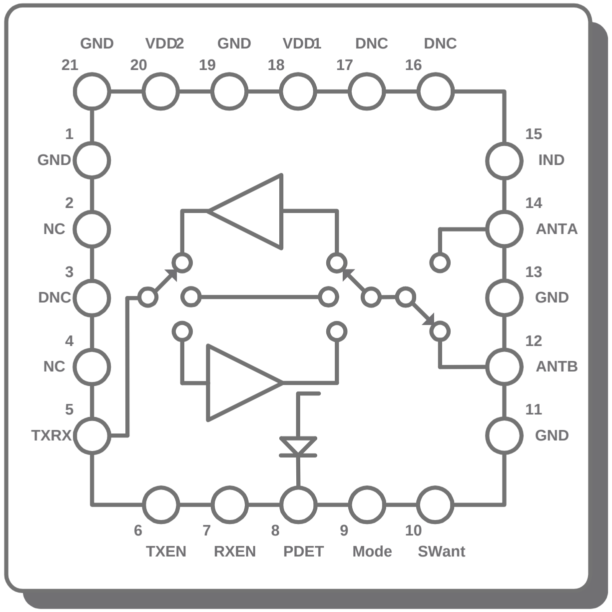
RFX2411N Single-Chip CMOS RFeIC with PA, LNA, Antenna Switch, Combined TX/RX Transceiver Port, Input Port to Antenna Port Bypass Mode, and Diversity Switch

Evaluation Board Results
Summary & Technical Notes

RFX2411N RFeIC Key Features and Benefits

3x3x0.55mm
20L QFN



RFX2411N Differentiating Features

- Integration of PA, LNA, Tx-Rx Switching Circuitry, Associated Matching Network, Harmonic Filter, PA Power Detection Circuit and Diversity switch all in a Single-Chip, Single-Die pure CMOS Solution
- Greatly Reduced and Simplified Tx/Rx Control
- Low Voltage Battery Operation down to 2.0V
- Digital Logic with 1.2V Turn-On Voltage
- No Vref Regulator for Biasing
- Common Tx/Rx Port Saves Additional SPDT
- Requires Minimal External Components
- Small, Ultra-Thin 3x3x0.55mm 20L QFN Package

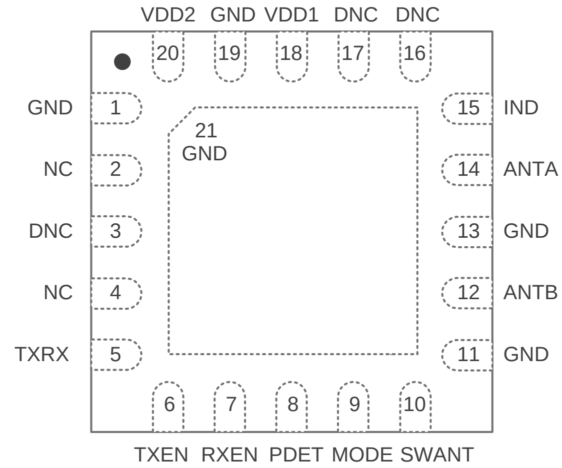
APPLICATIONS

- 802.15.4 ZigBee Extended Range Devices
- ZigBee Smart Power
- Bluetooth Low Energy
- RF4CE Remote Control
- Wireless Sensor Networks
- Other 2.4GHz ISM Band Systems

RFX2411N Customer Benefits

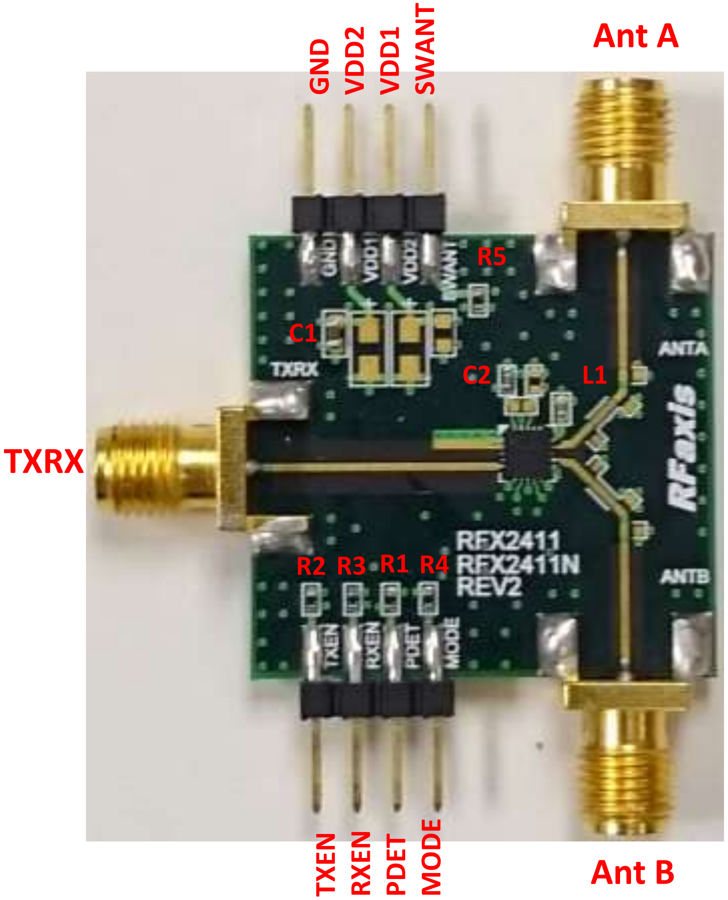
- Greatly Simplified, 50 Ohm “Plug & Play” PCB Implementation
- Small Form-Factor and Quick Design Cycle
- Simplest Approach to Improve Link Performance including Range and Receiver Sensitivity
- Very Low BOM Cost and Competitive Price

RFX2411N Pin Description



Pin Number	Pin Name	Description
1, 11,13, 19, 21	GND	Ground – Must be connected to Ground in the Application Circuit
2, 4	NC	No Internal Connection
5	TXRX	RF signal to/from the Transceiver; DC shorted to GND
6	TXEN	CMOS Input to Control TX Enable
7	RXEN	CMOS Input to Control RX Enable
8	PDET	Analog Voltage Proportional to the PA Power Output
9	MODE	CMOS Input to control mode of operation
10	SWANT	CMOS Input to select antenna for diversity
12	ANTB	RF Signal from the PA or RF Signal Applied to the LNA; DC Shorted to GND
14	ANTA	RF Signal from the PA or RF Signal Applied to the LNA; DC Shorted to GND
15	IND	Inductor to GND
3, 16, 17	DNC	Reserved – Do Not Connect in the Application Circuit
18	VDD1	Voltage Supply Connection (Internally Connected to Pin 20)
20	VDD2	Voltage Supply Connection

RFX2411N Evaluation Board and Preliminary BOM



VDD = 3.3V Nominal; Operational from 3.6V to 1.8V

VDD decoupling:
C1 =1.0uF
C2 =220pF

Detector Loading:
R1 = 10Kohm

Digital Control Protection:
R2, R3, R4, R5 = 10Kohm (Recommended for control lines to protect input circuits from over voltage).
Control lines TXEN, RXEN, MODE, and SWANT have on-die 1Mohm pull down resistors.

For Harmonic Suppression:
L1=2.0nH Murata LQP03 Series
(Inductor value may need to be optimized in final application circuit for layout dependency)
Additional filtering may be required for compliance depending on system configuration and application.

Eval PCB Information:
- 4-Layer Stack, 10mil/40mil/10mil
- FR4 with εr=4.5, tan δ = 0.02 (typ.)

Antenna Selection

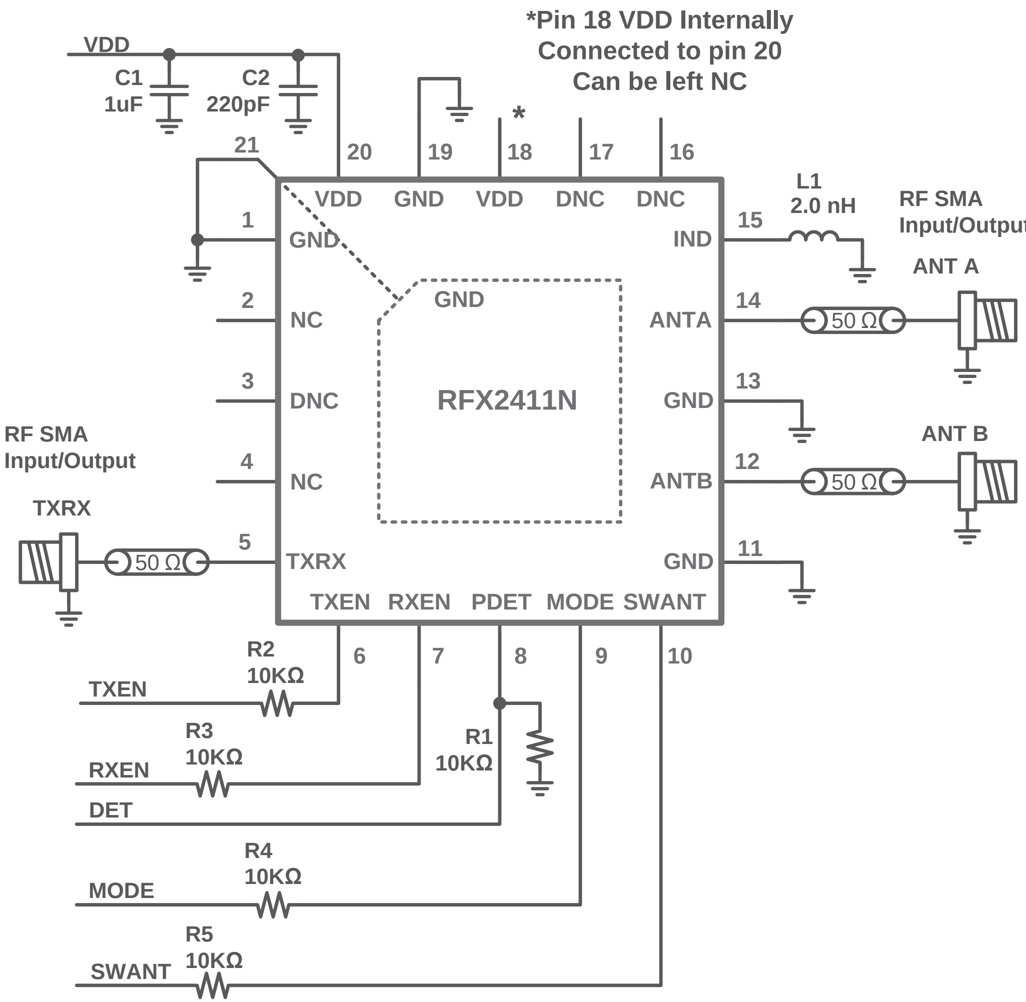
SWant	Mode of Operation
1	ANTA port enabled
0	ANTB port enabled

Control Logic Truth Table

TXEN	RXEN	MODE	Mode of Operation
0	0	0	Shutdown Mode
X	X	1	Bypass Mode
1	X	0	Transmit Mode
0	1	0	Receive Mode

Note: “1” denotes high voltage state (> 1.2V) at Control Pins
“0” denotes low voltage state (< 0.3V) at Control Pins
“X” denotes do not care: either “1” or “0” can be applied

RFX2411N Application Test Circuit



Tested Report BOM:

R1 – R5=10K
C1=1.0uF
C2=220pF
L1=2.0nH Murata LQP03 Series

Notes:

- L1 can be optimized for final design configuration
- R2, R3, R4, R5 on the control lines are recommended in the system implementation to protect the input circuits from damaging over-voltage spikes

RFX2411N Eval Board De-Embedding and Iq Table

EVB Signal Loss De-Embedding

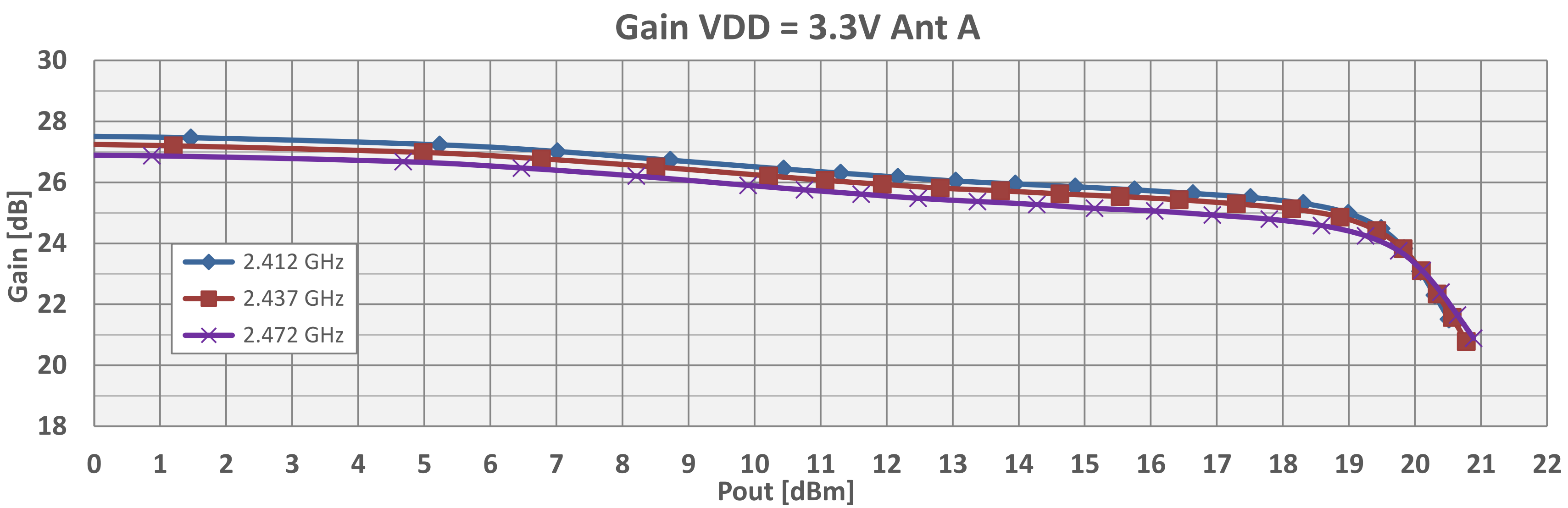
Total EVB Loss Includes the Trace and Connector
All measurements have this loss de-embedded

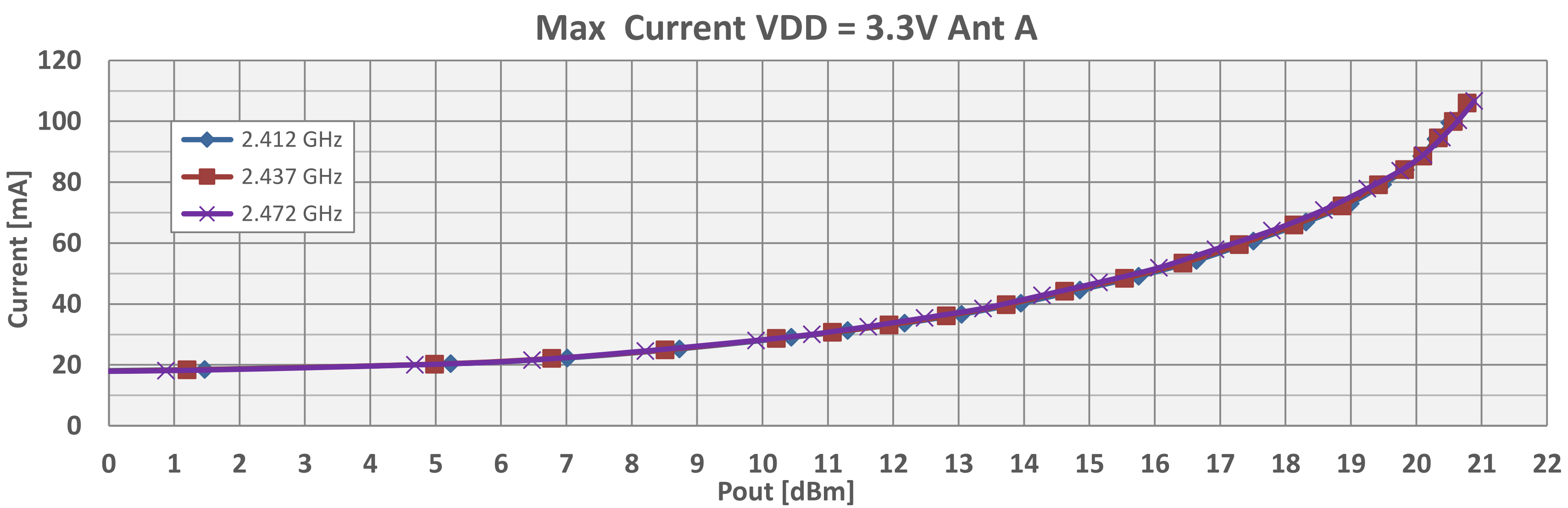
RF Port	Loss
ANT A	.25 dB
ANT B	.25 dB
TXRX	.25 dB

Iq Across VDD

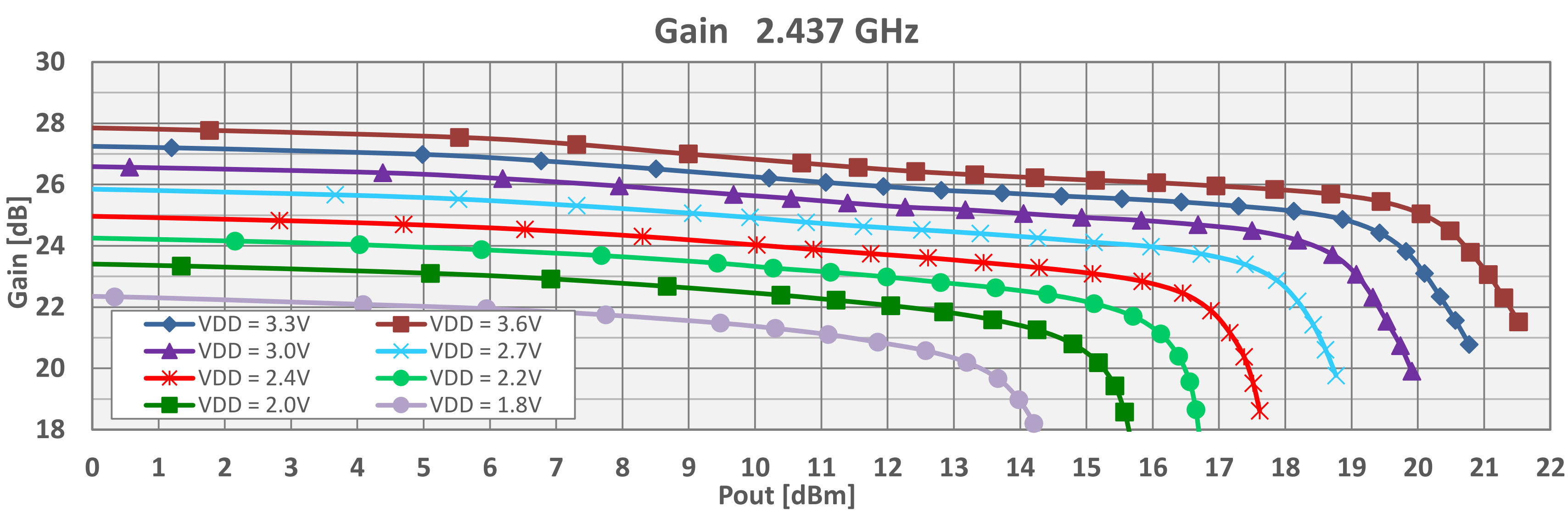
Mode	3.6V	3.3V	3.0V	2.7V	2.4V	2.2V	2.0V	1.8V
TX	21 mA	20 mA	19 mA	18 mA	17 mA	16 mA	16 mA	15 mA
RX	8 mA	8 mA	8 mA	8 mA	7 mA	7 mA	7 mA	6 mA
Bypass	<1uA	<1uA	<1uA	<1uA	<1uA	<1uA	<1uA	<1uA

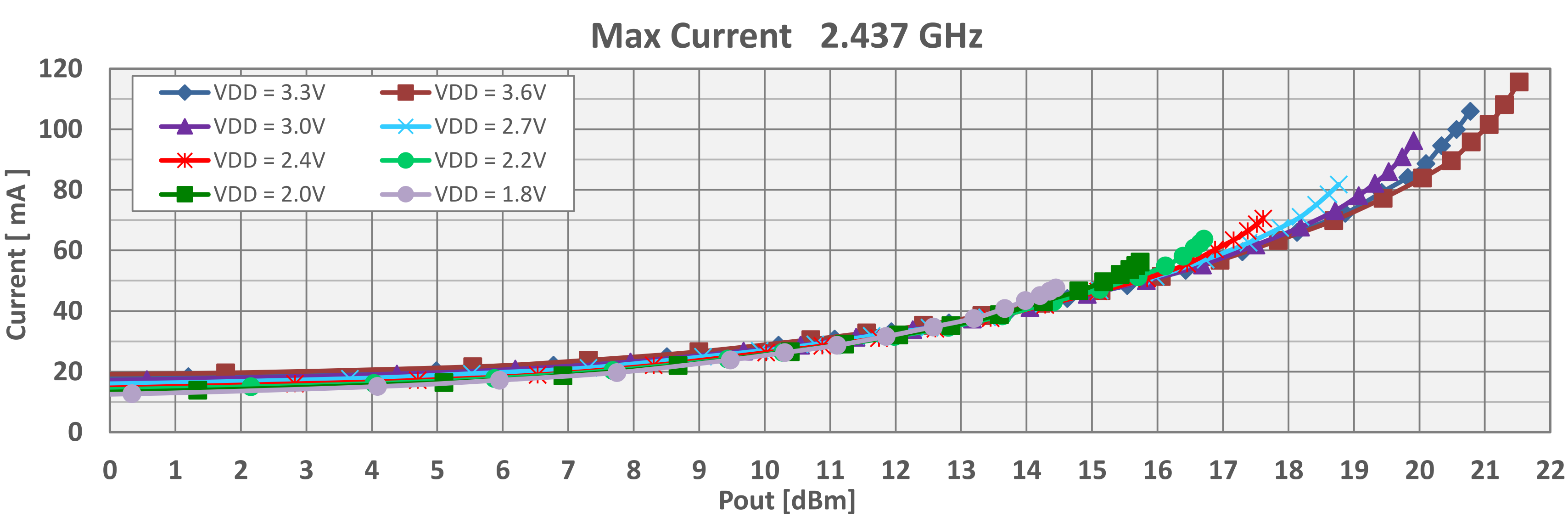
TX Gain & Current vs. Pout Across Frequency
Antenna A, CW Signal



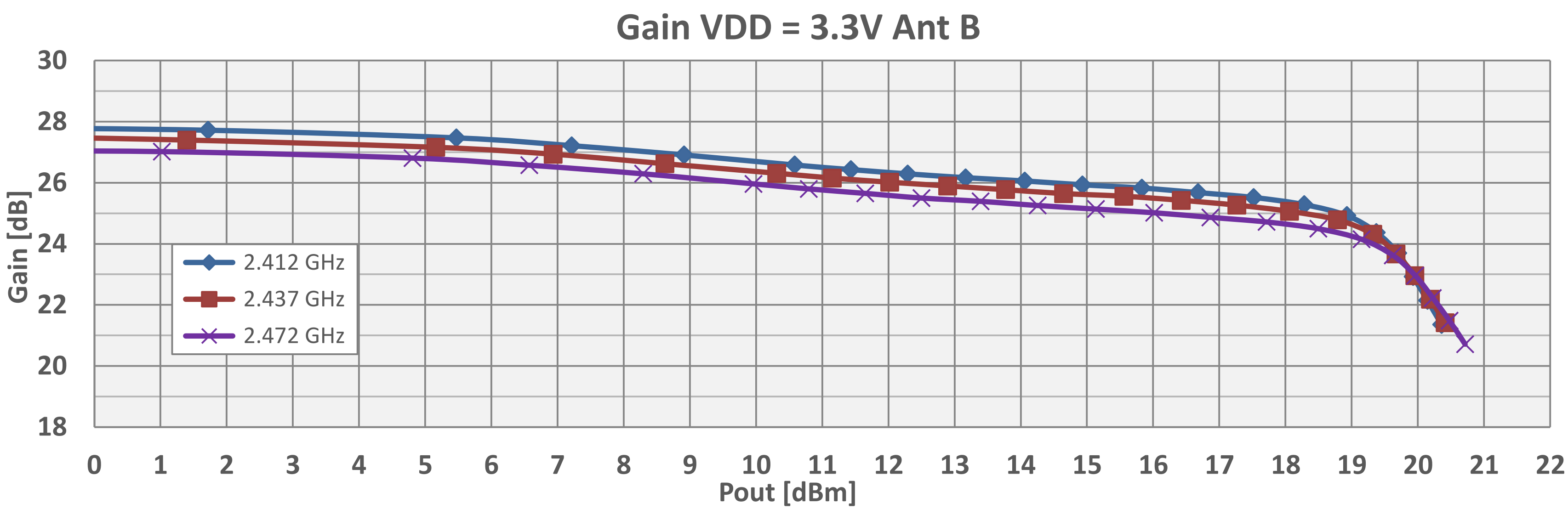


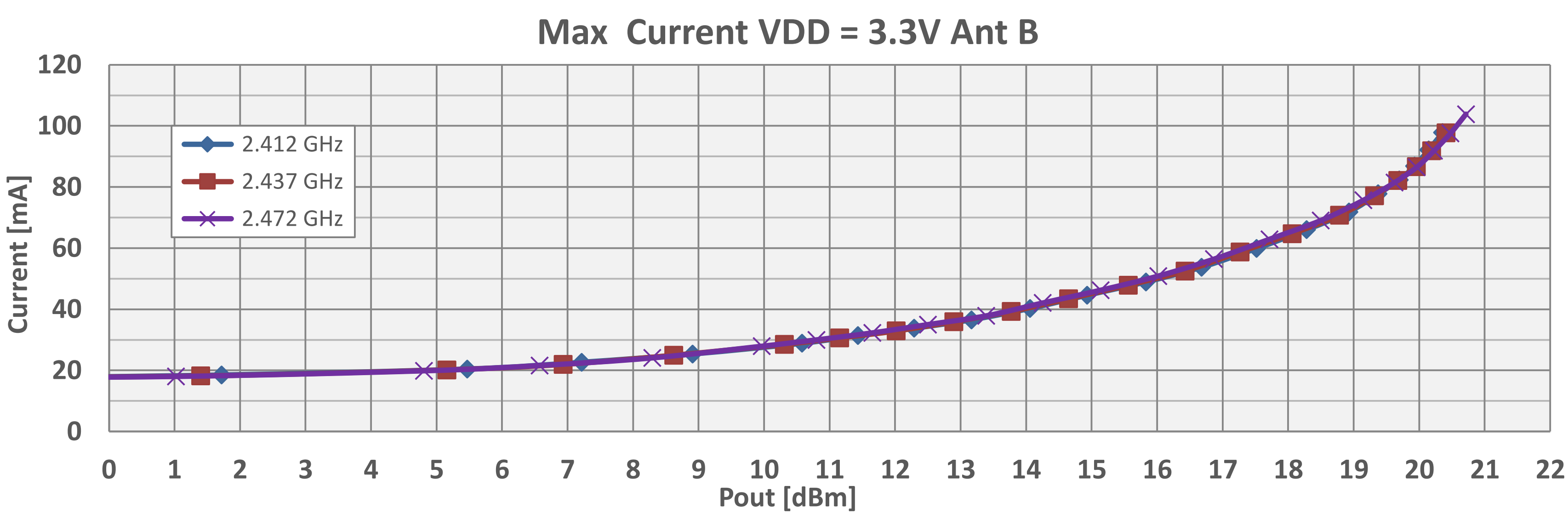
TX Gain & Current vs. Pout Across Voltage
2.437 GHz, Antenna A, CW Signal



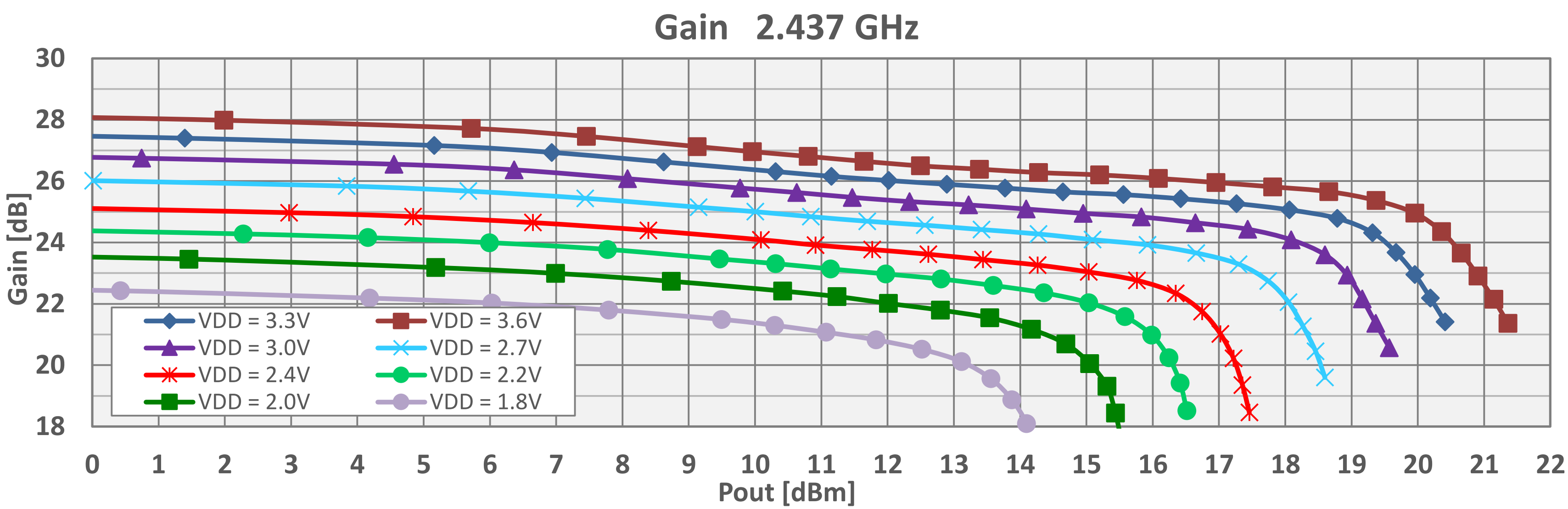


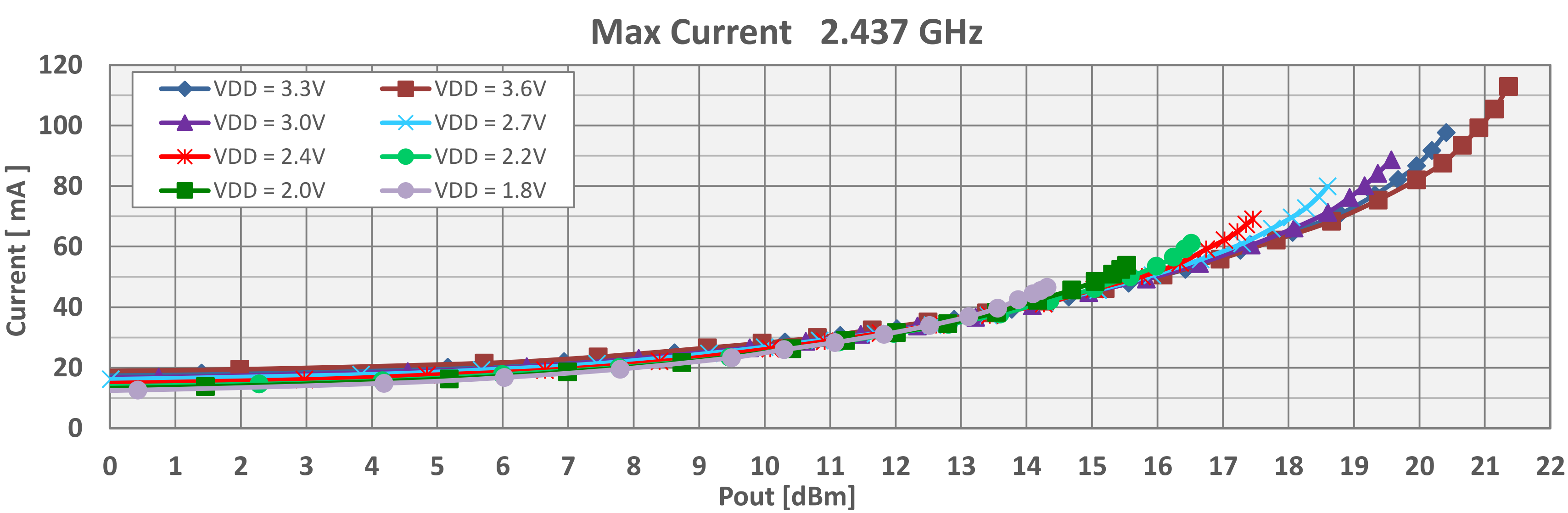
TX Gain & Current vs. Pout Across Frequency
Antenna B, CW Signal



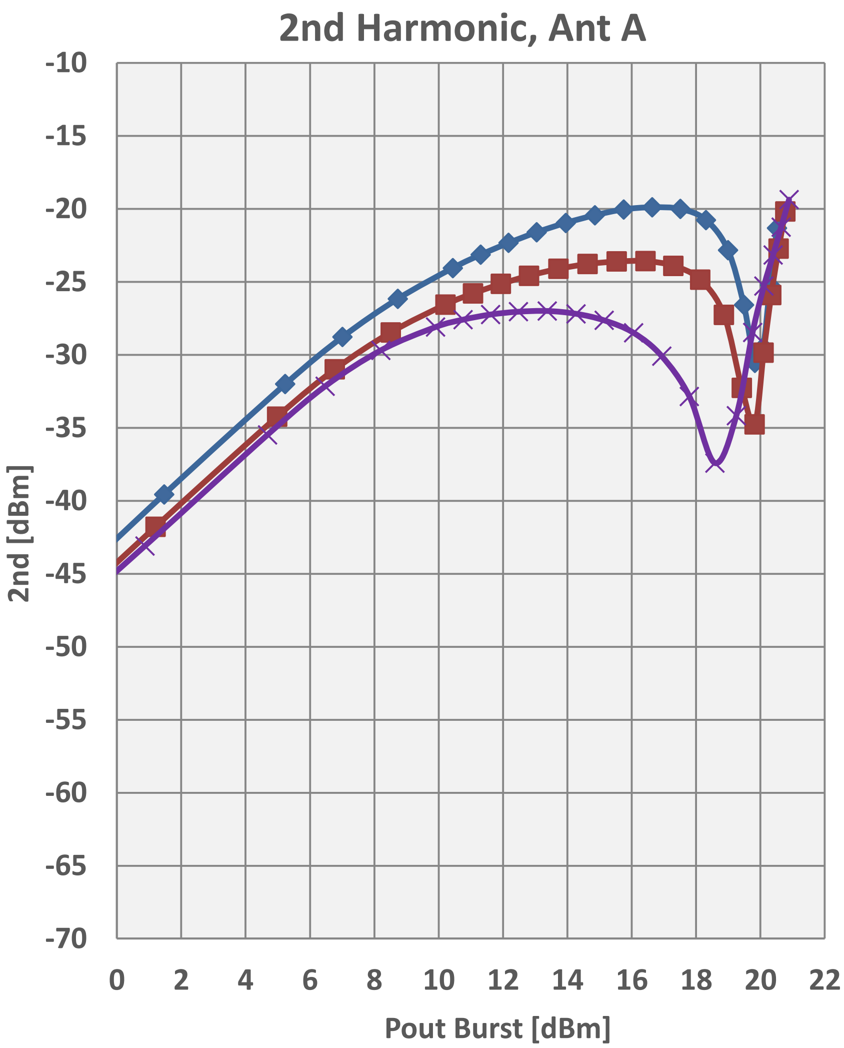


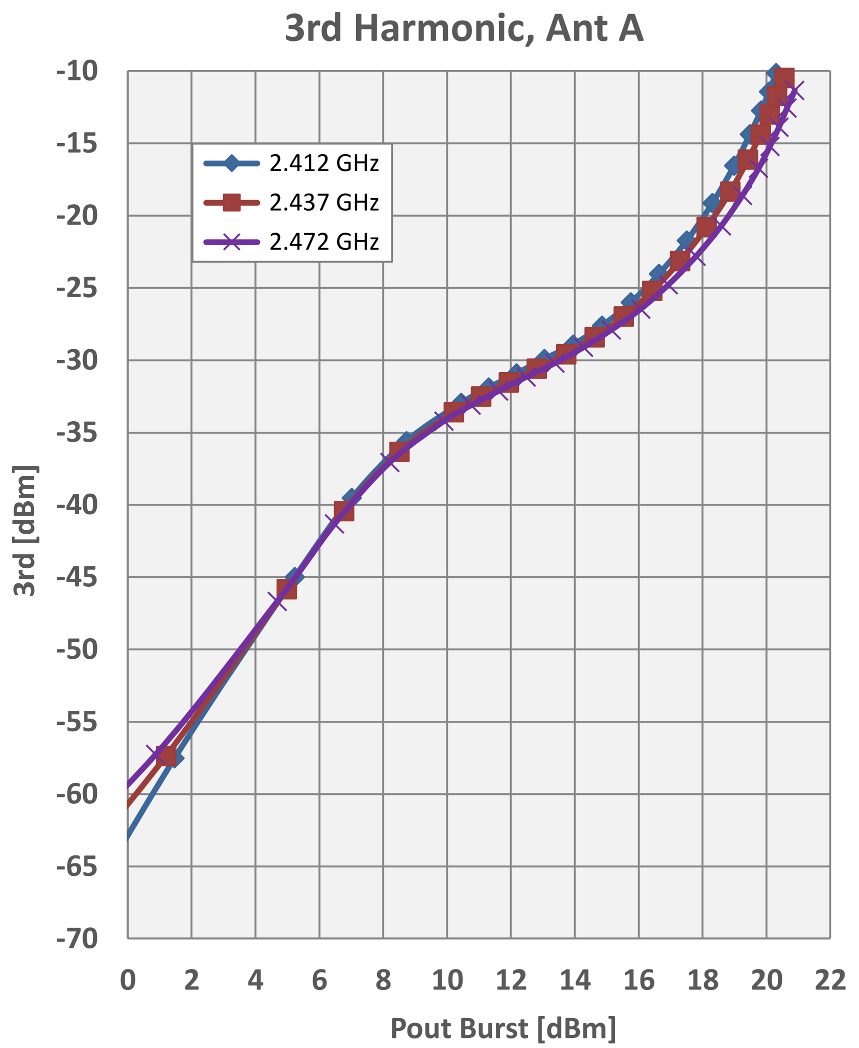
TX Gain & Current vs. Pout Across Voltage
2.437 GHz, Antenna B, CW Signal



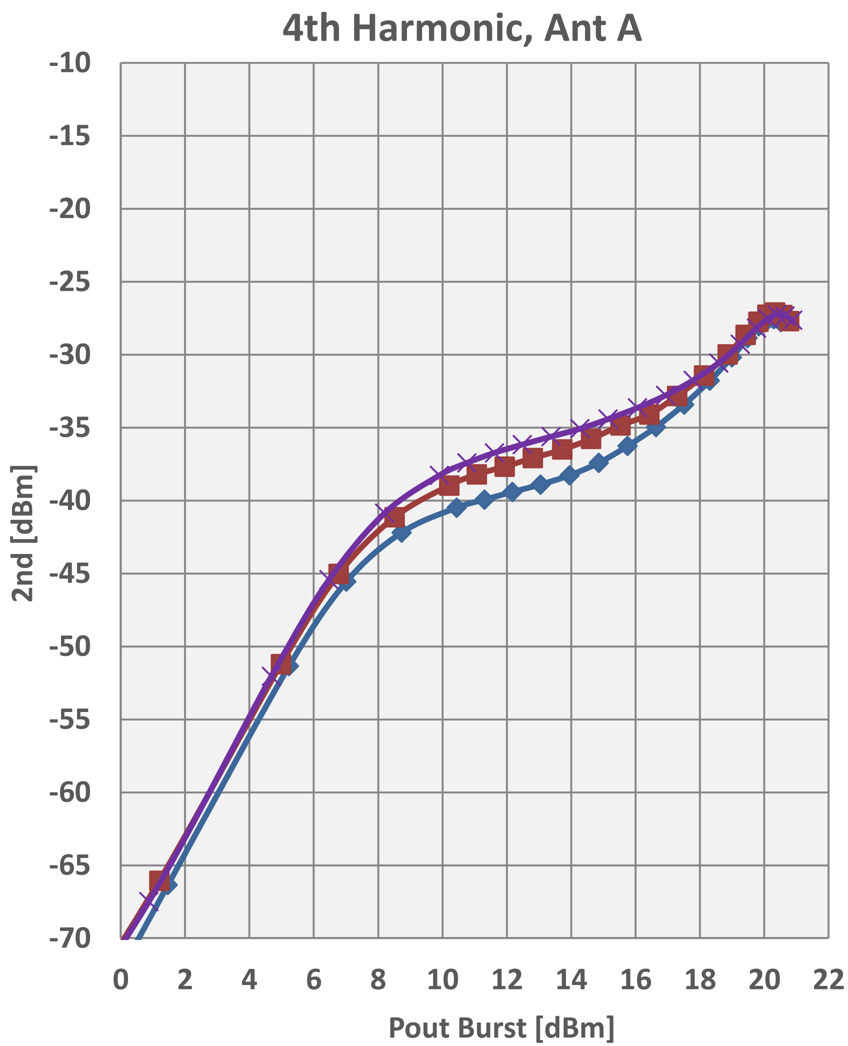


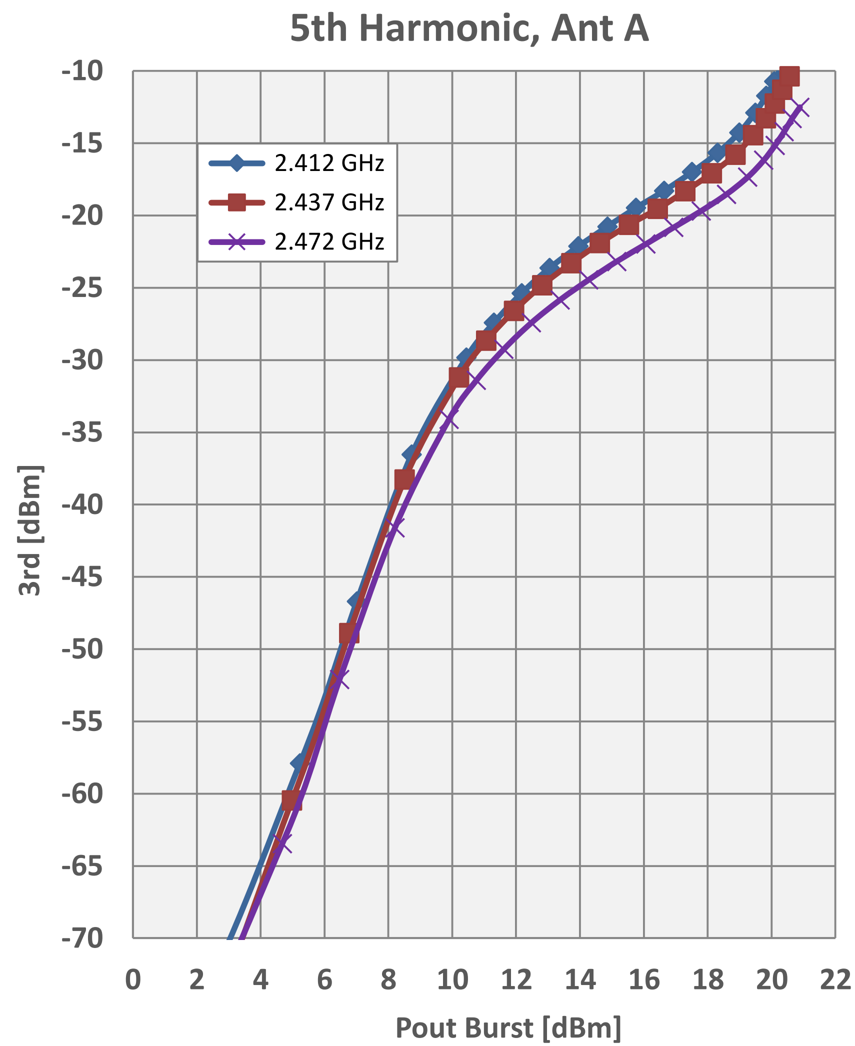
TX 2nd and 3rd Harmonics vs. Pout Across Frequency
Antenna A, VDD = 3.3V, CW Signal



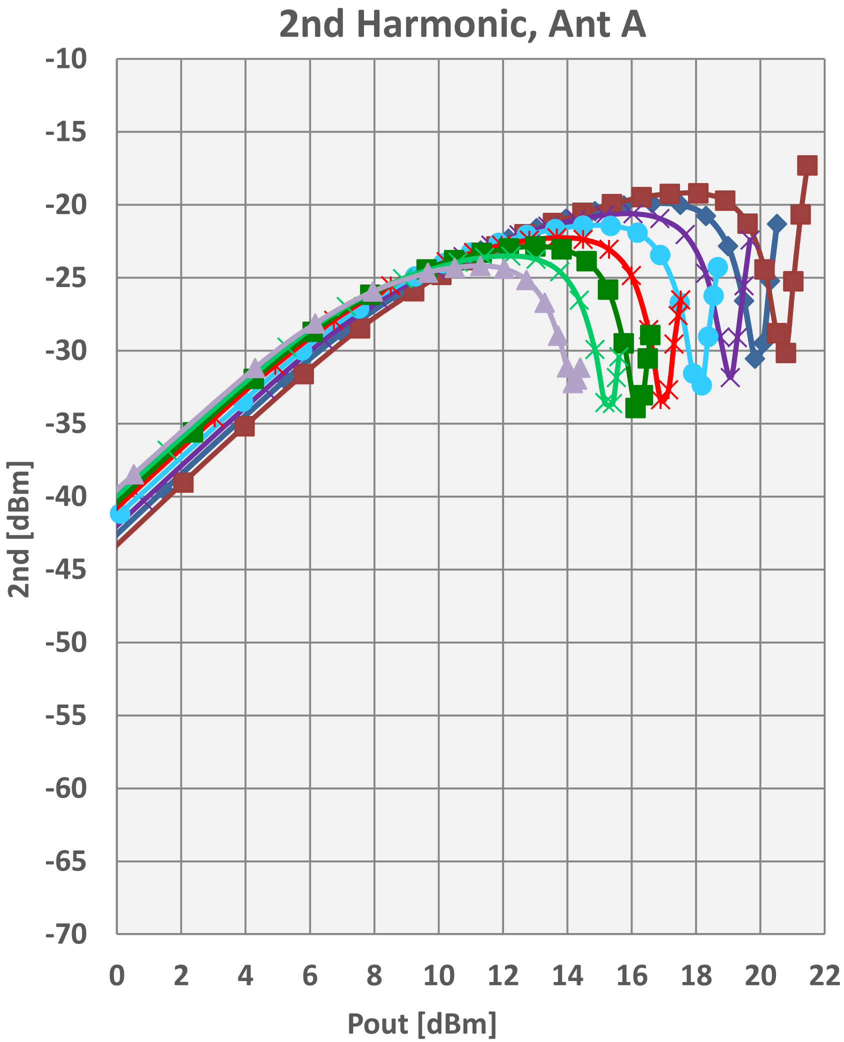


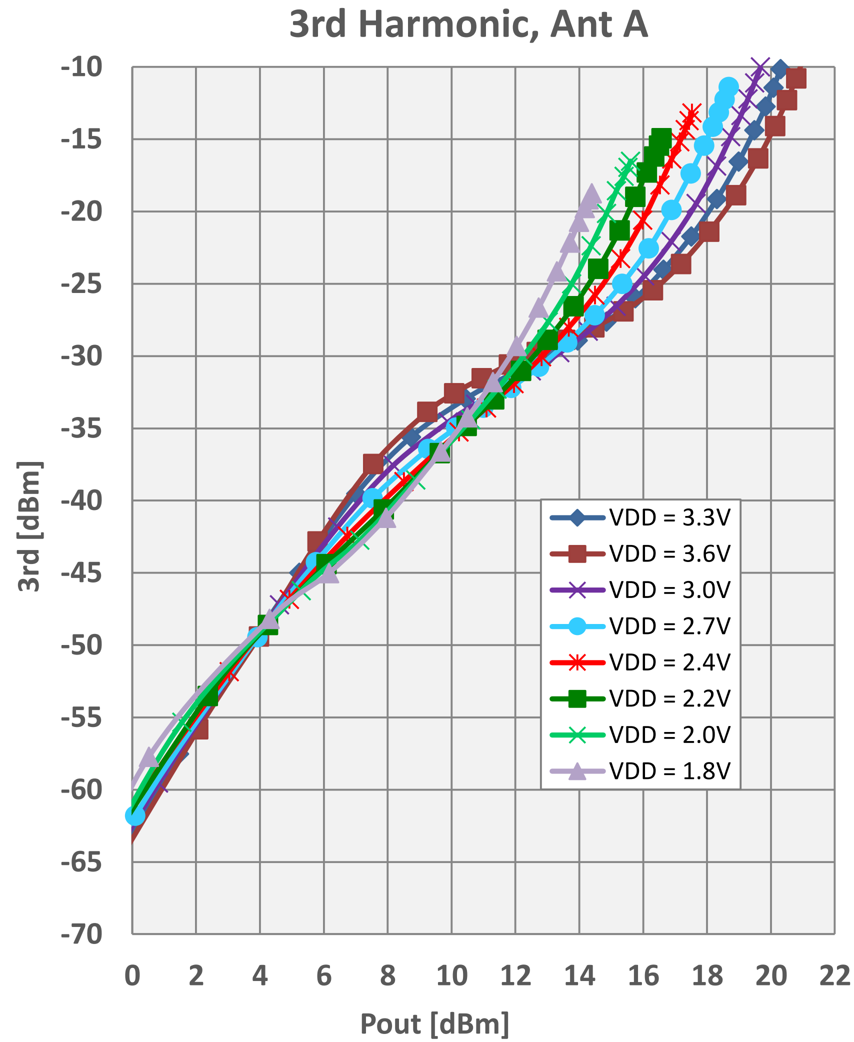
TX 4th and 5th Harmonics vs. Pout Across Frequency Antenna A, VDD = 3.3V, CW Signal





TX 2nd and 3rd Harmonics vs. Pout Across Voltage
2.412 GHz, Antenna A, CW Signal





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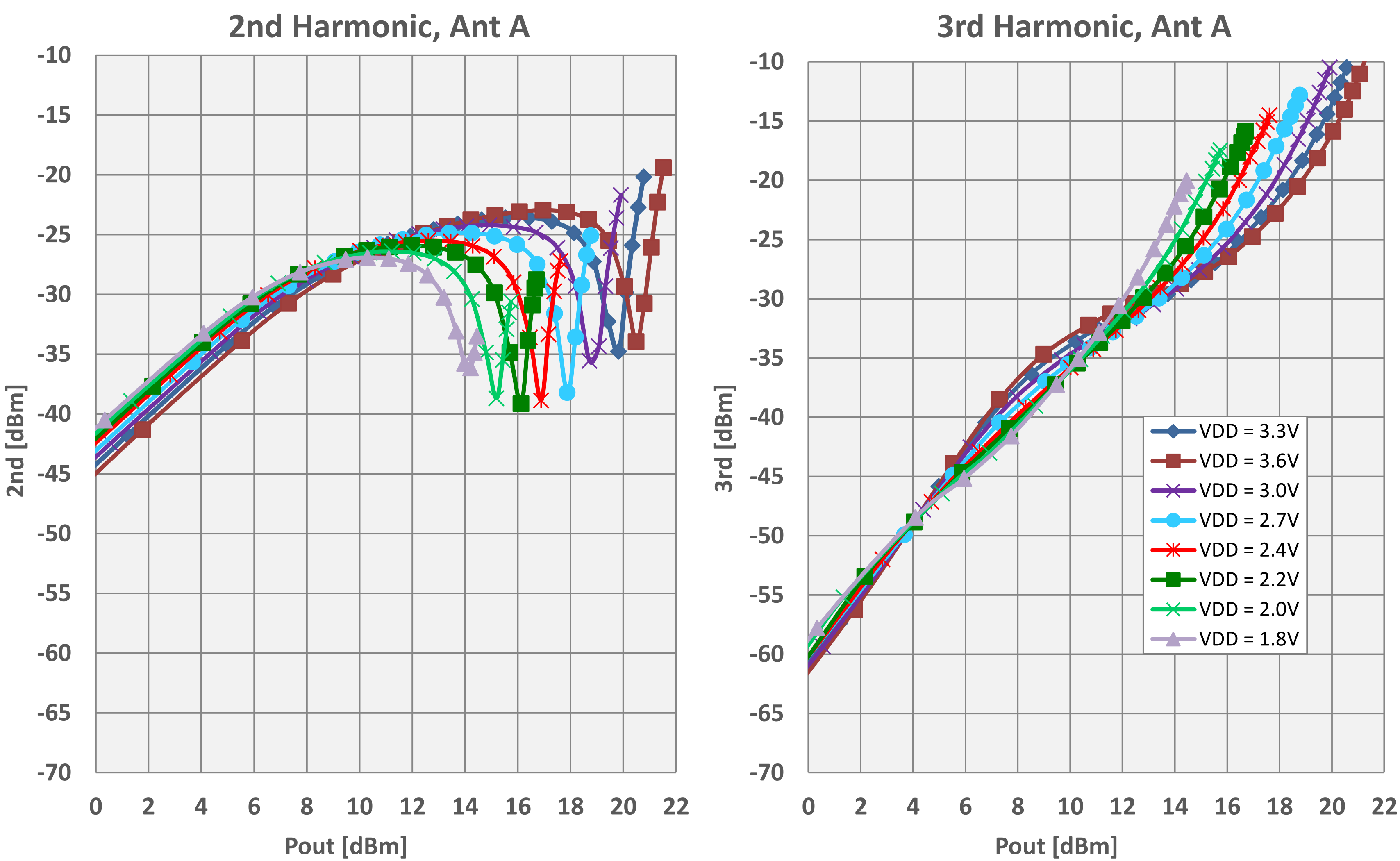
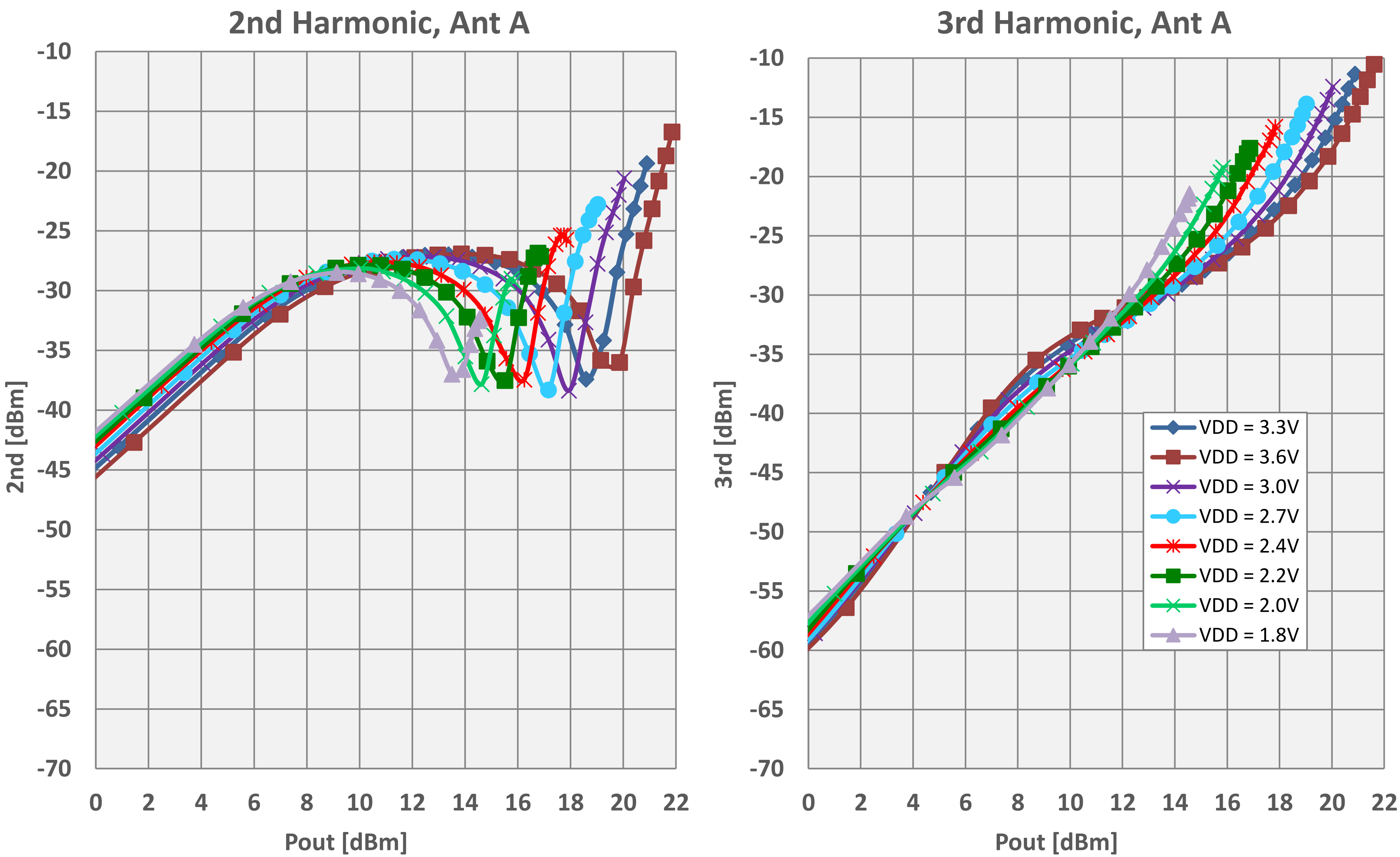
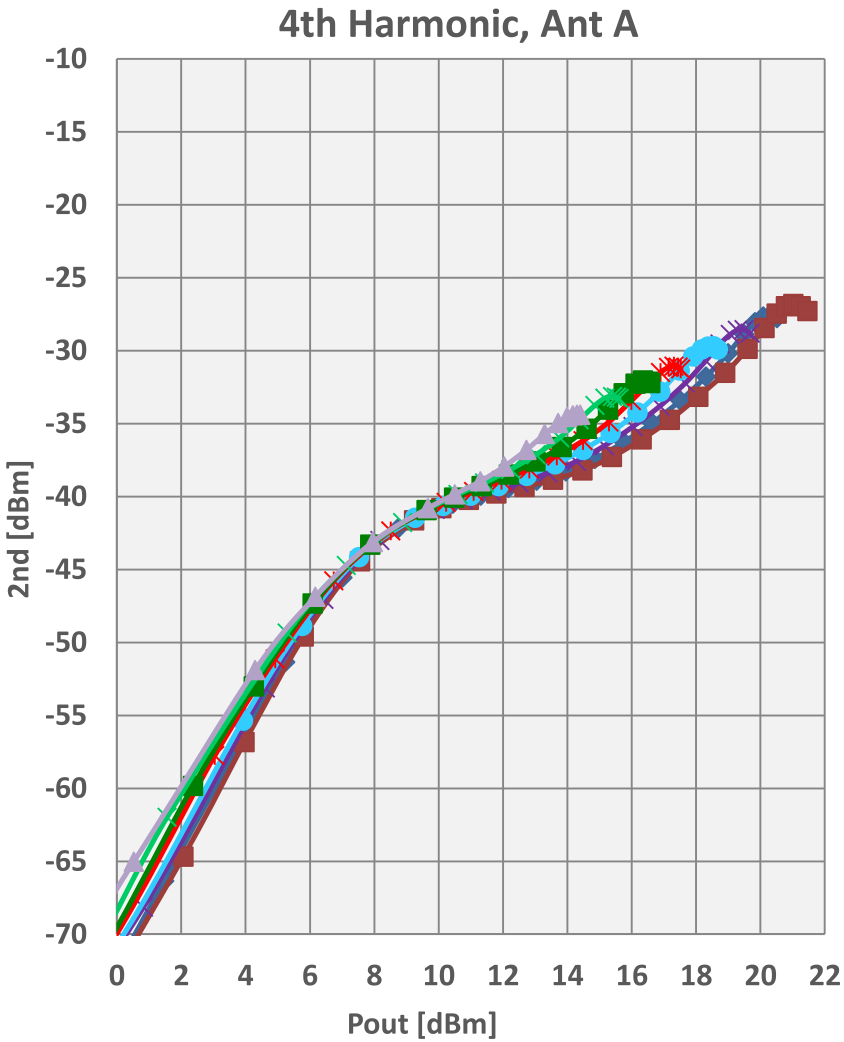
2.437 GHz, Antenna A, CW Signal

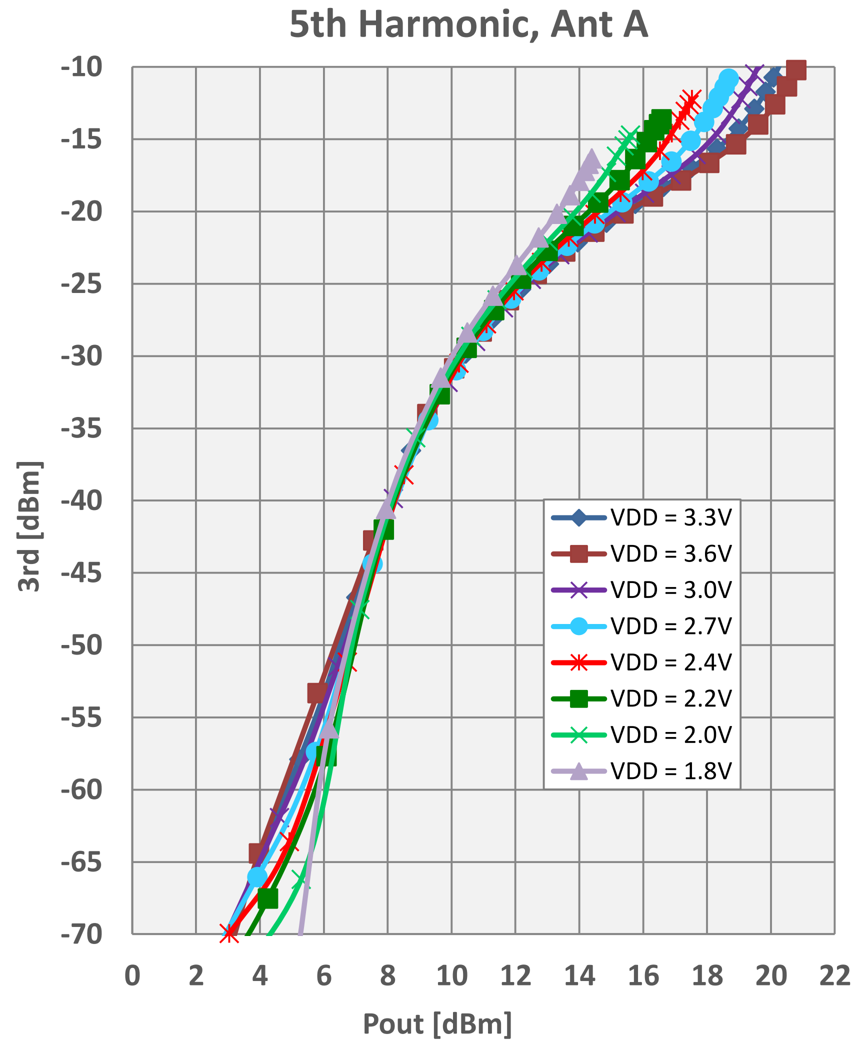


TX 2nd and 3rd Harmonics vs. Pout Across Voltage
2.472 GHz, Antenna A, CW Signal



TX 4th and 5th Harmonics vs. Pout Across Voltage
2.412 GHz, Antenna A, CW Signal





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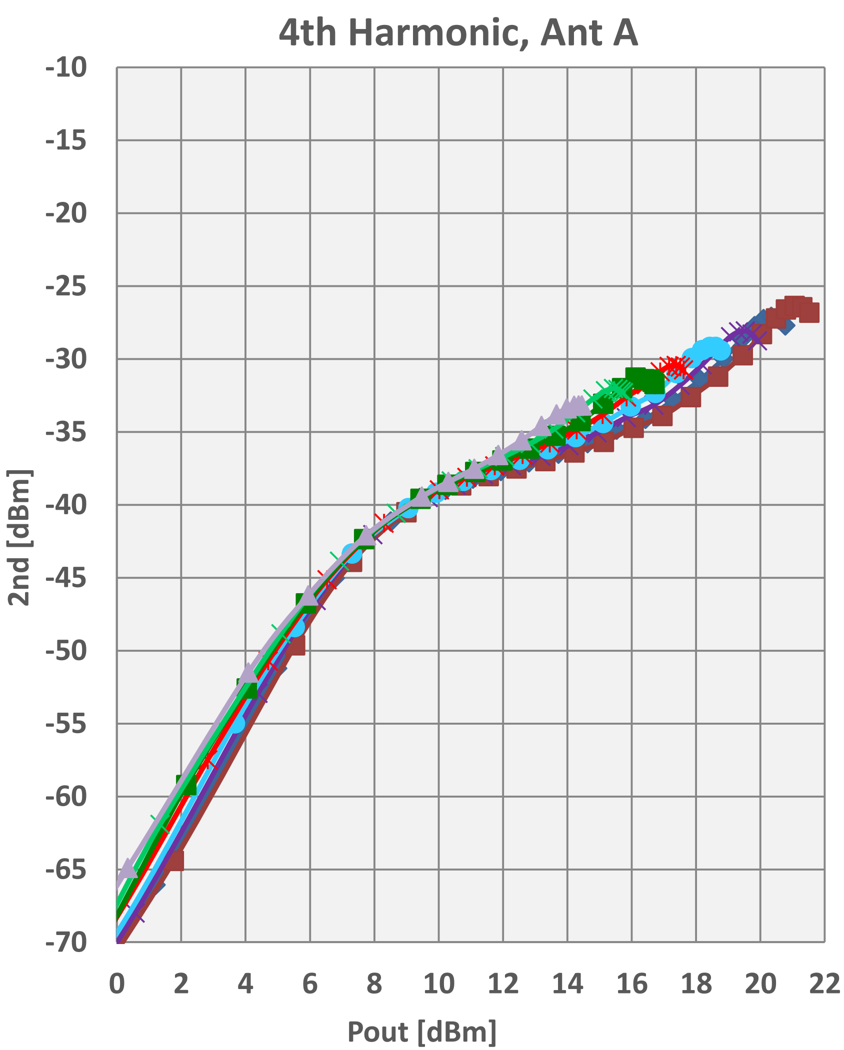
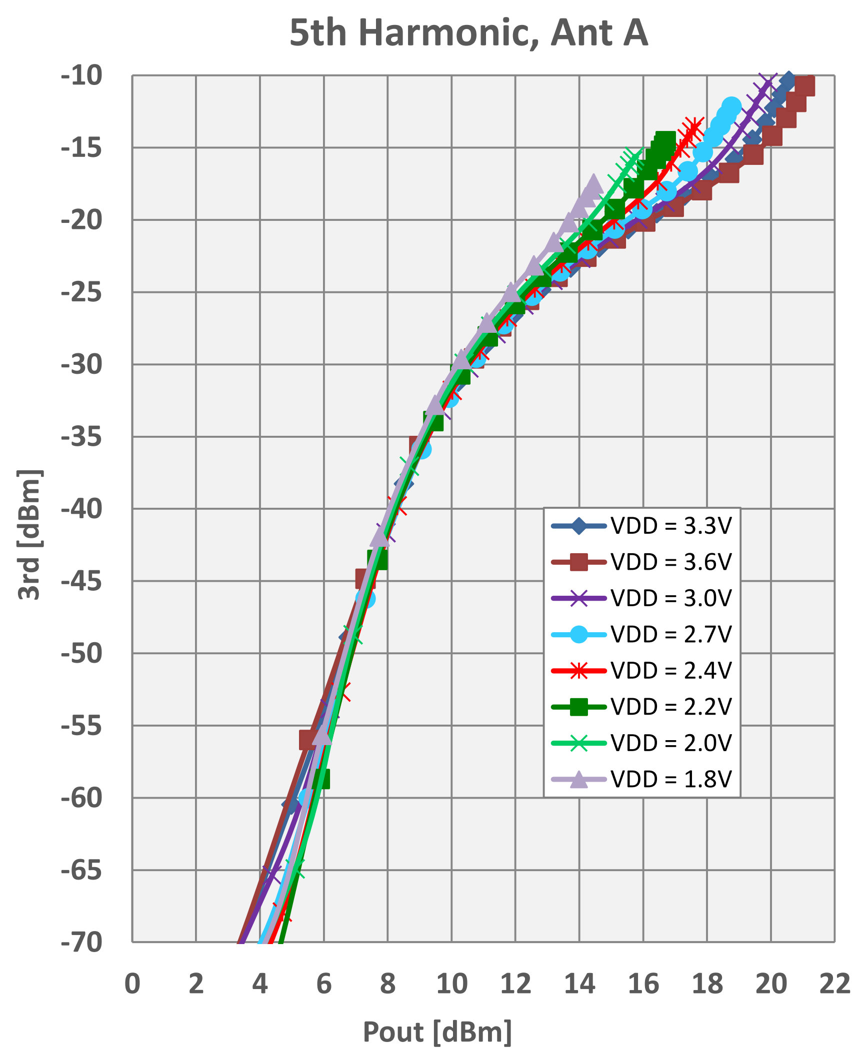
2.437 GHz, Antenna A, CW Signal





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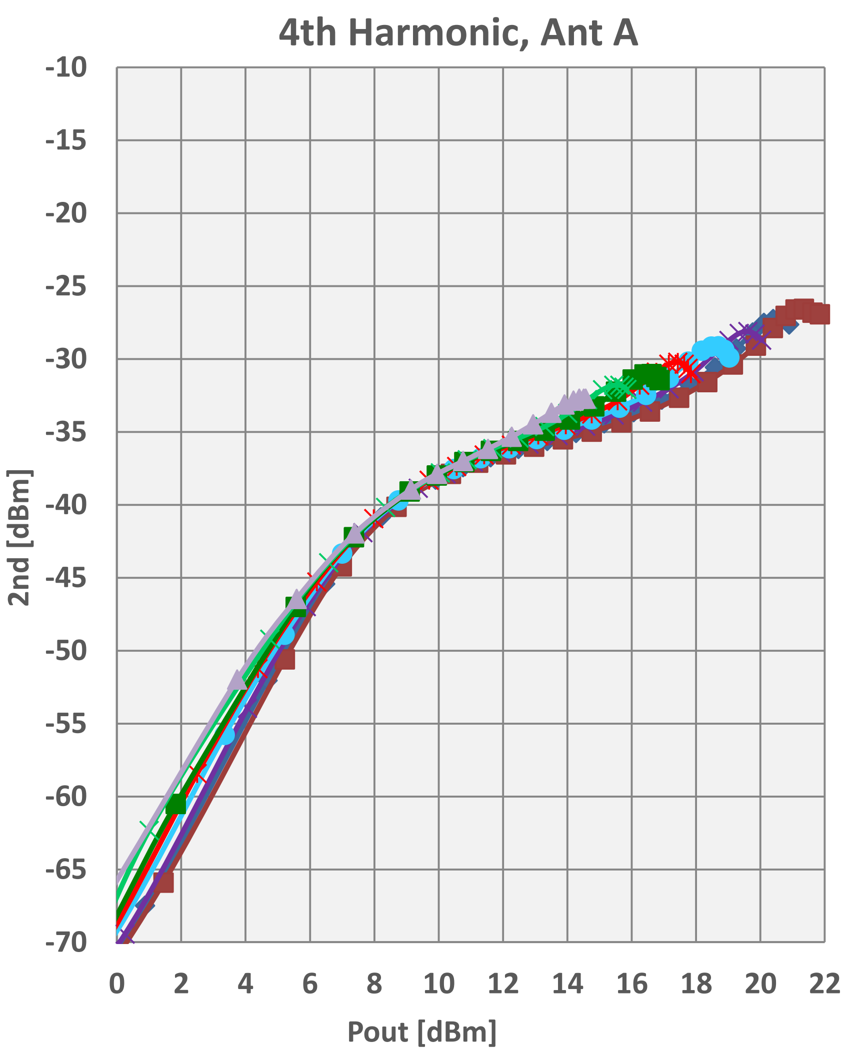
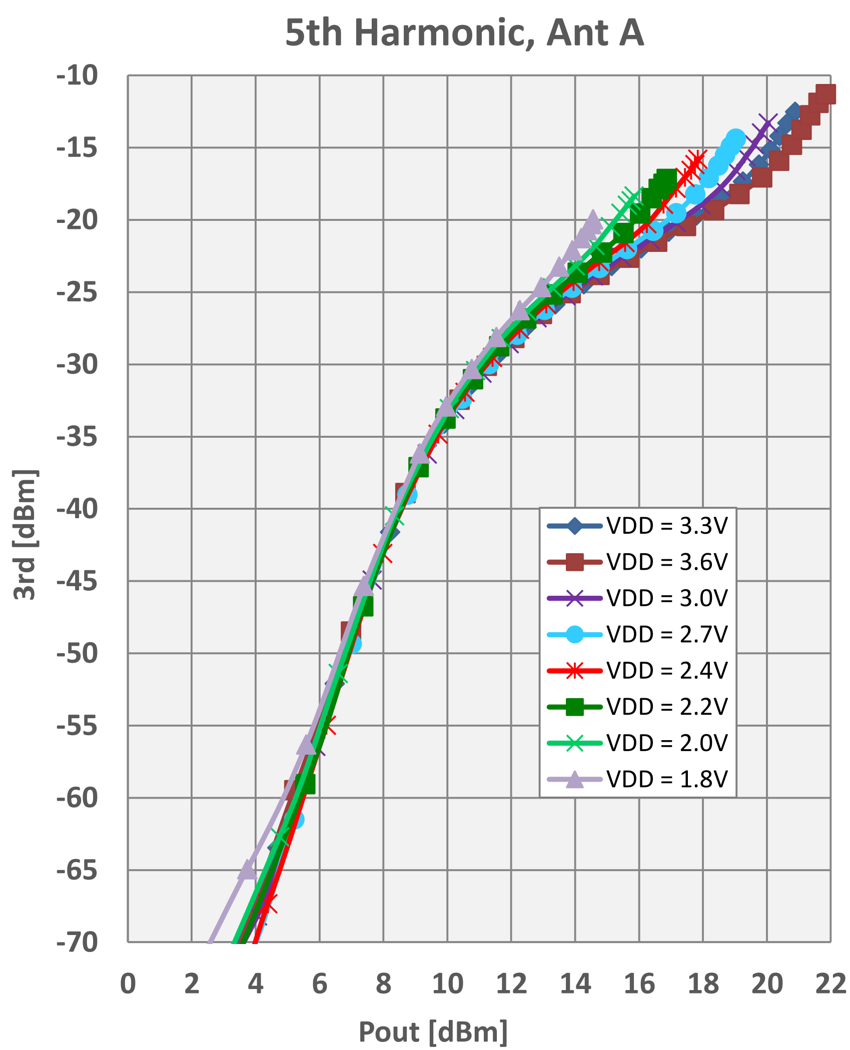
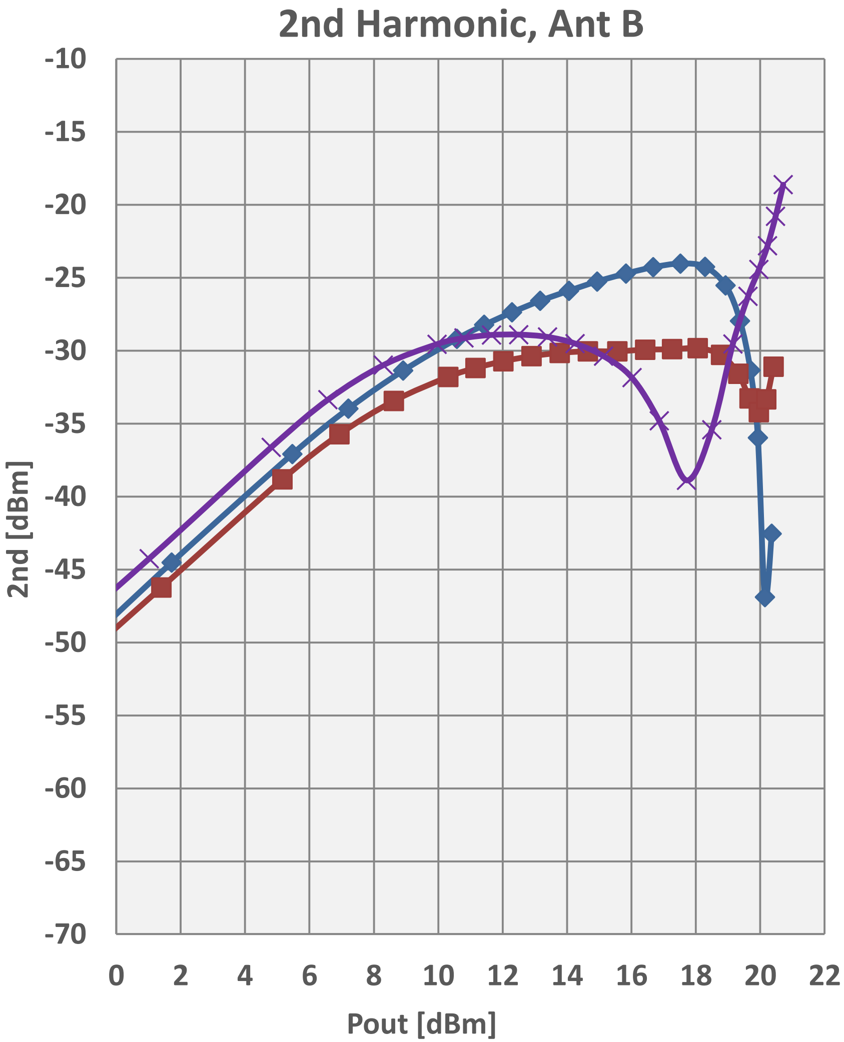
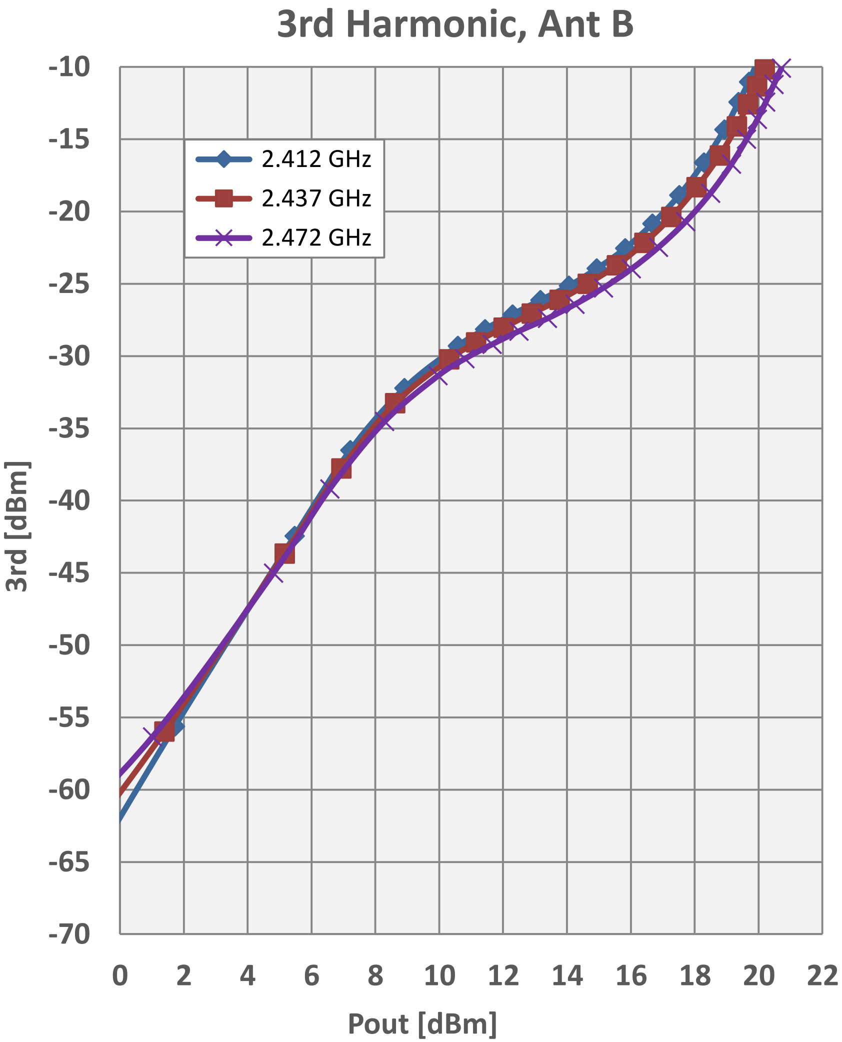
2.472 GHz, Antenna A, CW Signal



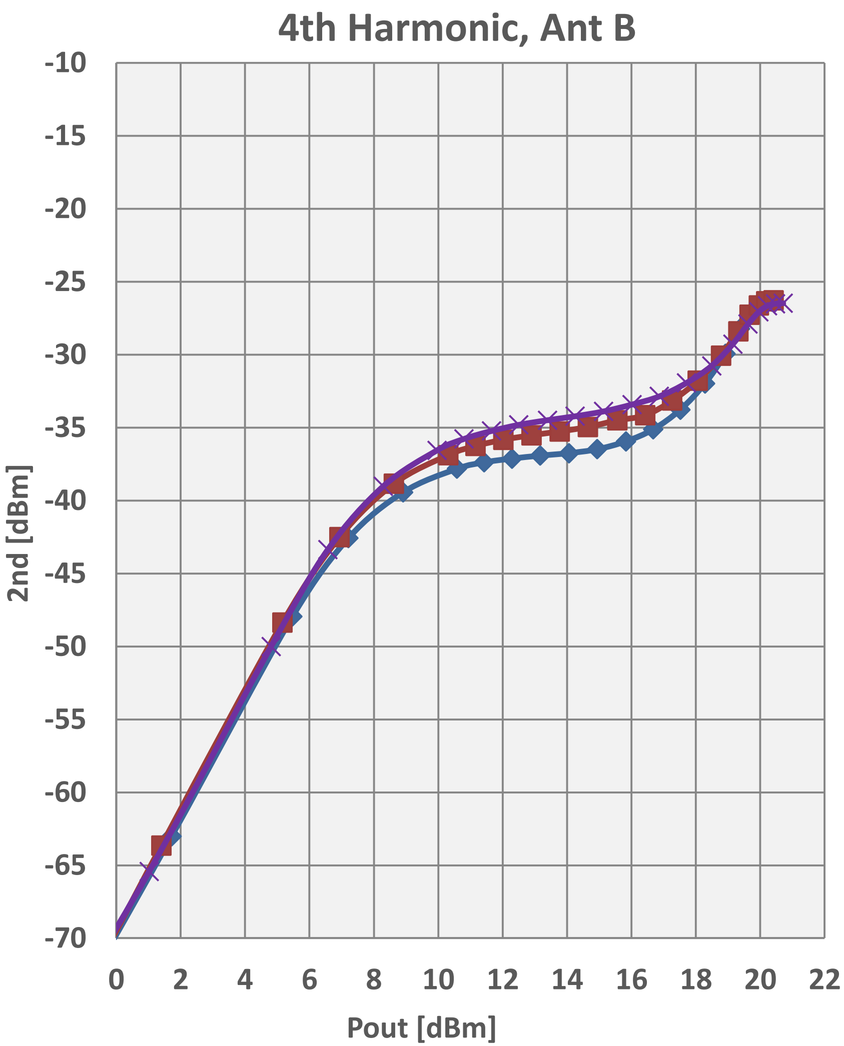


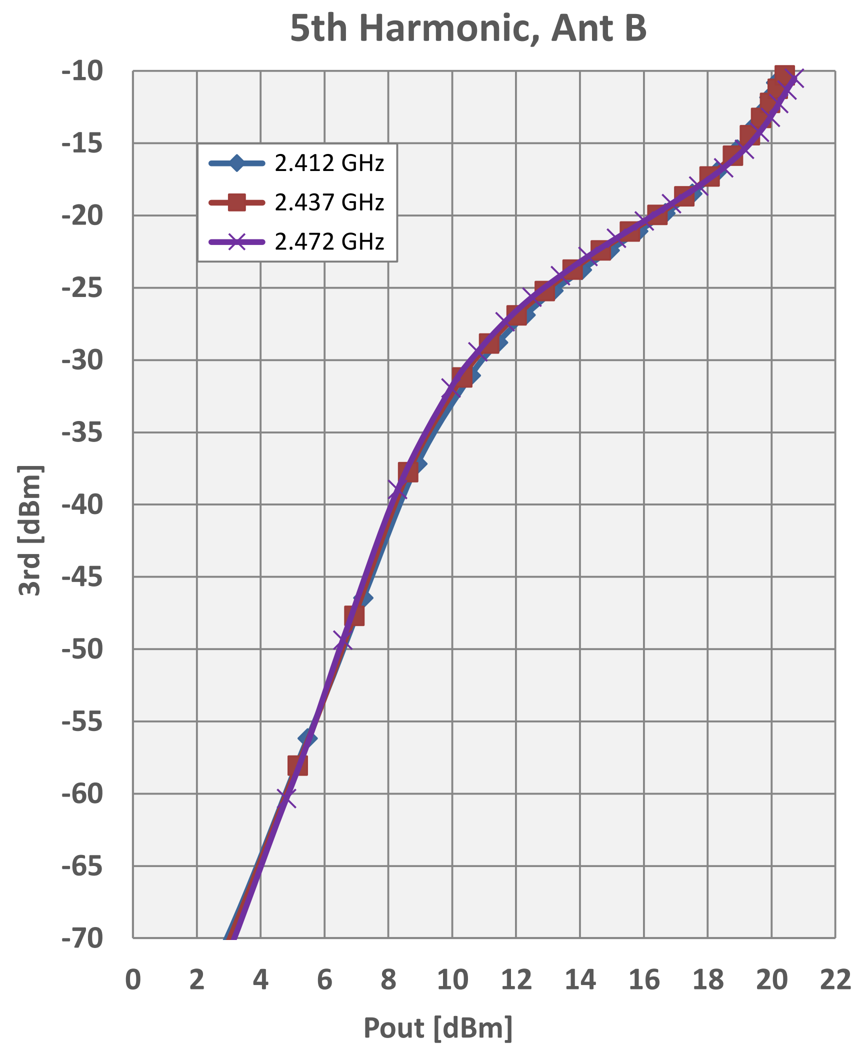
TX 2nd and 3rd Harmonics vs. Pout Across Frequency
Antenna B, VDD = 3.3V, CW Signal



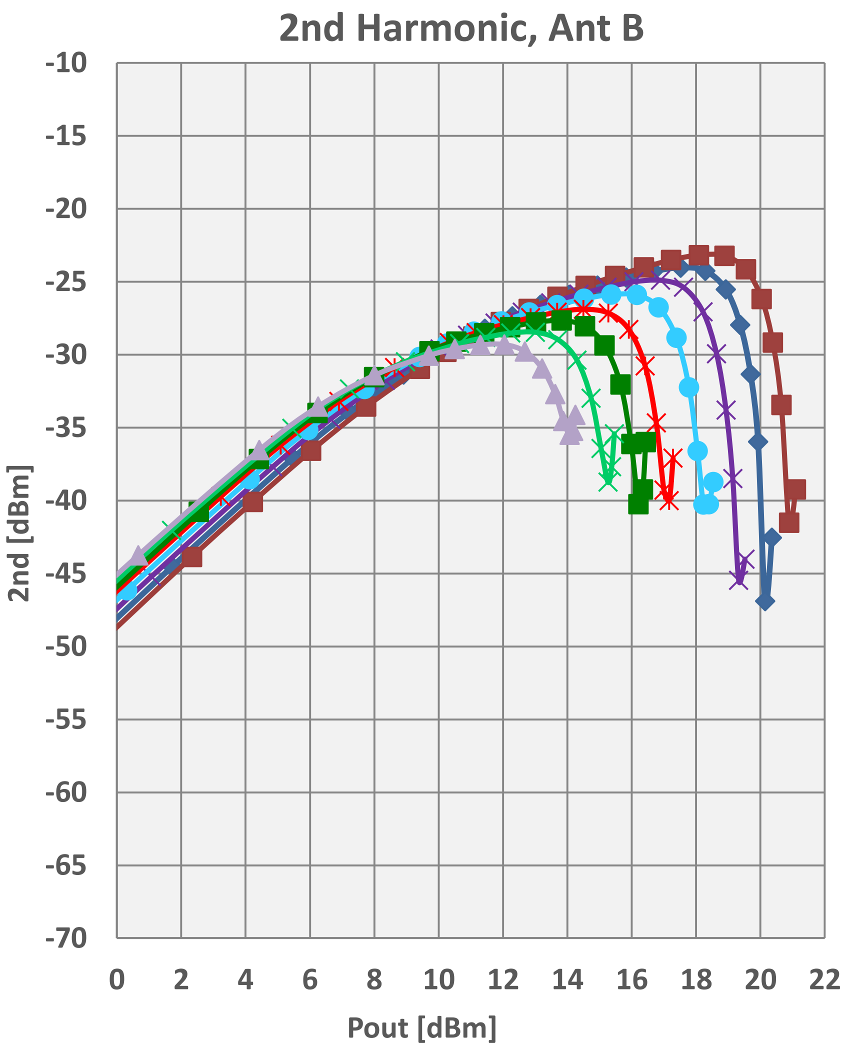


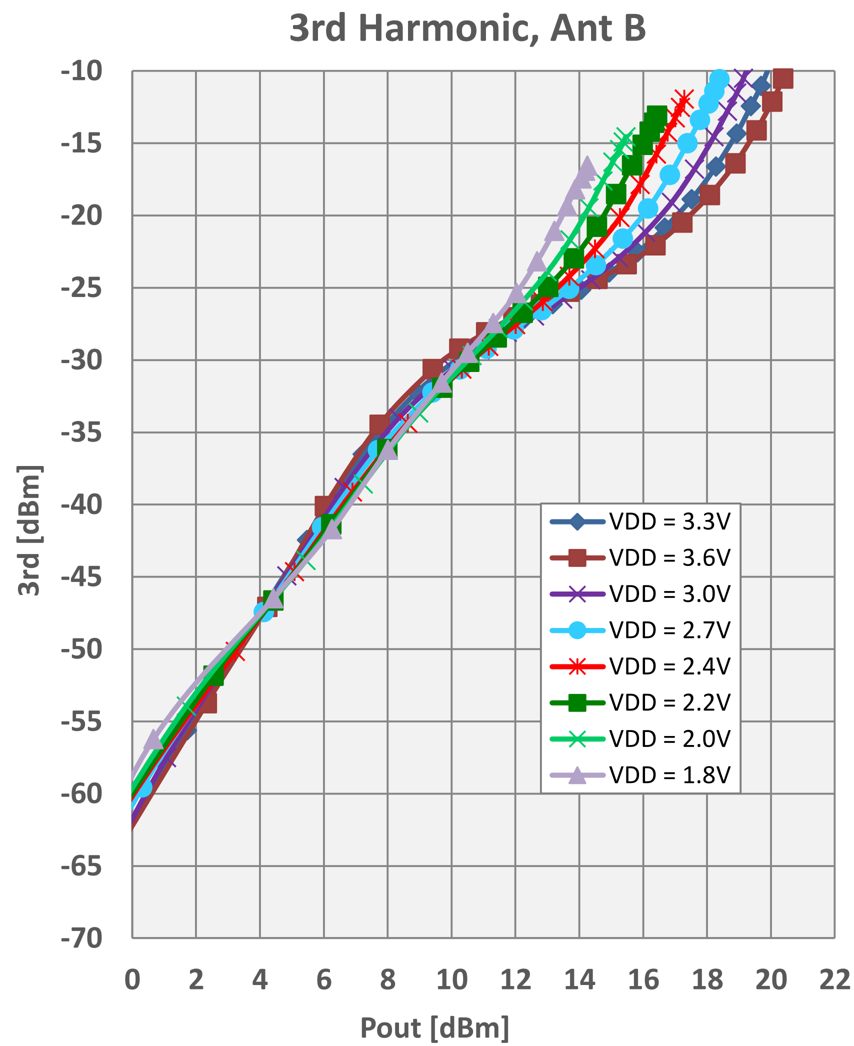
TX 4th and 5th Harmonics vs. Pout Across Frequency
Antenna B, VDD = 3.3V, CW Signal





TX 2nd and 3rd Harmonics vs. Pout Across Voltage
2.412 GHz, Antenna B, CW Signal





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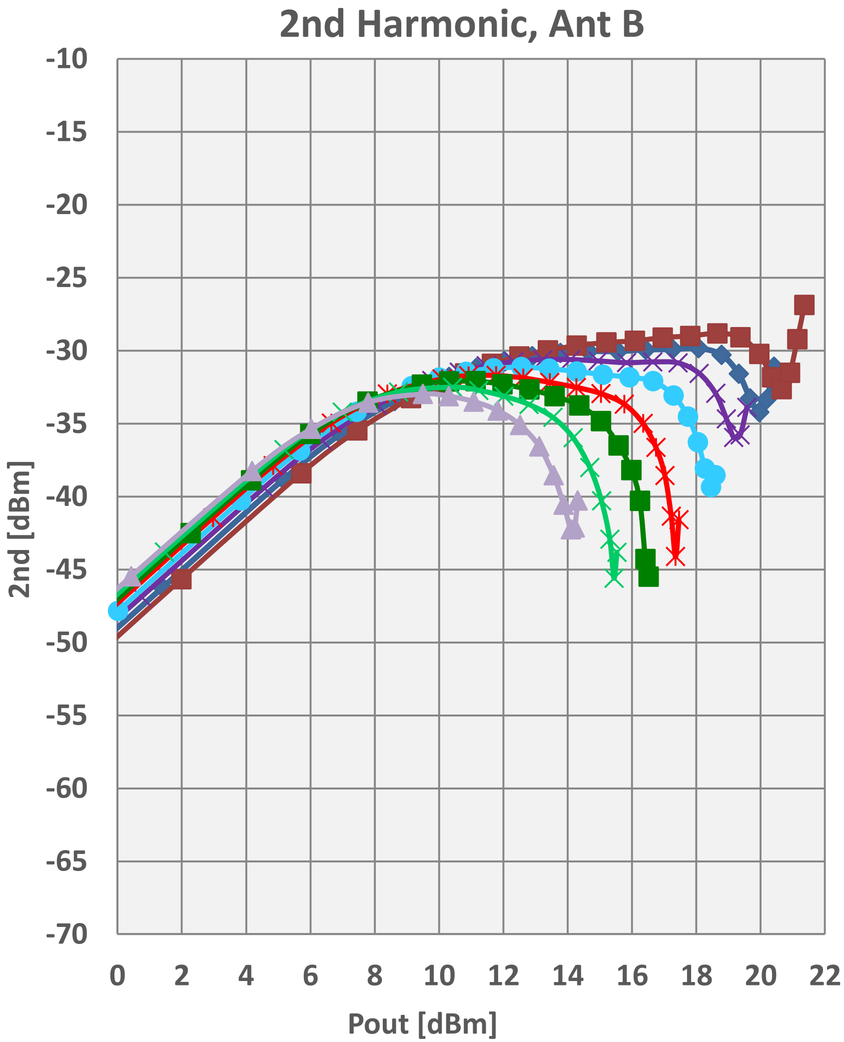

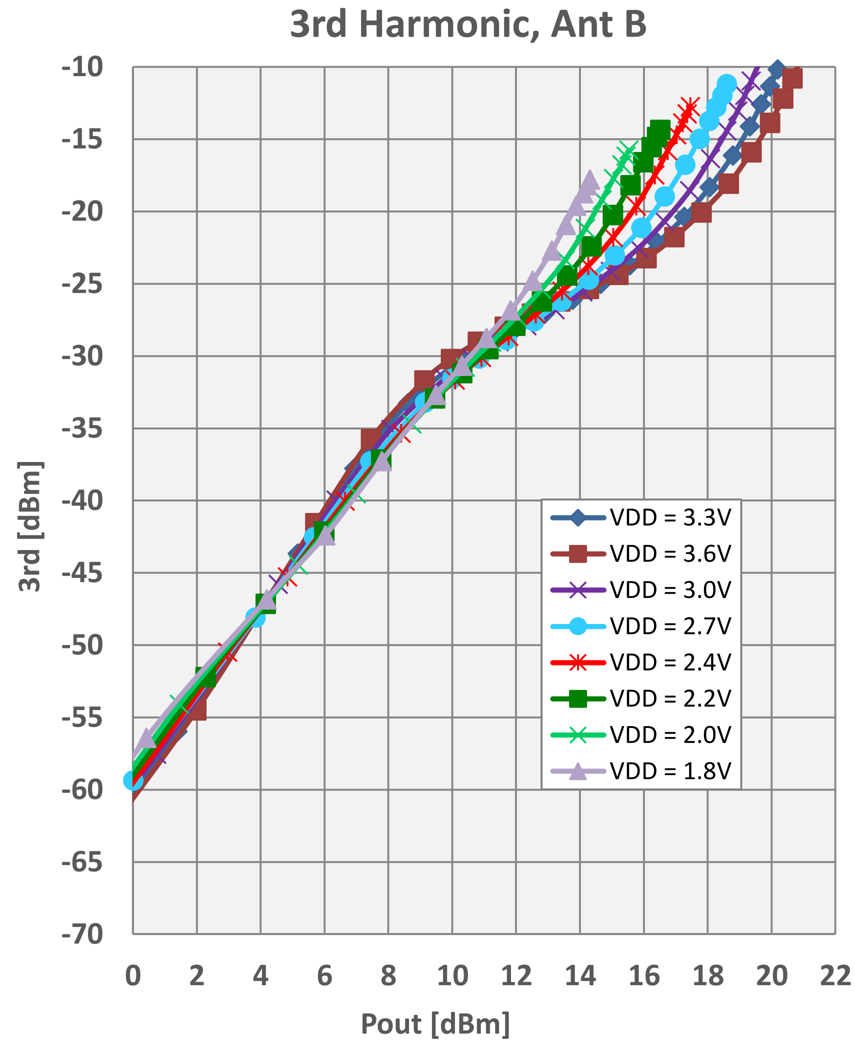

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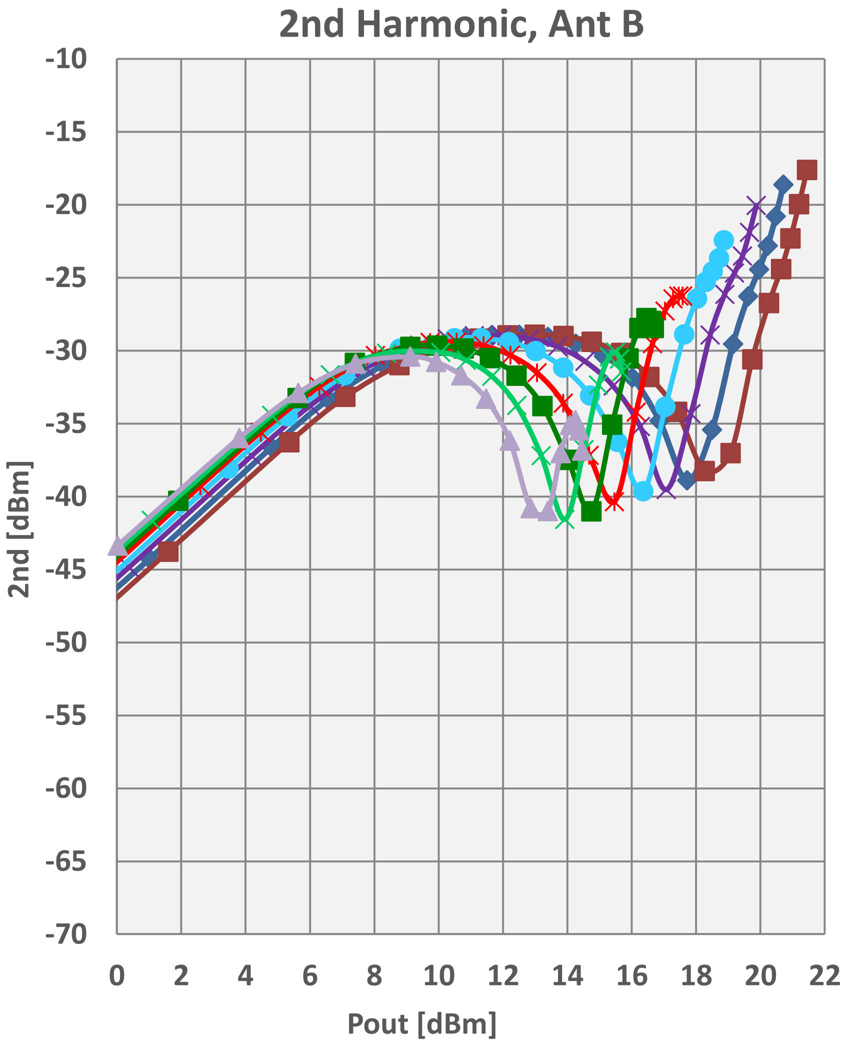
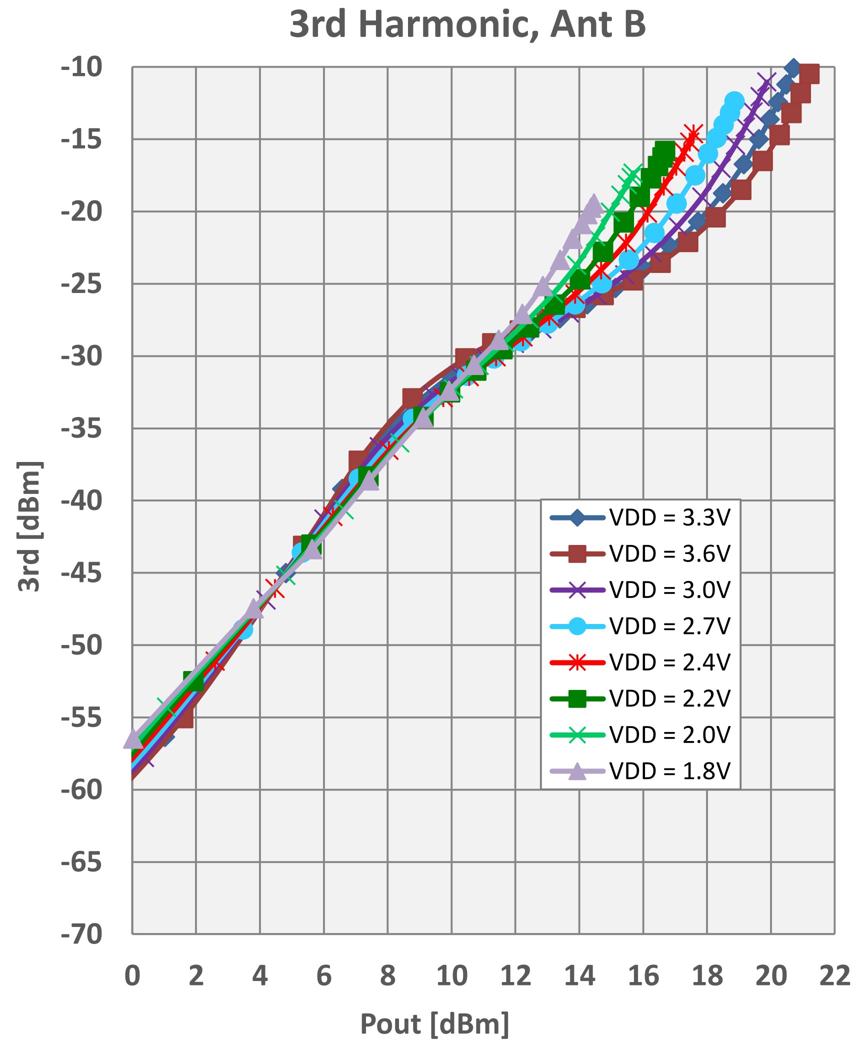
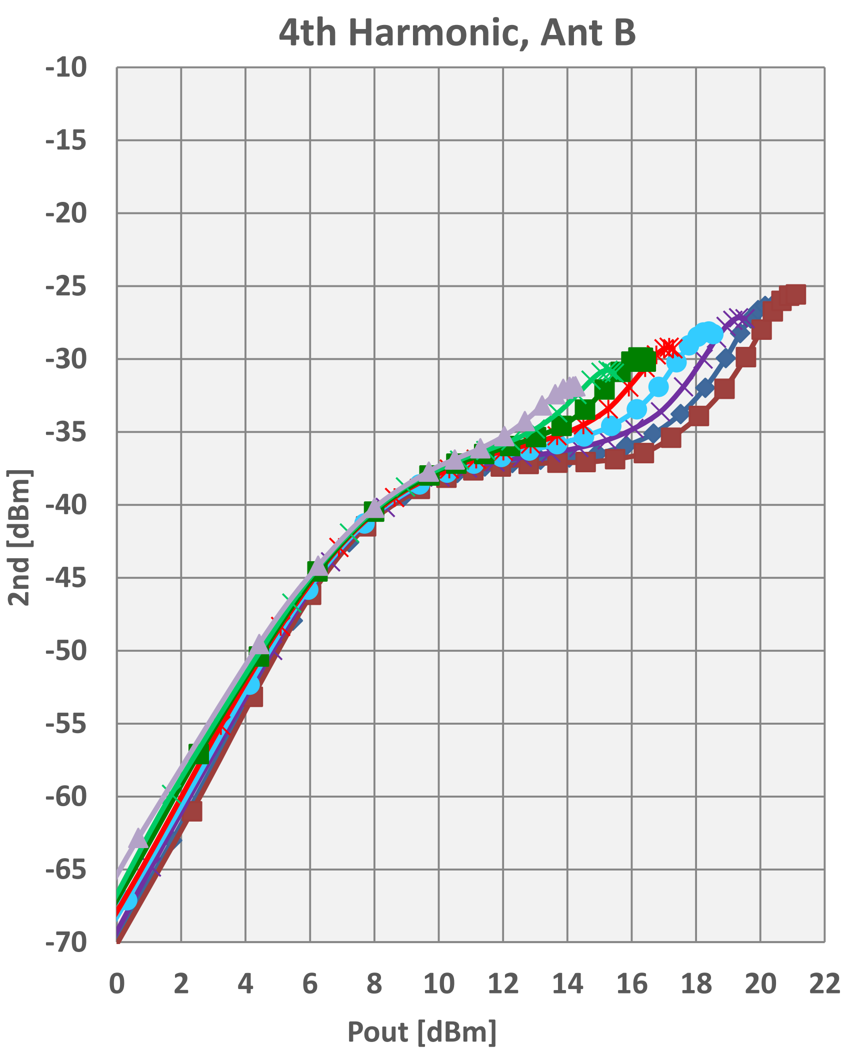
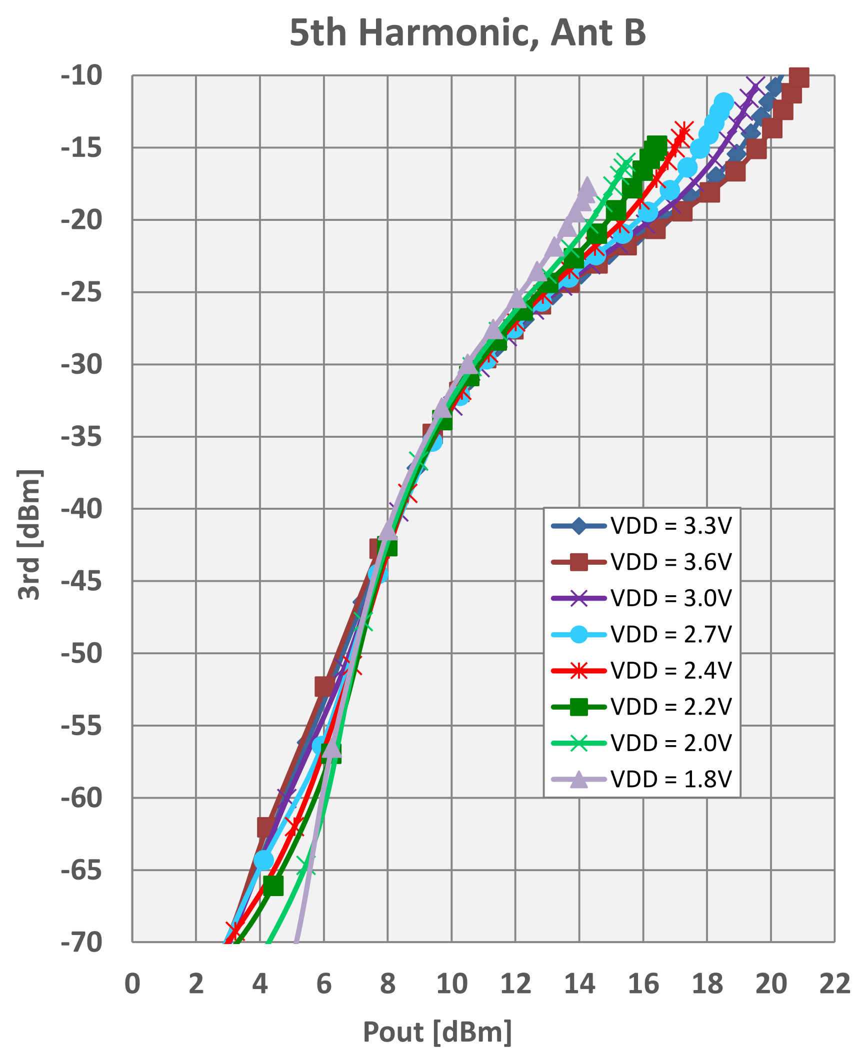
2.472 GHz, Antenna B, CW Signal





TX 4th and 5th Harmonics vs. Pout Across Voltage
2.412 GHz, Antenna B, CW Signal





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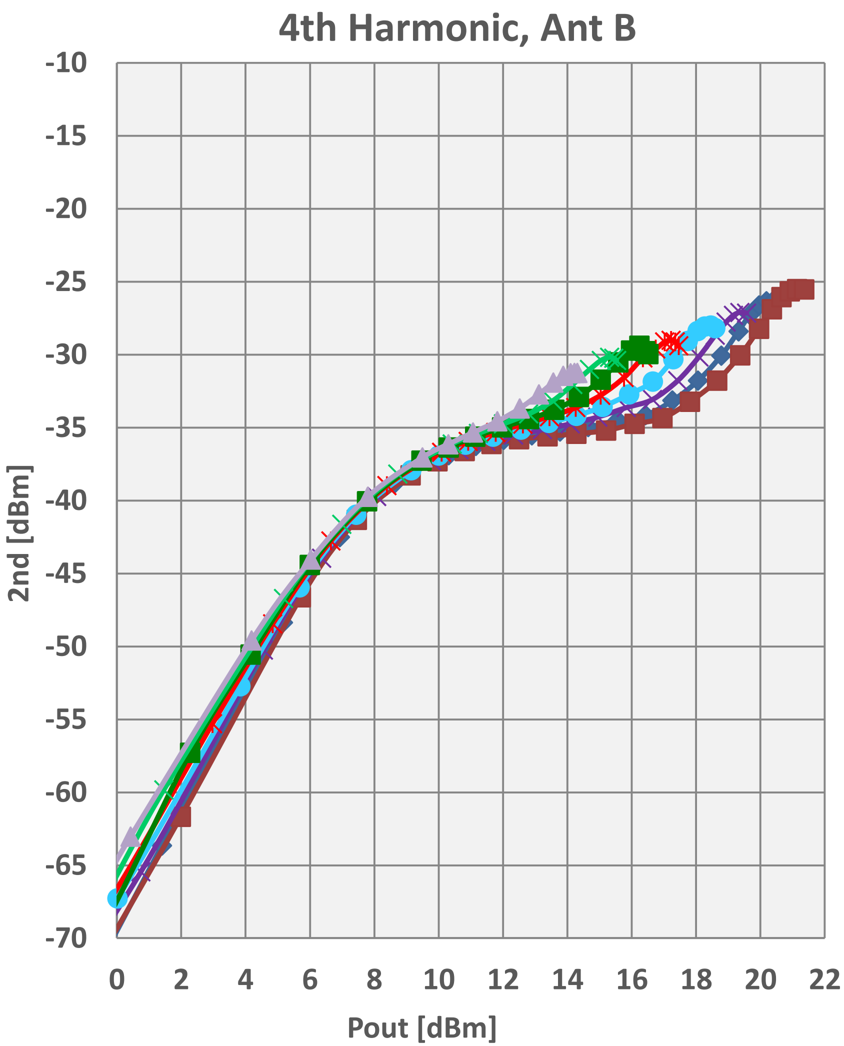
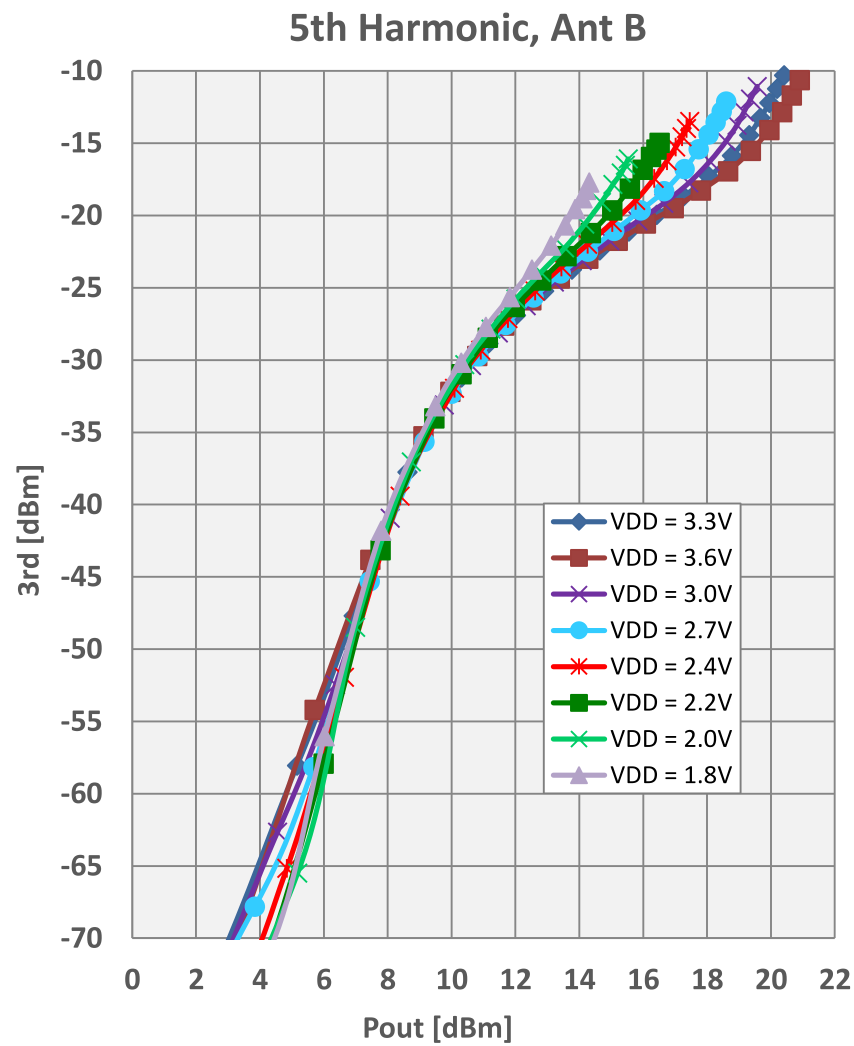
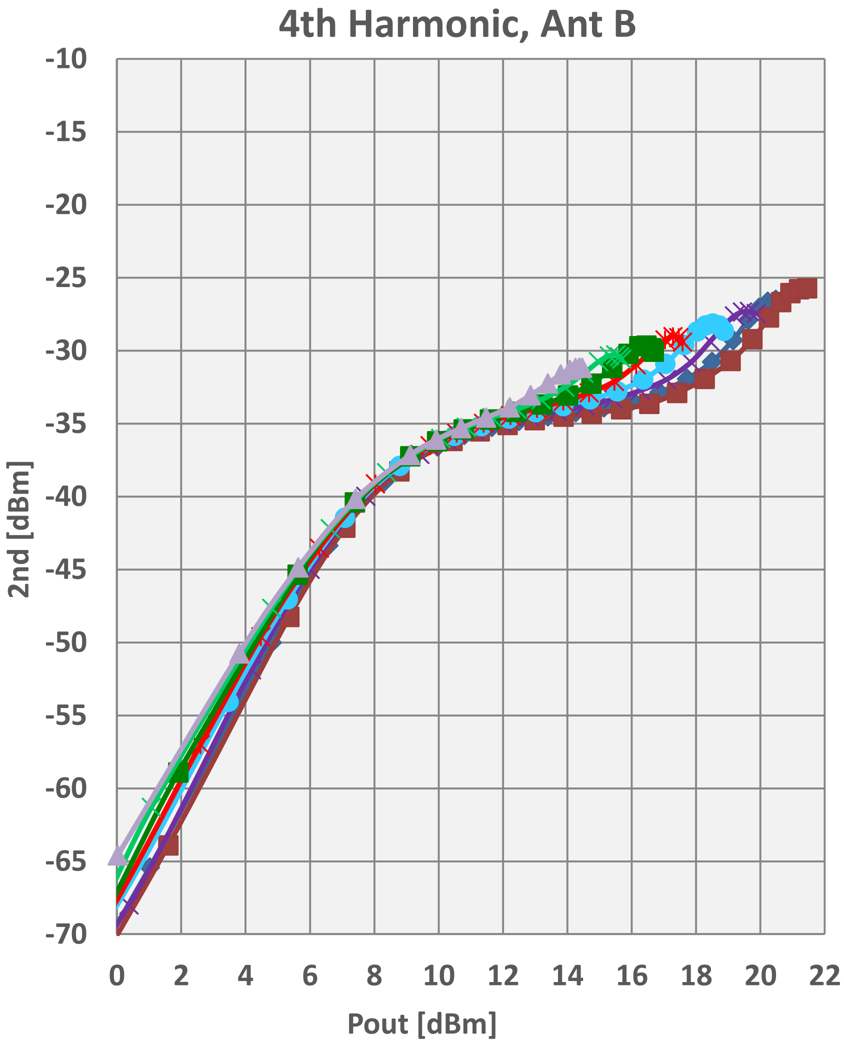
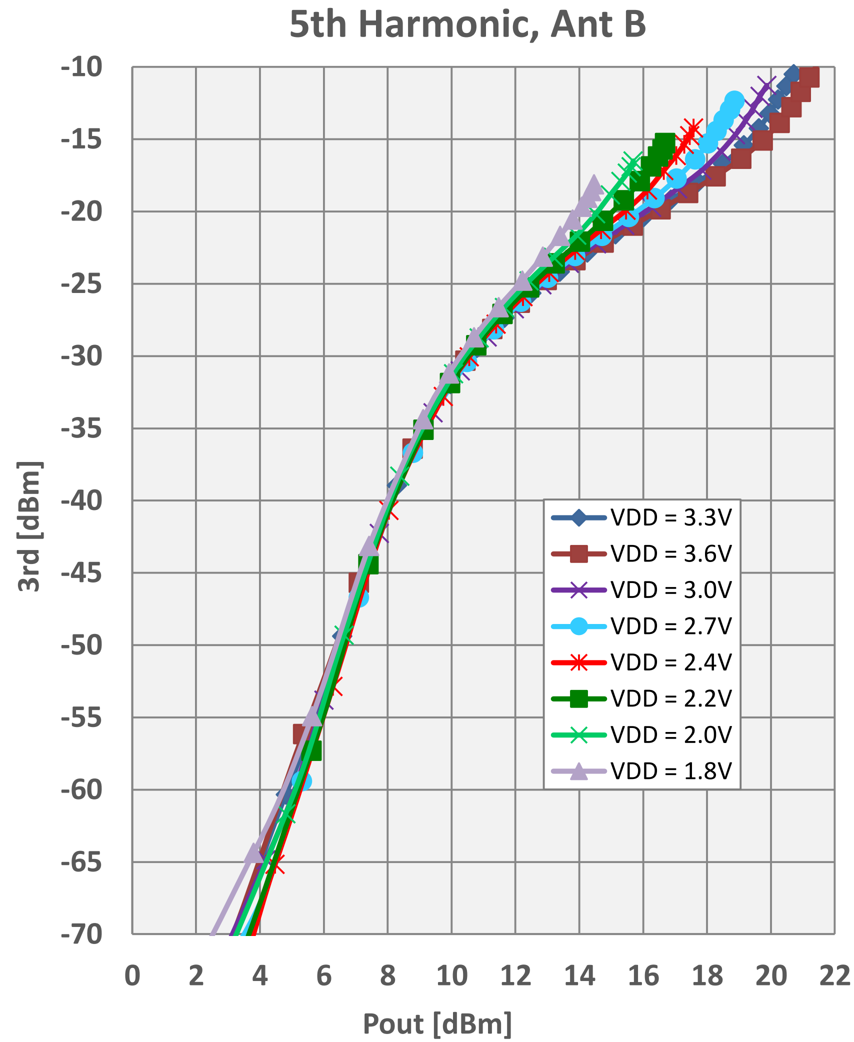


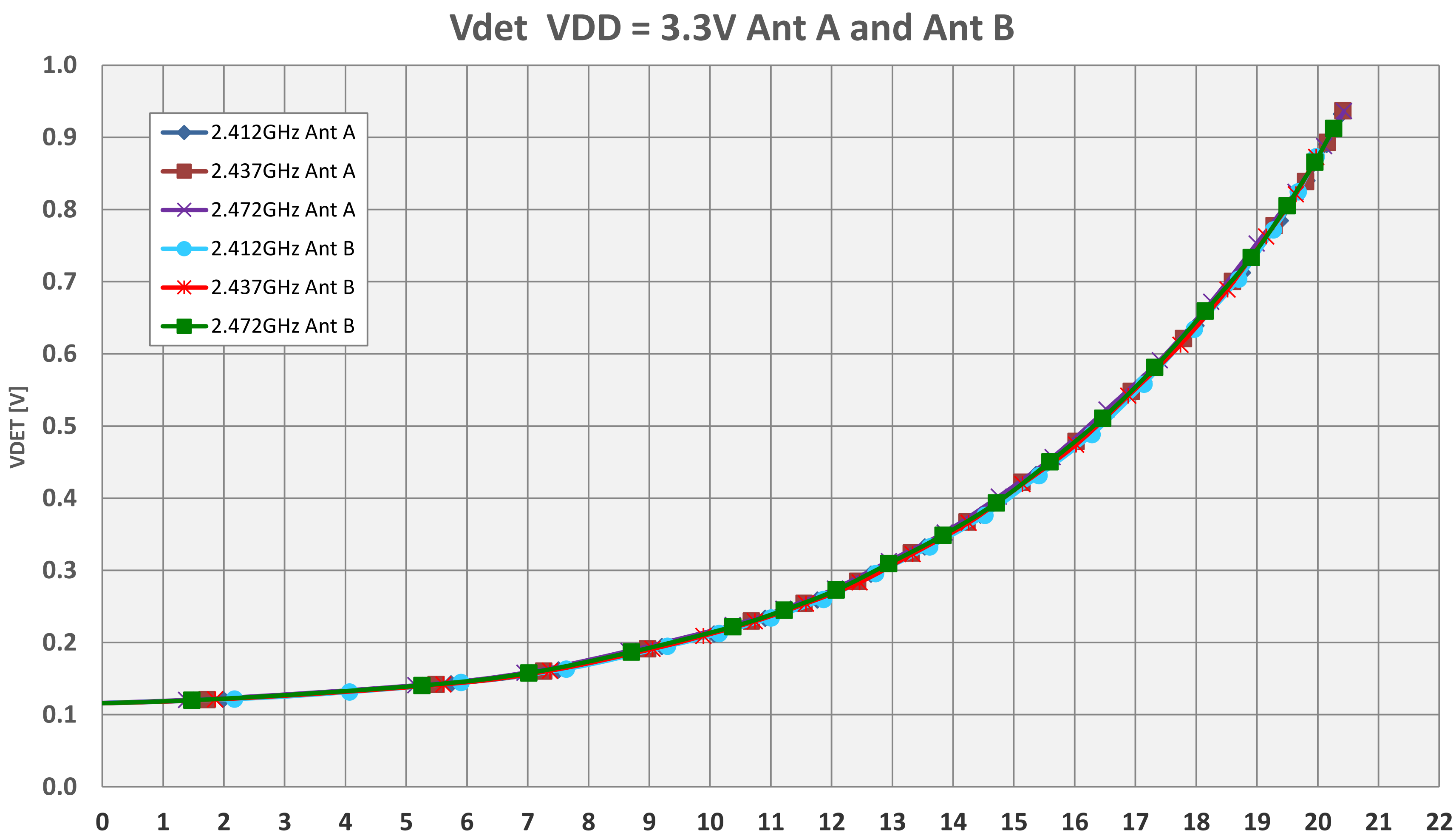


TX 4th and 5th Harmonics vs. Pout Across Voltage
2.472 GHz, Antenna B, CW Signal



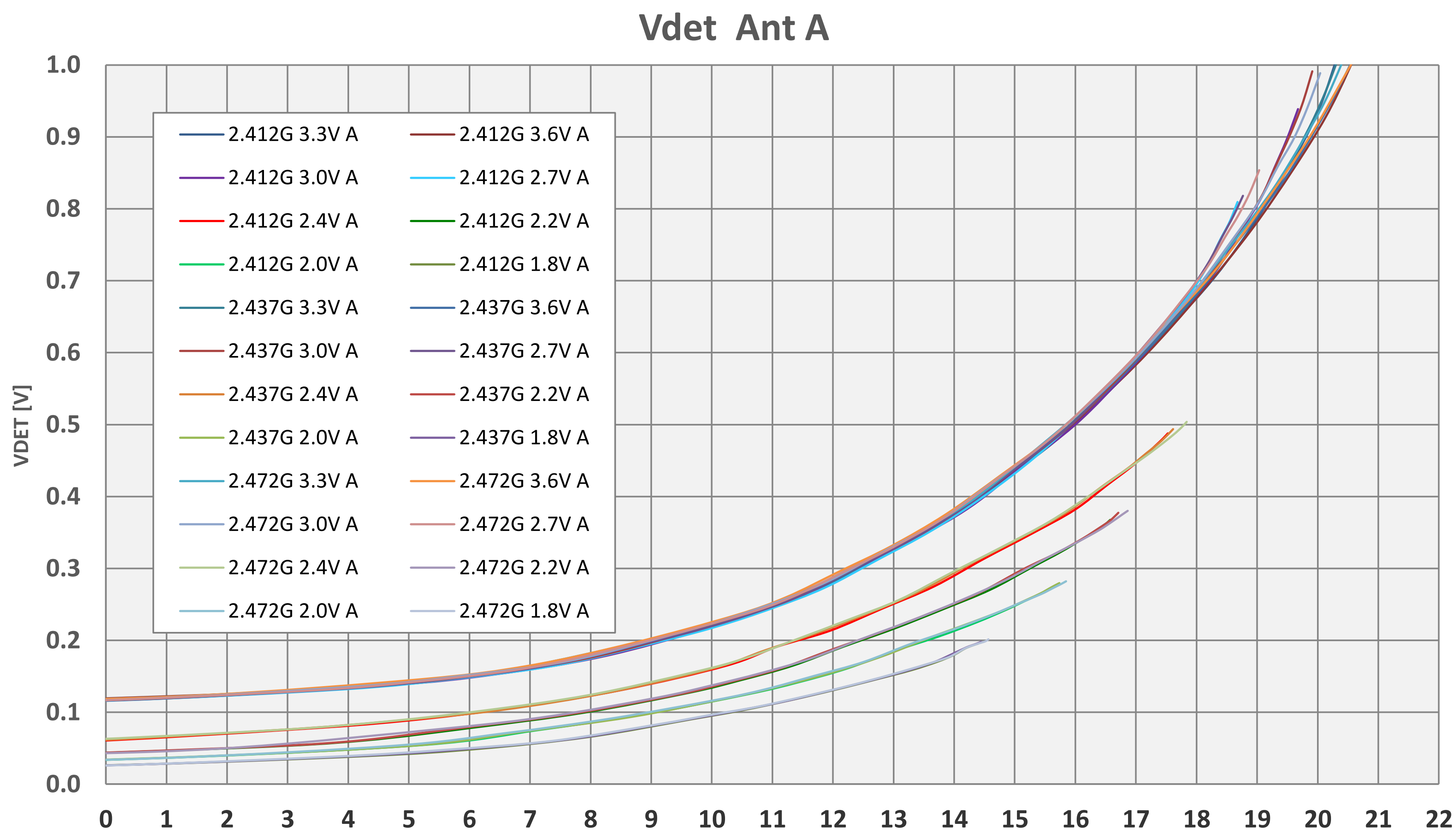


TX Detector Voltage vs. Pout Across Frequency
Ant A and Ant B, VDD = 3.3V



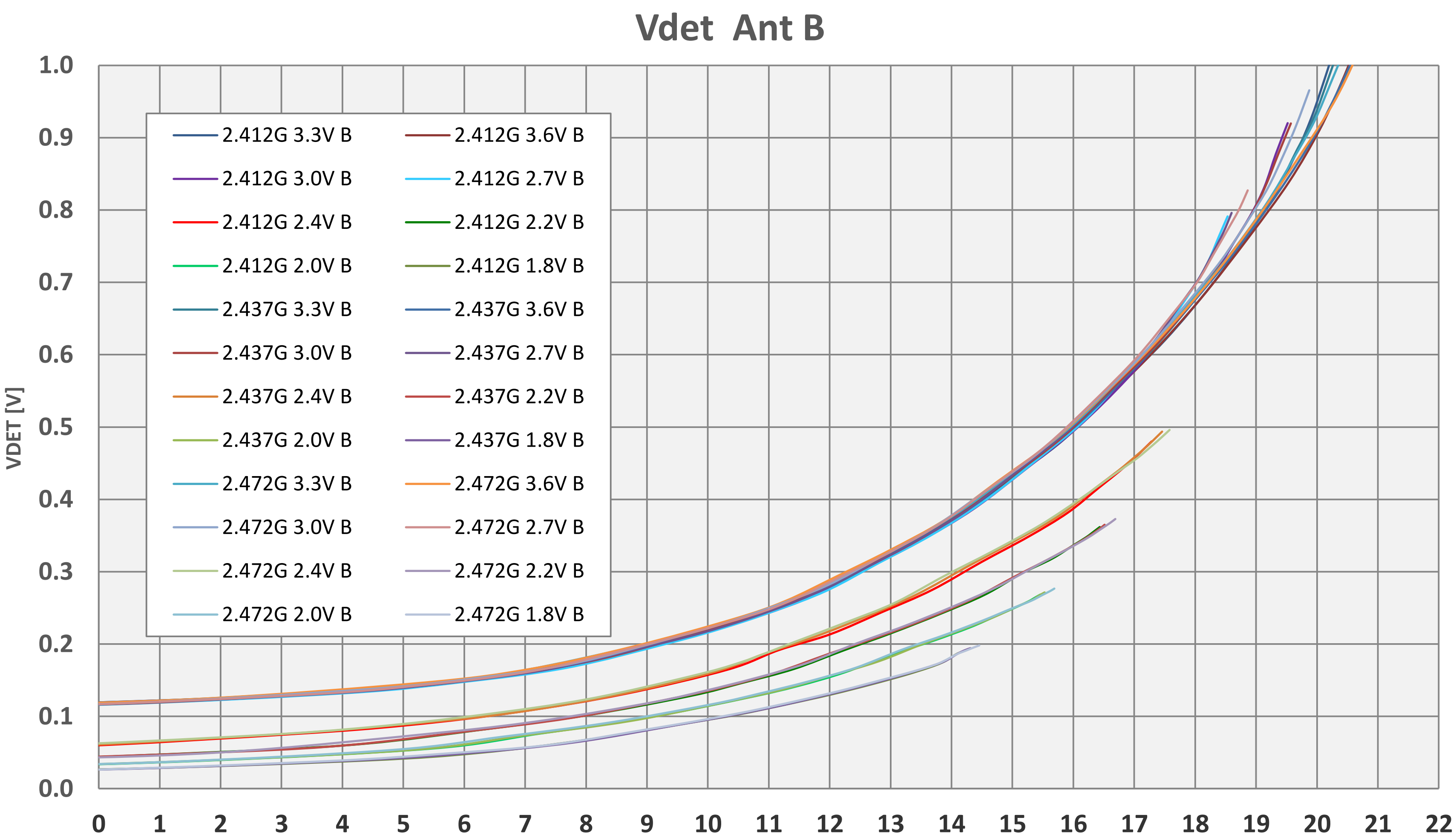
Detector voltage measured with 10kΩ load. Detector Voltage will vary with different resistor values.

TX Detector Voltage vs. Pout Across Voltage and Frequency Ant A



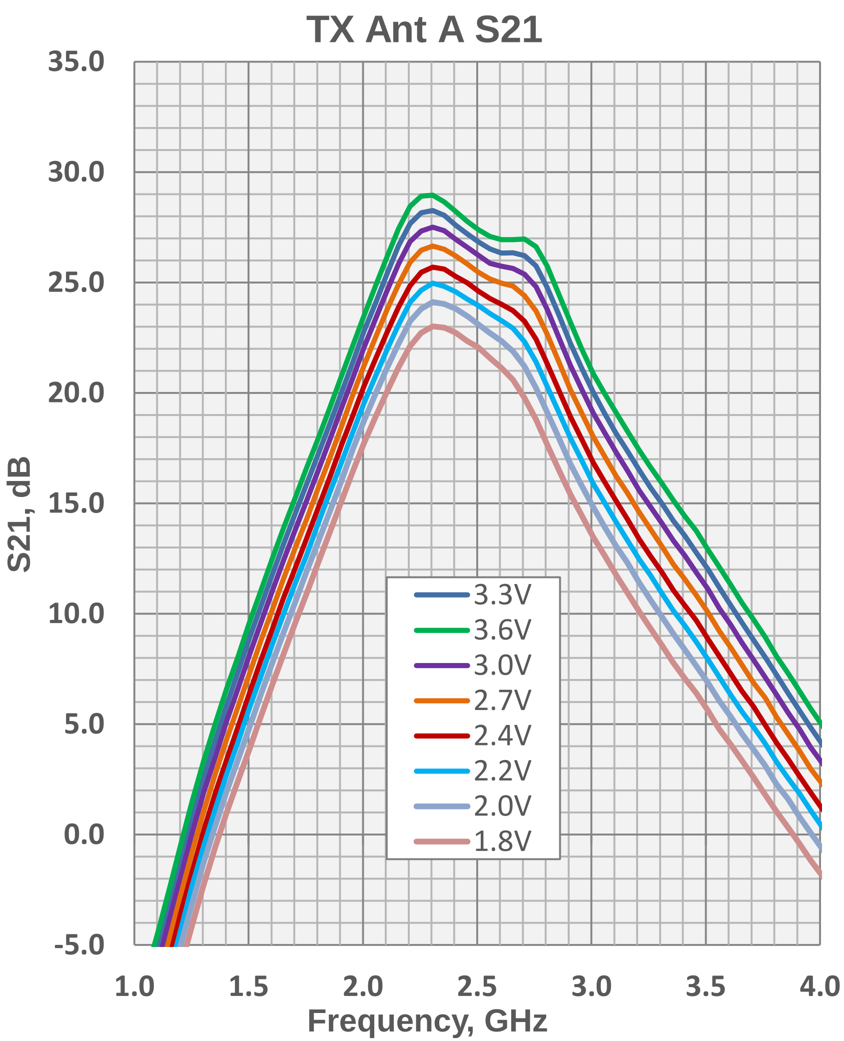
Detector voltage measured with 10kΩ load. Detector Voltage will vary with different resistor values.

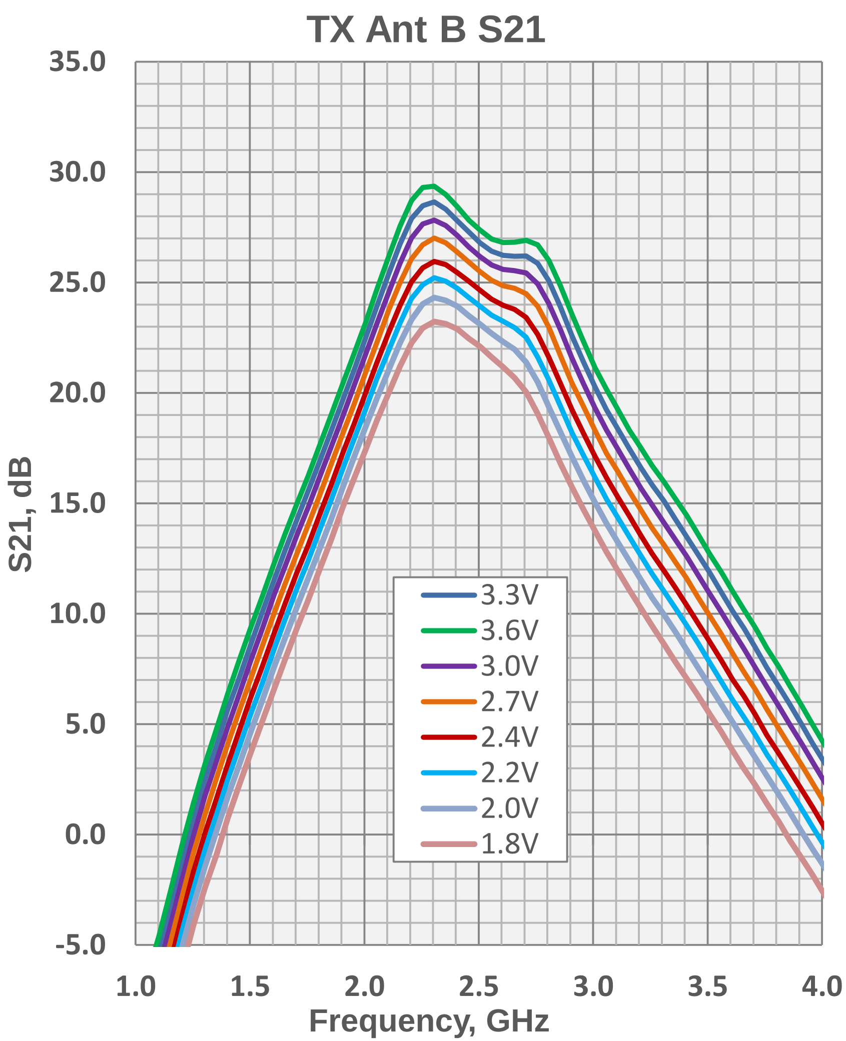
TX Detector Voltage vs. Pout Across Voltage and Frequency Ant B



Detector voltage measured with 10kΩ load. Detector Voltage will vary with different resistor values.

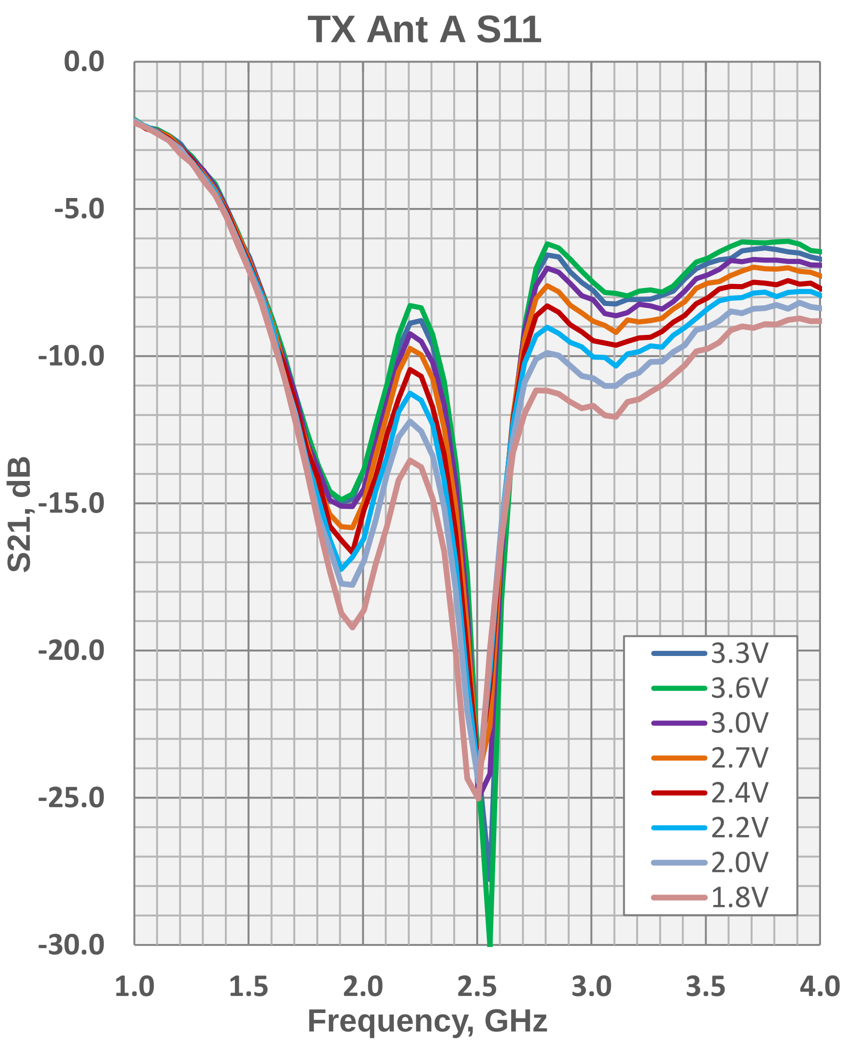
TX S-Parameter S21 Across Voltage
Ant A and Ant B

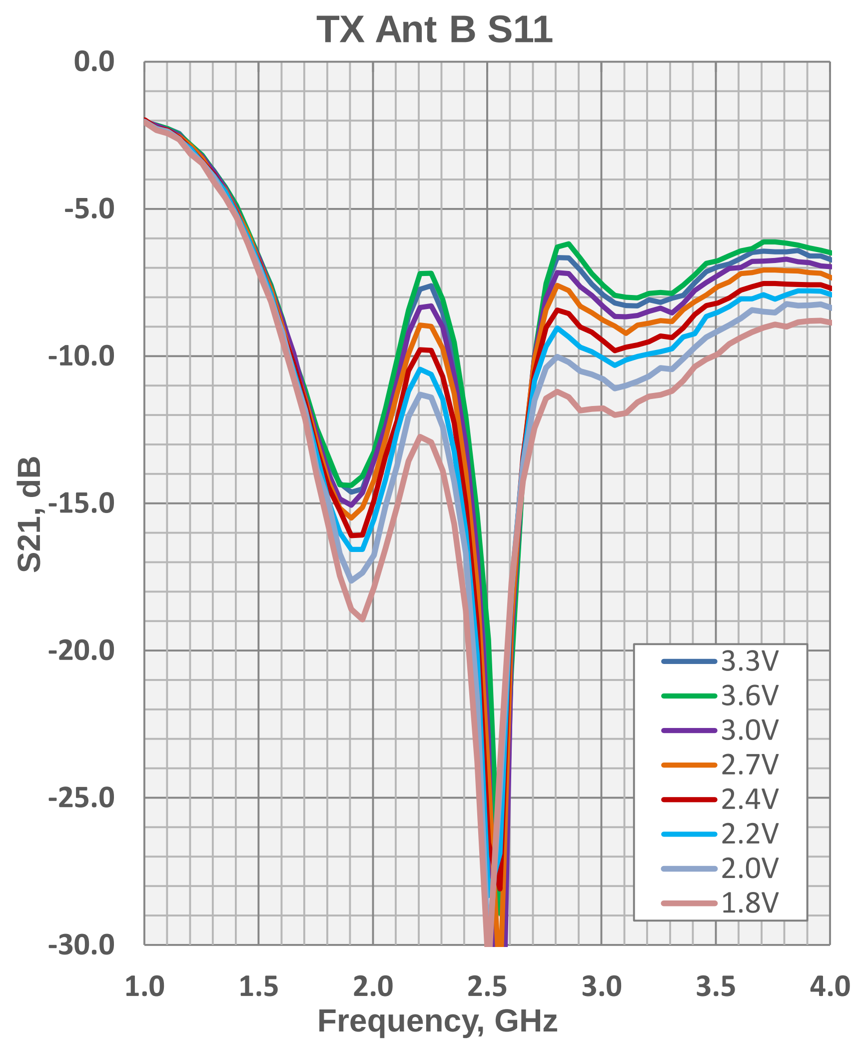




Iq = 20mA @ 3.3V

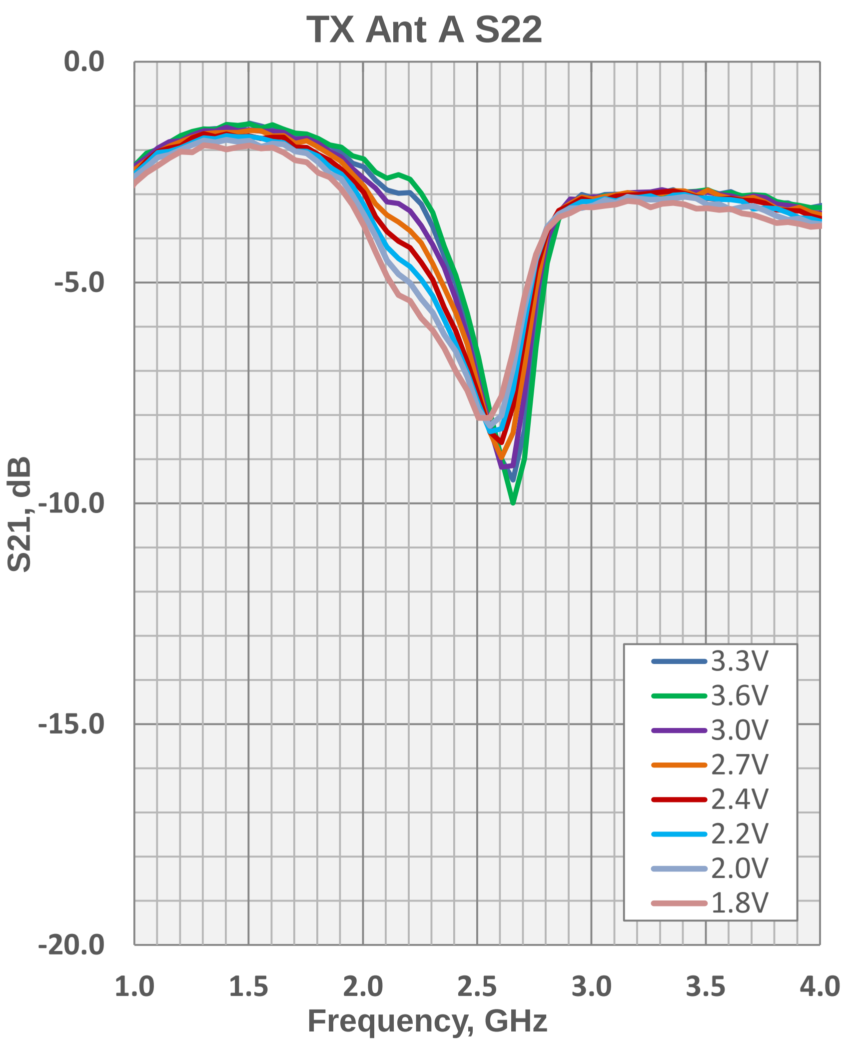
TX S-Parameter S11 Across Voltage
Ant A and Ant B

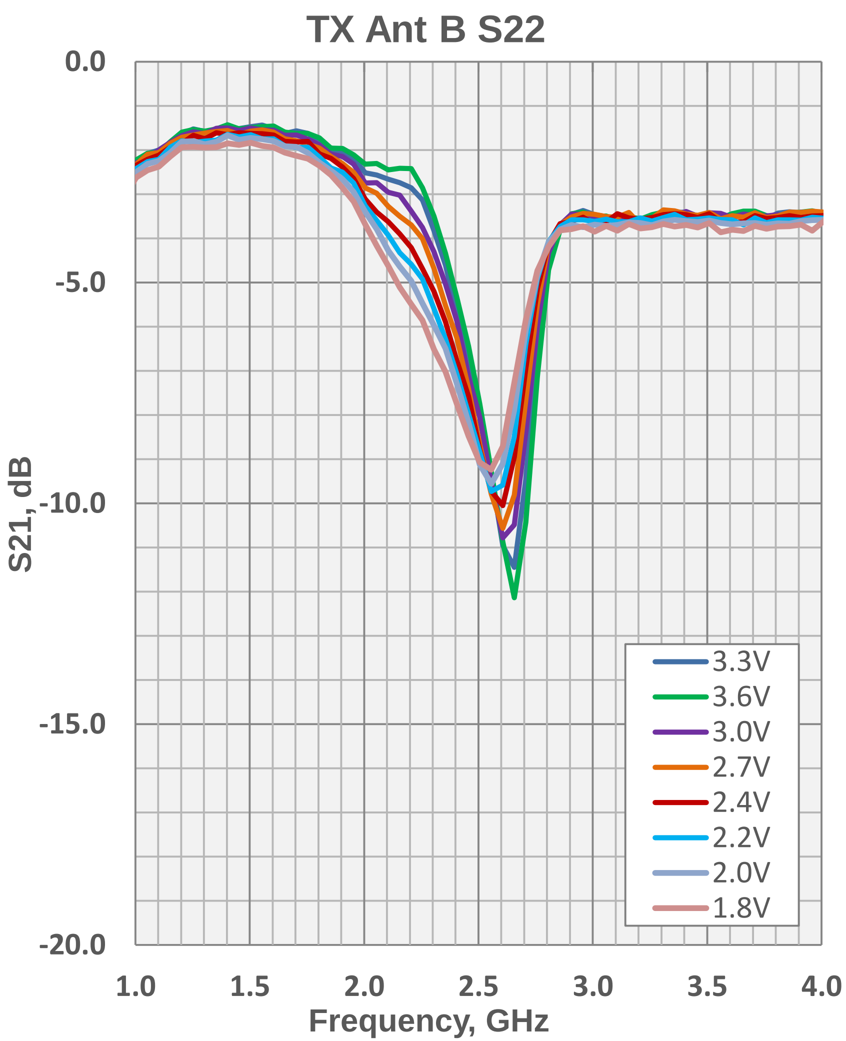




Iq = 20mA @ 3.3V

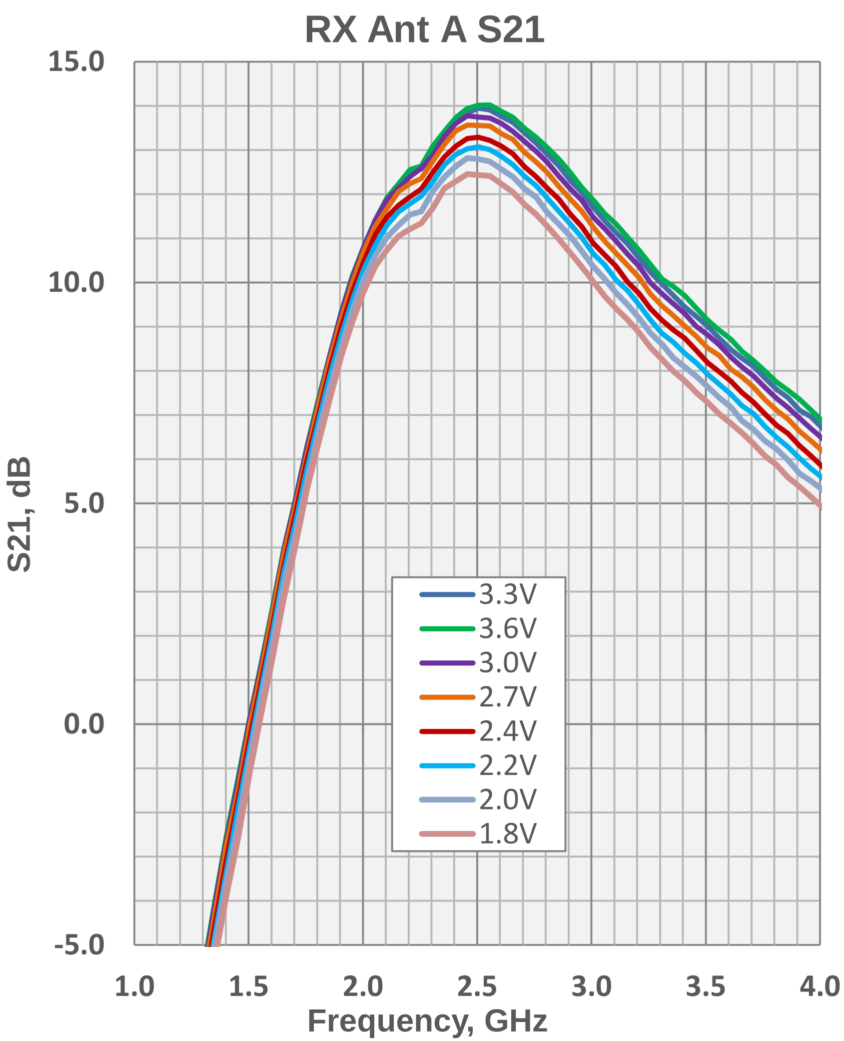
TX S-Parameter S22 Across Voltage
Ant A and Ant B

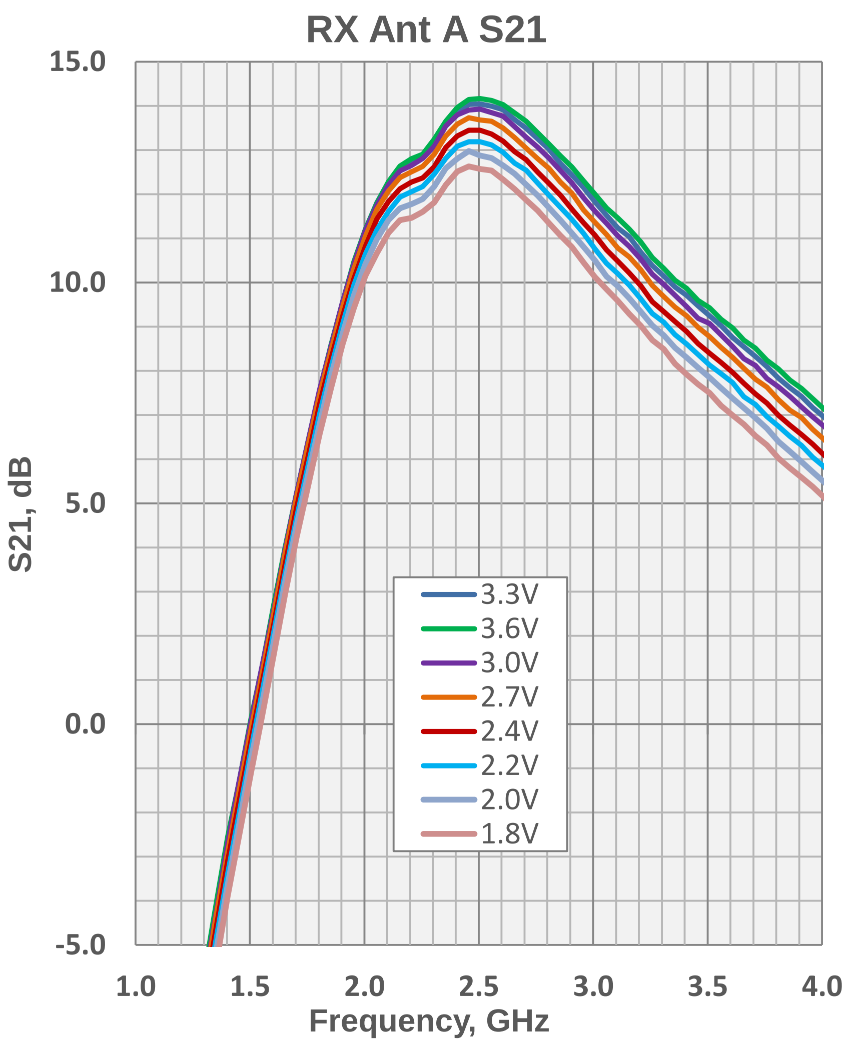




Iq = 20mA @ 3.3V

RX S-Parameter S21 Across Voltage
Ant A and Ant B

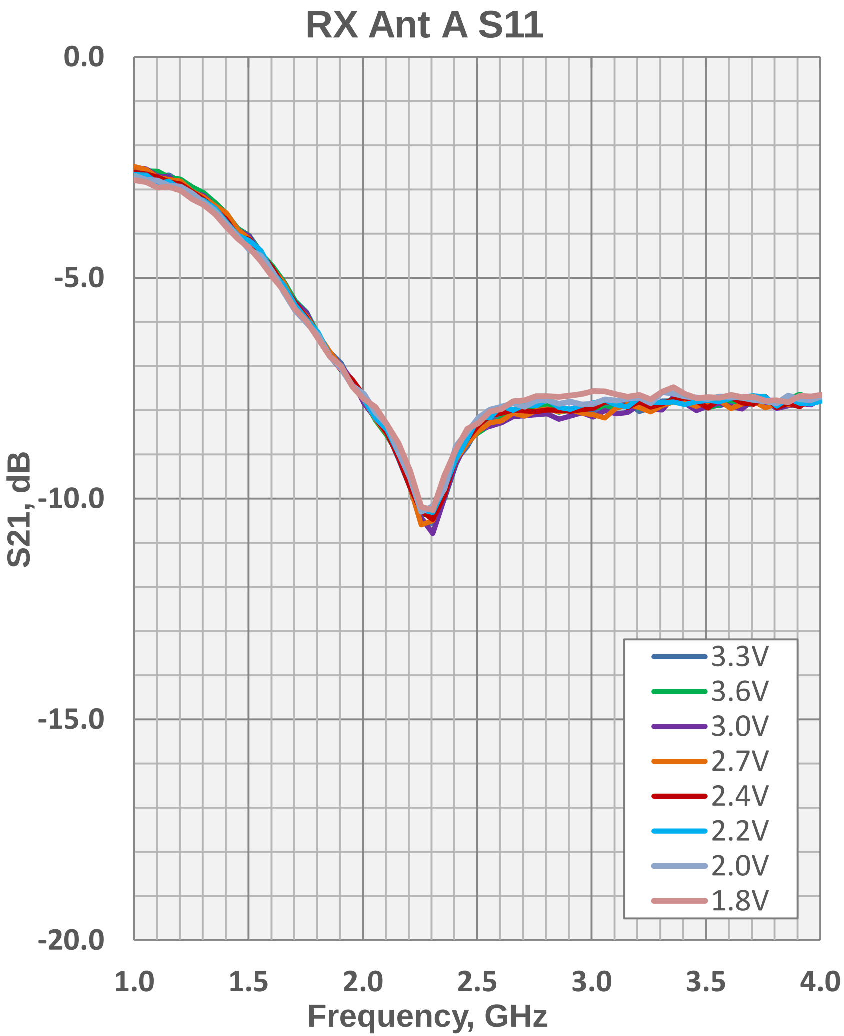


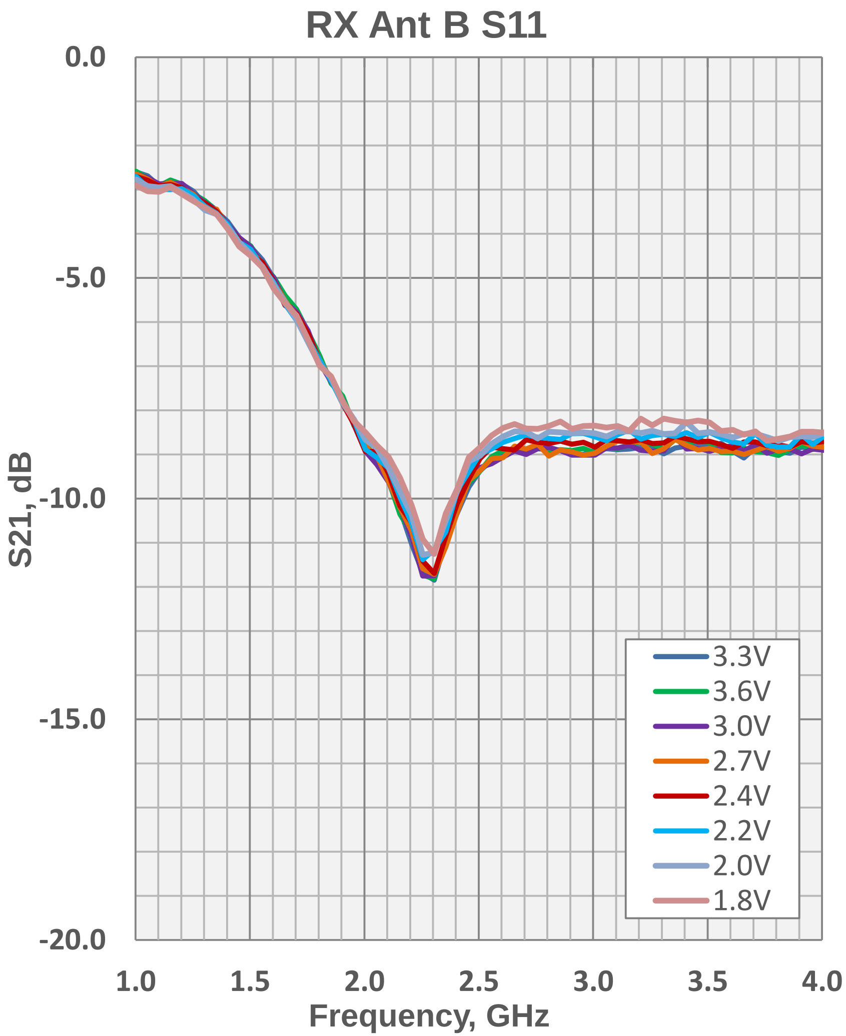


Iq = 8mA @ 3.3V

RFaxis BRIDGING THE RF GAP

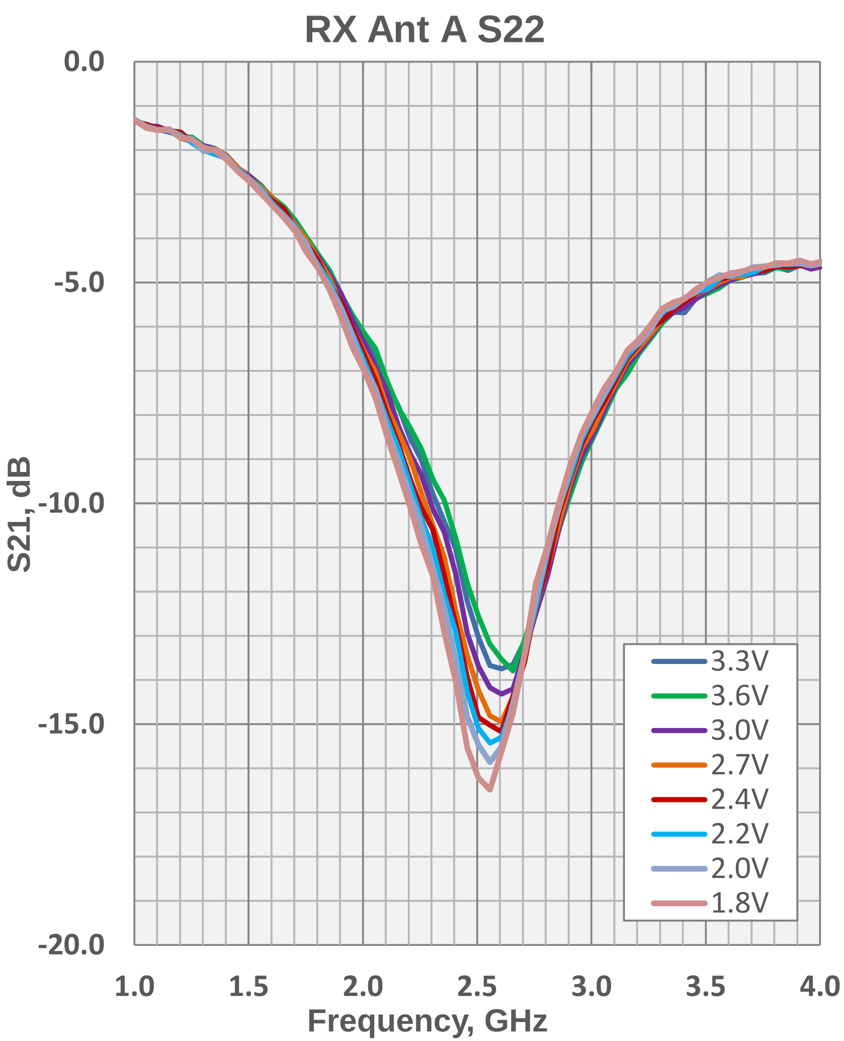
RX S-Parameter S11 Across Voltage Ant A and Ant B

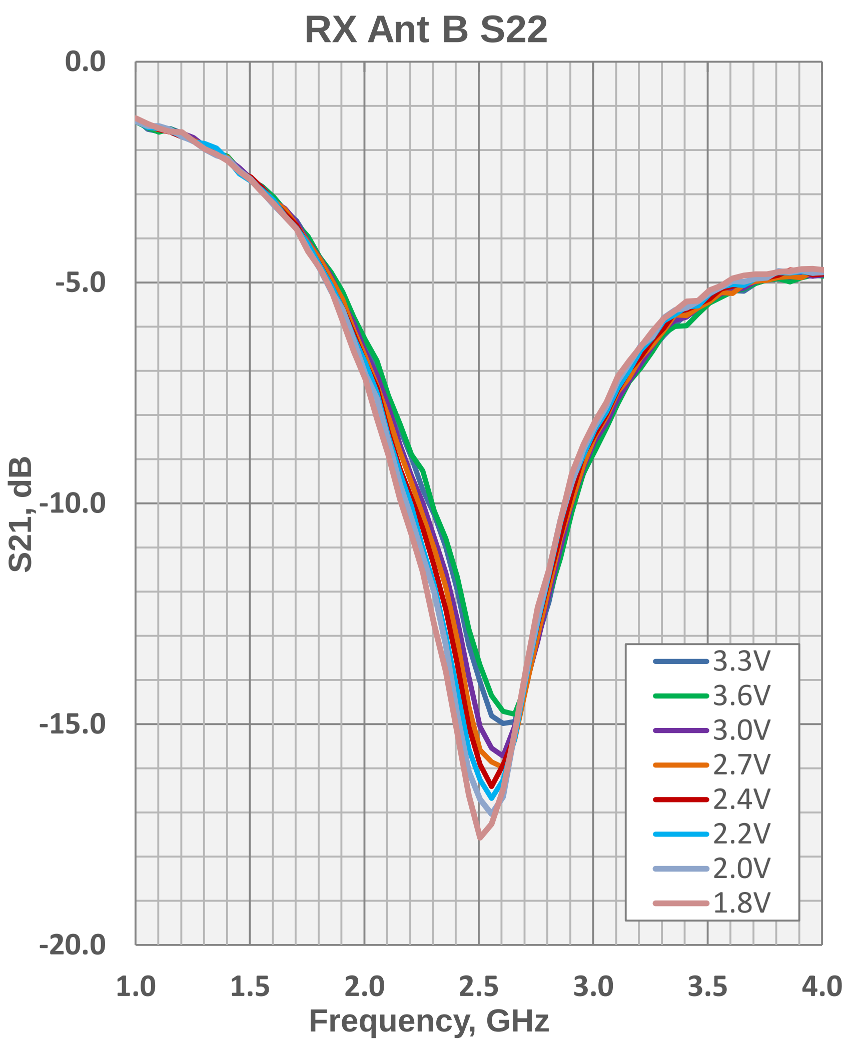




Iq = 8mA @ 3.3V

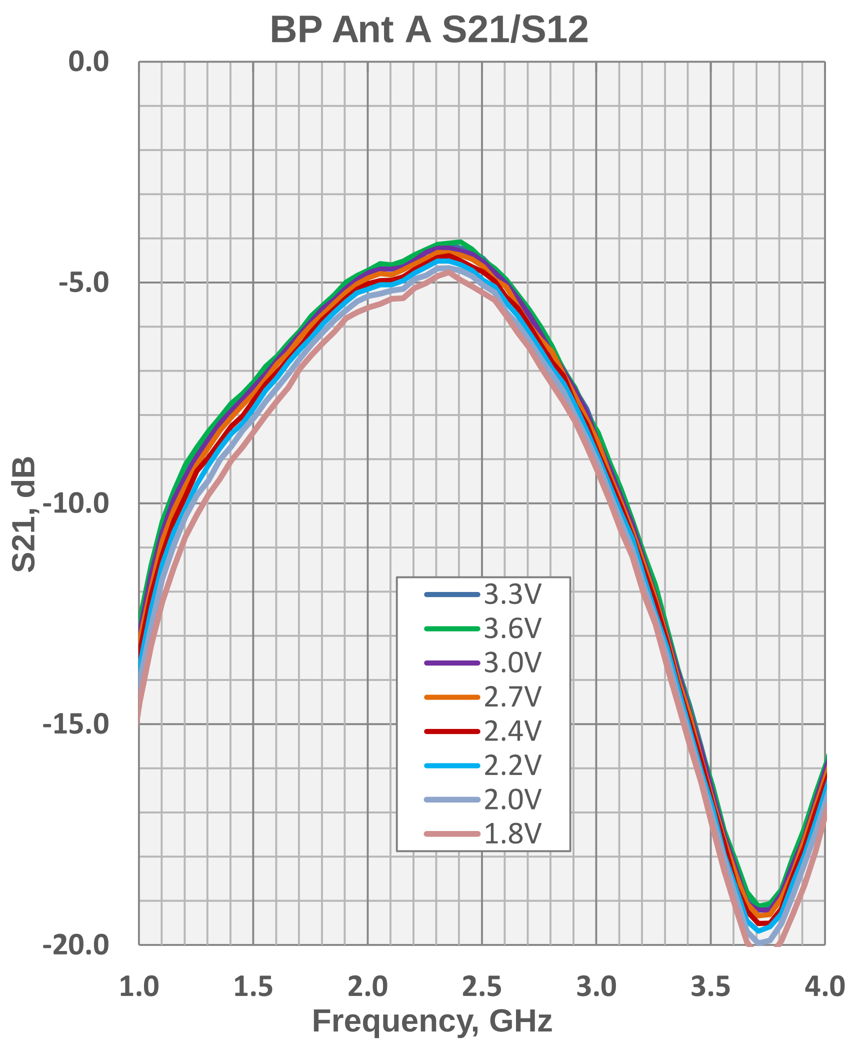
RX S-Parameter S22 Across Voltage
Ant A and Ant B

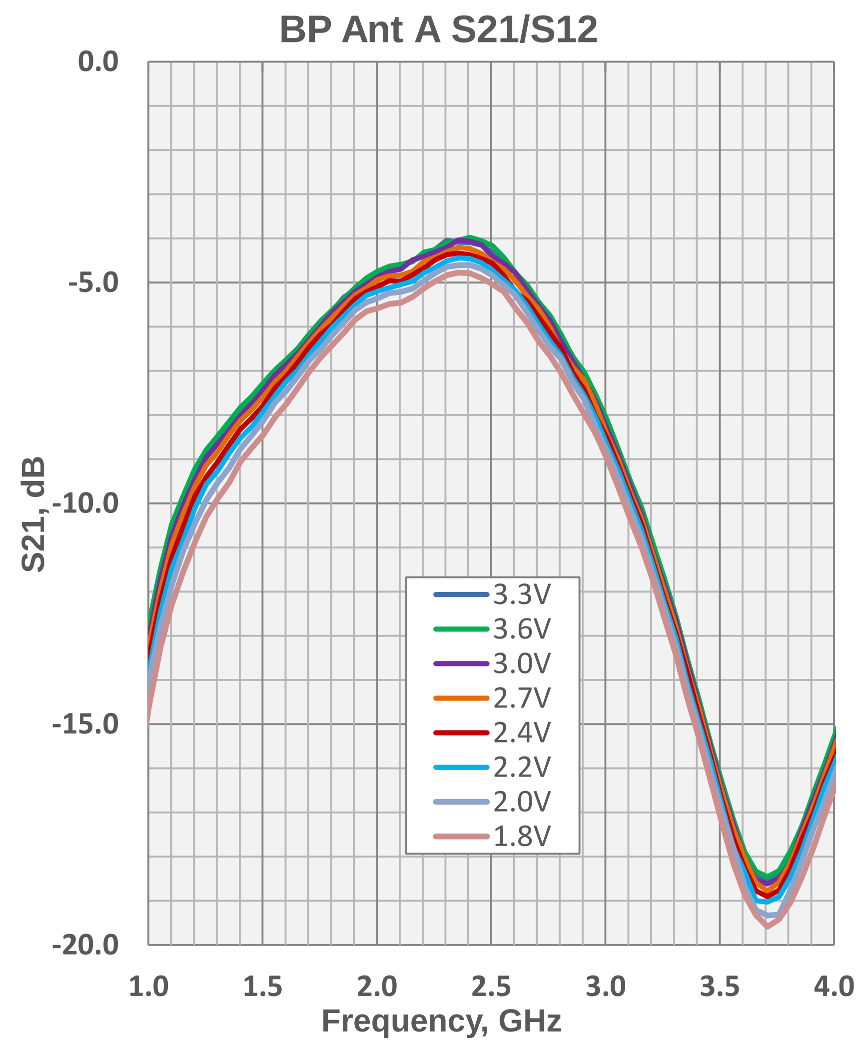




Iq = 8mA @ 3.3V

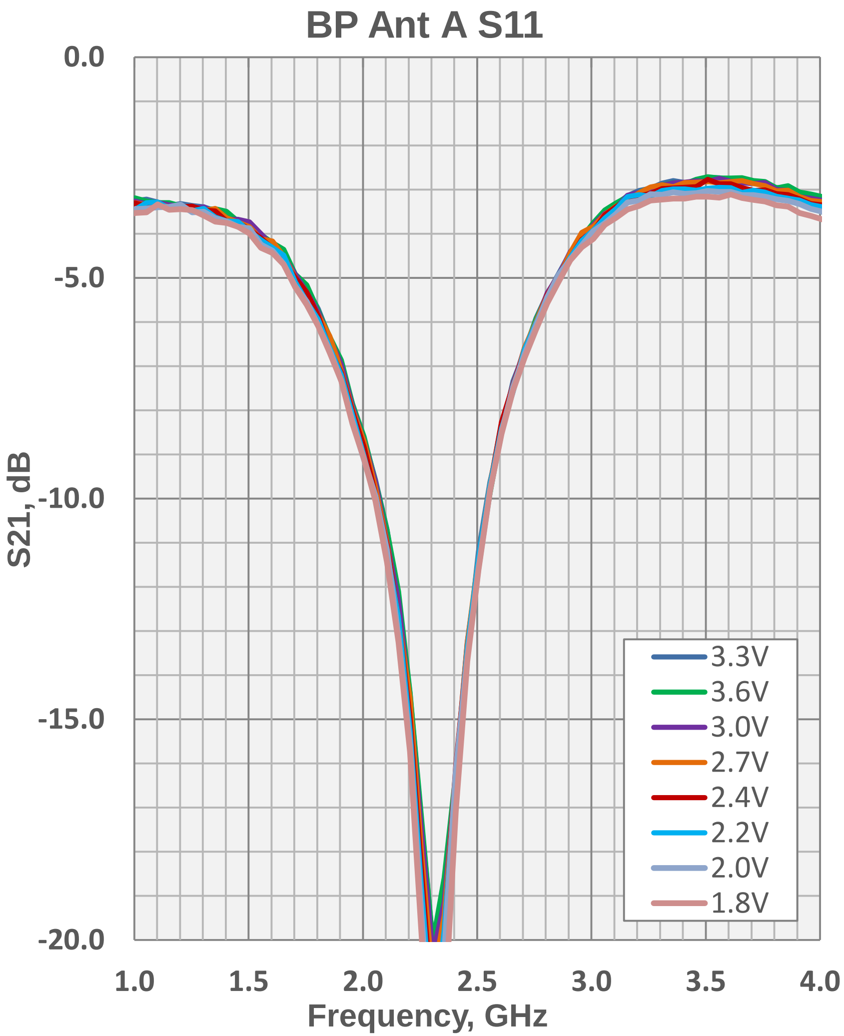
Bypass S-Parameter S21/S12 Across Voltage
Ant A and Ant B

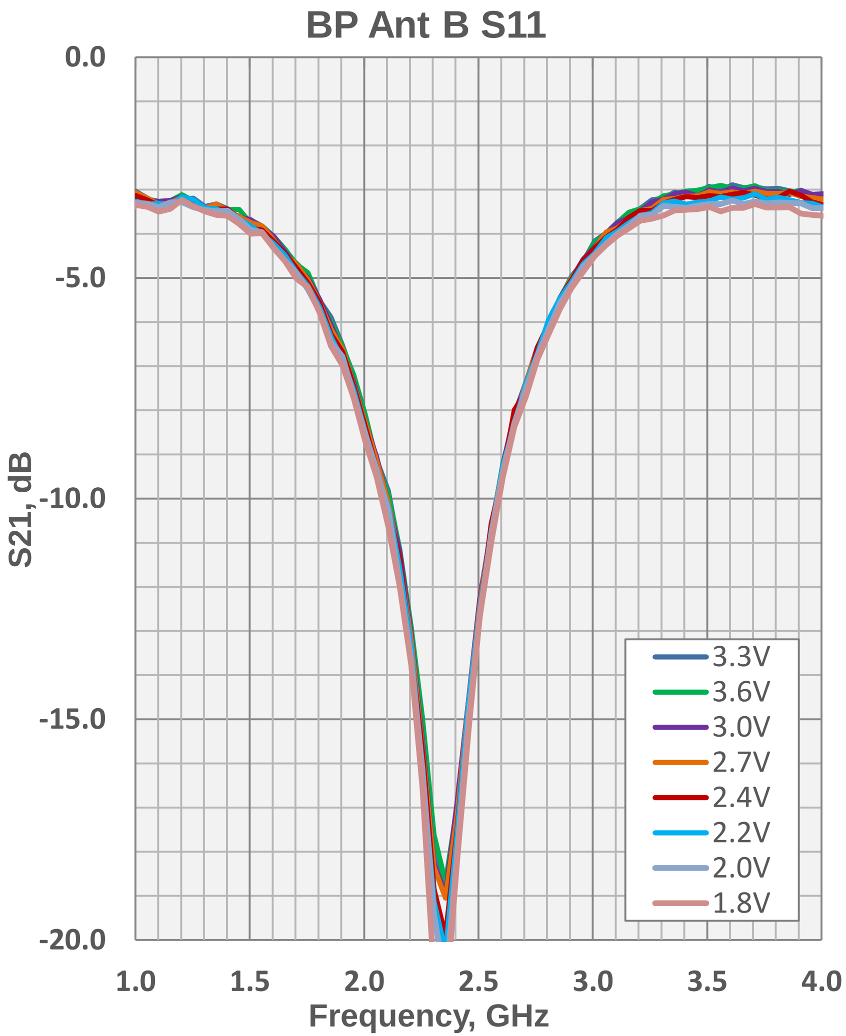




Iq < 1uA @ 3.3V

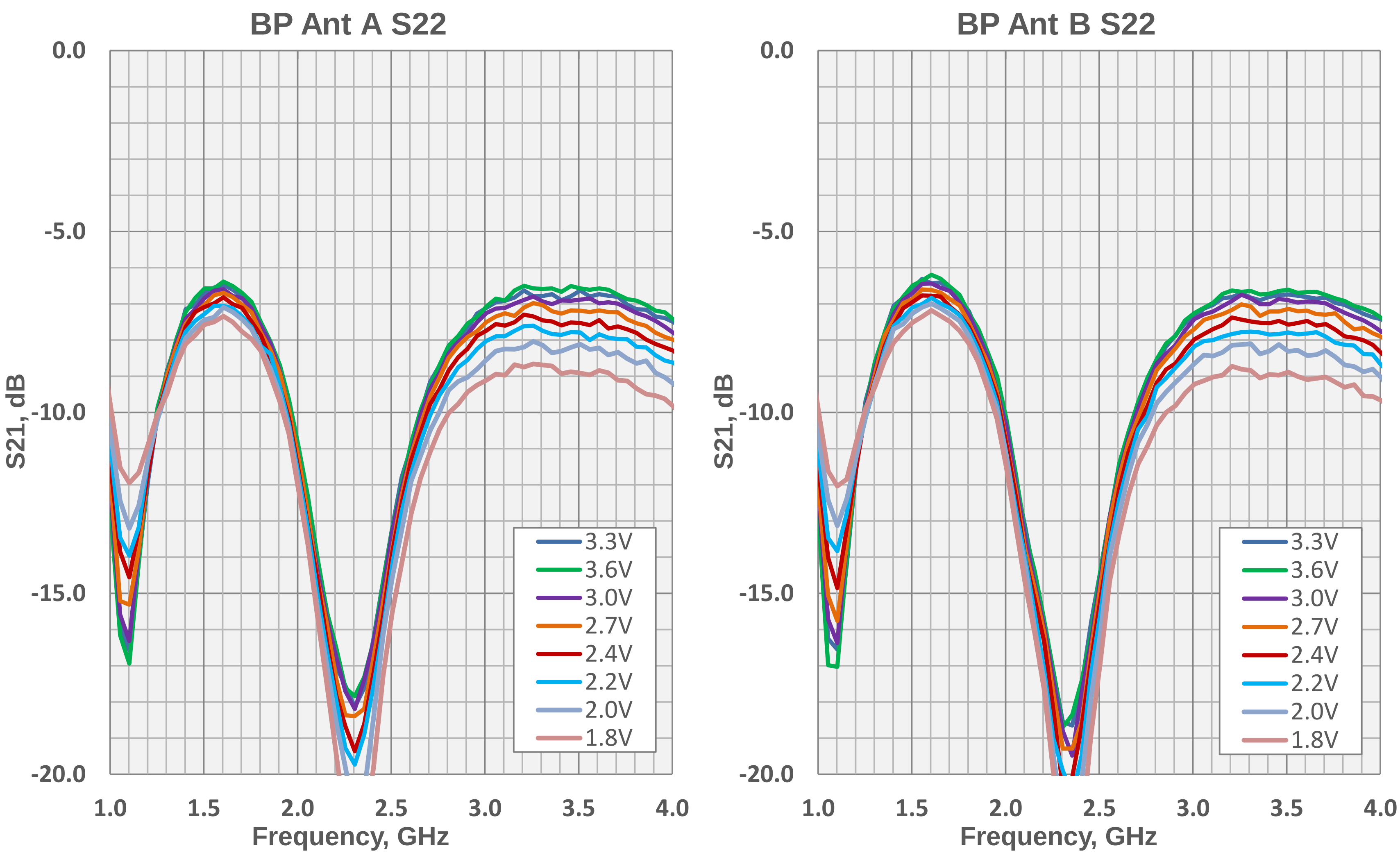
Bypass S-Parameter S11 Across Voltage
Ant A and Ant B





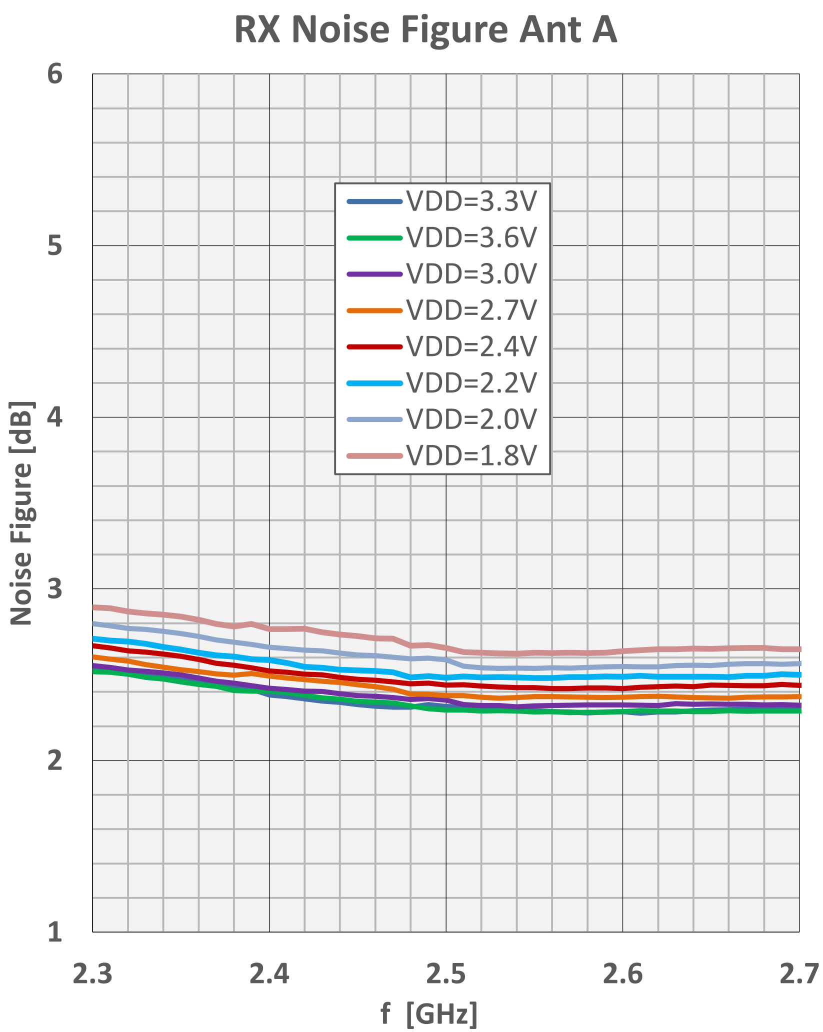
Iq < 1uA @ 3.3V

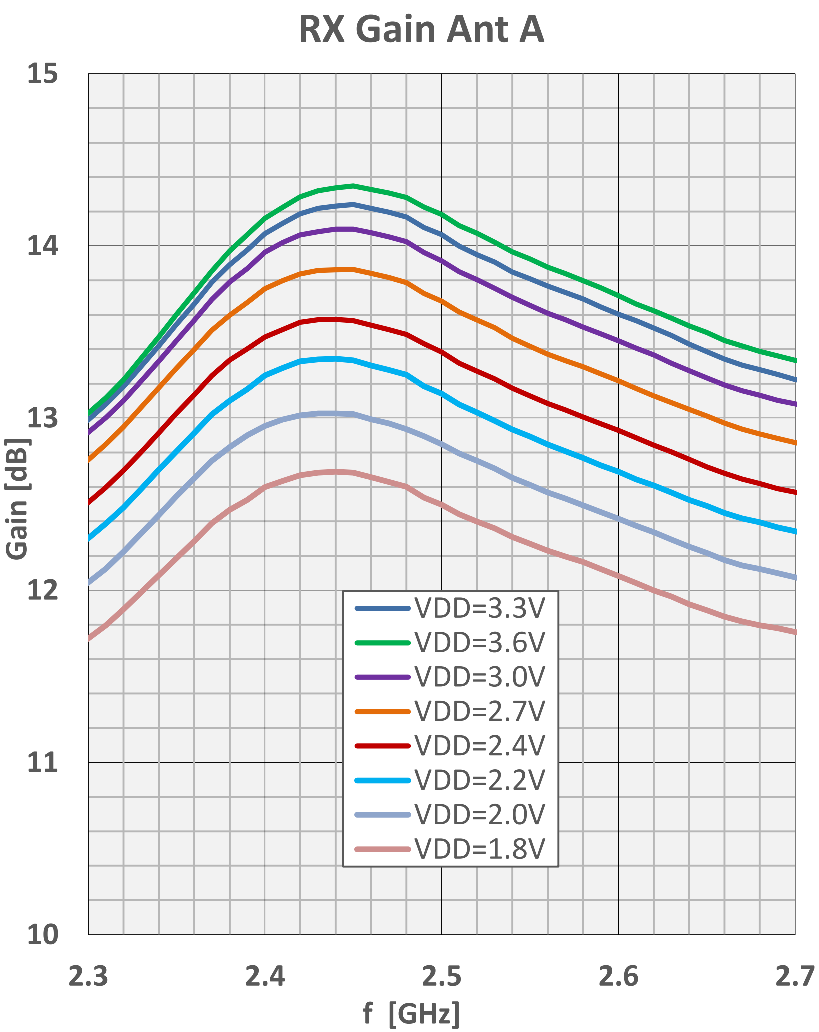
Bypass S-Parameter S22 Across Voltage
Ant A and Ant B



Iq < 1uA @ 3.3V

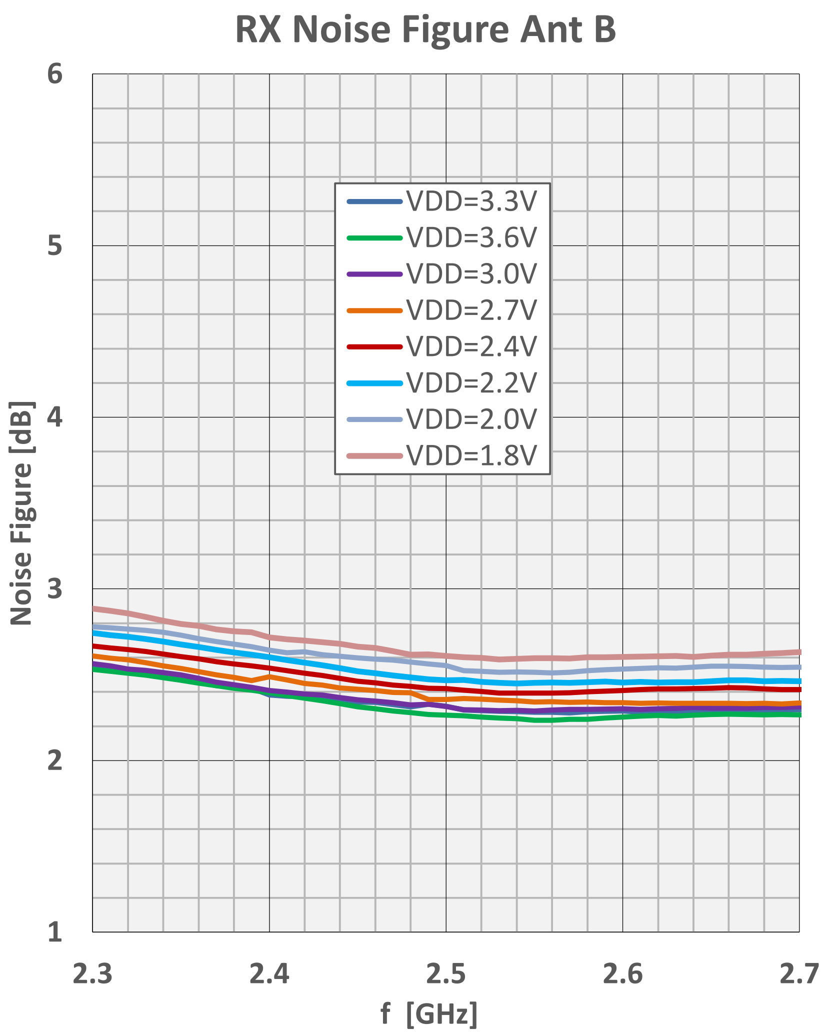
RX Noise Figure and Gain Across Voltage
Antenna A

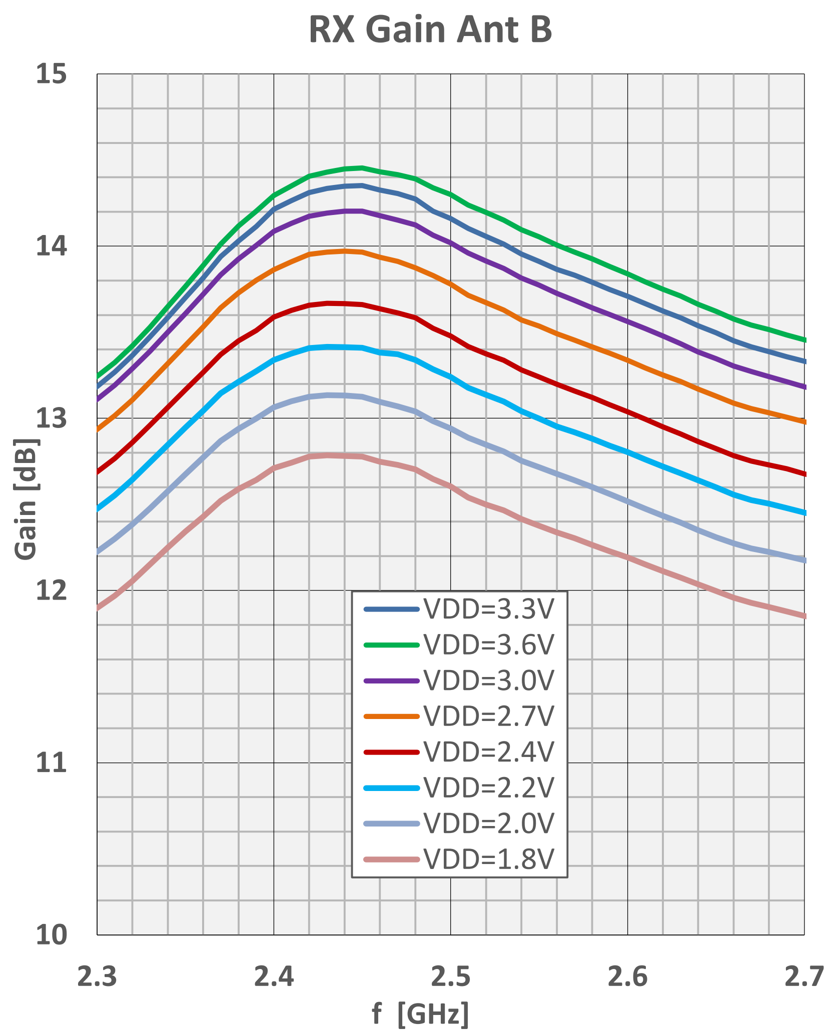




Iq = 8mA @ 3.3V

RX Noise Figure and Gain Across Voltage
Antenna B





Iq = 8mA @ 3.3V