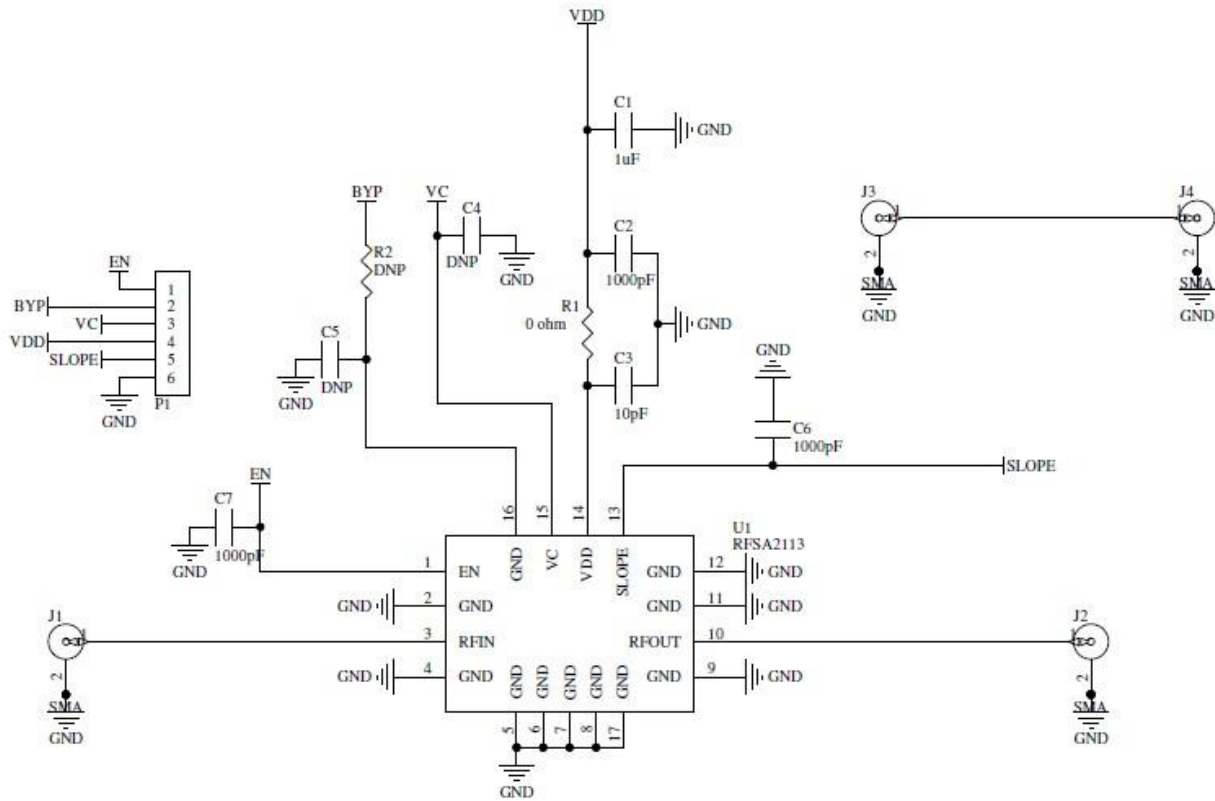


## Measured Negative Attenuation Slope Performance

Test conditions unless otherwise noted:  $V_{DD}=+3\text{ V}$ ,  $\text{Temp}=+25\text{ }^{\circ}\text{C}$ , includes PCB and connector losses.



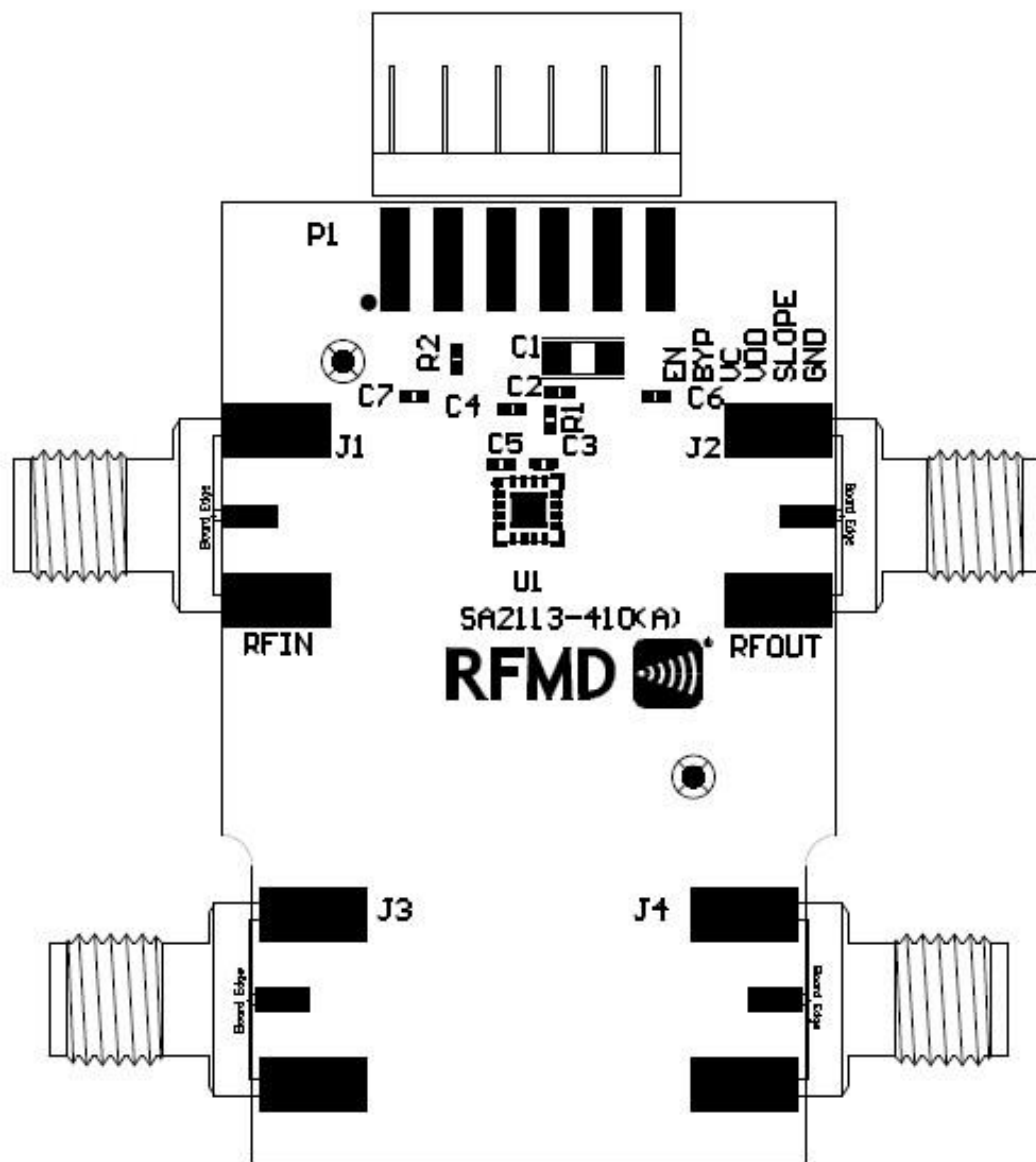
## Evaluation Board Schematic



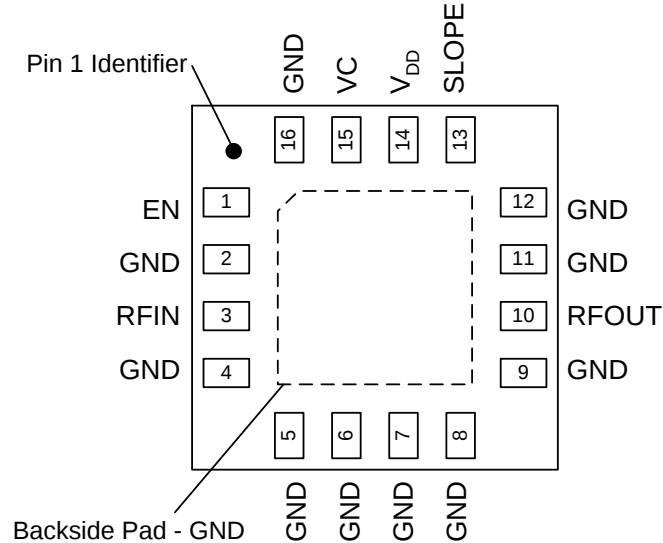
## Evaluation Board Bill of Material

| Ref. Des. | Value      | Description                          | Manuf.             | Part Number        |
|-----------|------------|--------------------------------------|--------------------|--------------------|
| U1        | n/a        | Voltage Controlled Attenuator VCA    | Qorvo              | RFSA2113           |
| J1-J4     | n/a        | CONN, SMA, END LNCH, RND PIN, 0.039" | Gigalane Co., Ltd. | PSF-S01-002        |
| P1        | n/a        | CONN, HDR, ST, 6-PIN, 0.100", T/H    | Molex              | 22-28-4063         |
| n/a       | n/a        | SA2113-410 Evaluation Board          | DDI                | SA2113-410(A)      |
| C2, C6-C7 | 1000 pF    | CAP, 10%, 25V, X7R, 0402             | Murata Electronics | GRM155R71H102KA01D |
| C1        | 1 $\mu$ F  | CAP, 10%, 16V, X7R, 1206             | Murata Electronics | GRM31MR71E105KC01L |
| C3        | 10 pF      | CAP, 5%, 50V, C0G, 0402              | Murata Electronics | GRM1555C1H100JZ01E |
| R1        | 0 $\Omega$ | RES, 0402                            | Kamaya, Inc        | RMC1/16SJPTH       |
| R2        | -          | DNP                                  |                    |                    |
| C4-C5     | -          | DNP                                  |                    |                    |

## Evaluation Board Assembly Drawing

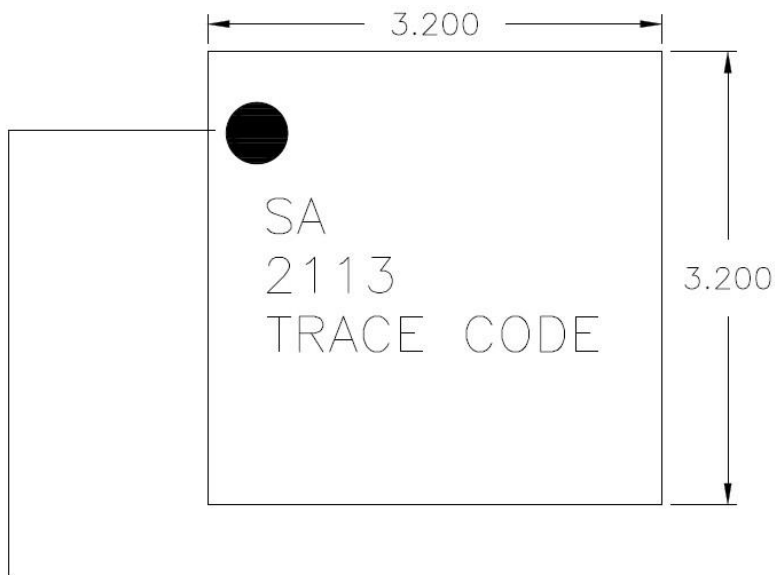
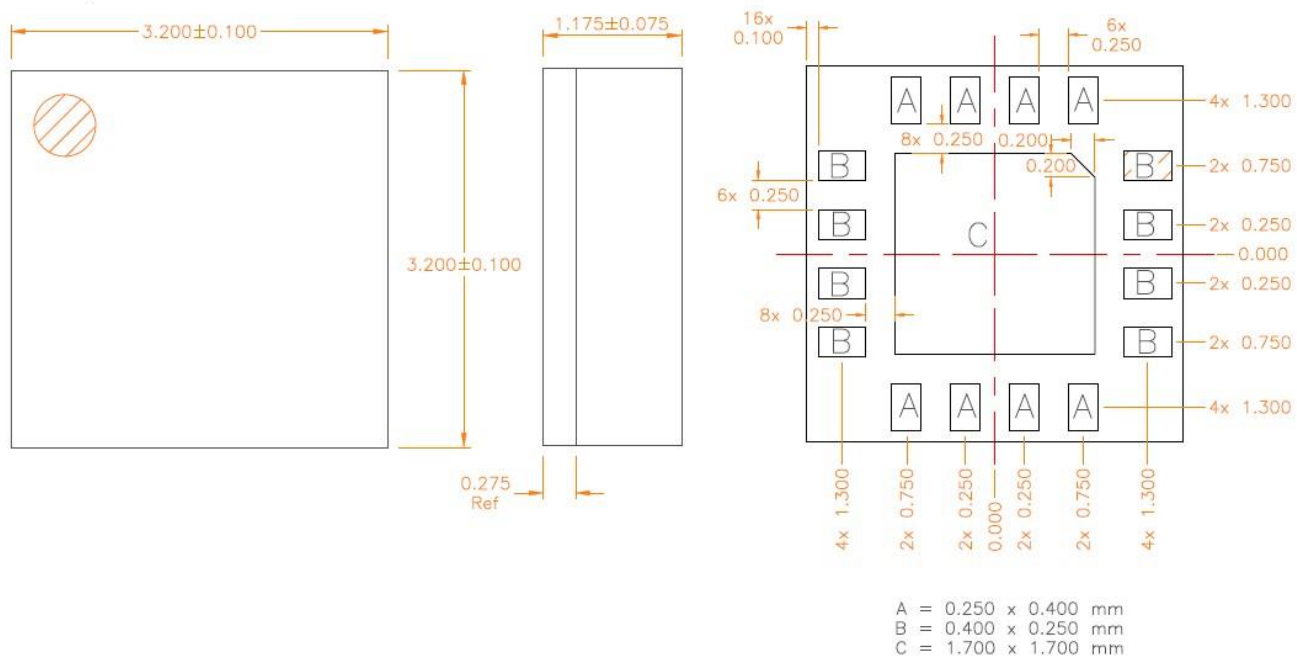


## Pin Configuration and Description



| Pin No.      | Label     | Description                                                                                                                                          |
|--------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1            | EN        | Supply Current Enable Control. Connect to Logic Low to Enable. Connect to Logic High to Disable                                                      |
| 2            | GND       | Ground Pin                                                                                                                                           |
| 3            | RFIN      | RF Input. Use External DC Block. RF input must be this pin to ensure linearity and thermal resistance specifications.                                |
| 4            | GND       | Ground Pin                                                                                                                                           |
| 5            | GND       | Ground Pin                                                                                                                                           |
| 6            | GND       | Ground Pin                                                                                                                                           |
| 7            | GND       | Ground Pin                                                                                                                                           |
| 8            | GND       | Ground Pin                                                                                                                                           |
| 9            | GND       | Ground Pin                                                                                                                                           |
| 10           | RFOUT     | RF Output. Use External DC Block. RF output must be this pin to ensure linearity and thermal resistance specifications.                              |
| 11           | GND       | Ground Pin                                                                                                                                           |
| 12           | GND       | Ground Pin                                                                                                                                           |
| 13           | SLOPE     | Attenuation Slope Control<br>Connect to Logic Low to Enable Negative Attenuation Slope<br>Connect to Logic High to Enable Positive Attenuation Slope |
| 14           | VDD       | DC Supply                                                                                                                                            |
| 15           | VC        | Voltage Control                                                                                                                                      |
| 16           | GND       | Ground Pin                                                                                                                                           |
| Backside Pad | RF/DC GND |                                                                                                                                                      |

## Package Marking and Dimensions



Pin 1 Indicator

## Handling Precautions

| Parameter                        | Rating   | Standard                 |
|----------------------------------|----------|--------------------------|
| ESD – Human Body Model (HBM)     | Class 1C | ESDA / JEDEC JS-001-2012 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC JESD22-C101F       |
| MSL – Moisture Sensitivity Level | Level 3  | IPC/JEDEC J-STD-020      |



Caution!  
ESD-Sensitive Device

## Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes. Solder profiles available upon request.

Contact plating: Refer to Manufacturing Notes Document

## RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free



## Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

Web: [www.qorvo.com](http://www.qorvo.com)

Tel: 1-844-890-8163

Email: [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

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