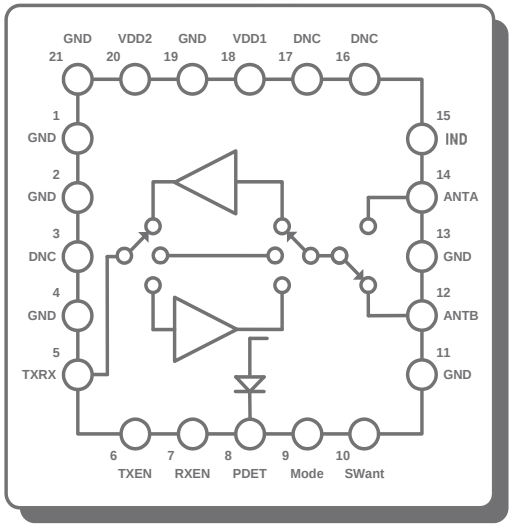
RFX2411 Single-Chip CMOS RFeIC with PA, LNA, Antenna Switch, Combined Tx/Rx Transceiver Port, Input Port to Antenna Port Bypass Mode, and Diversity Switch

Evaluation Board Results
Summary & Technical Notes

RFX2411 RFeIC Key Features and Benefits

3x3x0.55mm
20L QFN



RFX2411 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 Current Mode for ultra low power consumption
- 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

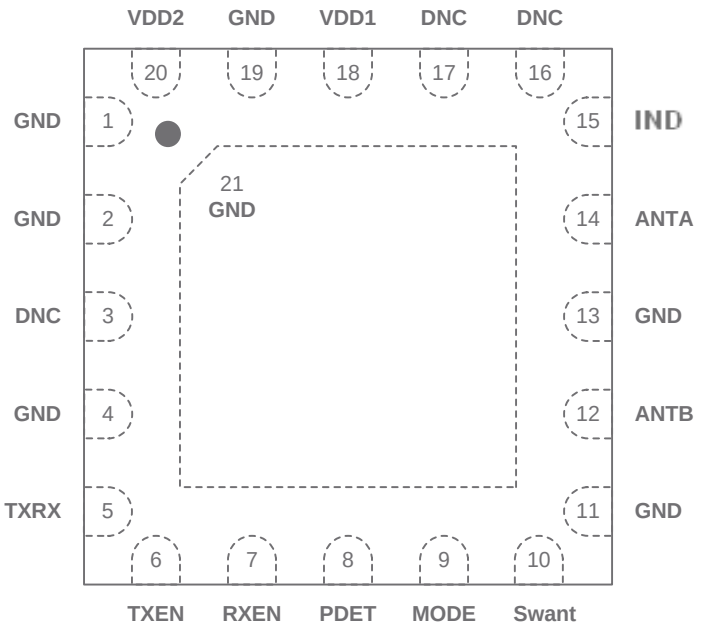
APPLICATIONS

- 802.15.4 ZigBee Extended Range Devices
- ZigBee Smart Power
- ZigBee Home Area Network
- RF4CE Remote Control
- Wireless Sensor Networks
- Other 2.4GHz ISM Band Systems

RFX2411 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

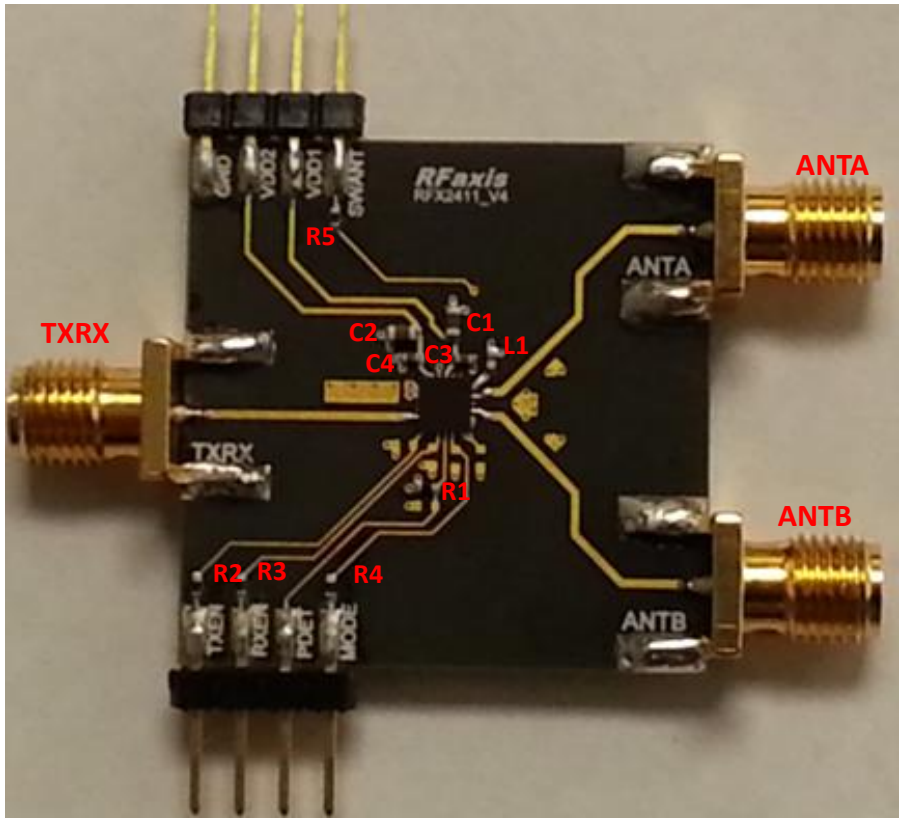
RFX2411 Pin Description



(Top "See-Through" View)

Pin Number	Pin Name	Description
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	External Inductor for Harmonic Suppression
1, 2, 4, 11,13, 19	GND	Ground – Must be connected to Ground in the Application Circuit
3, 16, 17	DNC	Reserved – Do Not Connect in the Application Circuit
18	VDD1	Voltage Supply Connection
20	VDD2	Voltage Supply Connection

RFX2411 Evaluation Board and Preliminary BOM



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

For VDD decoupling:
C1, C2=2.2uF
C3, C4=220pF

Detector Loading:
R1 = 10Kohm

Digital Control Protection:
R2 = R3 = R4 = R5 = 1Kohm (Recommended for control lines with voltage that may approach Vdd levels).

For Harmonic Suppression:
L1=1.2nH (Inductor value may need to be optimized in final application circuit since it is layout dependent)
Additional filtering may be required for compliance depending on system configuration and application.

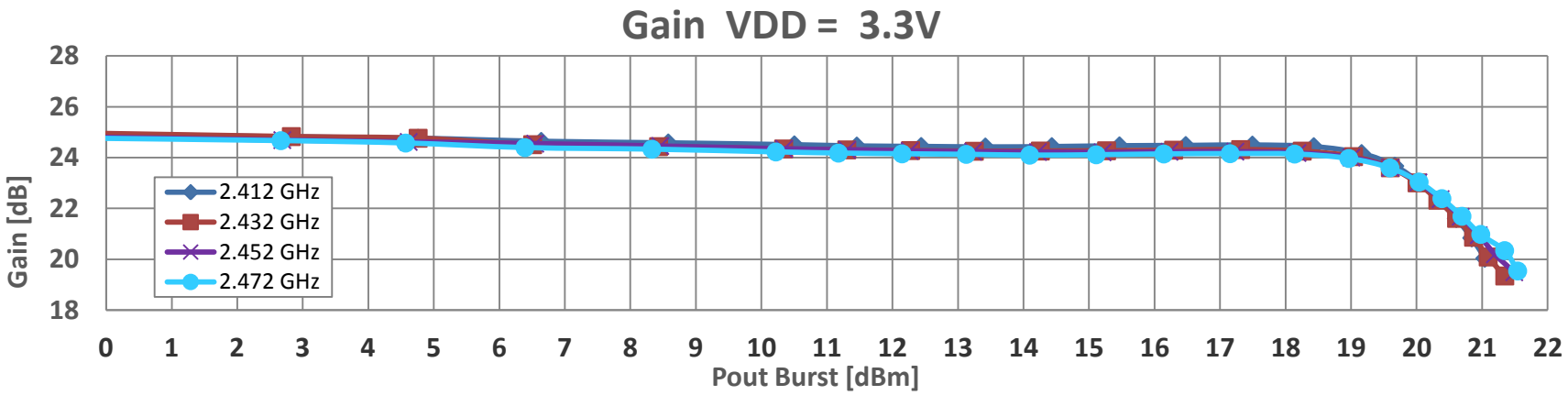
Eval PCB Information:
- 4-Layer Stack, 10mil/40mil/10mil
- FR4 with εr=4.5, tan δ = 0.02 (typ.)
- TXRX, ANTA, ANTB Trace Loss ~ 0.22dB.
- All trace losses have been de-embedded from the following Measurements.

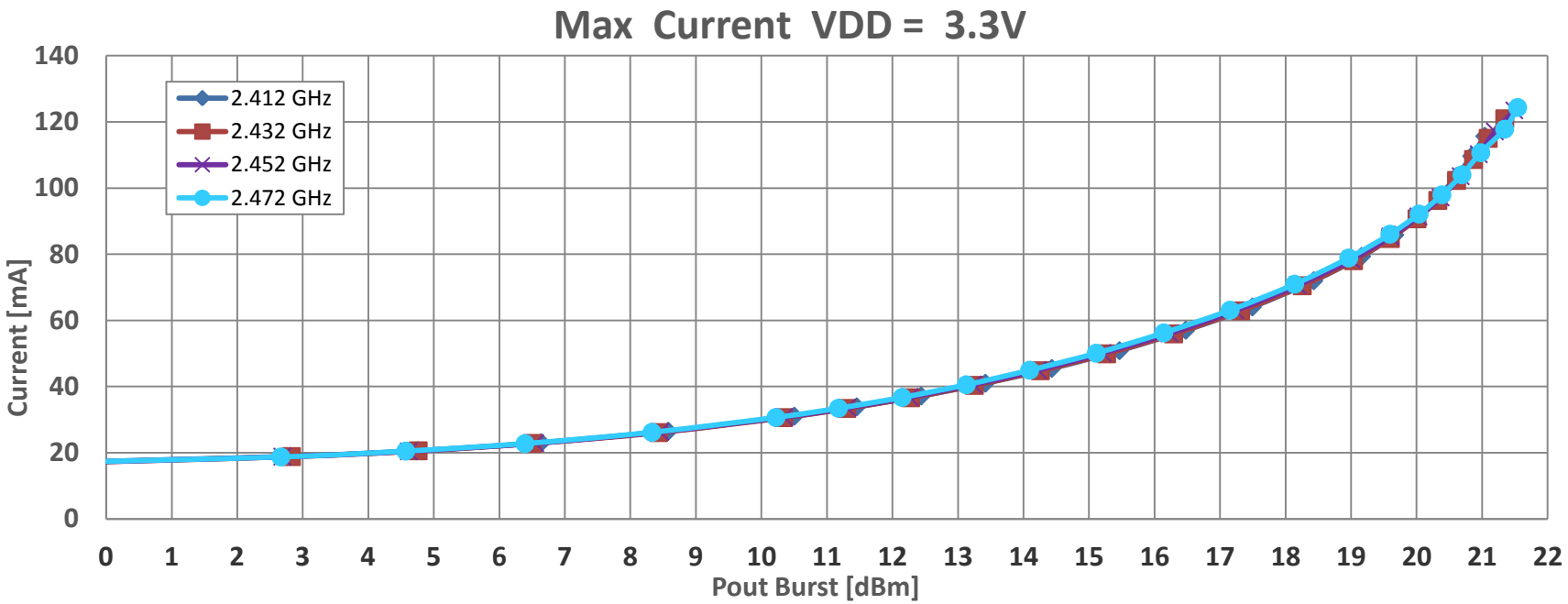
Control Logic Truth Table

TXEN	RXEN	MODE	Mode of Operation
0	0	0	Shutdown Mode
0	0	1	Bypass Mode (Bi-directional)
1	X	0	Transmit Mode
0	1	0	Low Noise Figure Receive Mode
0	1	1	Low Current Receive Mode

Note: "1" denotes high voltage state (> 1.2V) at Control Pins
"0" denotes low voltage state (< 0.3V) at Control Pins

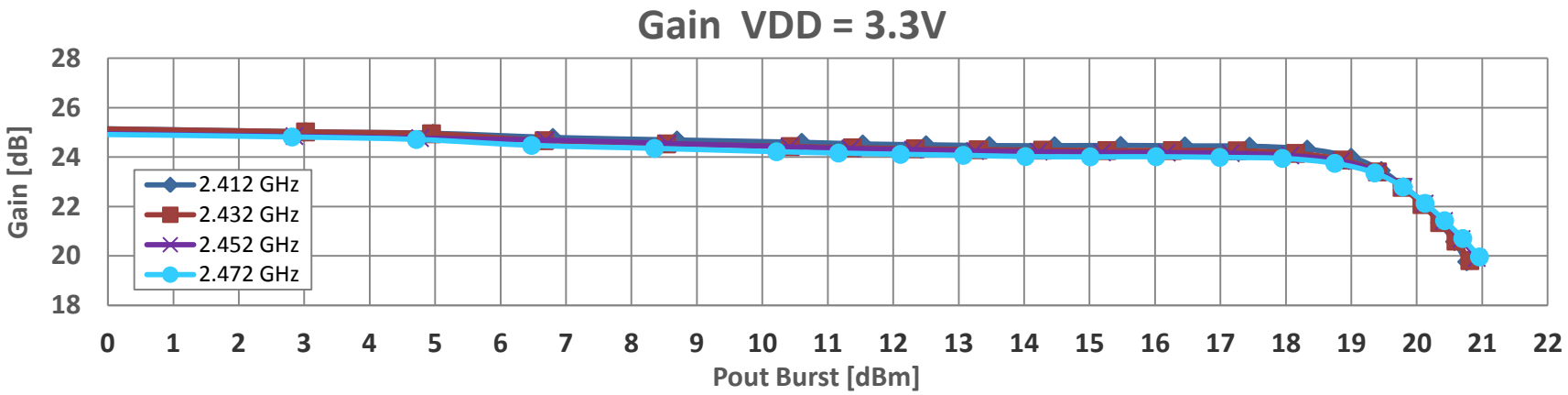
TX Large Signal Gain & Current vs. Pout Across Frequency, Antenna A, CW Signal

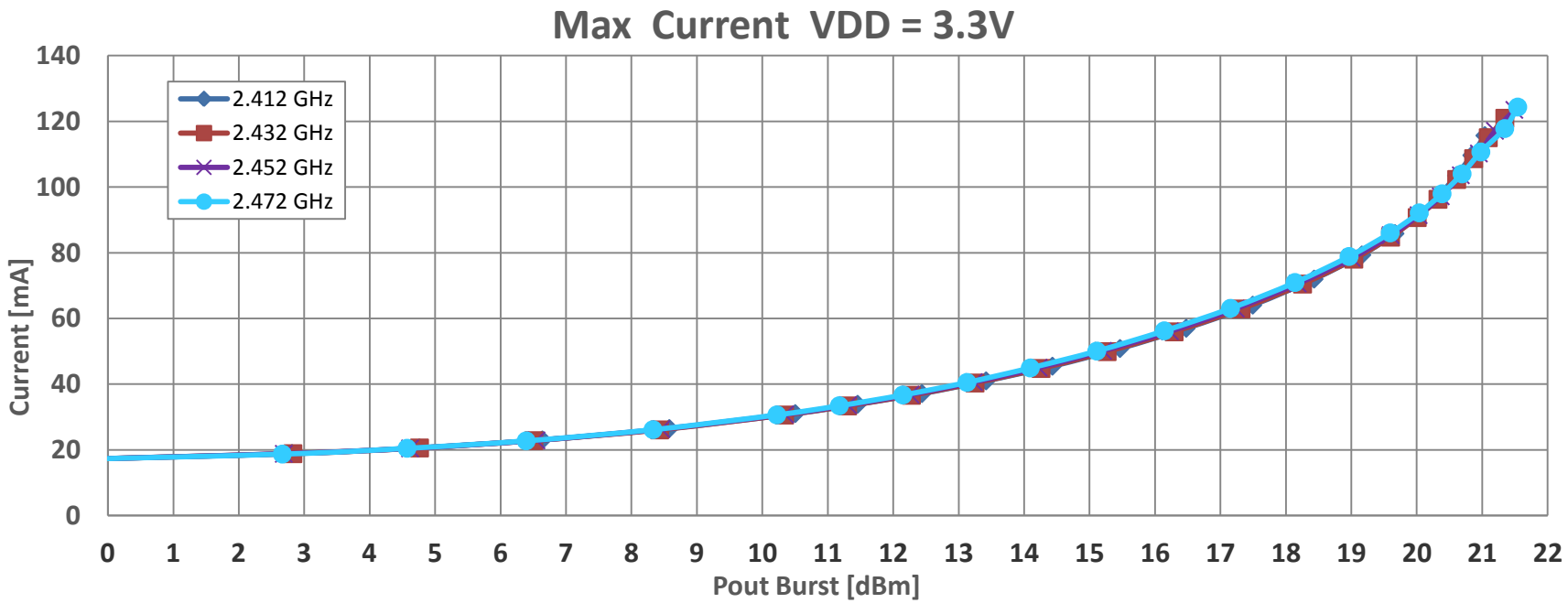




TXEN=1.2V, RXEN=0V, SWANT=1.2V, Mode=0V

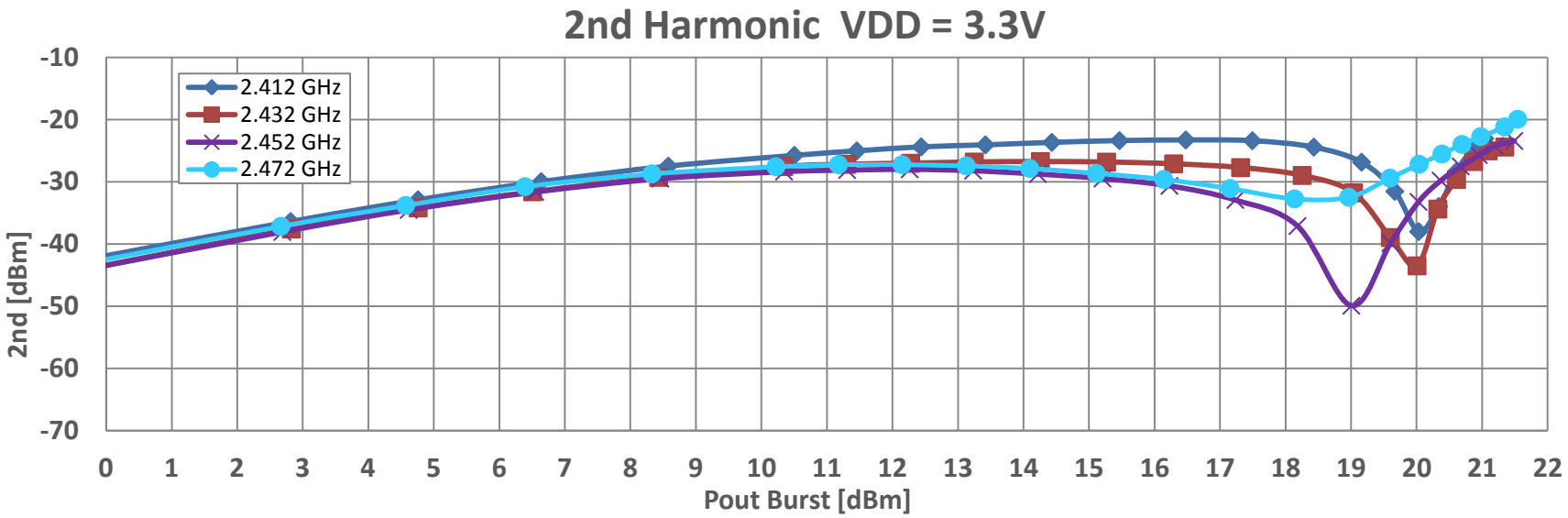
TX Large Signal Gain & Current vs. Pout Across Frequency, Antenna B, CW Signal

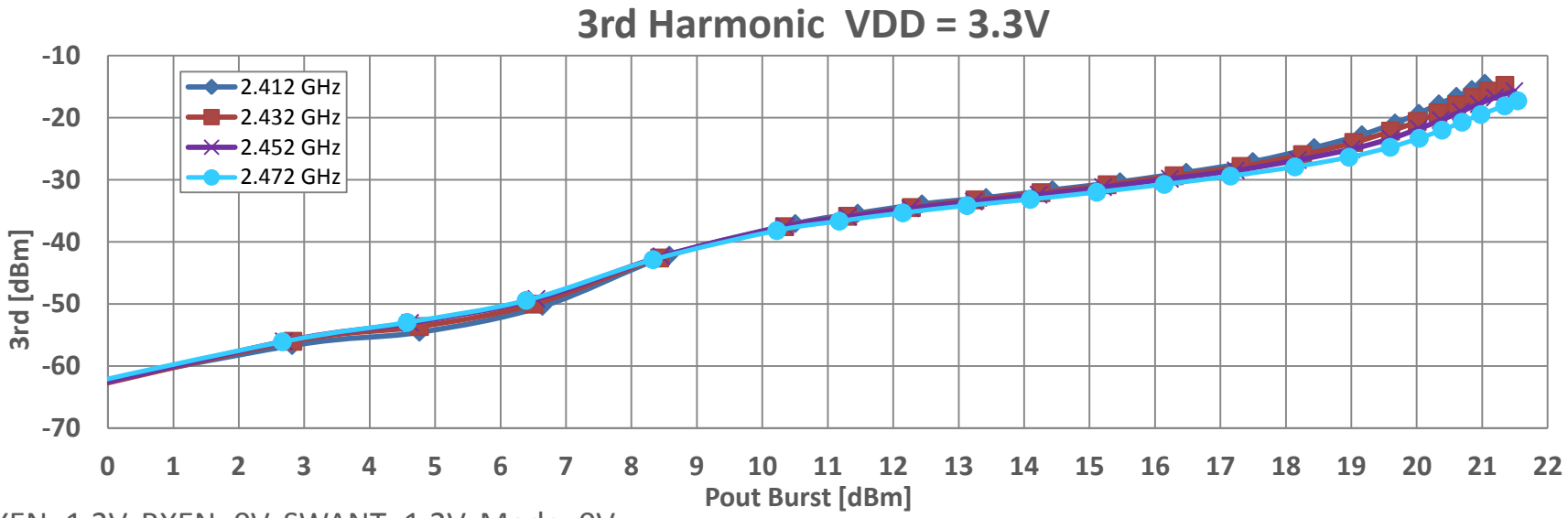




TXEN=1.2V, RXEN=0V, SWANT=0V, Mode=0V

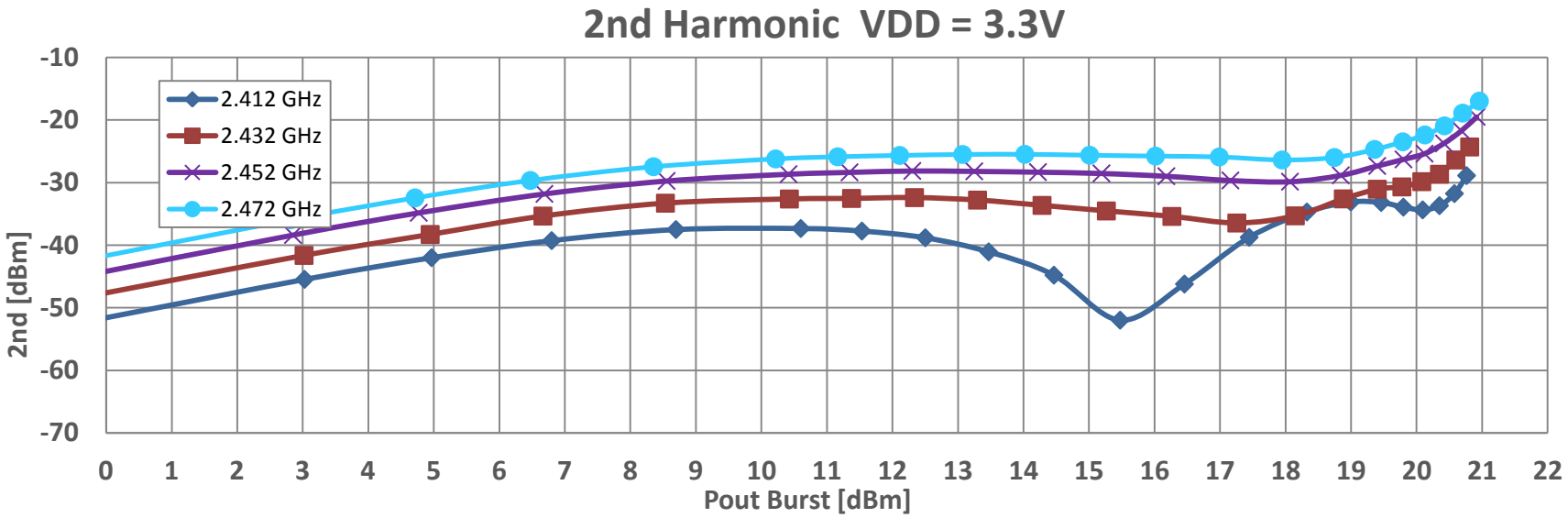
TX 2nd Harmonic vs. Pout Across Frequency, Antenna A

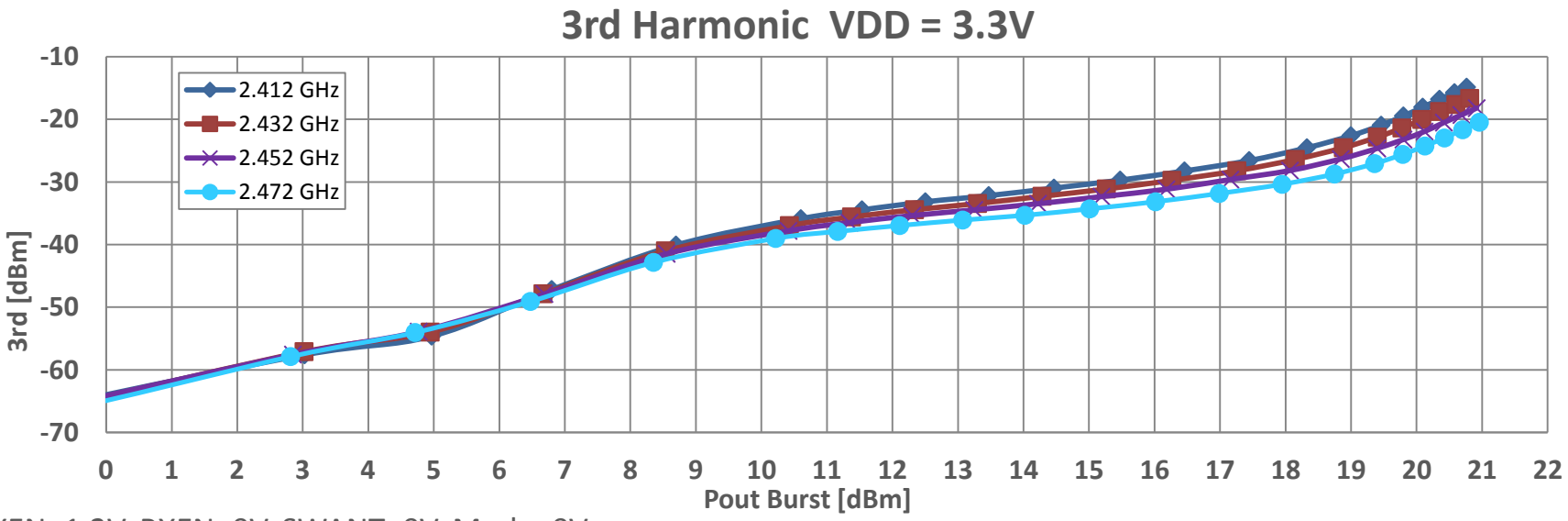




TXEN=1.2V, RXEN=0V, SWANT=1.2V, Mode=0V

TX 2nd & 3rd Harmonic vs. Pout Across Frequency, Antenna B

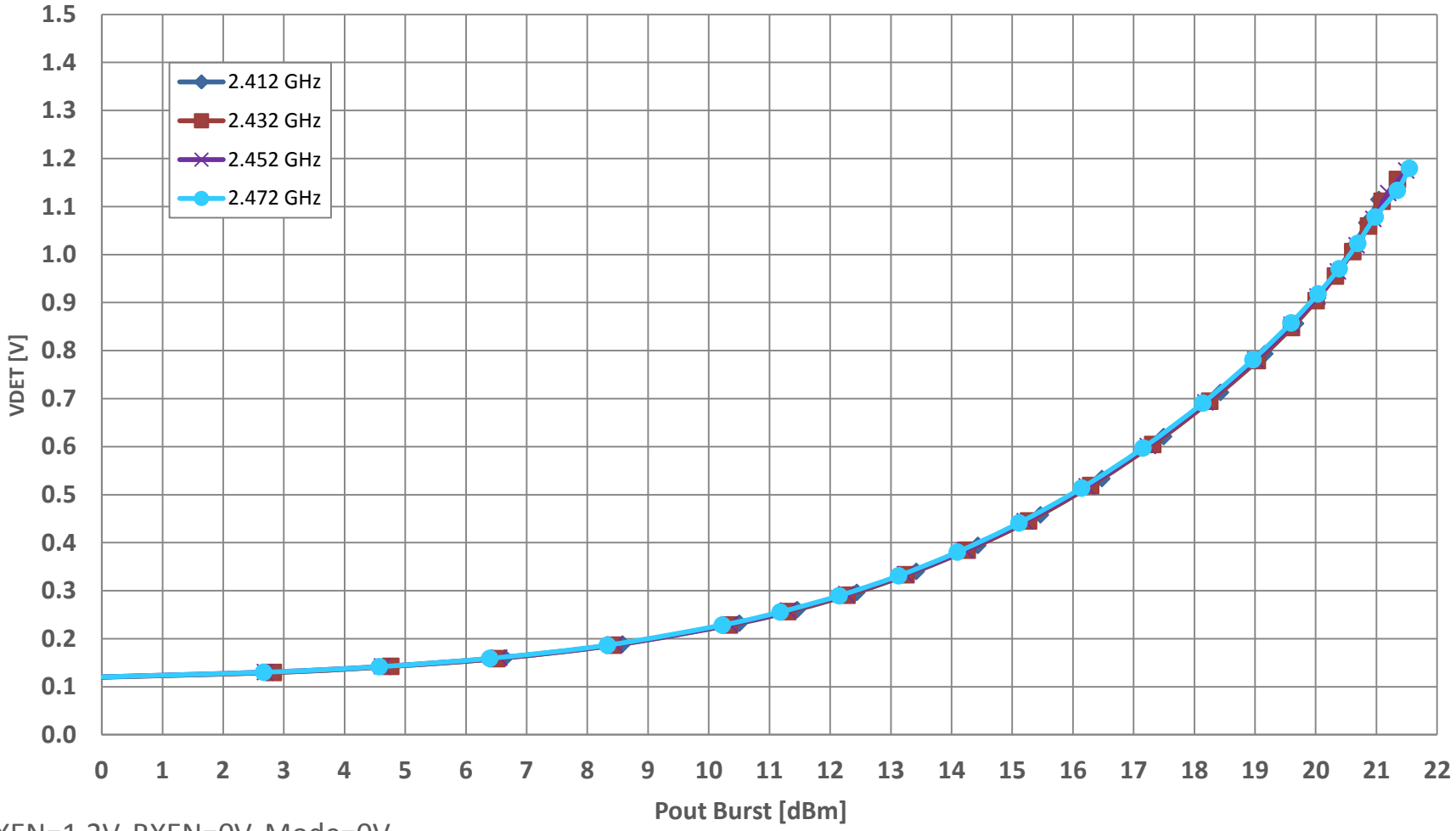




TXEN=1.2V, RXEN=0V, SWANT=0V, Mode=0V

TX Detector Voltage vs. Pout Across Frequency
Ant A or Ant B

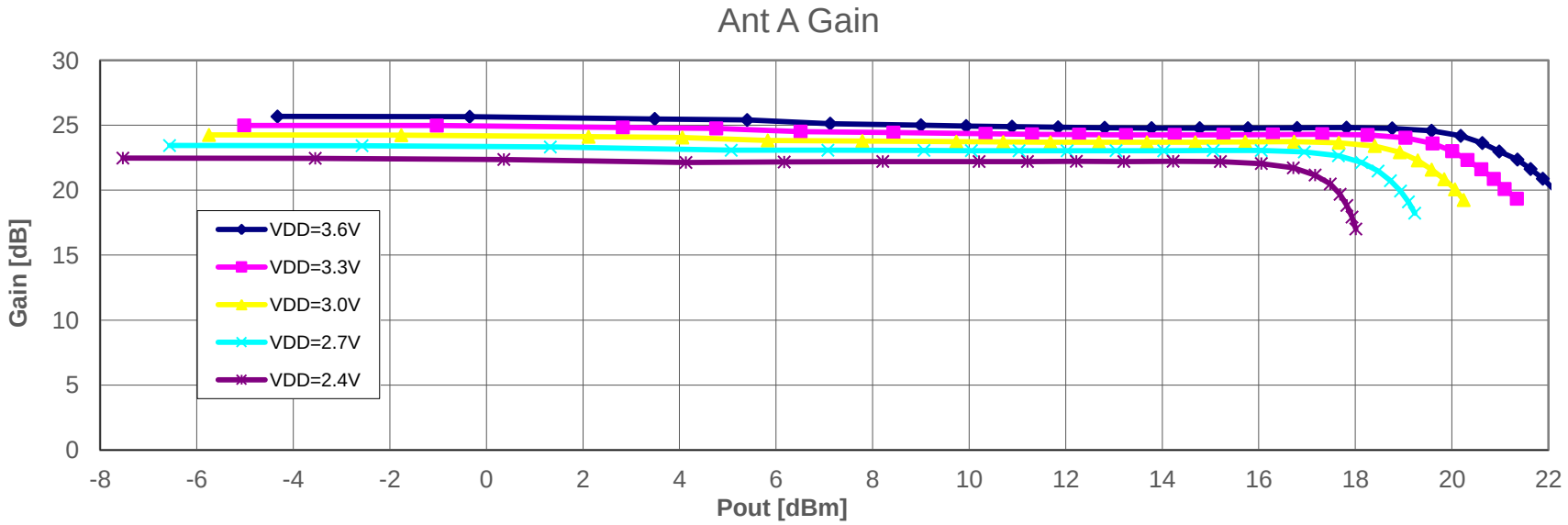
Vdet VDD = 3.3V

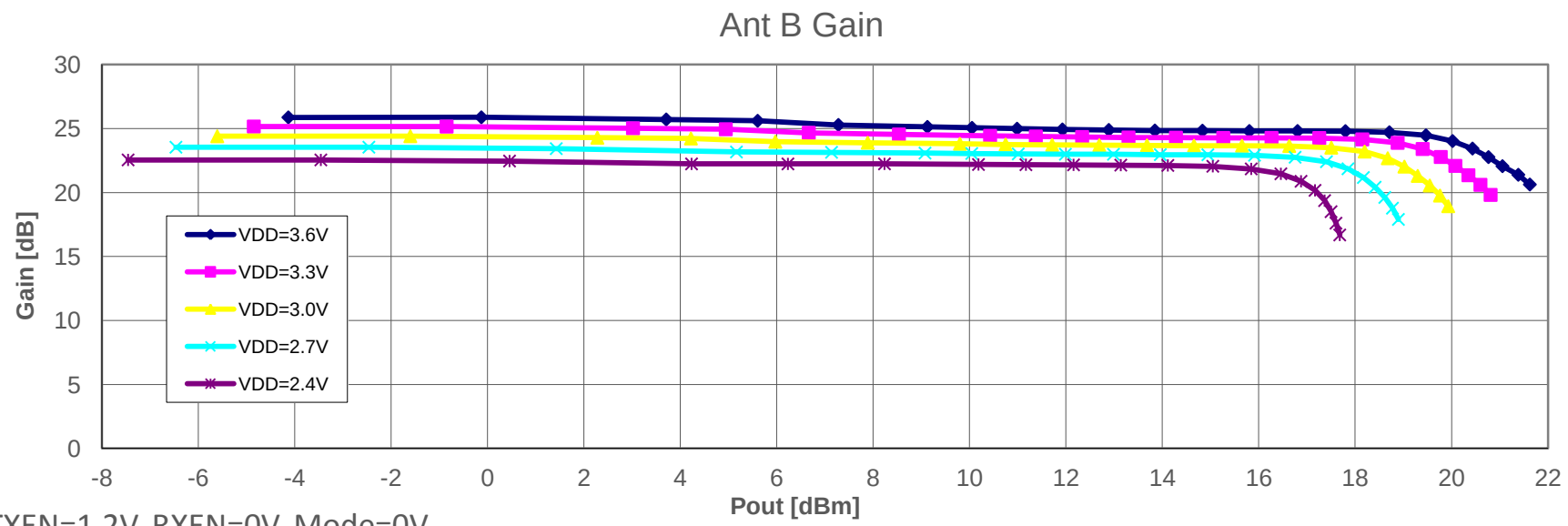


TXEN=1.2V, RXEN=0V, Mode=0V

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

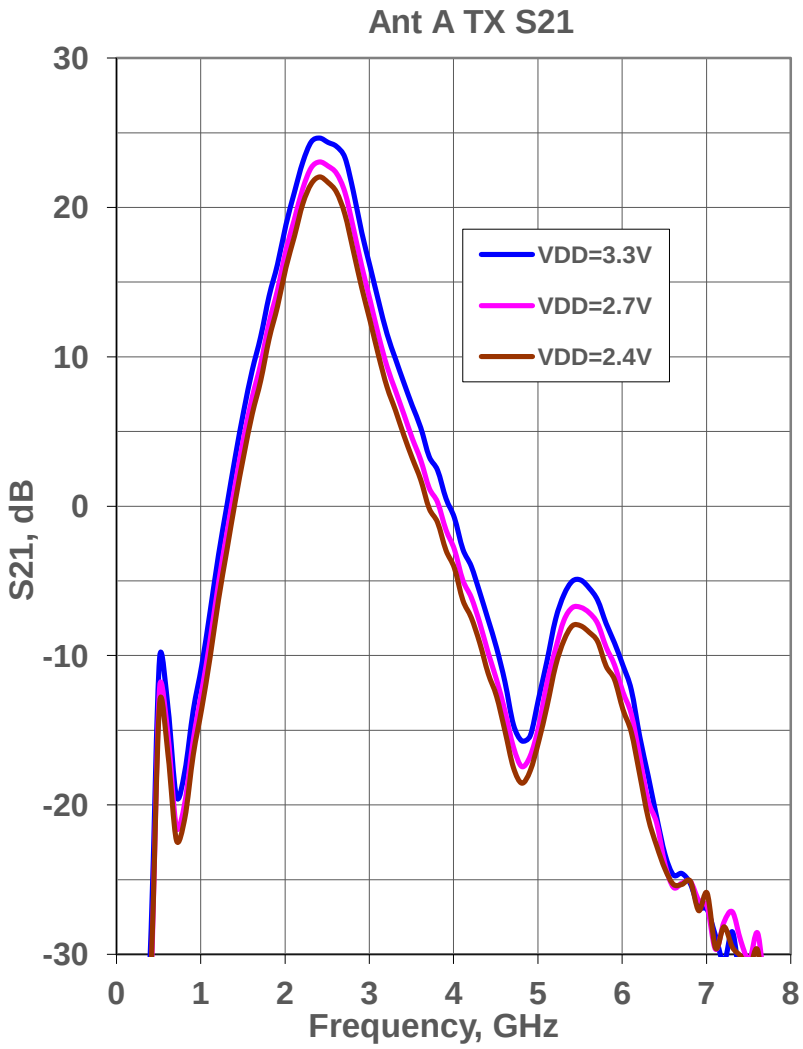
TX Large Signal Gain & Current vs. Pout Across VDD, 2.432 GHz, CW Signal

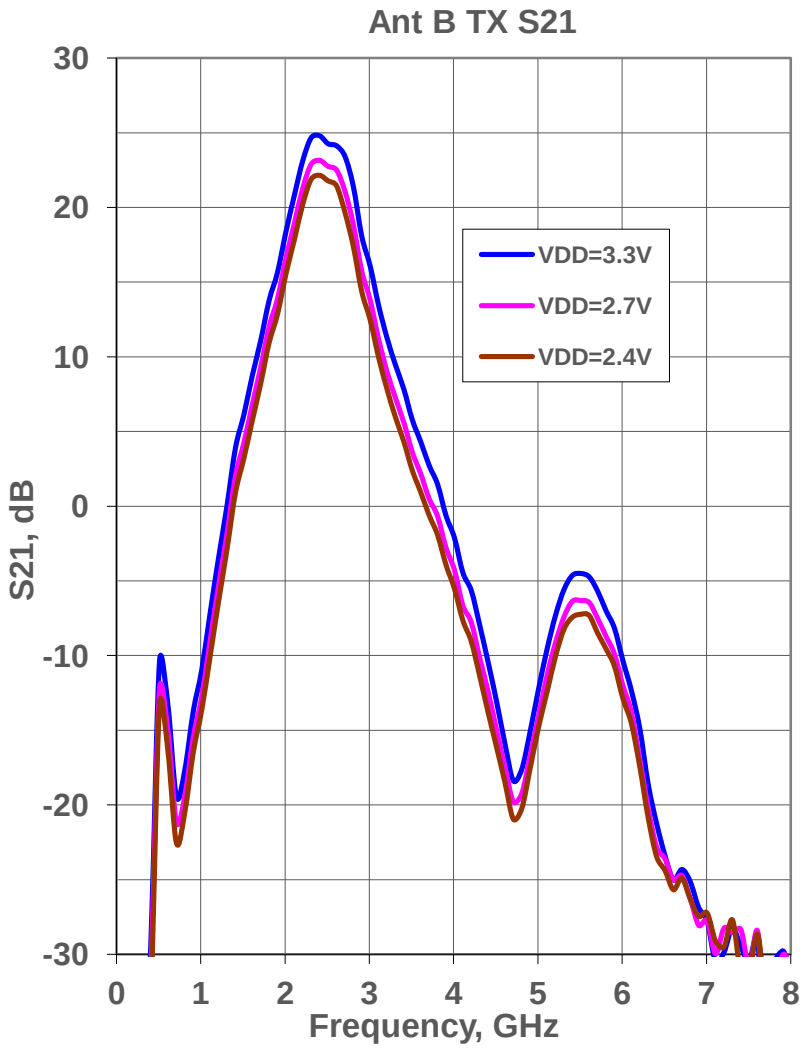




TXEN=1.2V, RXEN=0V, Mode=0V

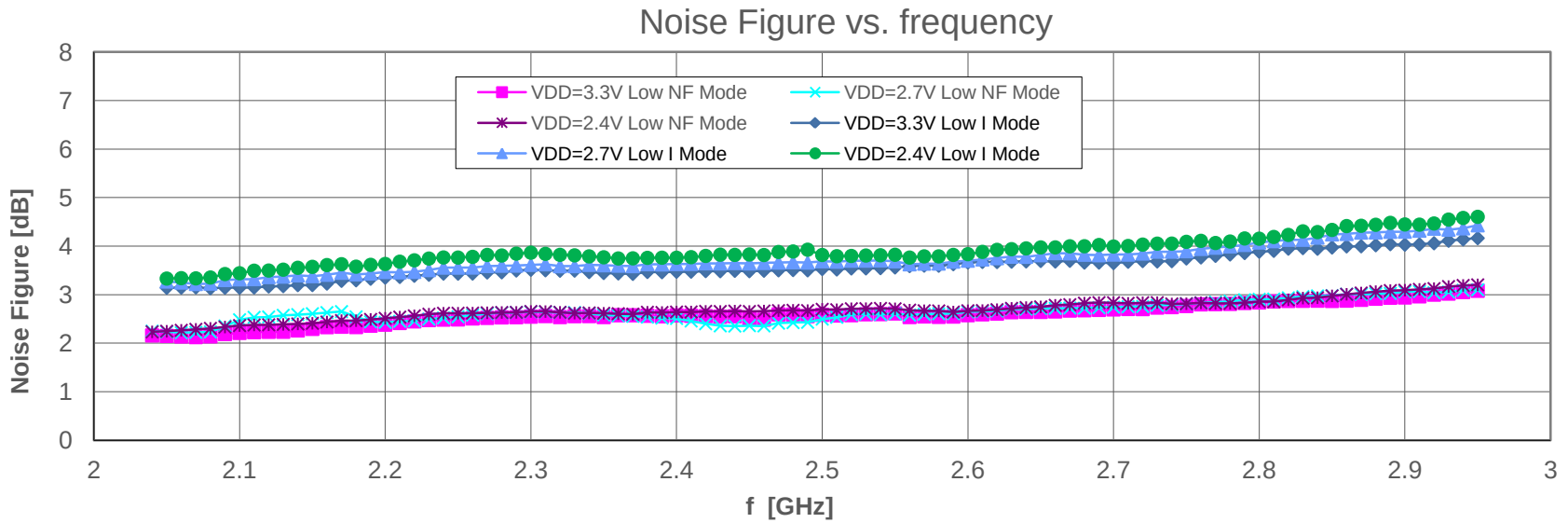
TX Small Signal S21

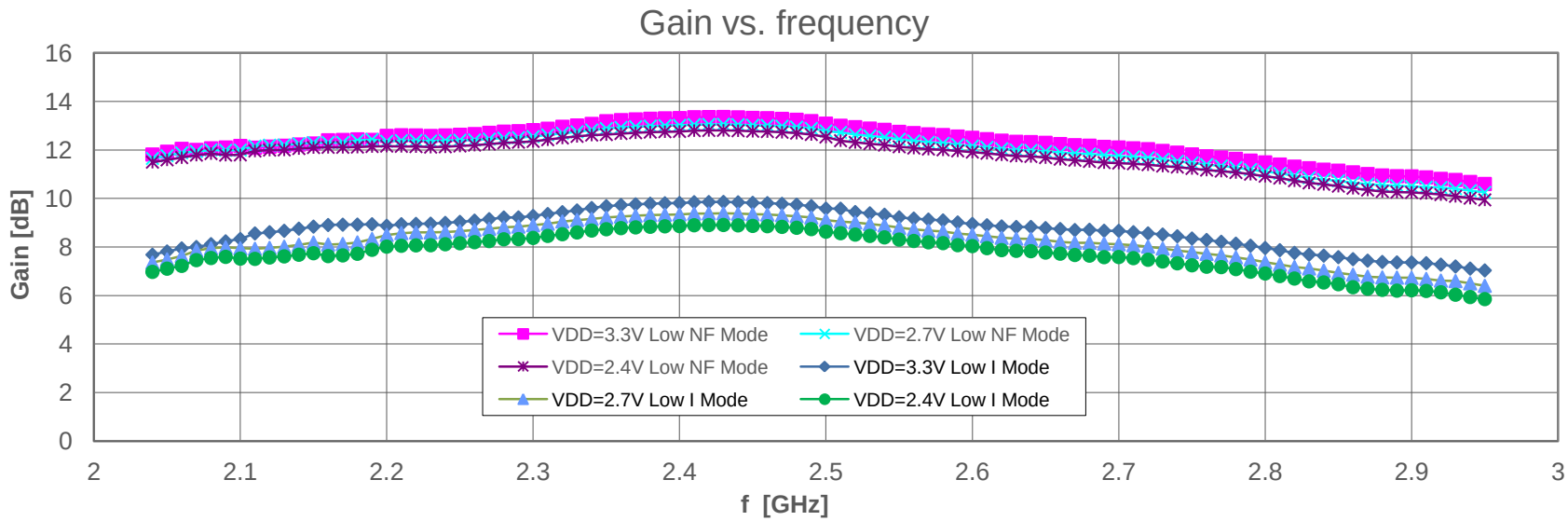




Icq ~ 18mA

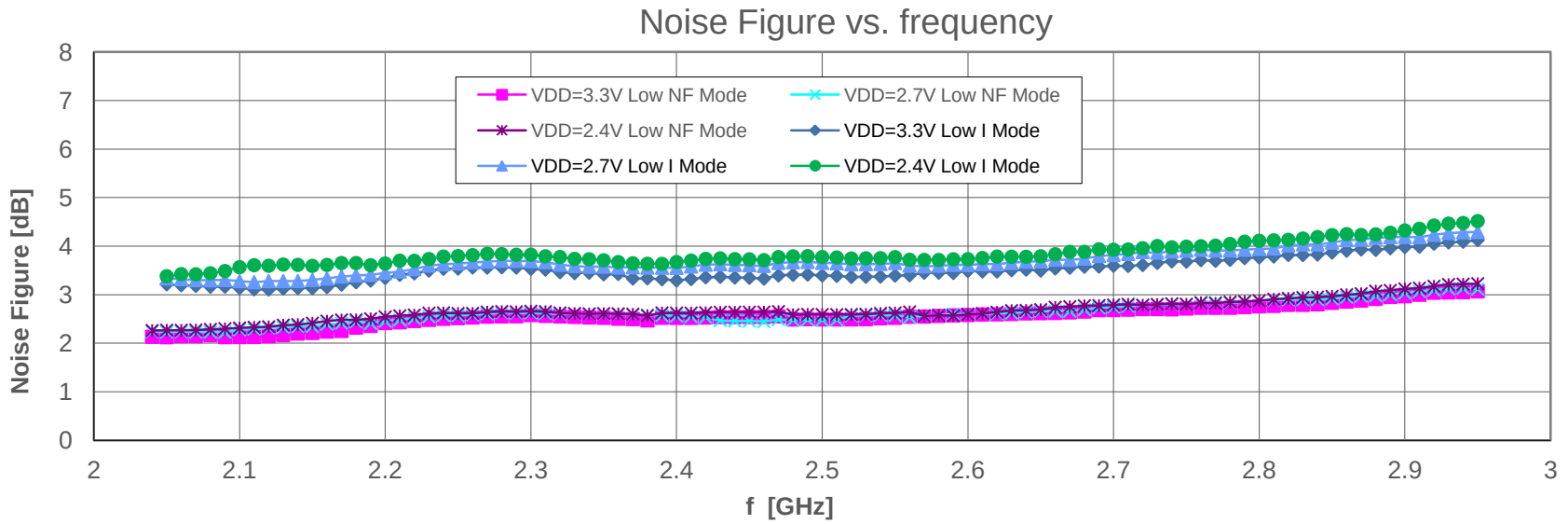
RX Noise Figure and Gain, Antenna A, Mode = High/Low

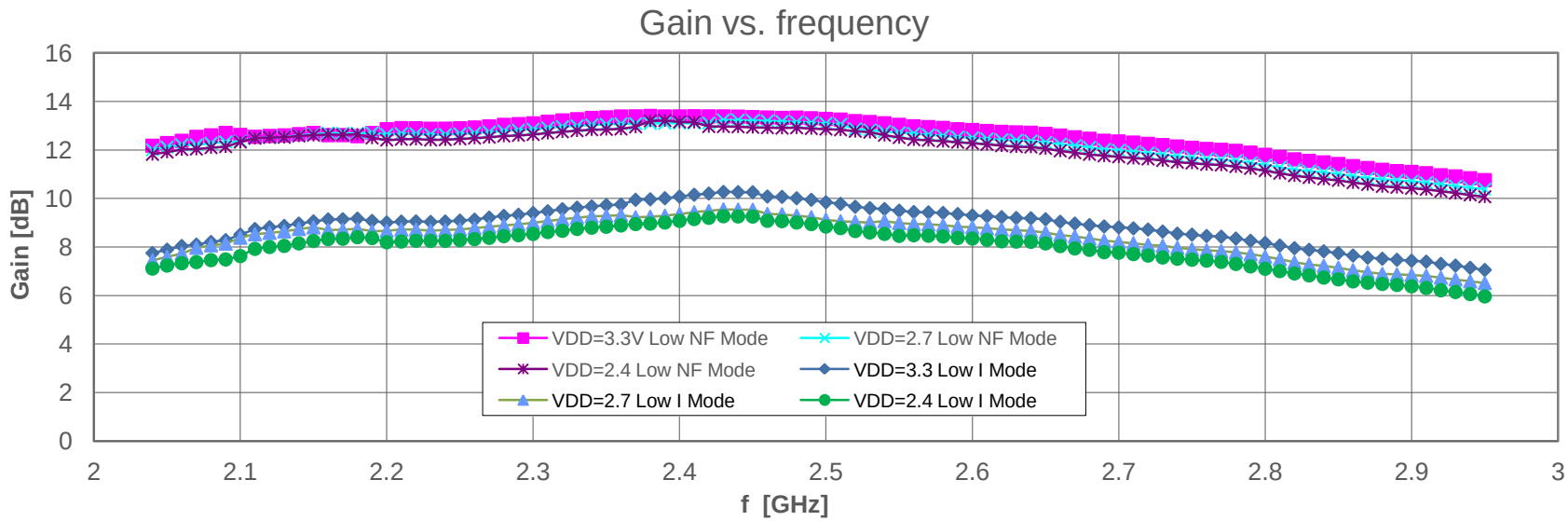




TXEN=0V, RXEN=1.2V, SWANT=1.2V Icq(Low NF Mode) = 9 mA Icq(Low I Mode) = 4 mA

RX Noise Figure and Gain, Antenna B, Mode = High/Low

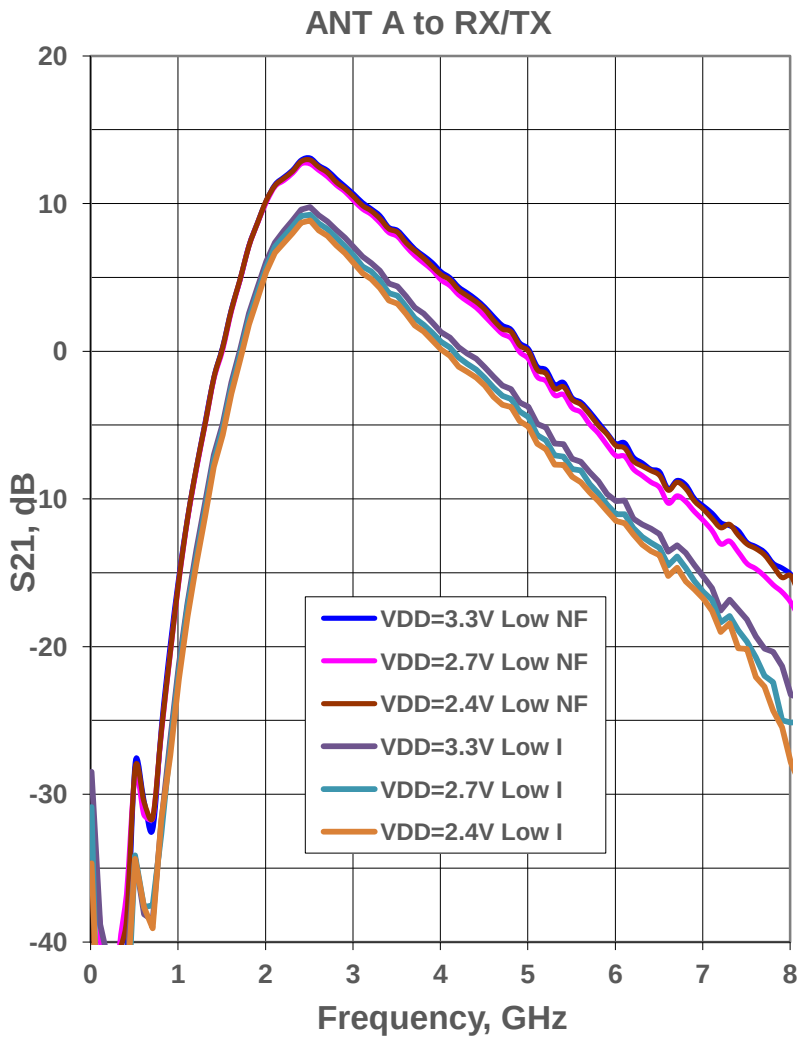


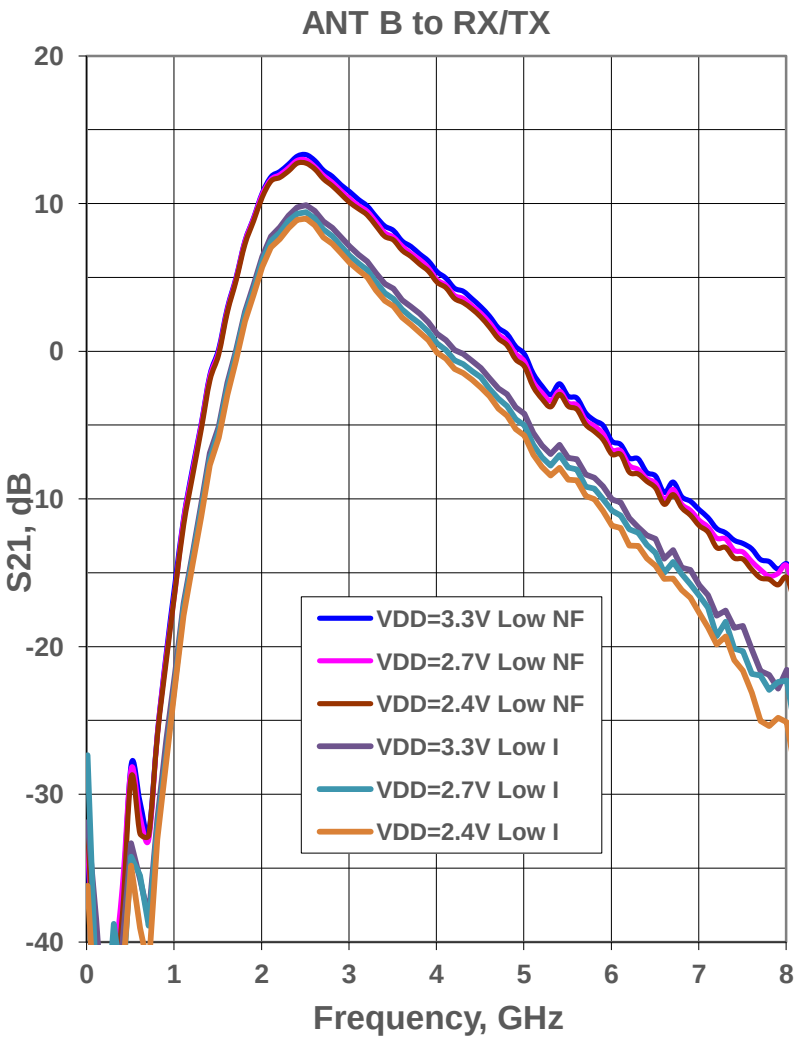


TXEN=0V, RXEN=1.2V, SWANT=0V Icq(Low NF Mode) = 9 mA Icq(Low I Mode) = 4 mA

RFaxis
BRIDGING THE RF GAP

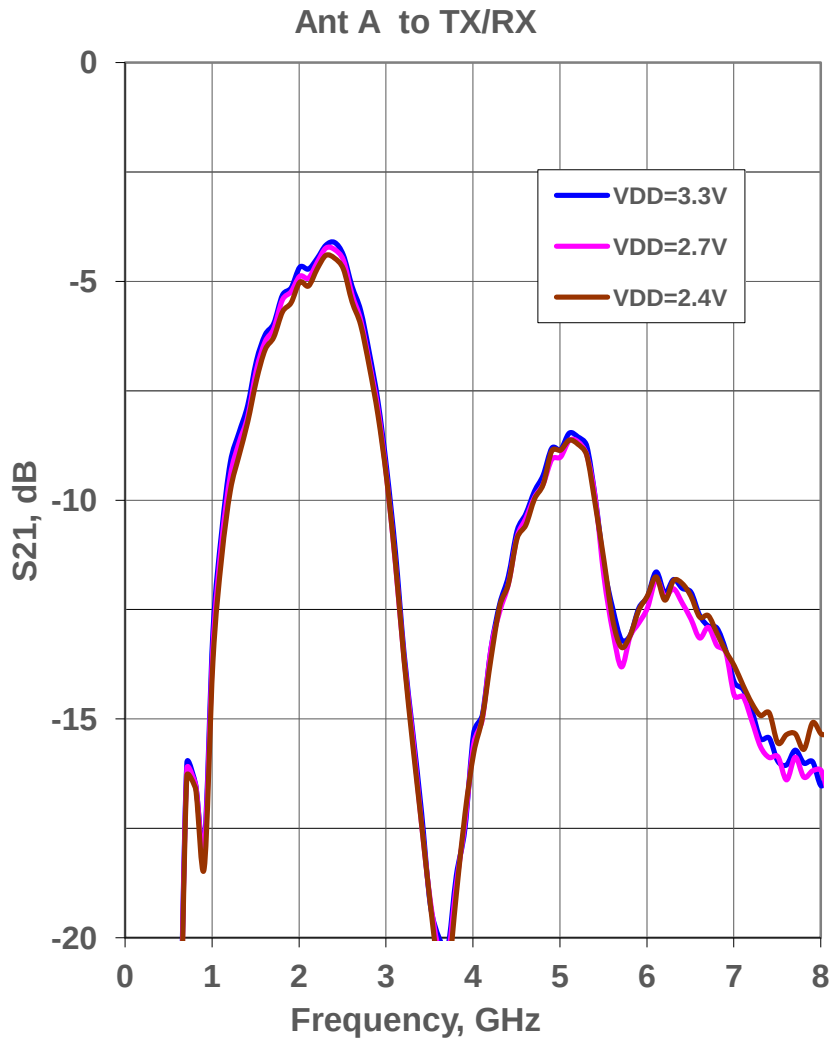
RX Small Signal Gain, Antenna A and B
Mode = Low NF and Mode = Low Current (I)

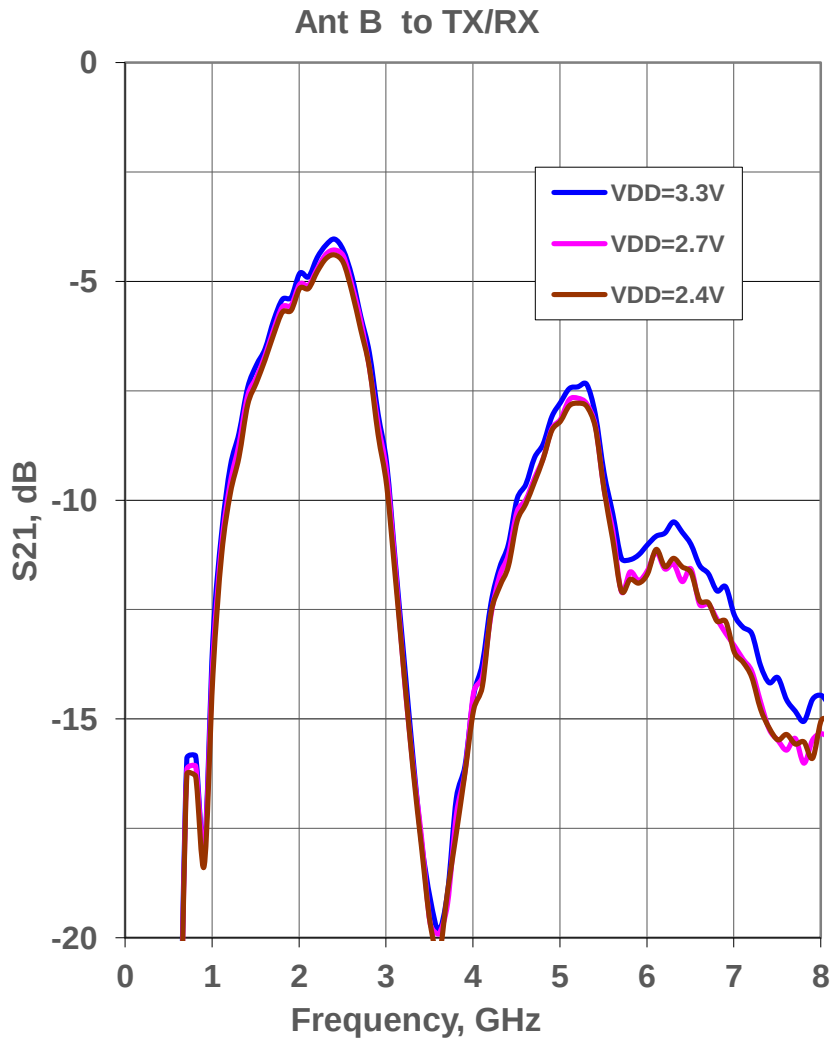




TXEN=0V, RXEN=1.2V Icq(Low NF Mode) = 9 mA Icq (Low Current Mode) = 4 mA

Bypass Small Signal S21, Antenna A/B

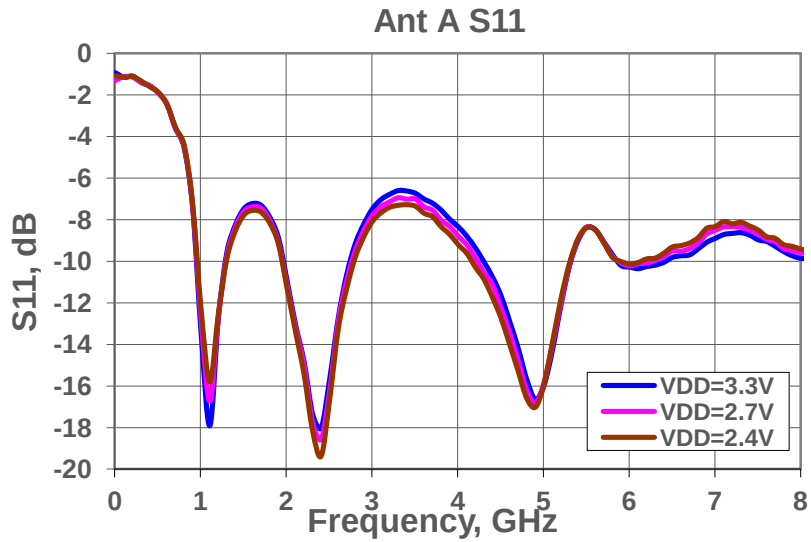


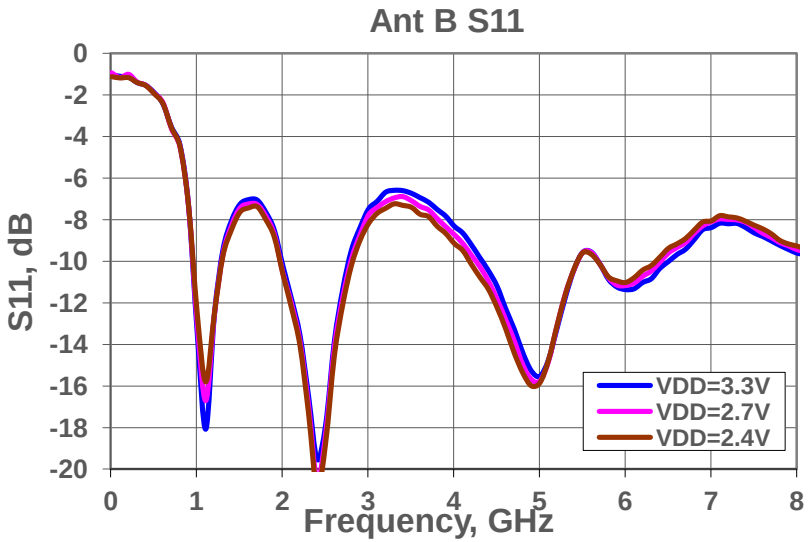


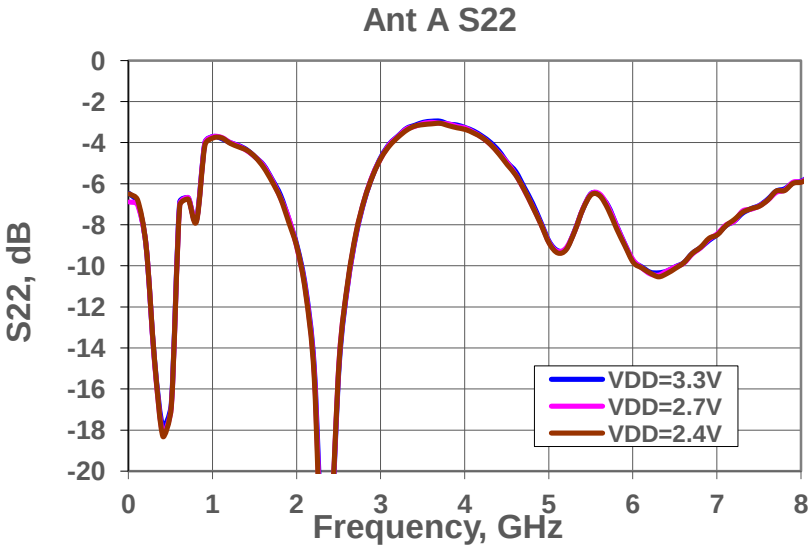
TXEN=0V, RXEN=0V, MODE=1.2V

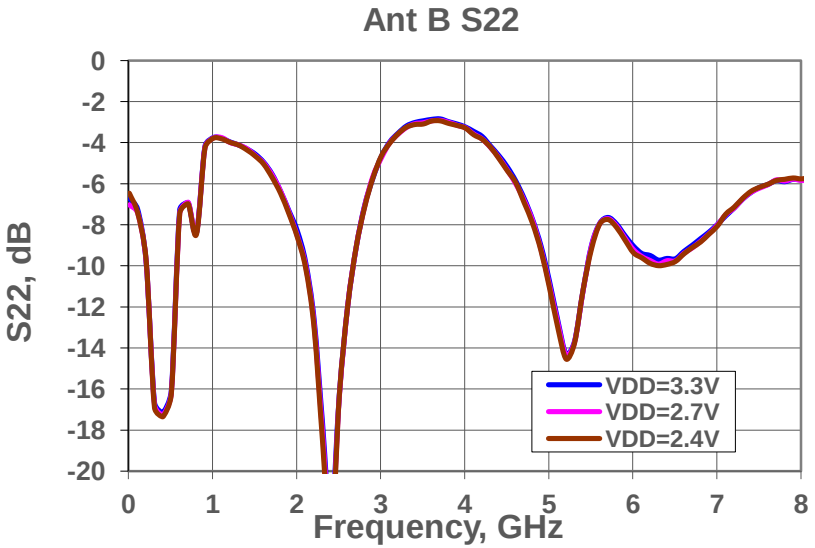
Note: Bypass mode performance is bi-directional and could be used in TX and/or RX modes

Bypass Small Signal S11, S22
Antenna A/B





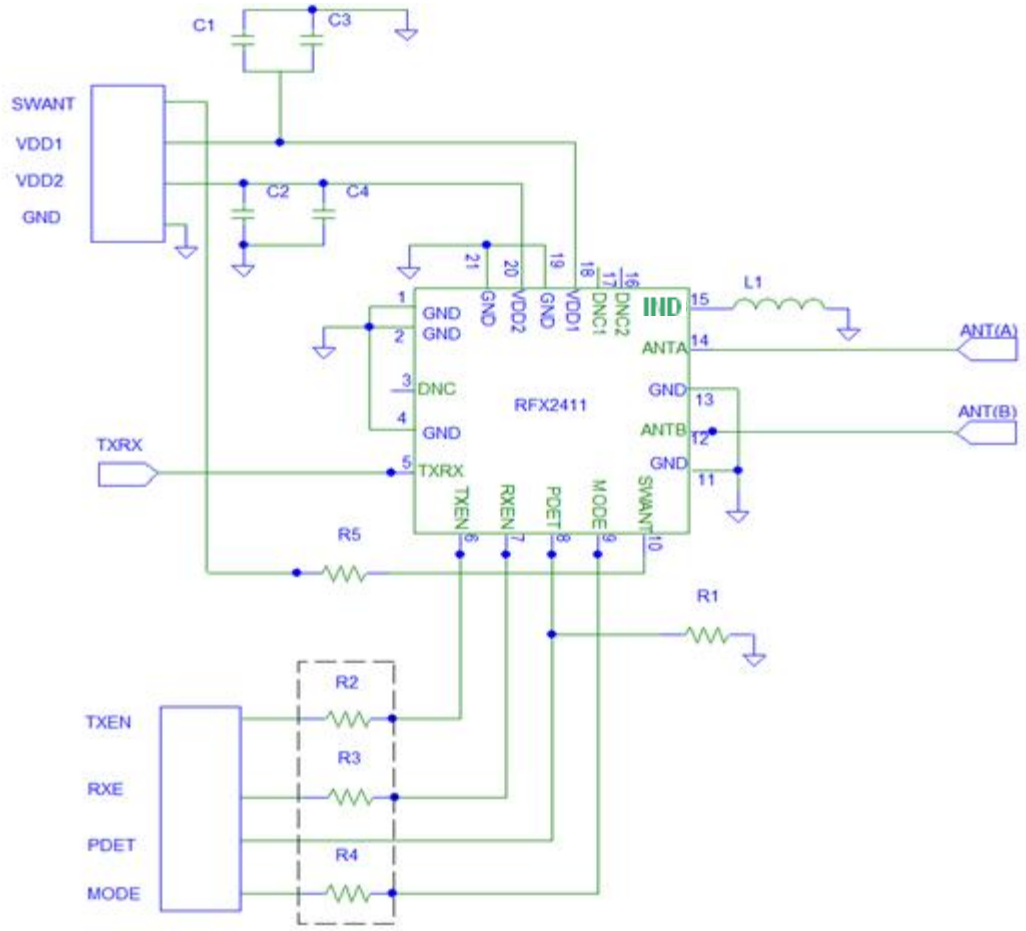




TXEN=0V, RXEN=0V, MODE=1.2V

Note: Port1 is connected to TXRX and Port 2 is Connected to ANT A/B

RFX2411 Application Schematic



Recommended BOM:

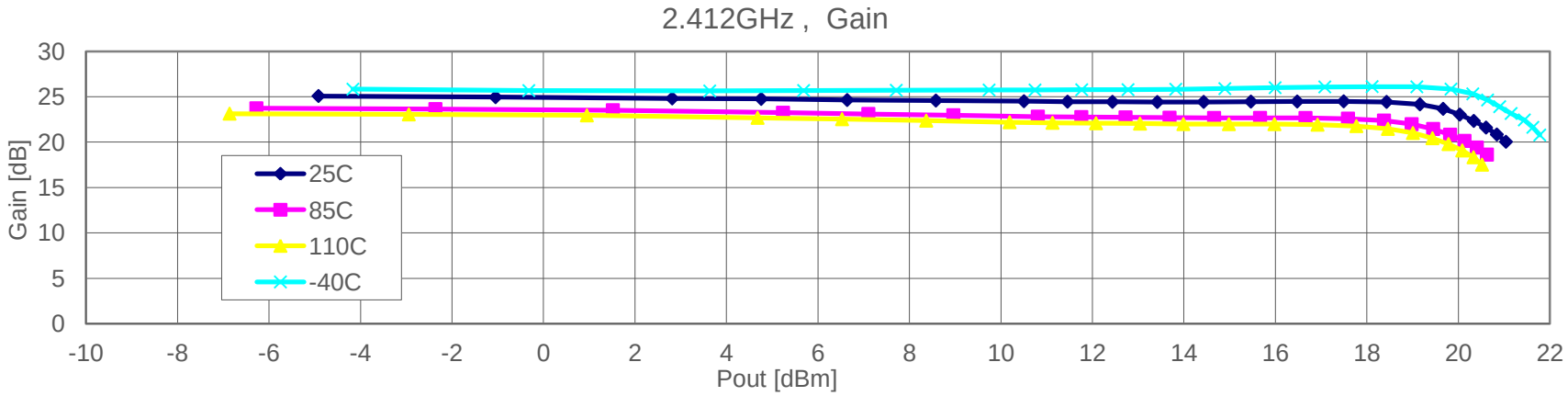
R1=10K
R2=R3=R3=R5=1K
C1=C2=2.2uF
C3=C4=220pF
L1=1.2nH

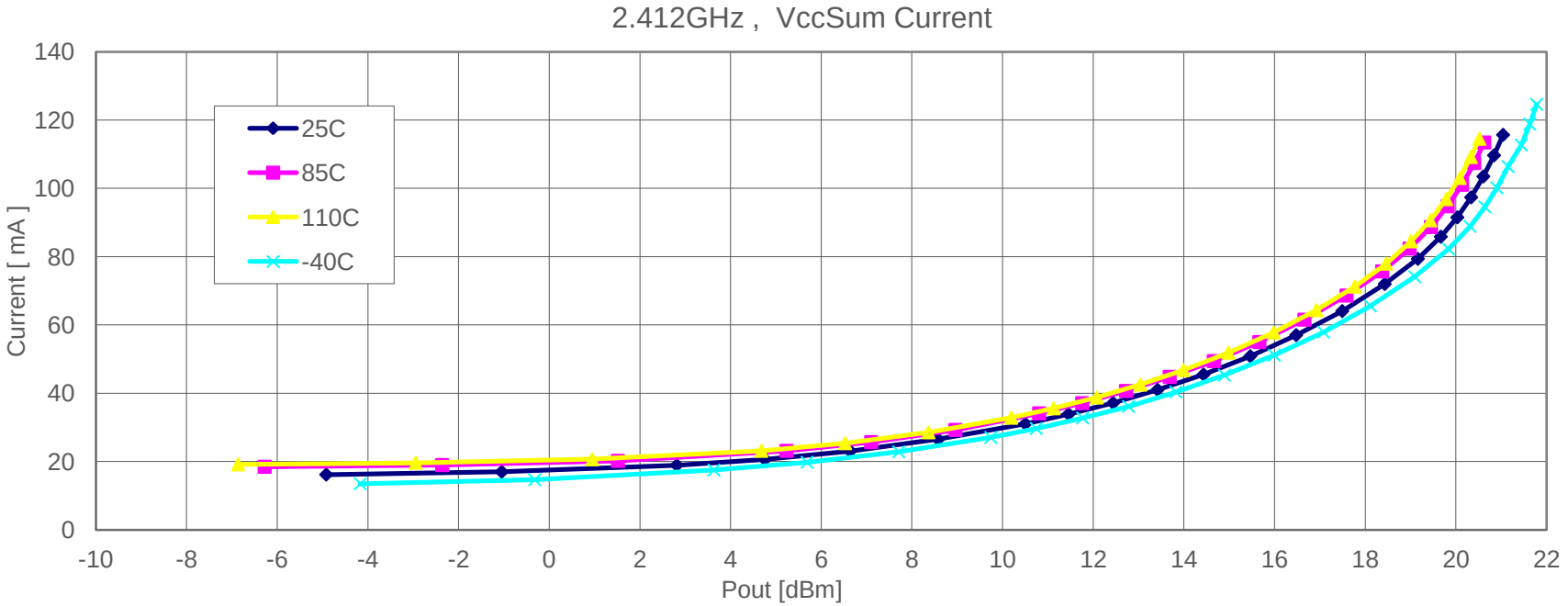
Notes:
R2, R3, R4, R5 on the control lines are for standalone EVBs, and are recommended in actual system implementation when the control line voltage will approach VDD

Appendix A

Supplemental Temperature Data Evaluation Board Test Results

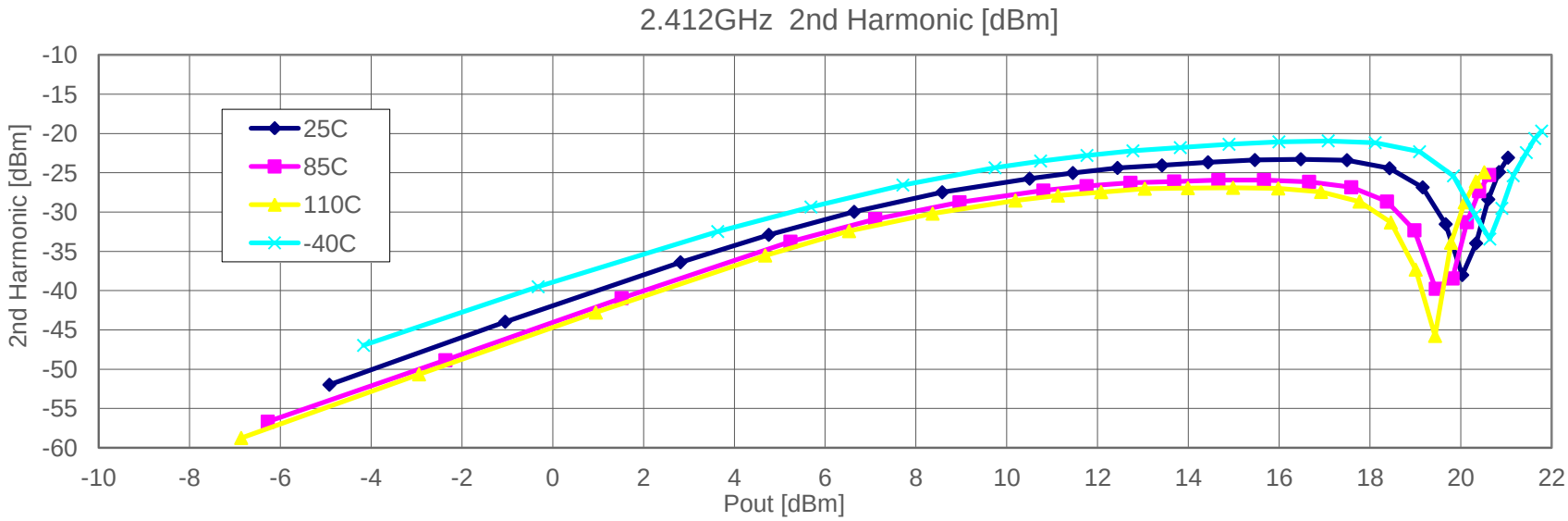
Gain and Current, Ant A, 2.412 GHz CW Signal, VDD = 3.3V

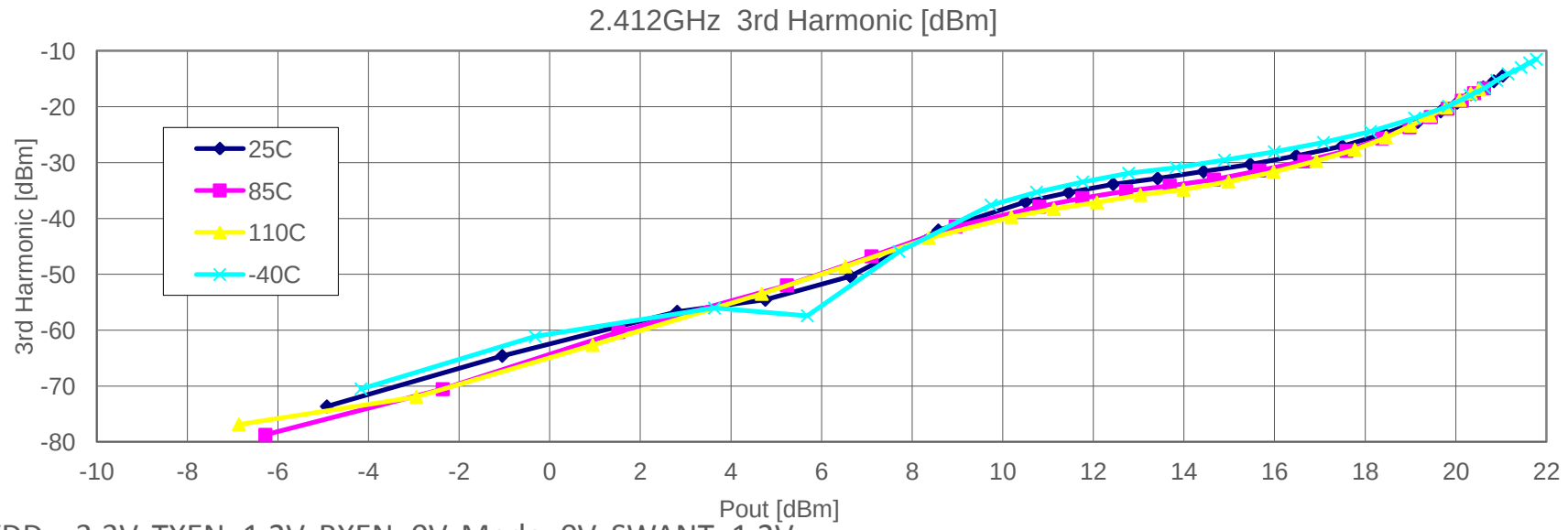




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=1.2V

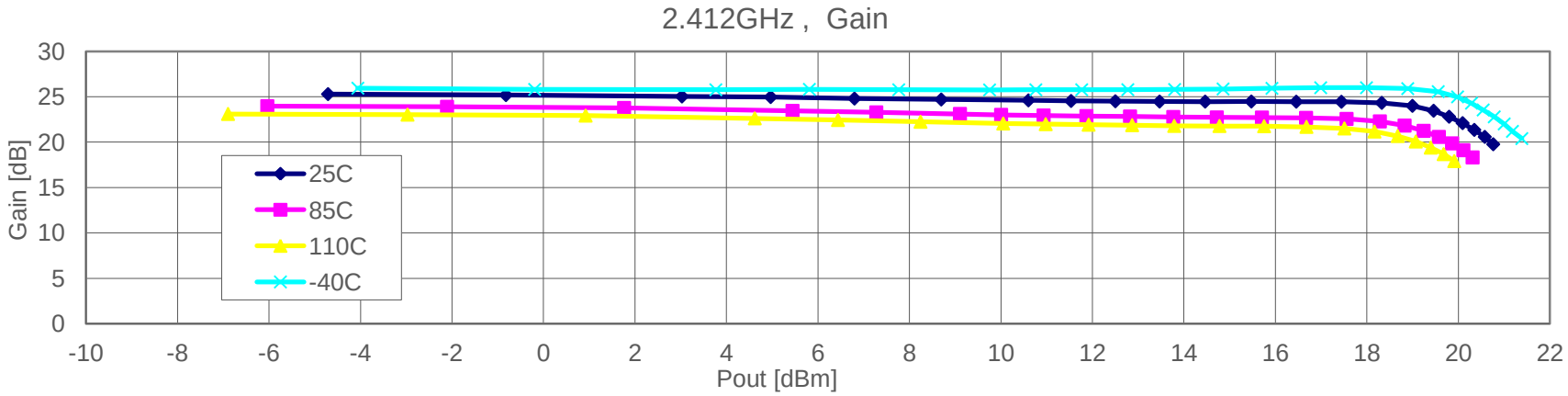
Harmonics, Ant A, 2.412 GHz CW, VDD = 3.3V

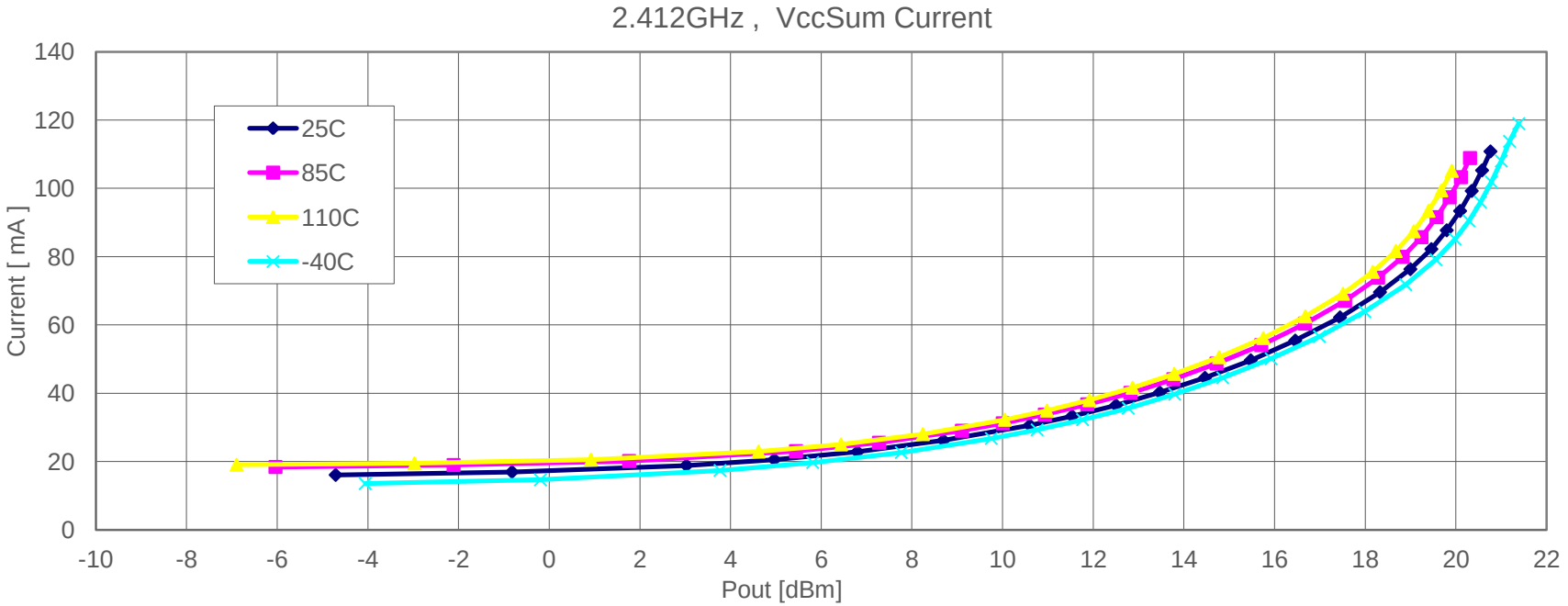




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=1.2V

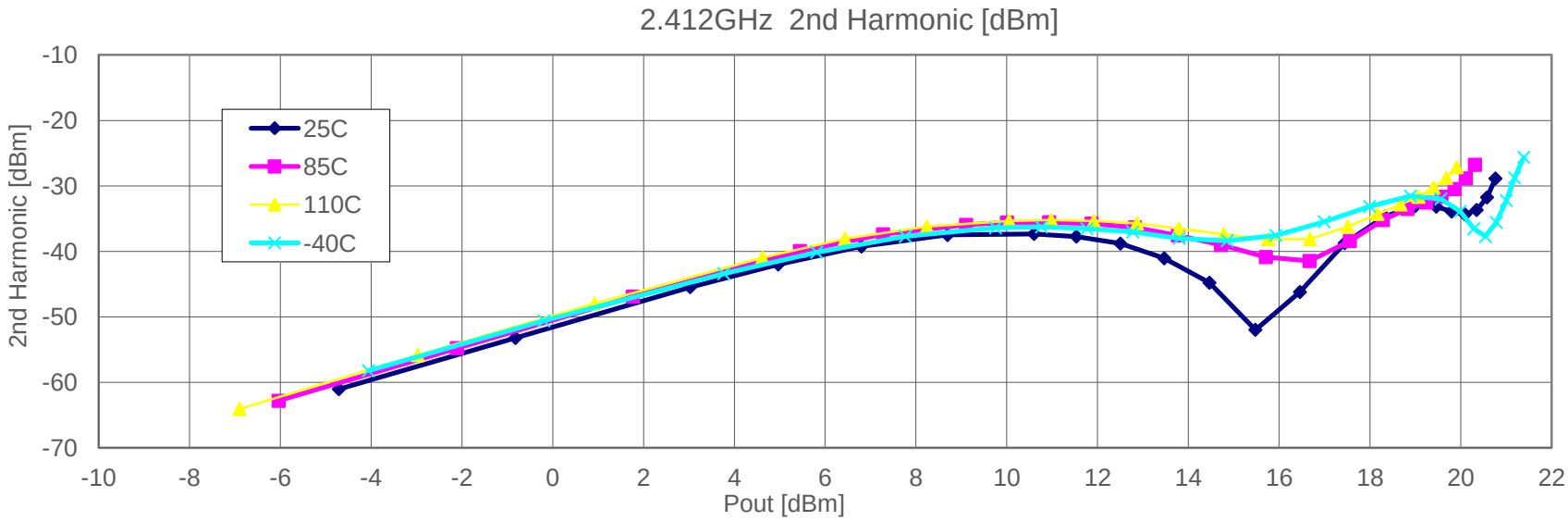
Gain and Current, Ant B, 2.412 GHz CW Signal, VDD = 3.3V

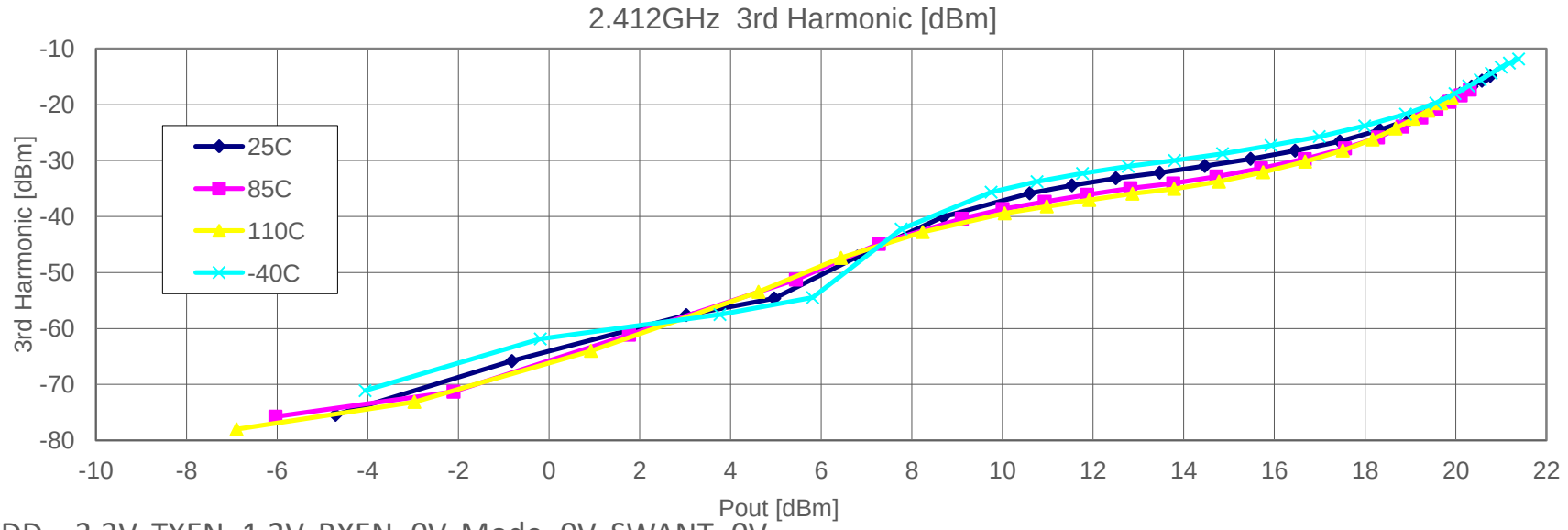




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=0V

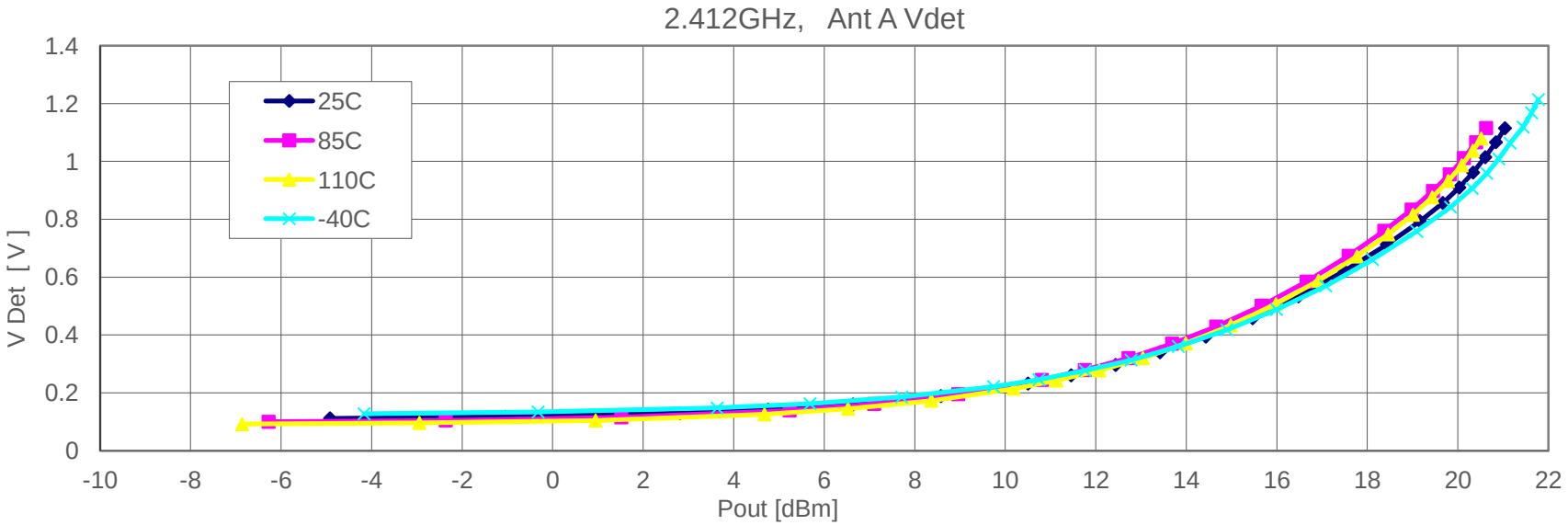
Harmonics, Ant B, 2.412 GHz CW, VDD = 3.3V

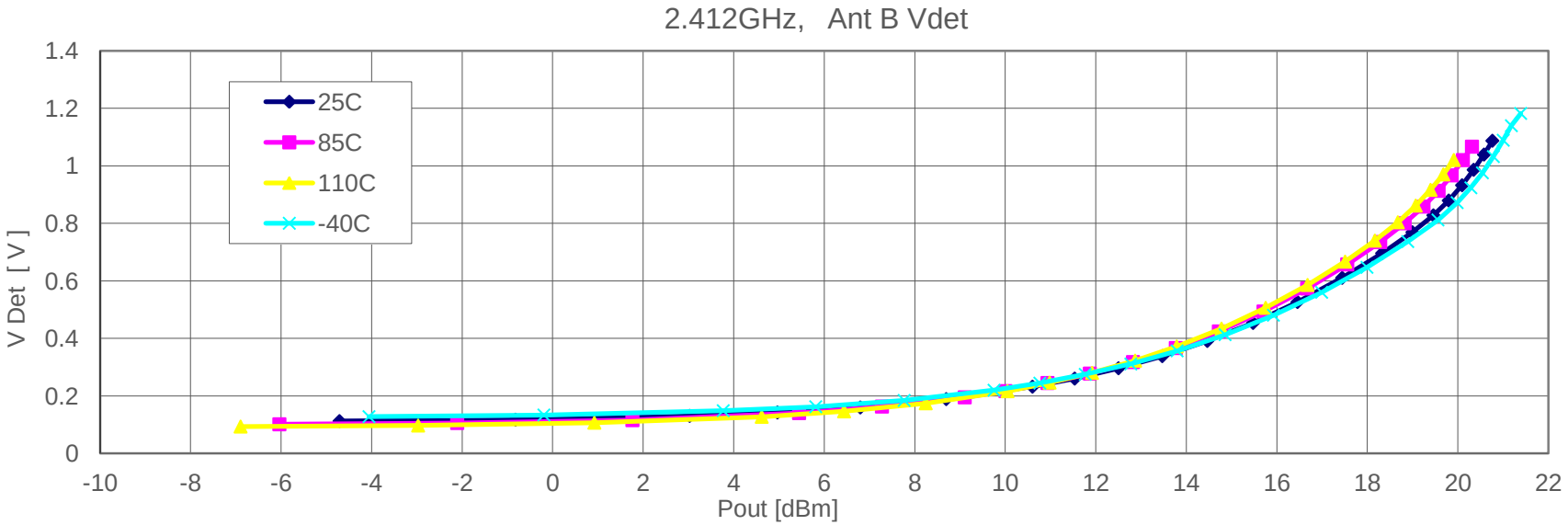




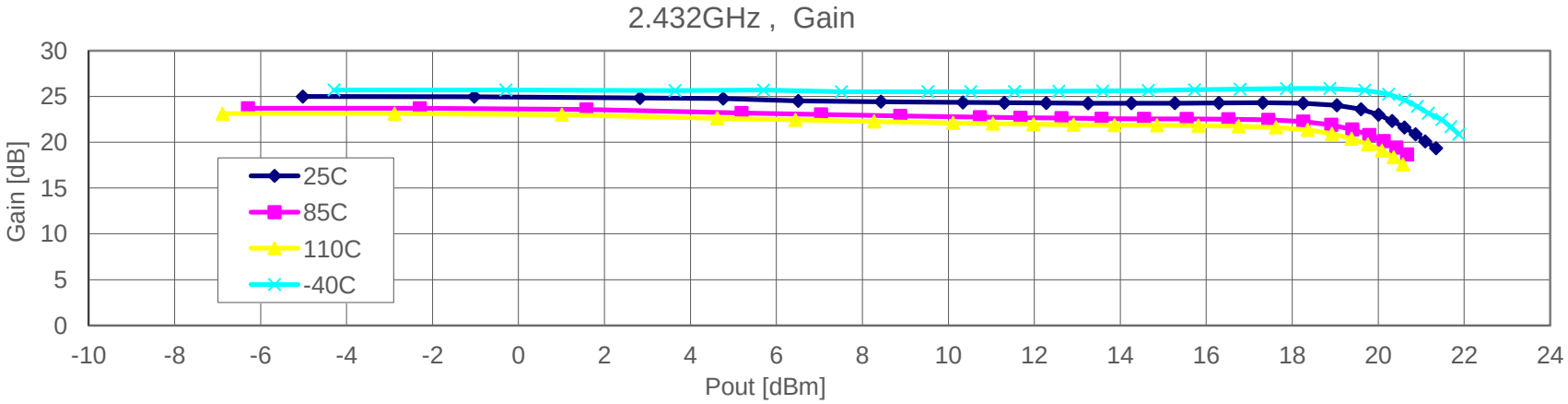
VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=0V

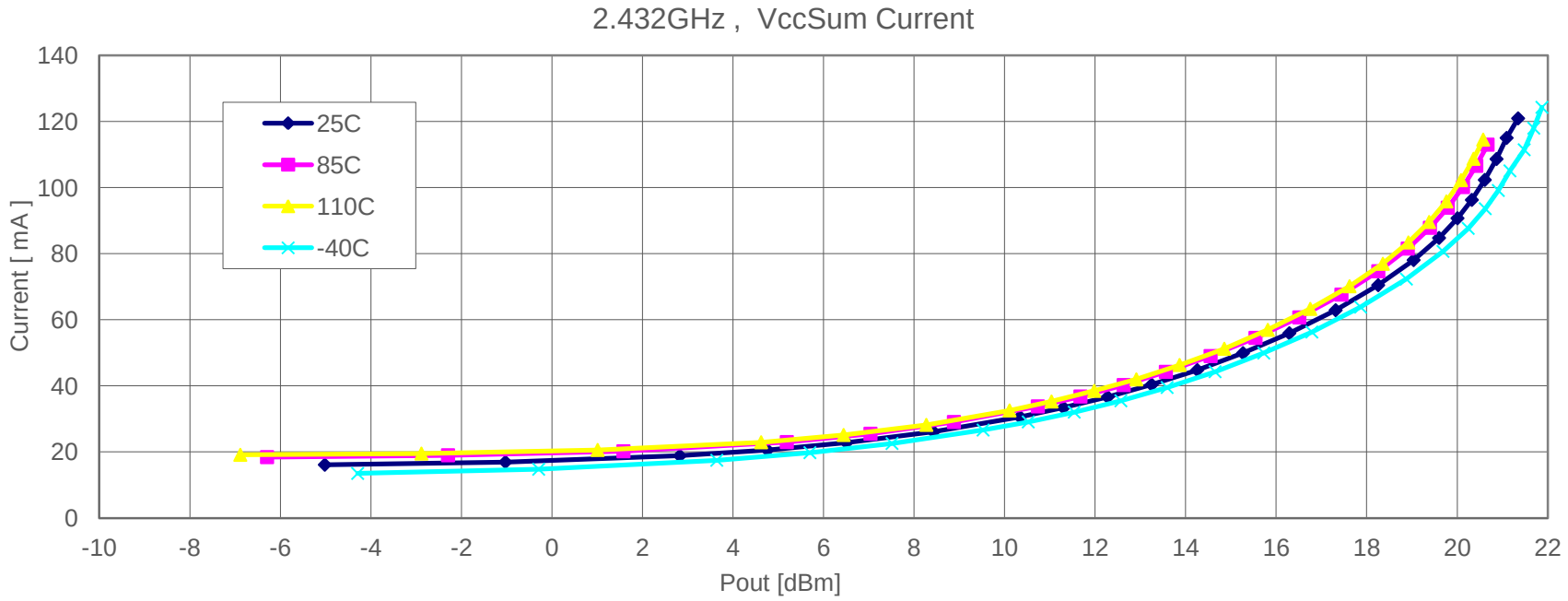
Detector Voltage, 2.412 GHz CW Signal, VDD = 3.3V





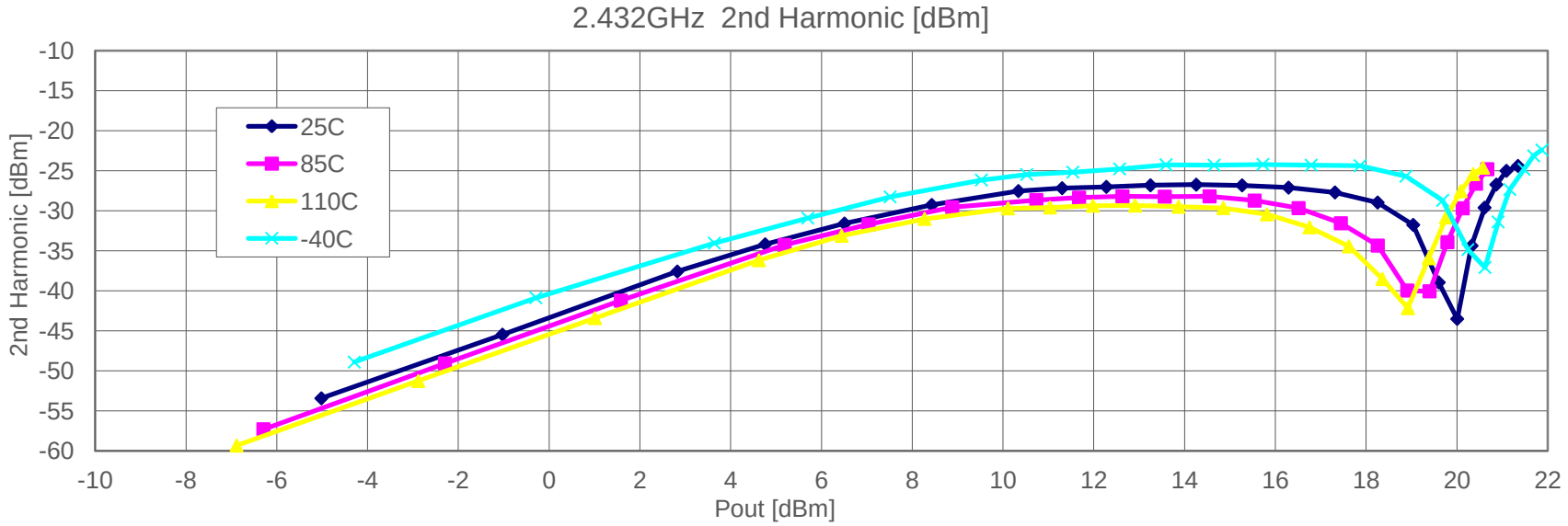
Gain and Current, Ant A, 2.432 GHz CW Signal, VDD = 3.3V

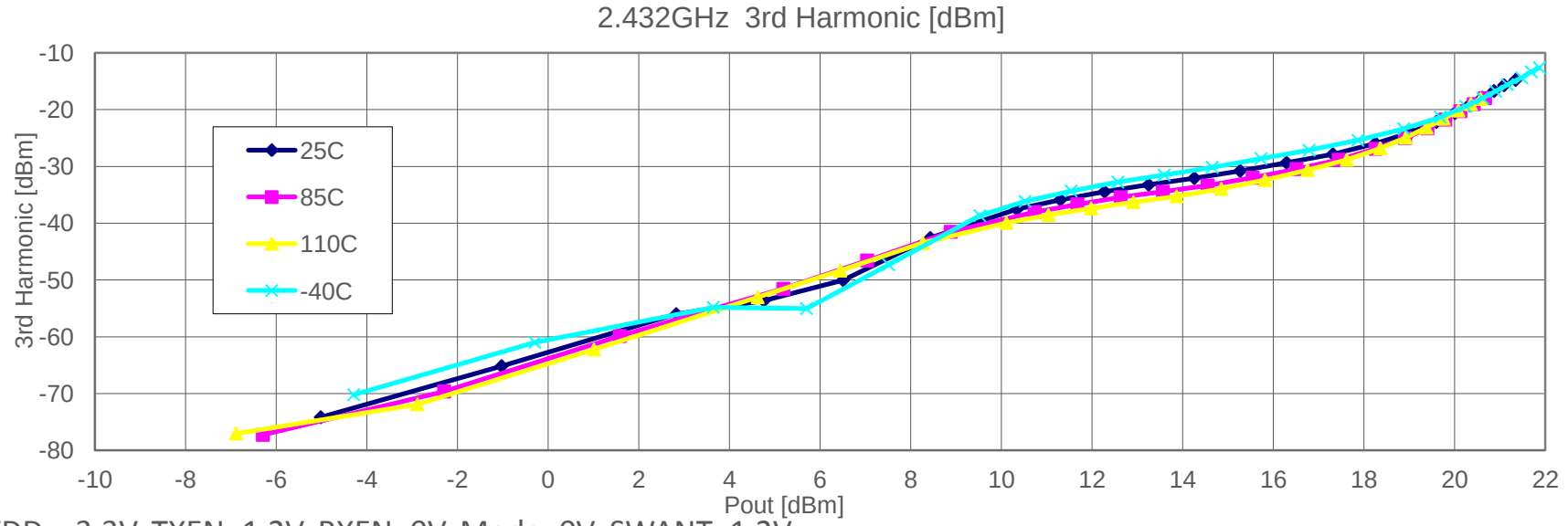




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=1.2V

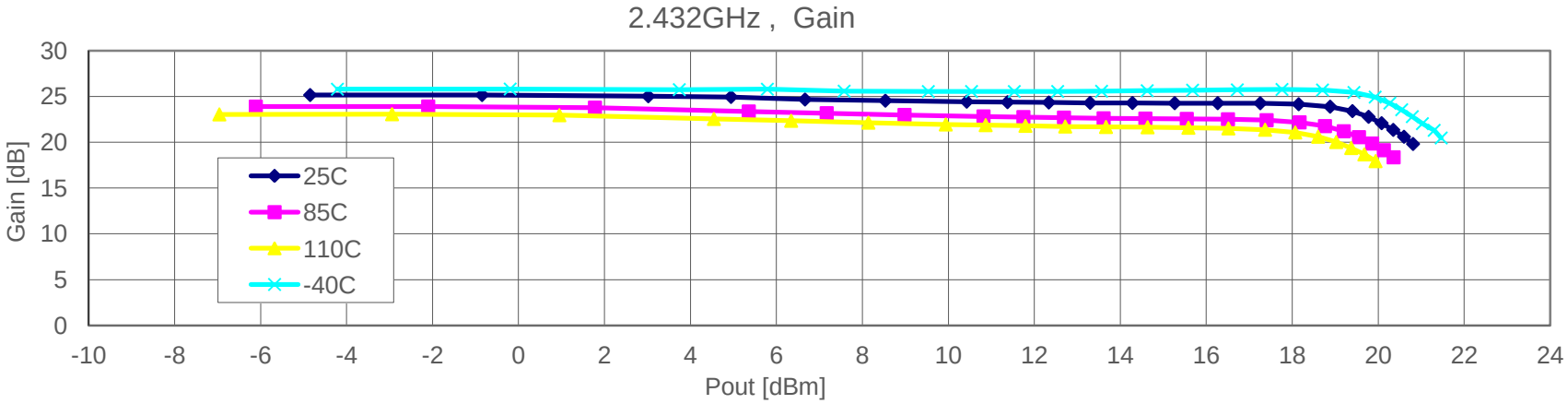
Harmonics, Ant A, 2.432 GHz CW, VDD = 3.3V

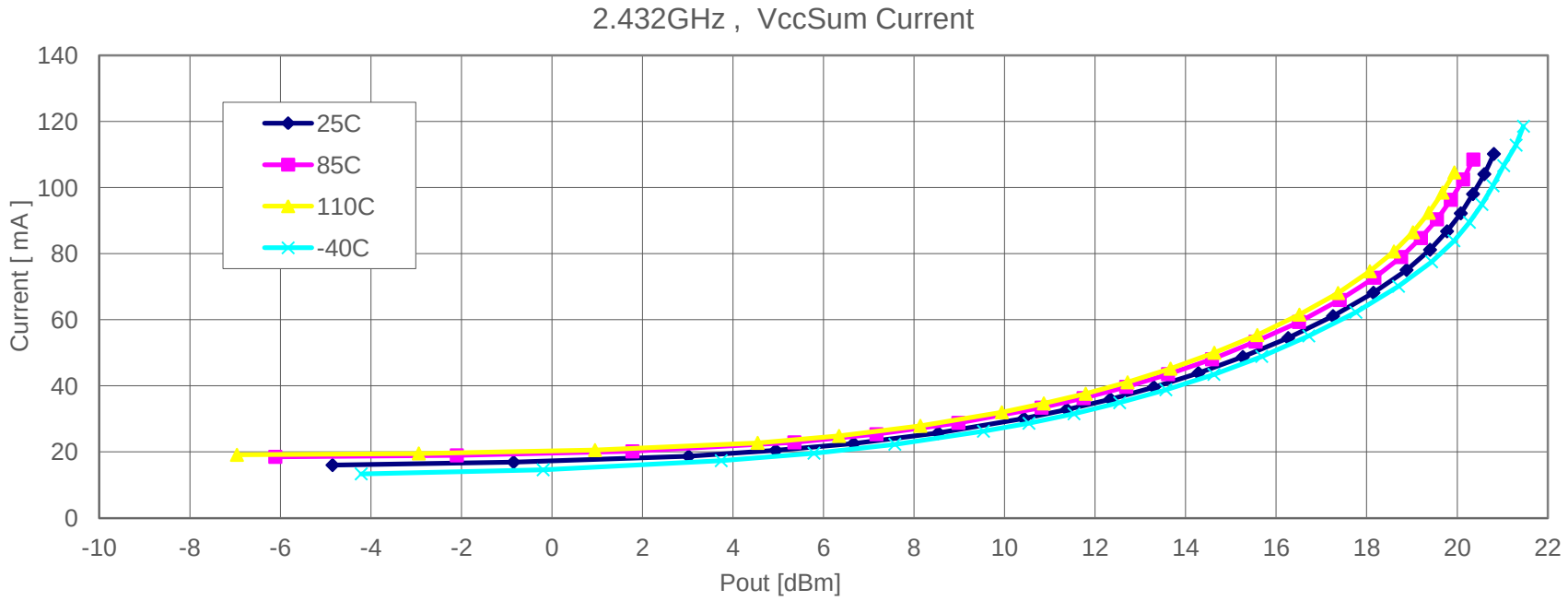




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=1.2V

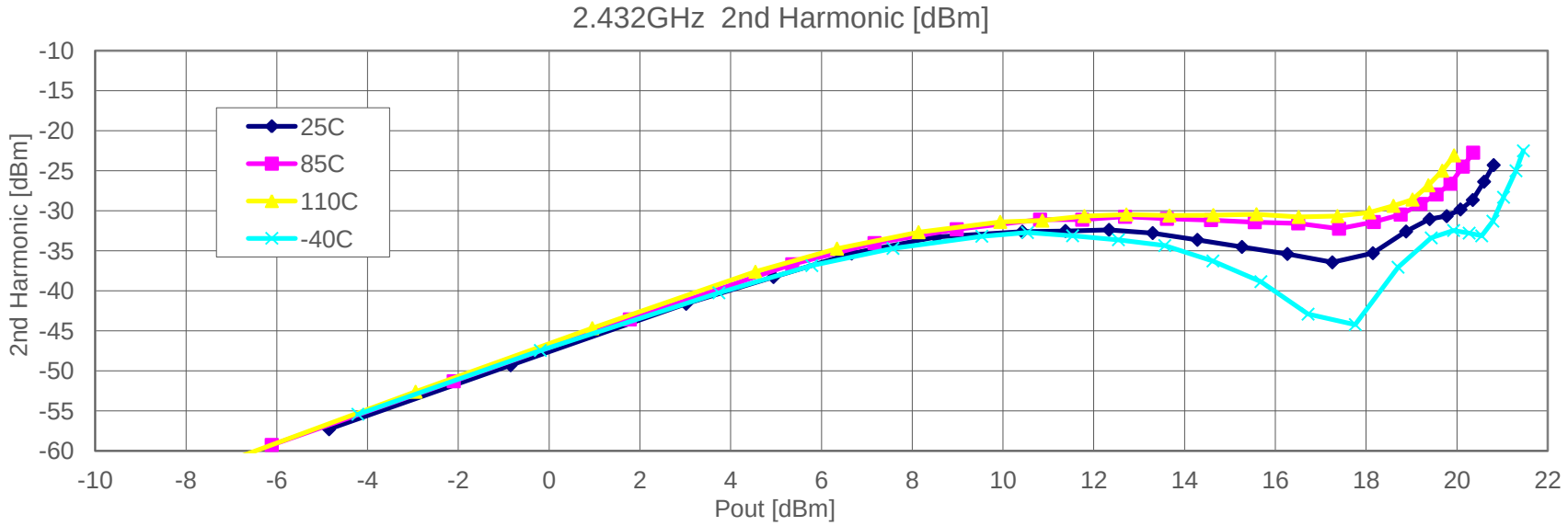
Gain and Current, Ant B, 2.432 GHz CW Signal, VDD = 3.3V

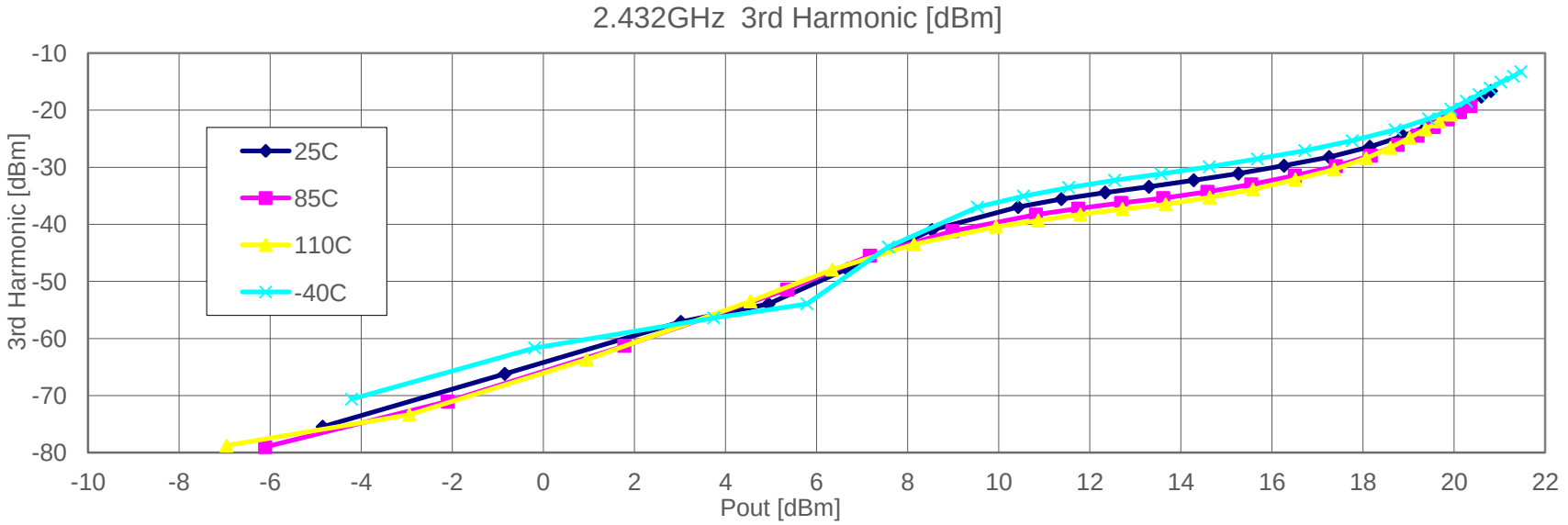




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=0V

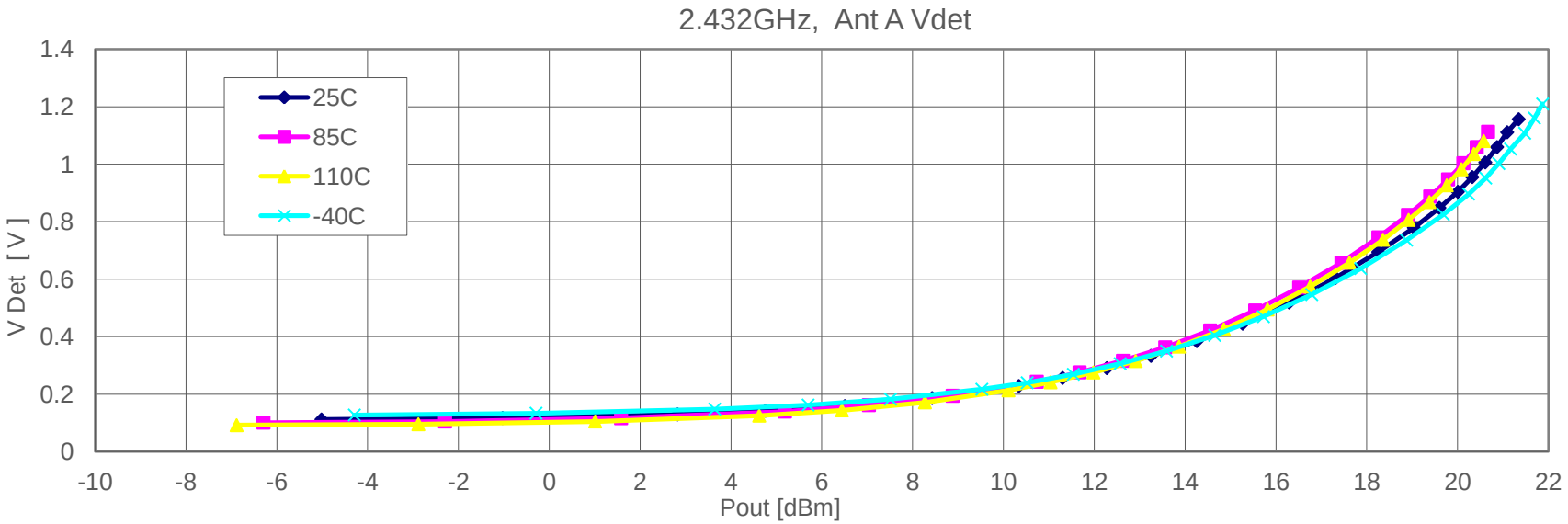
Harmonics, Ant B, 2.432 GHz CW, VDD = 3.3V

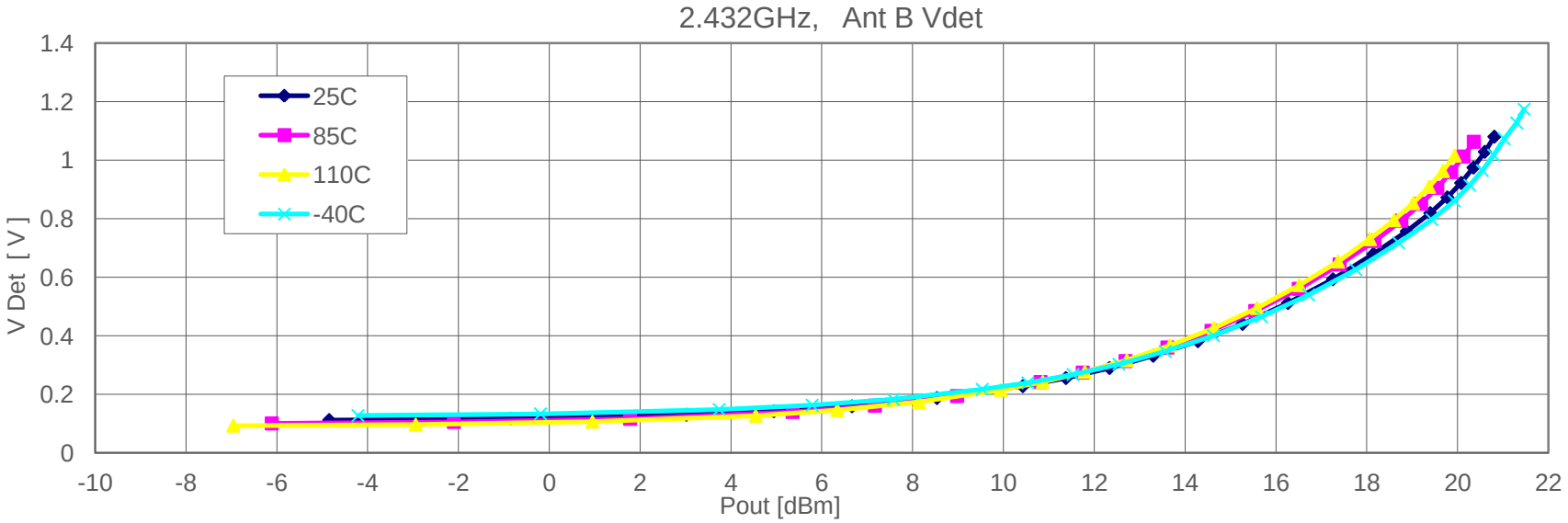




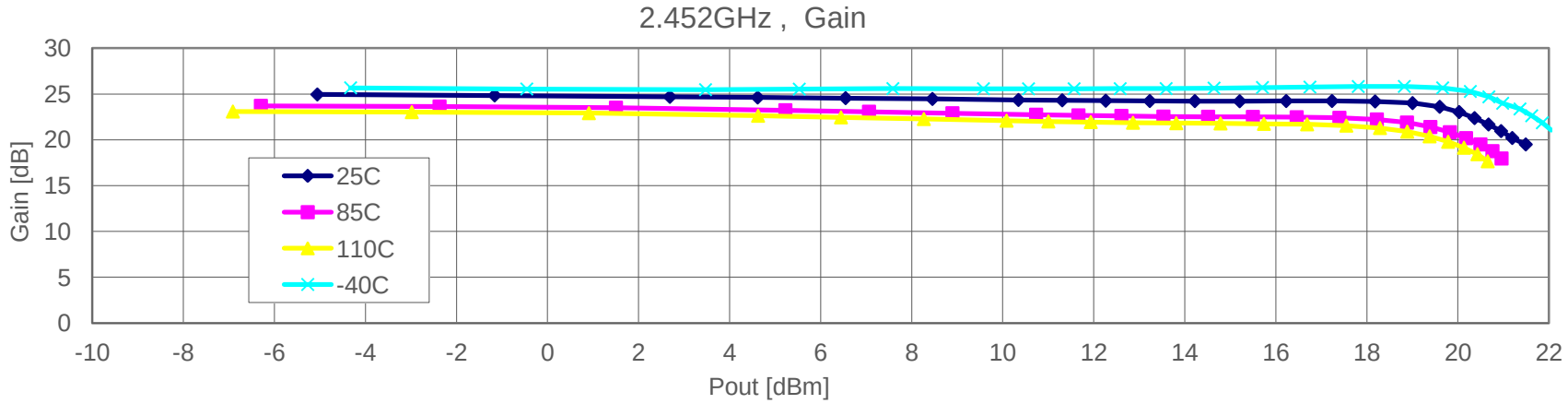
VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=0V

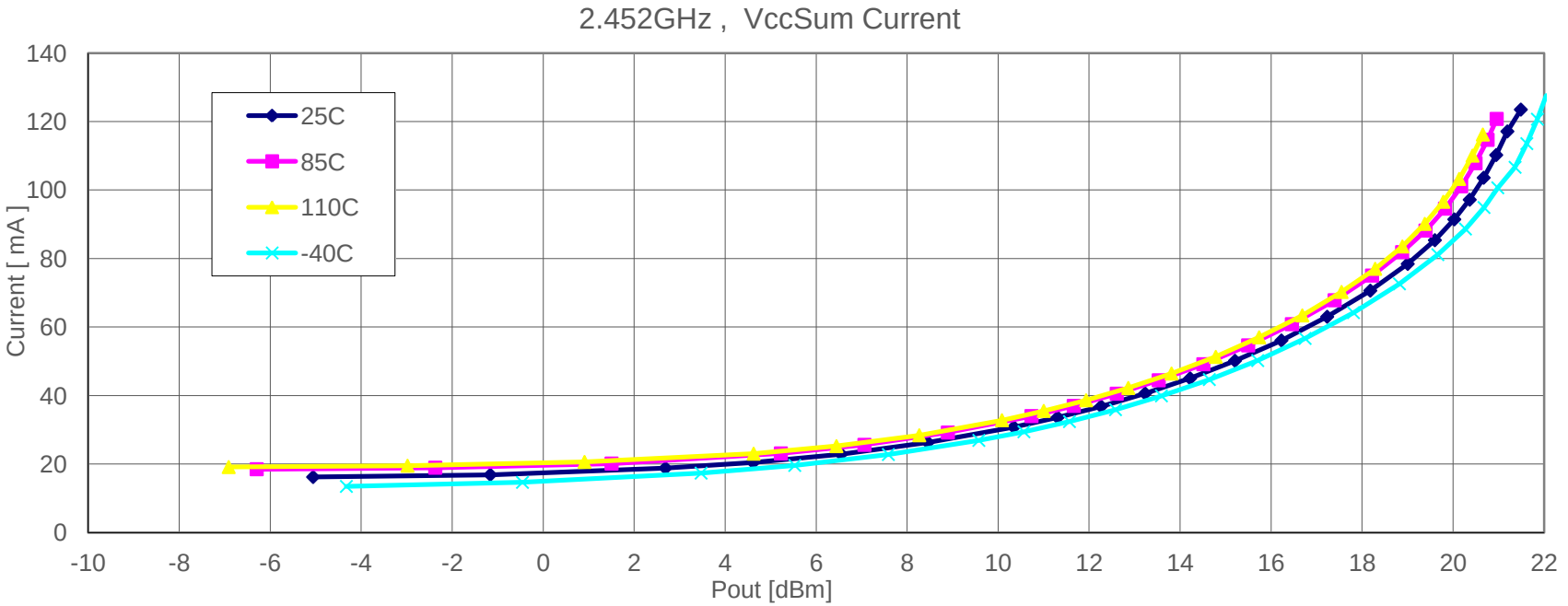
Detector Voltage, 2.432 GHz CW Signal, VDD = 3.3V





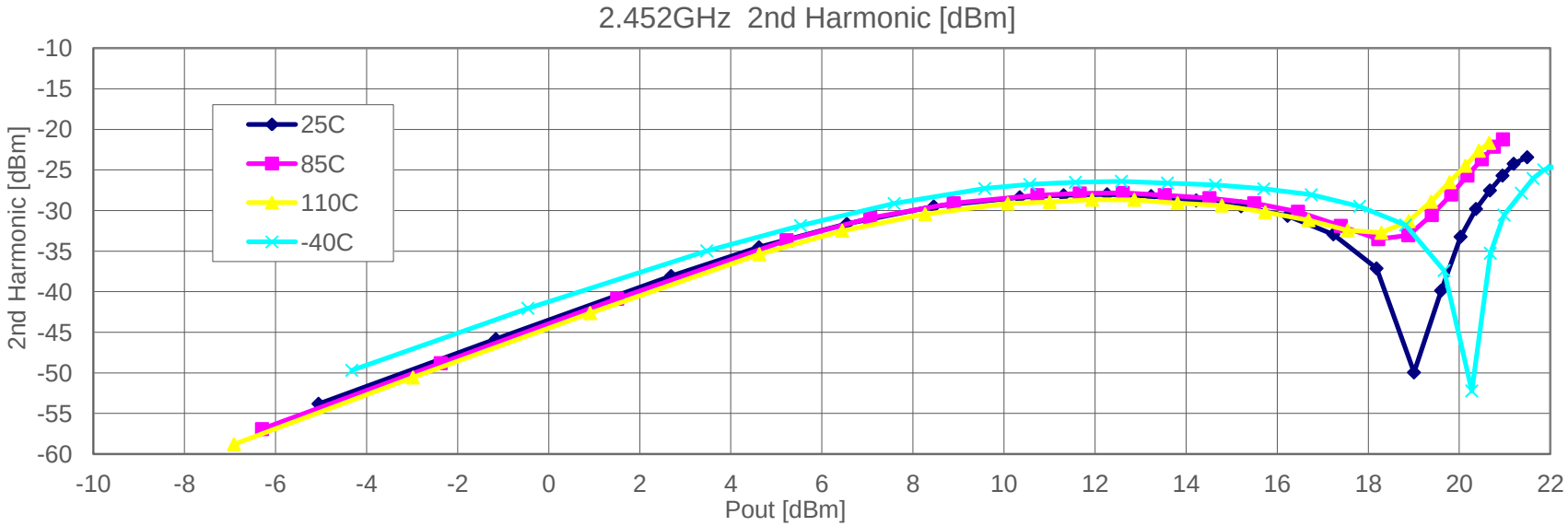
Gain and Current, Ant A, 2.452 GHz CW Signal, VDD = 3.3V

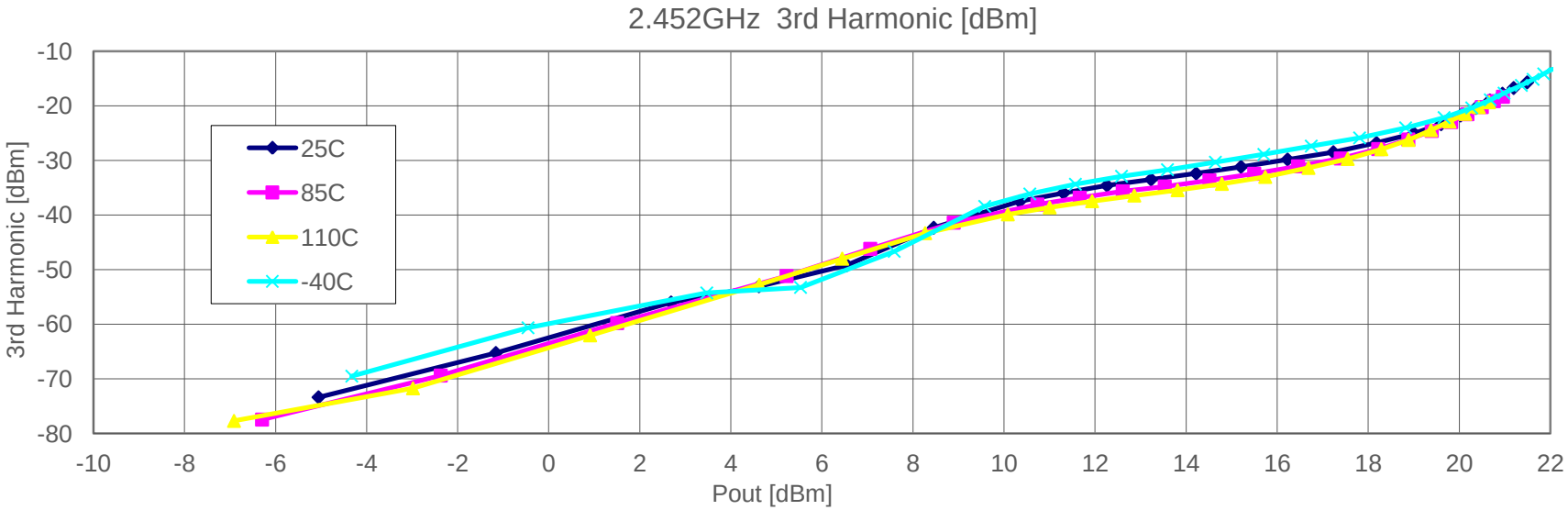




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=1.2V

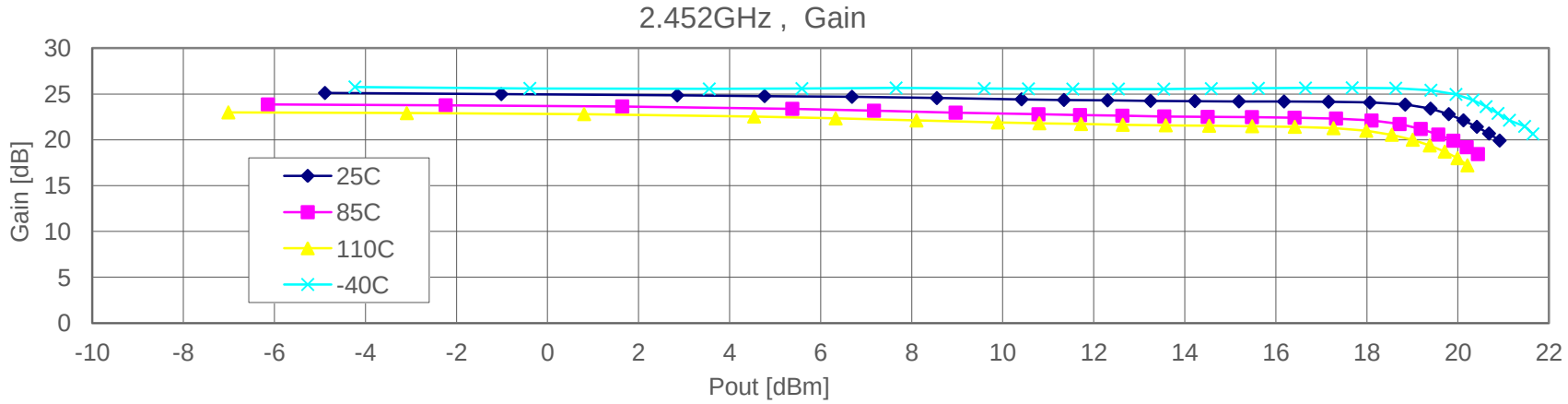
Harmonics, Ant A, 2.452 GHz CW, VDD = 3.3V

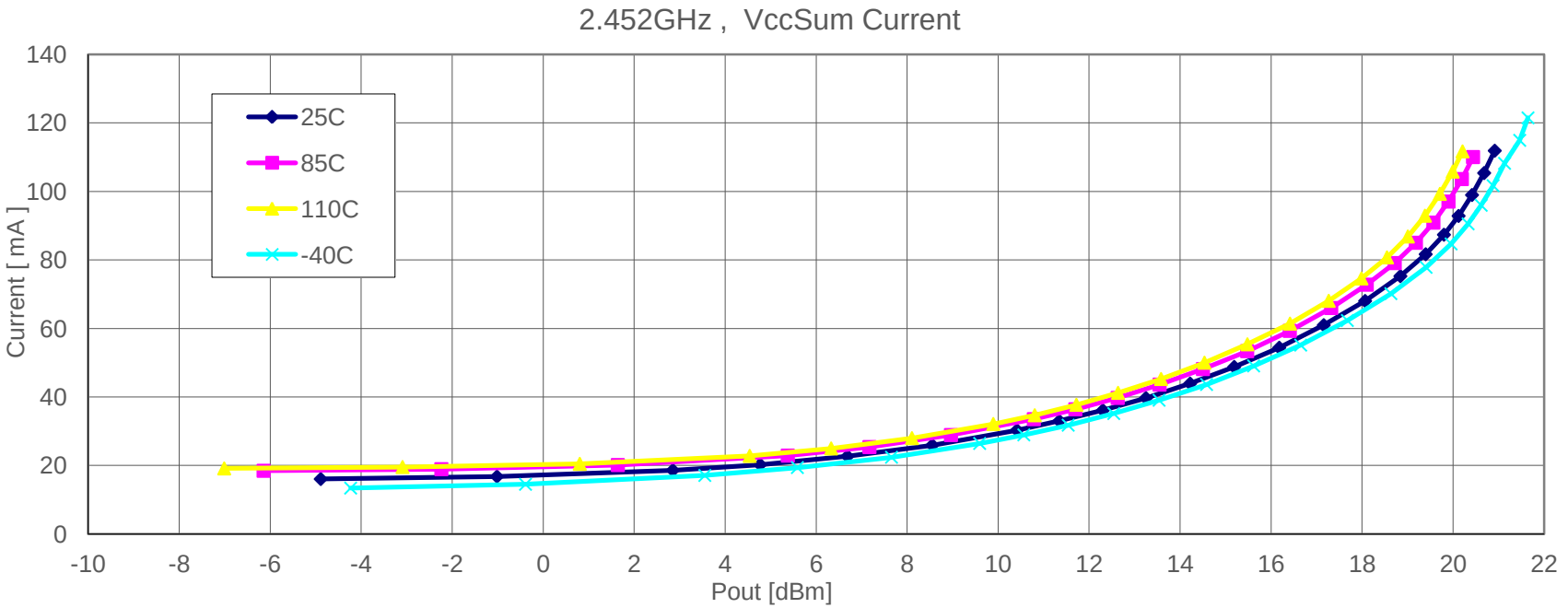




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=1.2V

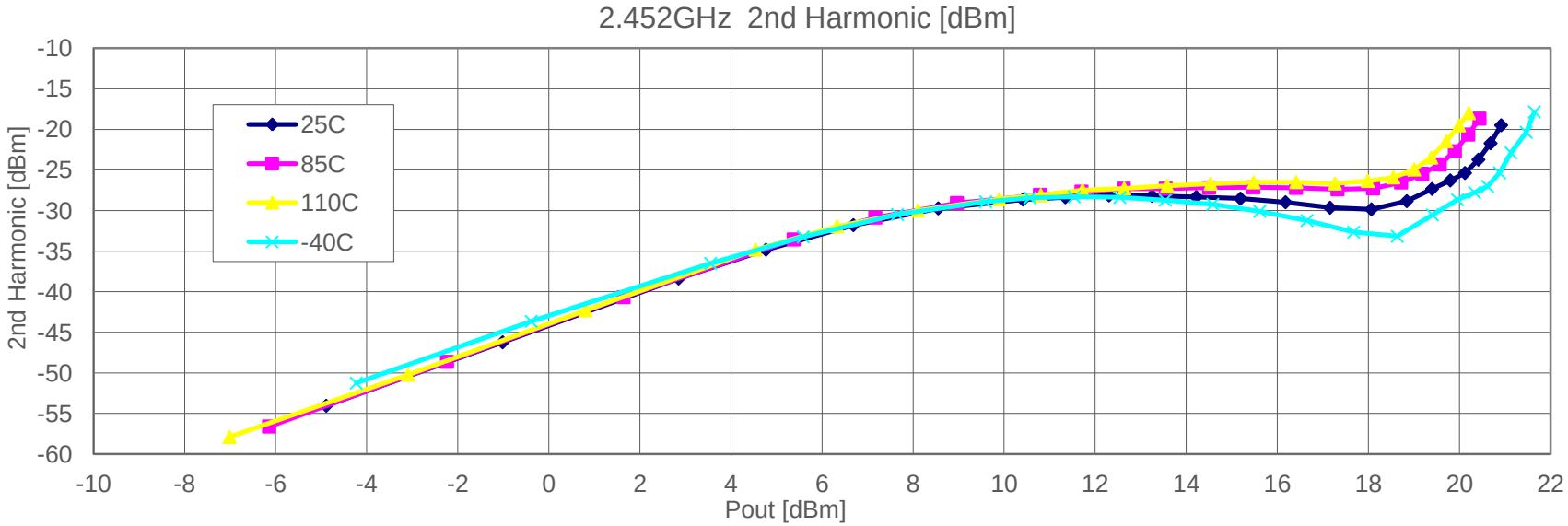
Gain and Current, Ant B, 2.452 GHz CW Signal, VDD = 3.3V

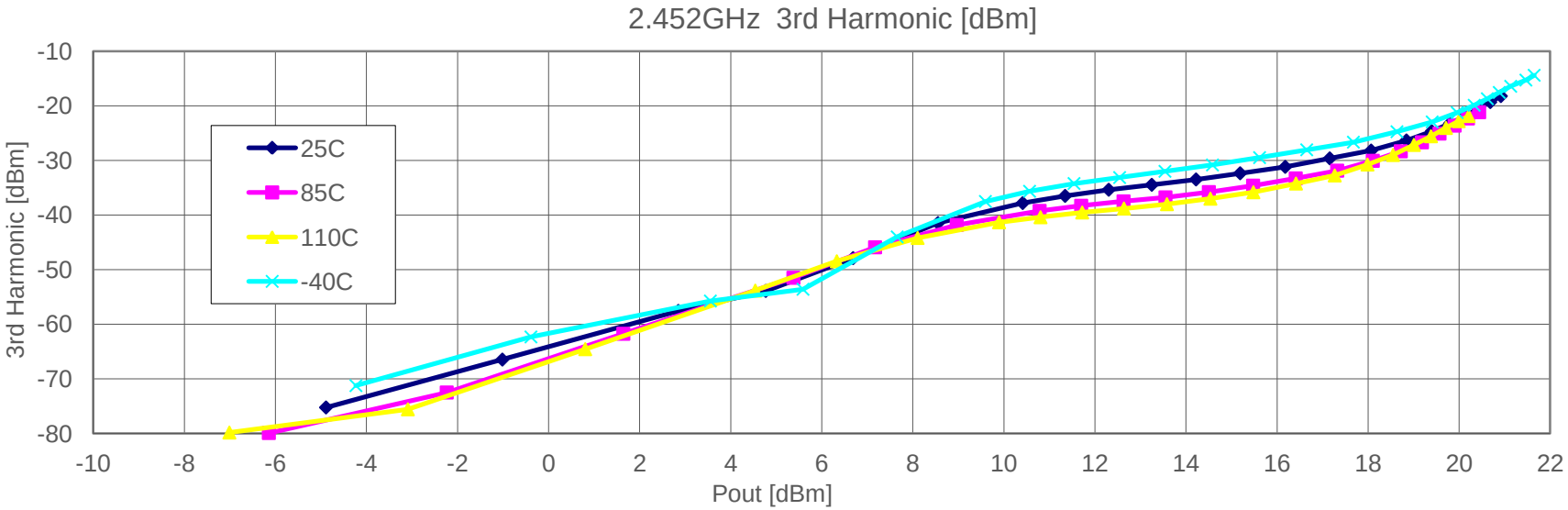




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=0V

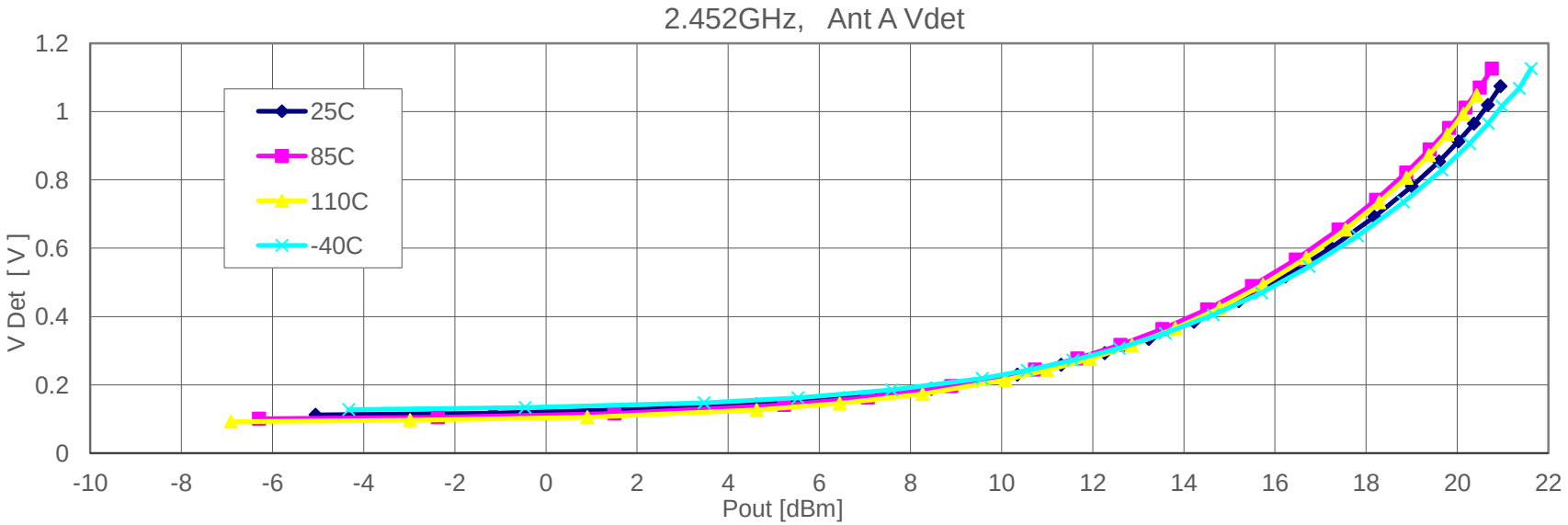
Harmonics, Ant B, 2.452 GHz CW, VDD = 3.3V

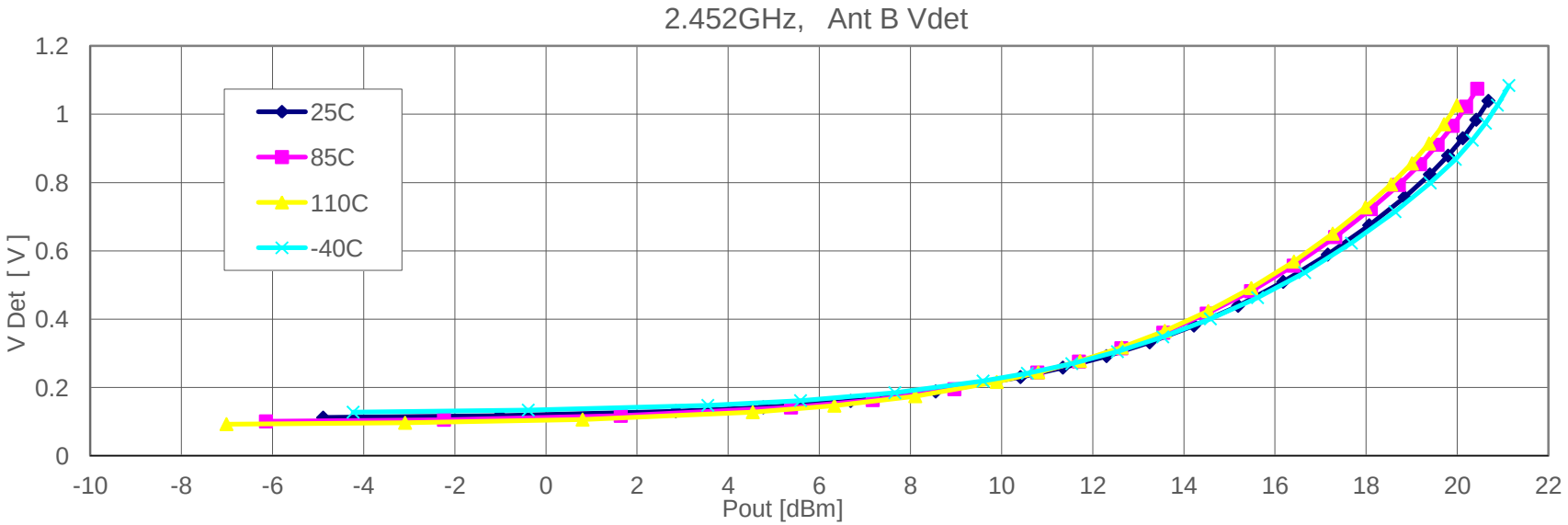




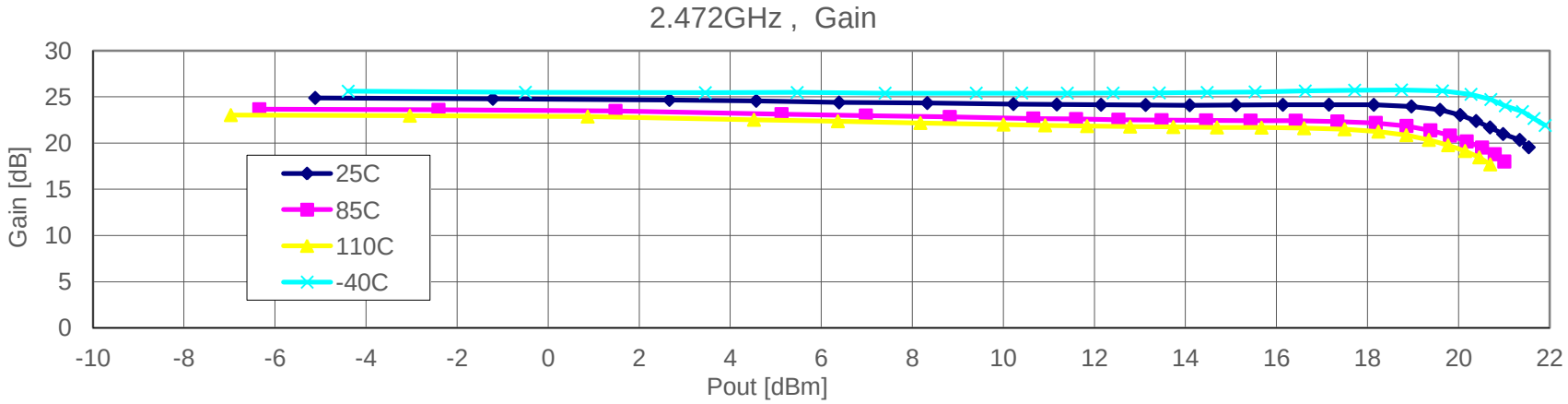
VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=0V

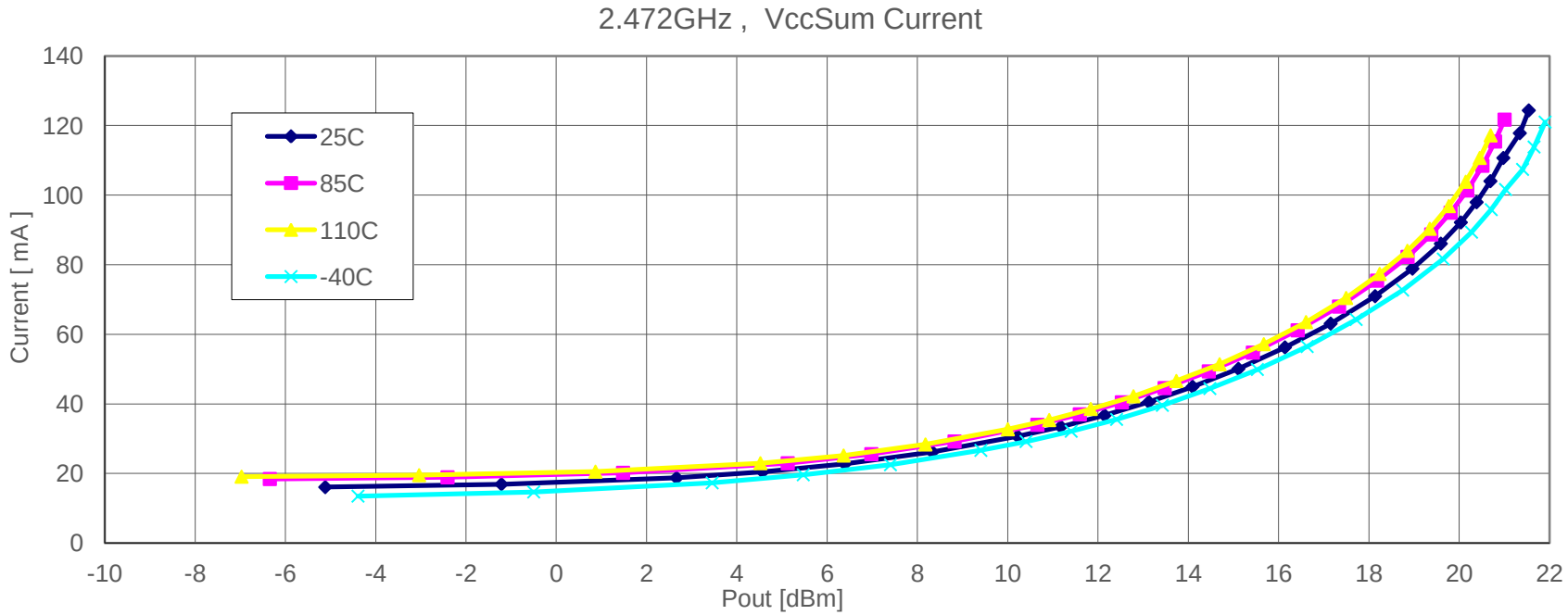
Detector Voltage, 2.452 GHz CW Signal, VDD = 3.3V





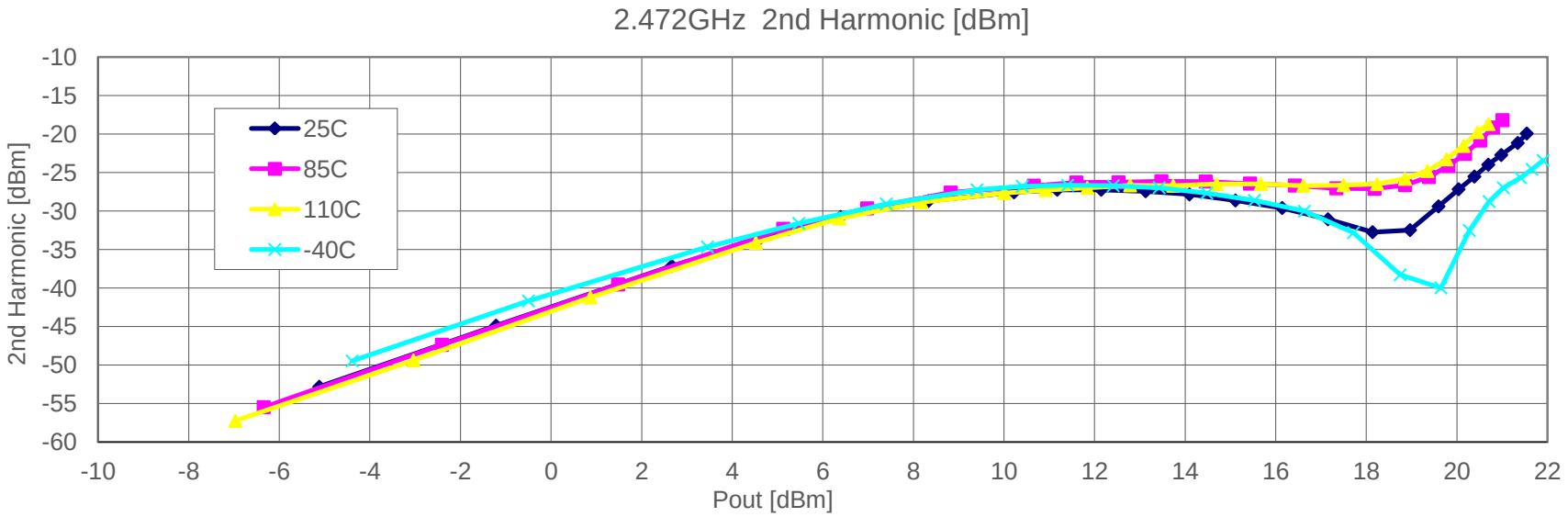
Gain and Current, Ant A, 2.472 GHz CW Signal, VDD = 3.3V

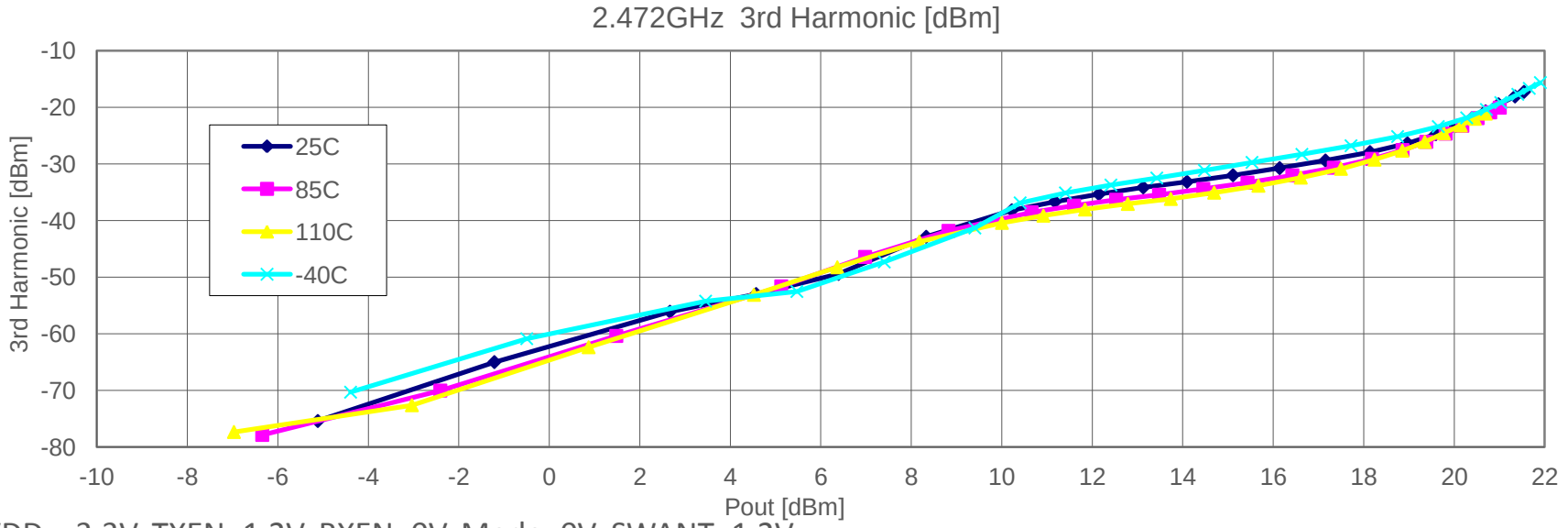




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=1.2V

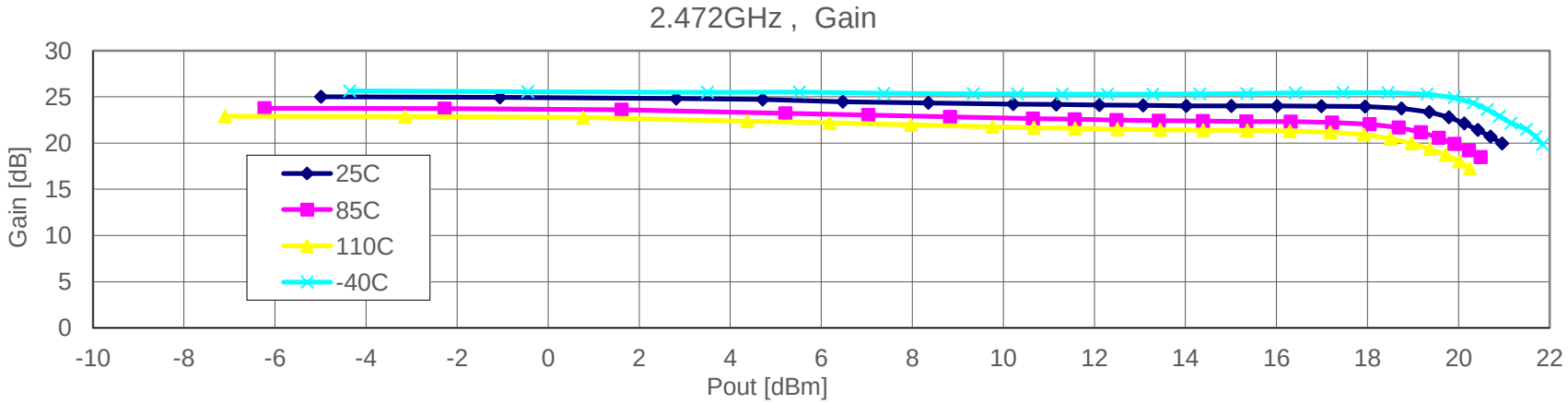
Harmonics, Ant A, 2.472 GHz CW, VDD = 3.3V

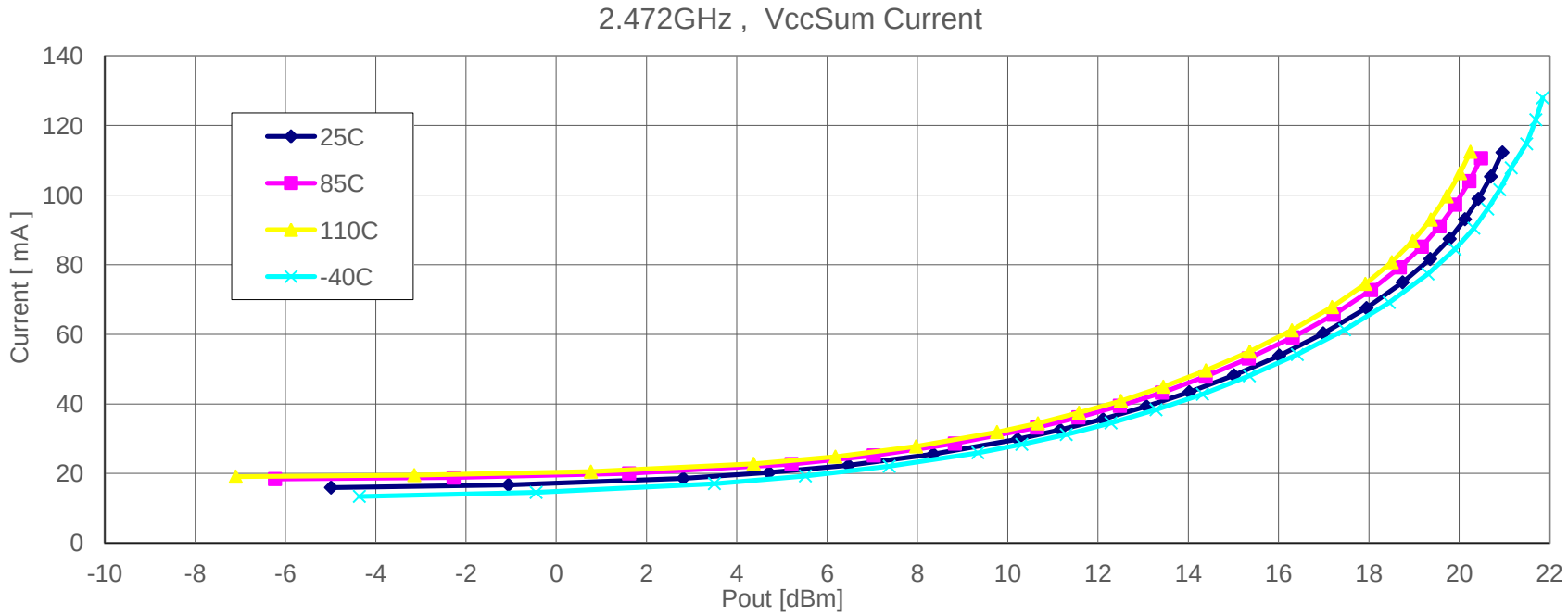




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=1.2V

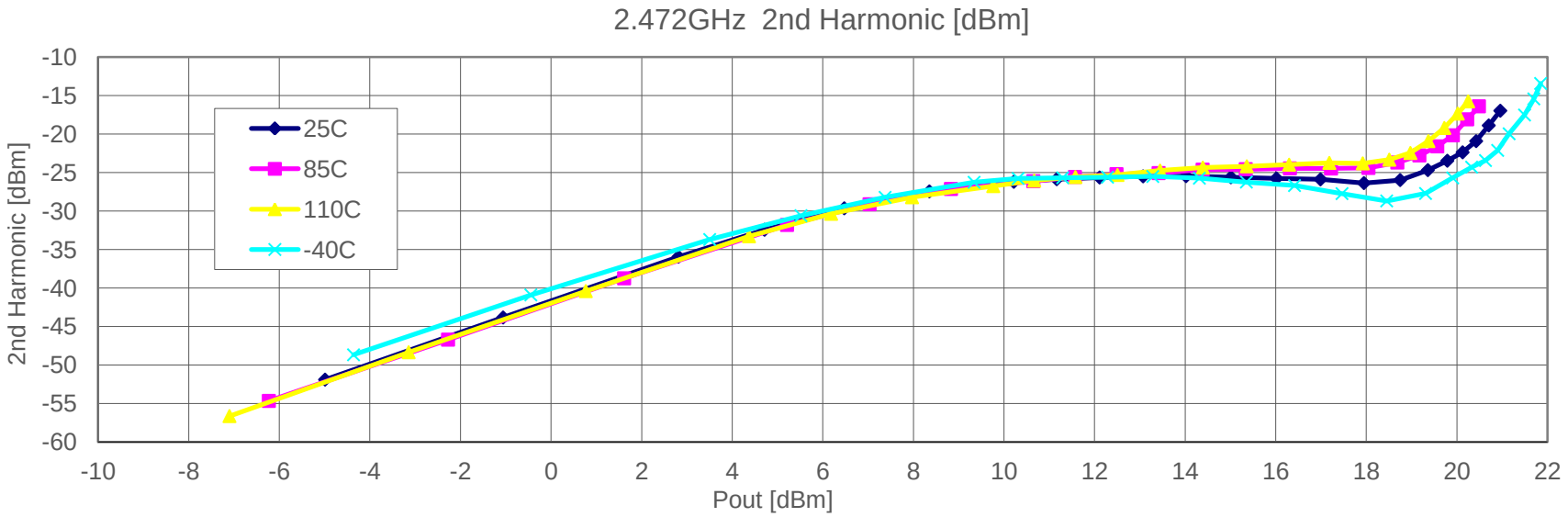
Gain and Current, Ant B, 2.472 GHz CW Signal, VDD = 3.3V

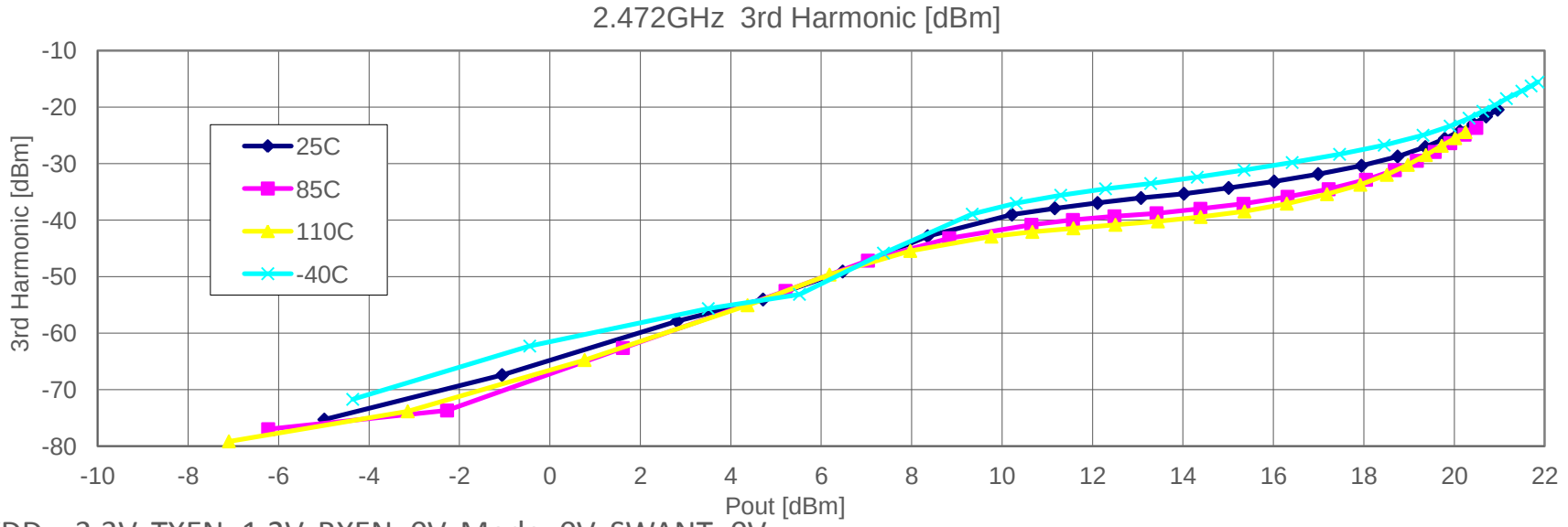




VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=0V

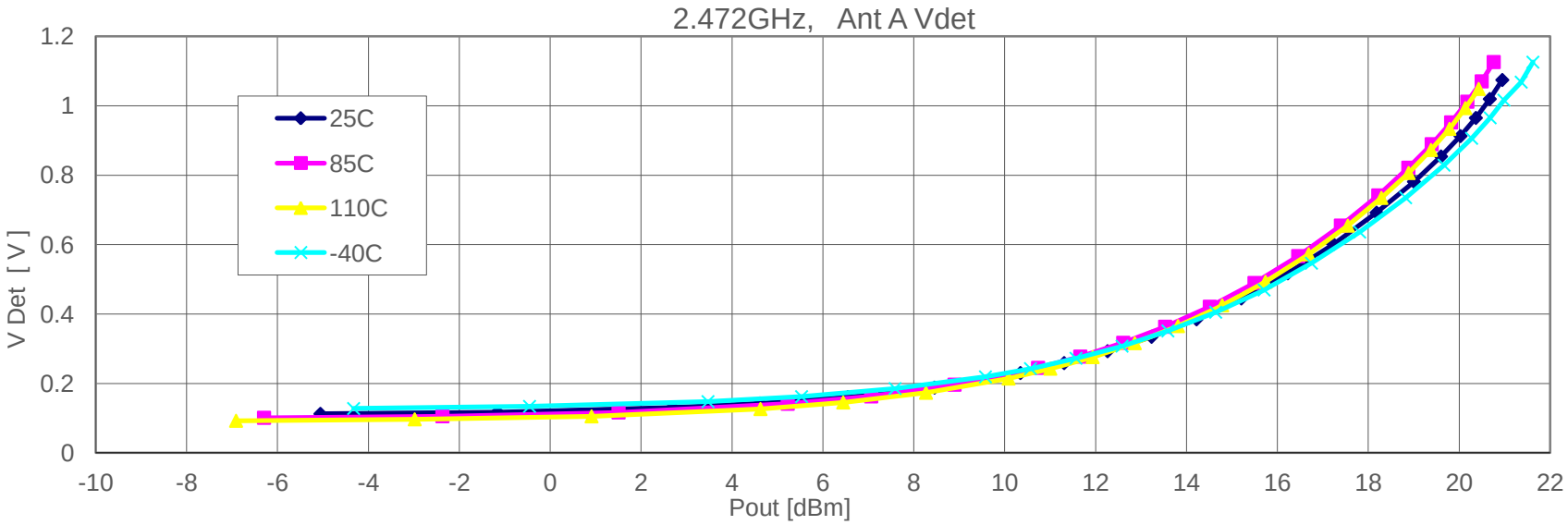
Harmonics, Ant B, 2.472 GHz CW, VDD = 3.3V

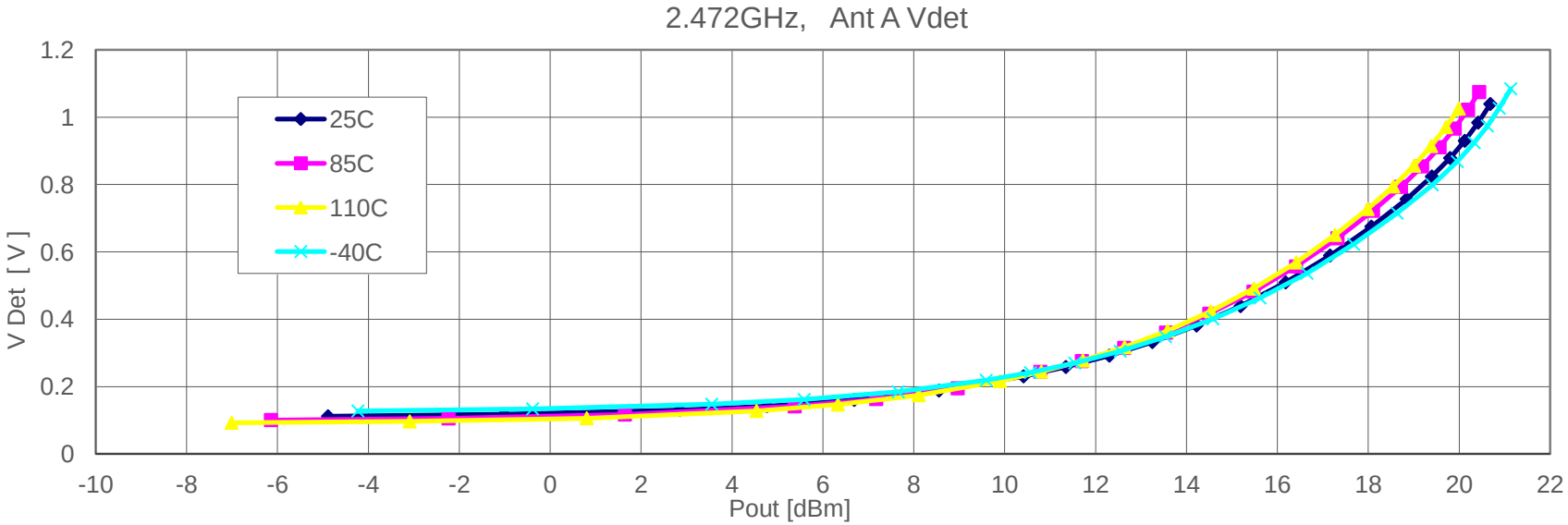




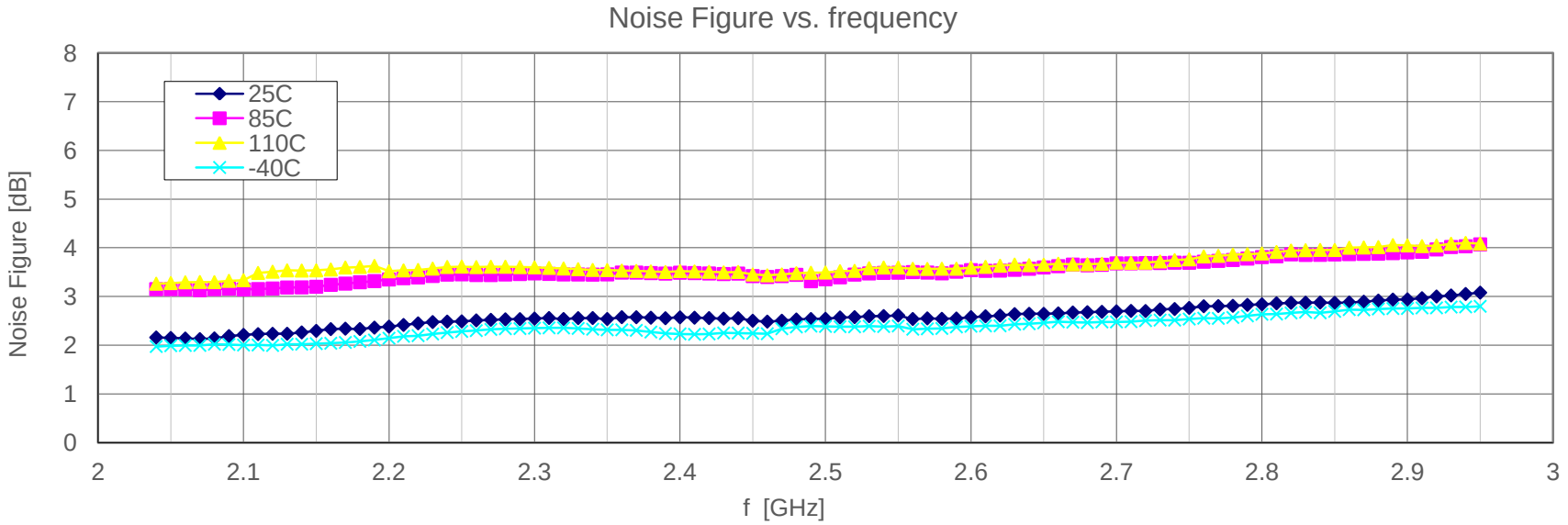
VDD = 3.3V, TXEN=1.2V, RXEN=0V, Mode=0V, SWANT=0V

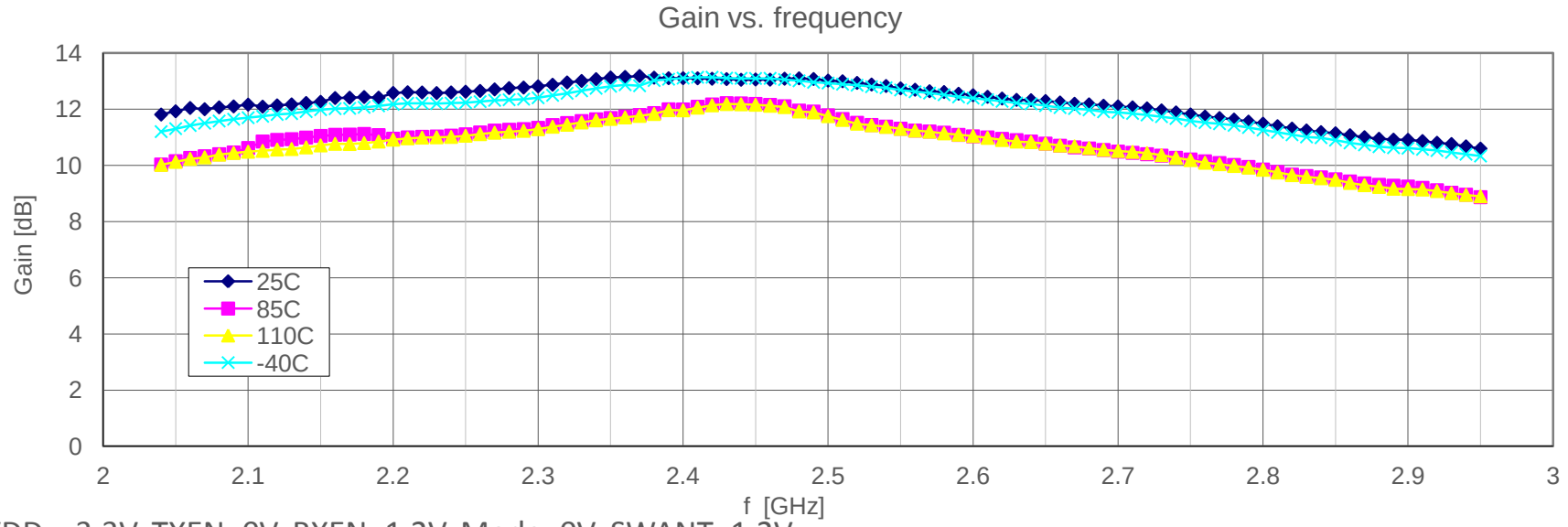
Detector Voltage, 2.472 GHz CW Signal, VDD = 3.3V





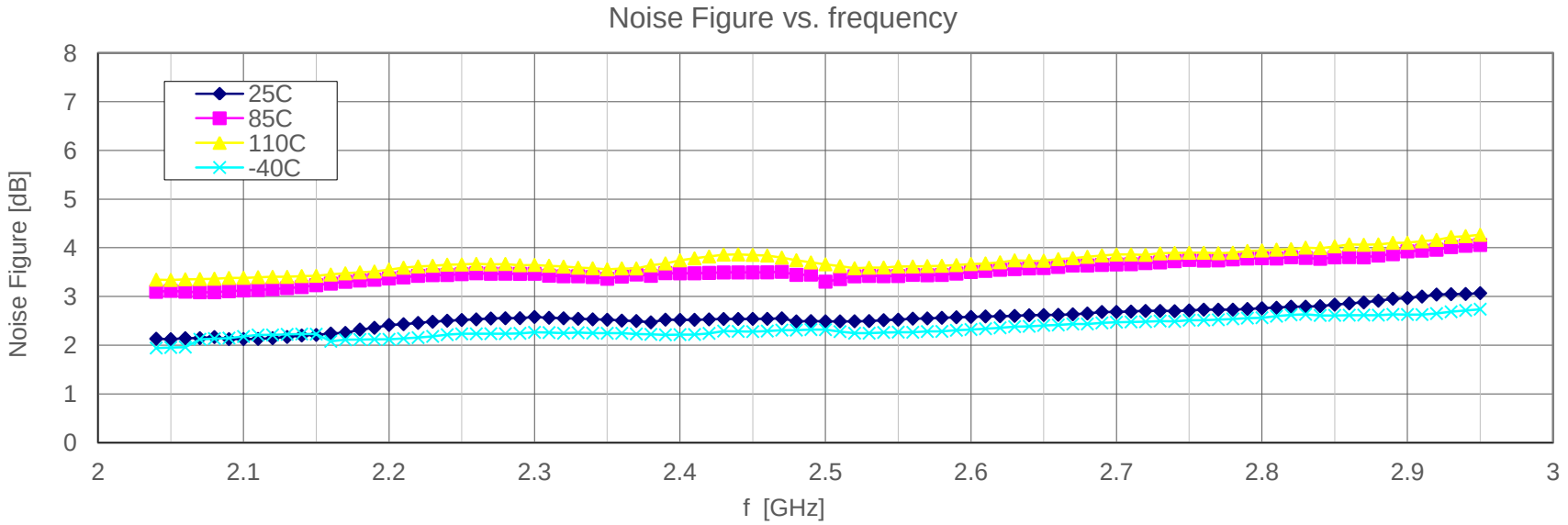
LNA Noise Figure and Gain, ANT A, VDD = 3.3V

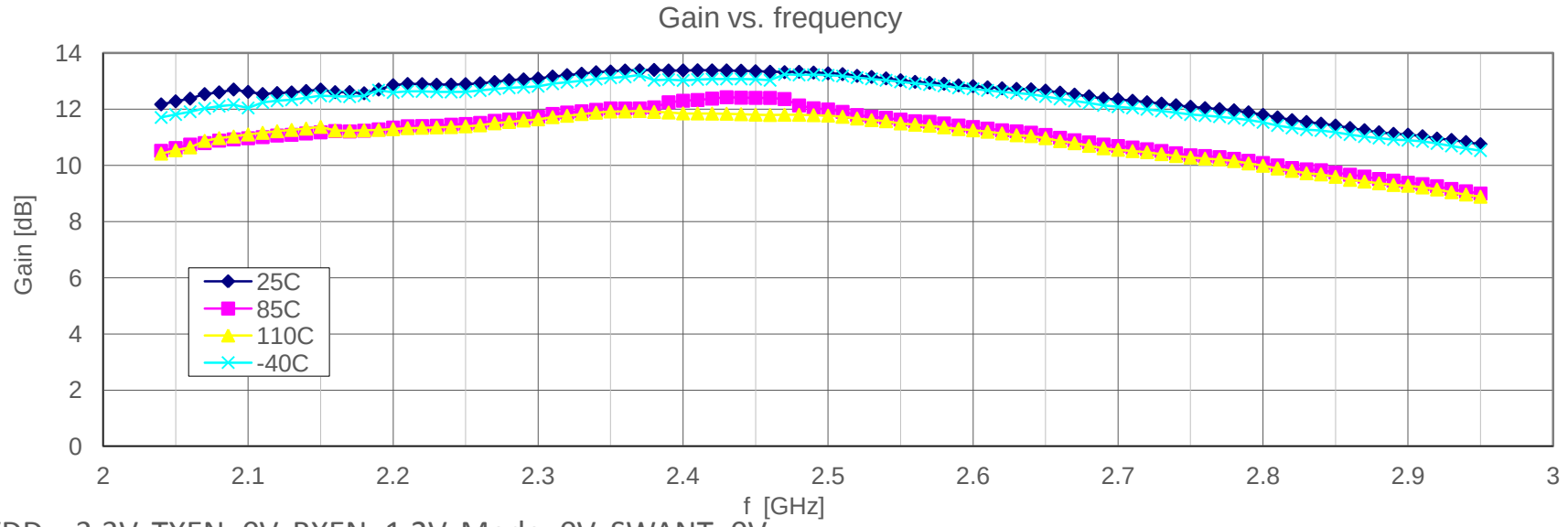




VDD = 3.3V, TXEN=0V, RXEN=1.2V, Mode=0V, SWANT=1.2V

LNA Noise Figure and Gain, ANT B, VDD = 3.3V





VDD = 3.3V, TXEN=0V, RXEN=1.2V, Mode=0V, SWANT=0V