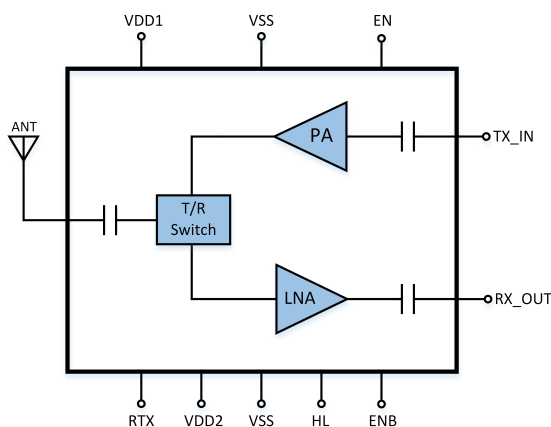
Product Overview

The ASF6004 is a GaN PHEMT MMIC RF Front End chip which operates from 8.5 to 10.5 GHz. The ASF6004 combines a low noise amplifier, power amplifier and one single-pole-double-throw (SPDT) switch; each can be switched on/off with a digital voltage of 0/3.3 V. The receive path has 6 dB gain switching feature; which offers 24 dB small signal gain and 3 dB noise figure at high gain mode. The measured output IP3 and output P1dB of receiver are 28 dBm and 16 dBm, respectively. The transmit path provides 17.5 dB of power gain, +29.5 dBm of saturated output power and 31% power added efficiency. The ASF6004 has a power handling capacity of 1 W continuous wave (CW) into the antenna port, eliminating the need for a limiter. All data is measured with the chip in a 50 Ohm test fixture connected via two 0.025 mm (1mil) diameter bond wires of minimal length 0.51mm (20mil).

Key Features

1. Fully integrated, high performance front-end MMIC
2. Integrated DC blocking at RF input/output
3. Enable/Disable mode with digital signal
4. Frequency Range: 8.5 GHz to 10.5 GHz
5. RX Gain: 24 dB
6. RX Noise Figure: 3 dB
7. 8 dB Receiver Gain Switching
8. RX OIP3: 28 dBm
9. TX Power Gain: 17.5 dB
10. TX Saturated Output Power: 29.5 dBm
11. TX PAE: 31%
12. 50 Ohm Matched Input/output
13. Die Size: 3.0 x 2.7 x 0.1 mm

Functional Block Diagram



Applications

1. Communications
2. Point to Point Radios
3. Phased Array Antenna

Main Electrical Specifications

Parameter	Min.	Typ.	Max.	Units
Frequency Range	8.5	-	10.5	GHz
TX Power Gain	-	17.5	-	dB
TX Psat	-	29.5	-	dBm
RX Gain (at high gain)	21	24	26	dB
RX Noise Figure (at high gain)	-	3	3.8	dB

Electrical Specifications, RX

Parameter	Min.	Typ.	Max.	Units
Frequency Range	8.5	-	10.5	GHz
Small Signal Gain (at high gain HL=3.3V)	21	24	26	dB
Attenuation at Low Gain (HL=0V)	3.2	-	6.8	dB
Noise Figure (at high gain HL=3.3V)	-	3	3.8	dB
Input Return Loss	7	15	-	dB
Output Return Loss	10.5	15	-	dB
Output Power for 1 dB Compression (P1dB)	-	16	-	dBm
Saturated Output Power	21	-	21.8	dBm
Output Third Order Intercept (IP3)	-	28	-	dBm
Supply Current (with RF)	-	95	-	mA

Test conditions unless otherwise noted: TA=+25° C, VDD1=15 V, VDD2=10 V, VSS=-6 V, ENB=3.3 V, EN=0 V, RTX=0 V, IVDD2=115 mA, Z0=50 Ω
Tcase is Cold Plate temperature, and Base Plate temperature (TBP) is 85°C.

Electrical Specifications, TX

Parameter	Min.	Typ.	Max.	Units
Frequency Range	8.5	-	10.5	GHz
Power Gain	-	17.5	-	dB
Input Return Loss	9.5	15	-	dB
Saturated Output Power	-	29.5	-	dBm
Power Added Efficiency	28	31	32	%
Supply Current	-	190	-	mA

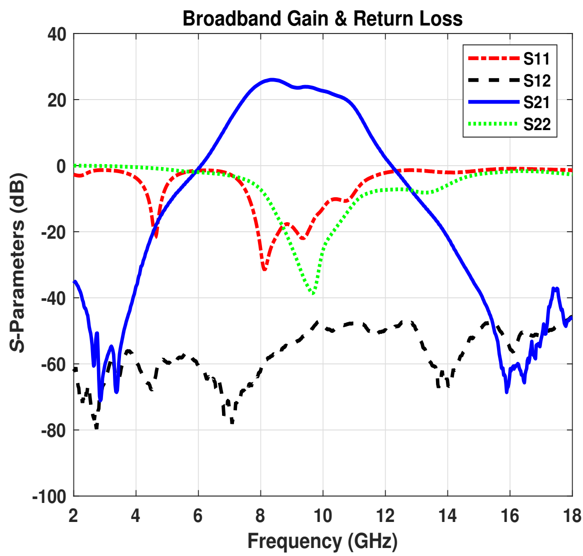
Test conditions unless otherwise noted: TA=+25° C, VDD1=15 V, VDD2=10 V, VSS=-6 V, ENB=0 V, EN=3.3 V, RTX=3.3 V, IVDD1=20 mA, Z0=50 Ω, Pin=12 dBm
Tcase is Cold Plate temperature, and Base Plate temperature (TBP) is 85°C.

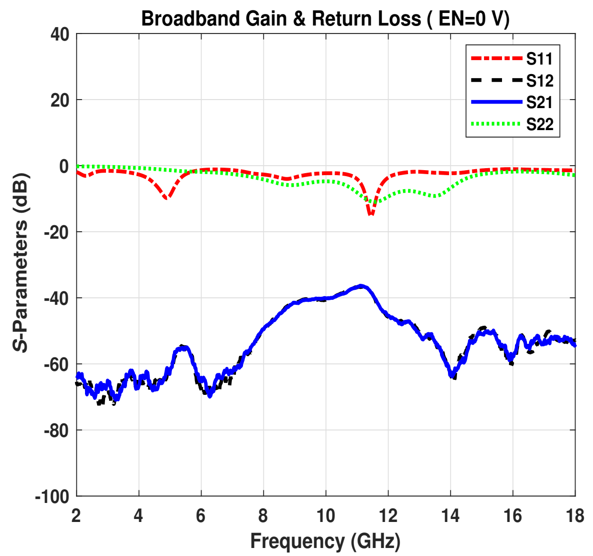
Typical Bias Condition

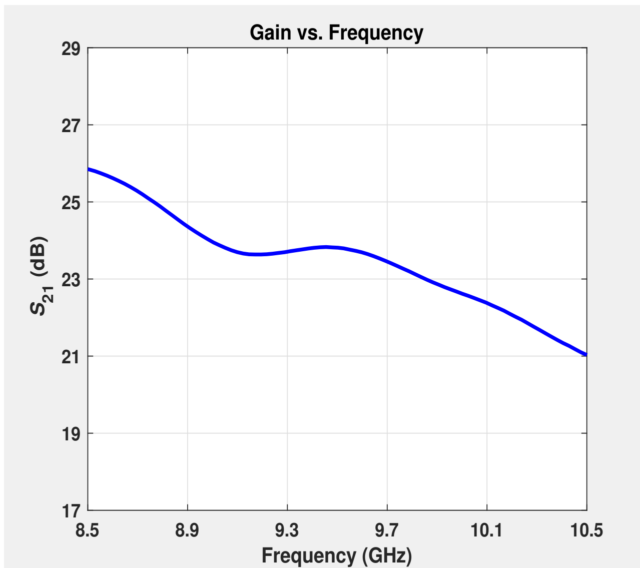
	VDD1	VDD2	VSS	EN	ENB	RTX	HL	Ivdd1	Ivdd2
TX Mode	15v	10v	-6v	3.3v	0v	3.3v	0/3.3v	20mA	11mA
RX Mode(High Gain)	15v	10v	-6v	0v	3.3v	0v	3.3v	4mA	95mA
RX Mode(Low Gain)	15v	10v	-6v	0v	3.3v	0v	0v	4mA	95mA

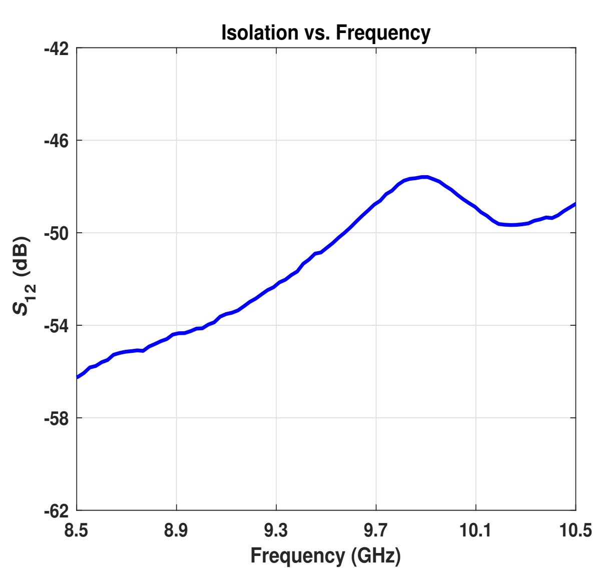
1. NOTE1: Currents are measured at 25 °C
2. NOTE2: The typical operation of amplifier is for supply voltages VSS = -6 V, VDD1 = +15 V and VDD2 = +10V.

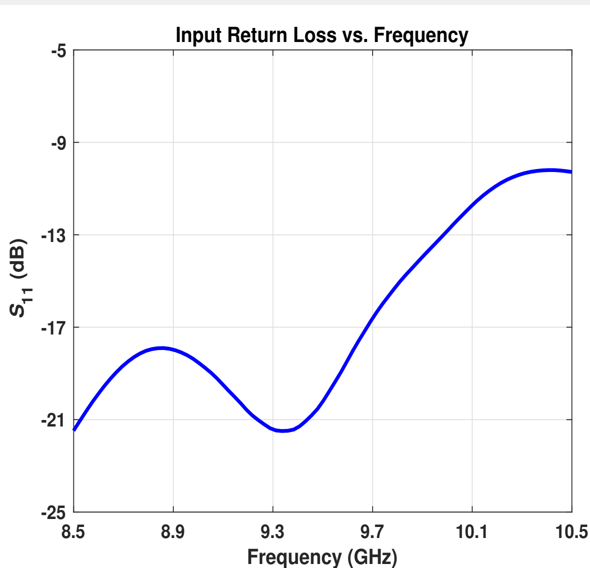
RX Performance Plots (High Gain @ 25°C)

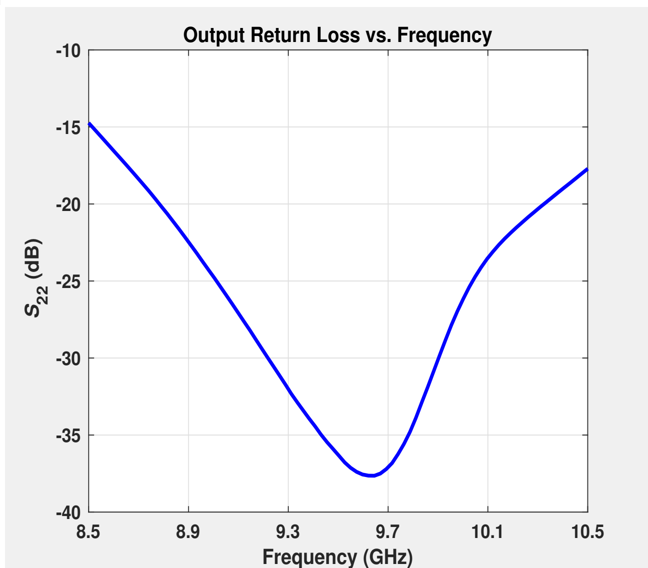




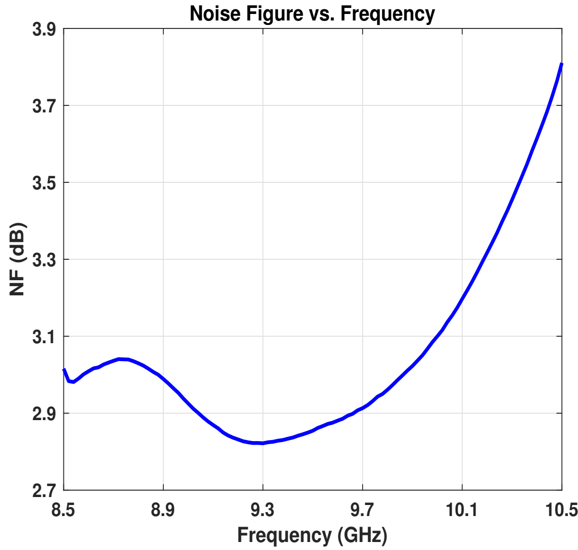


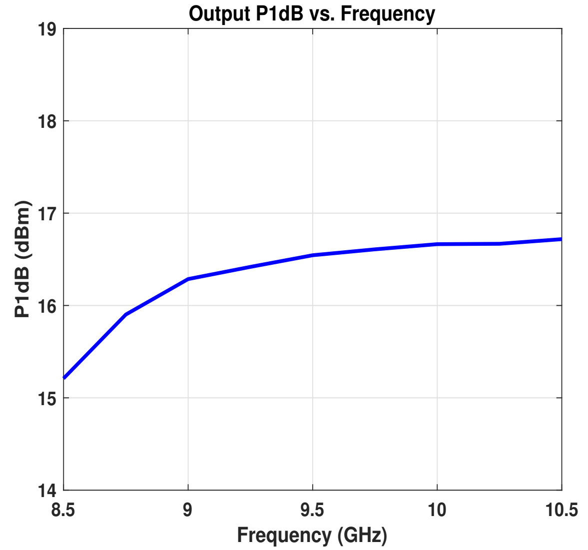


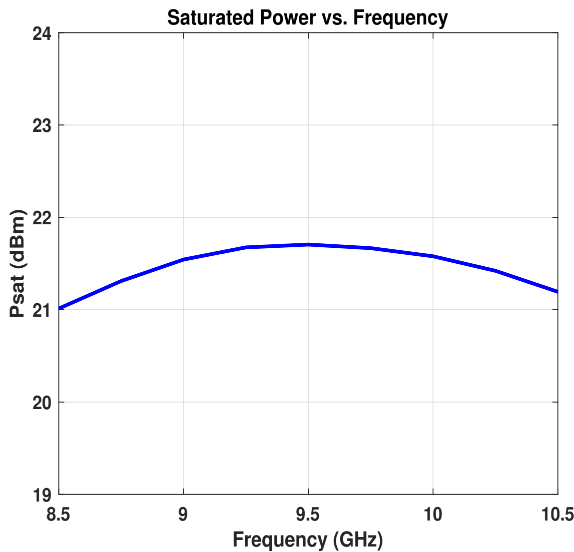


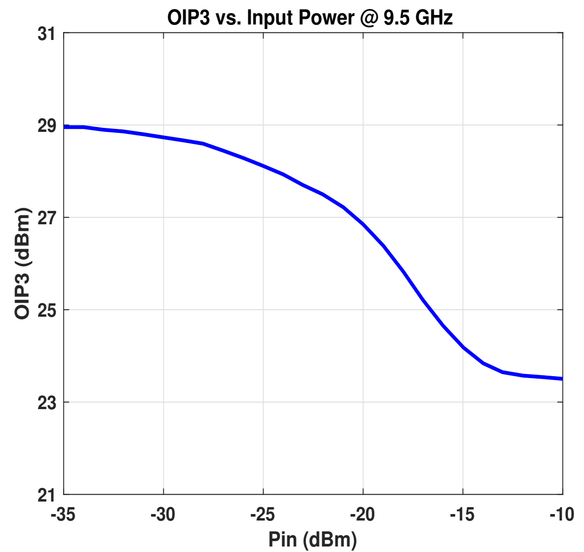


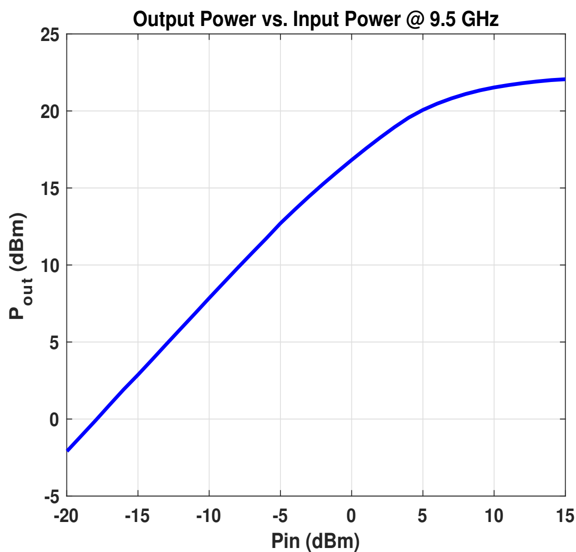
RX Performance Plots (High Gain @ 25°C)

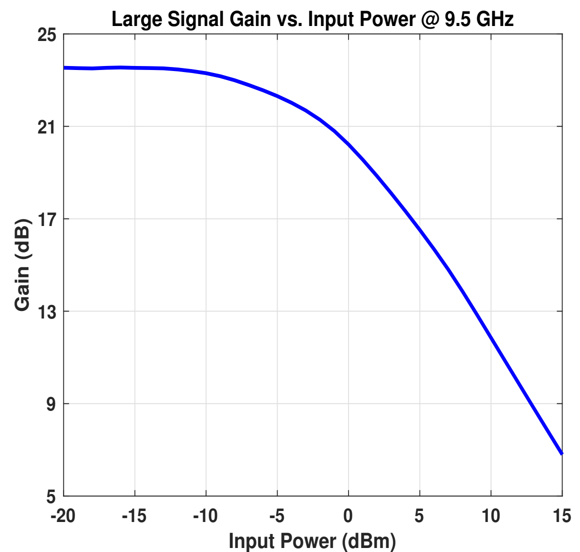


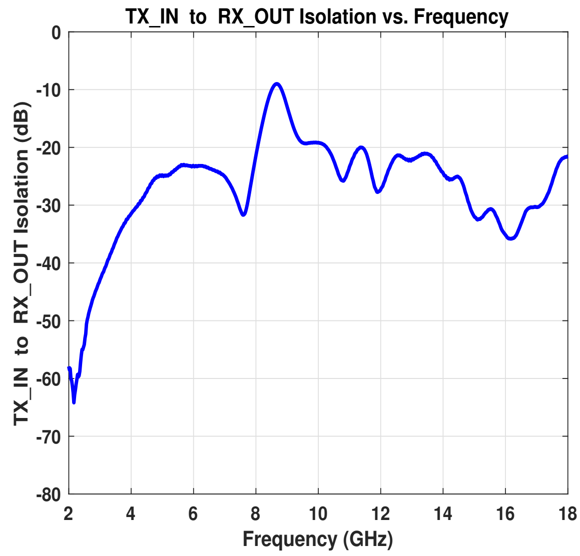




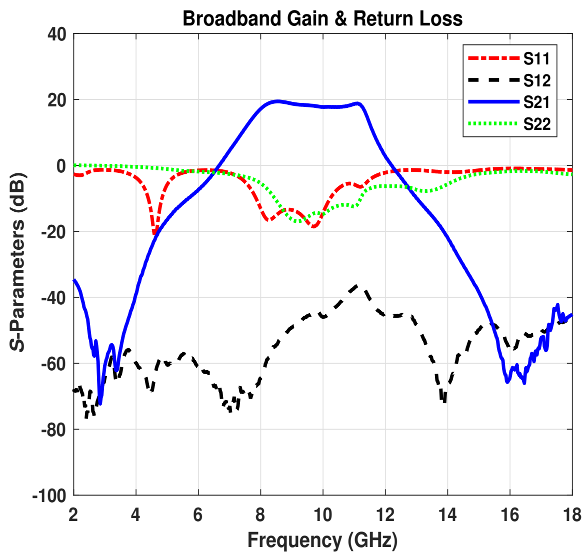


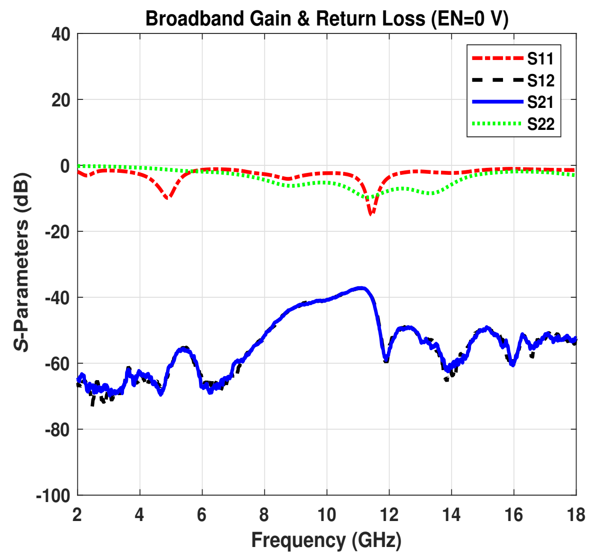


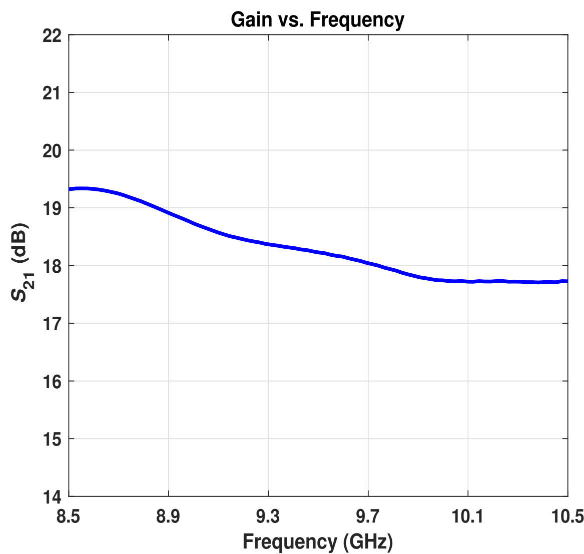


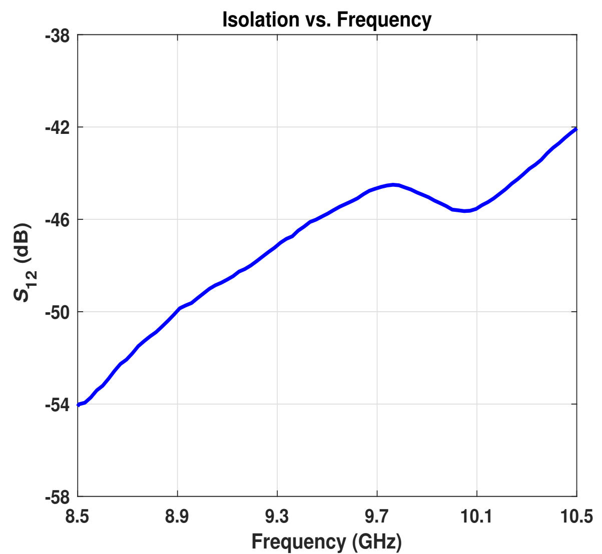

TX_IN to RX_OUT Isolation vs. Frequency
TX_IN to RX_OUT Isolation (dB)
Frequency (GHz)
0
-10
-20
-30
-40
-50
-60
-70
-80
2
4
6
8
10
12
14
16
18

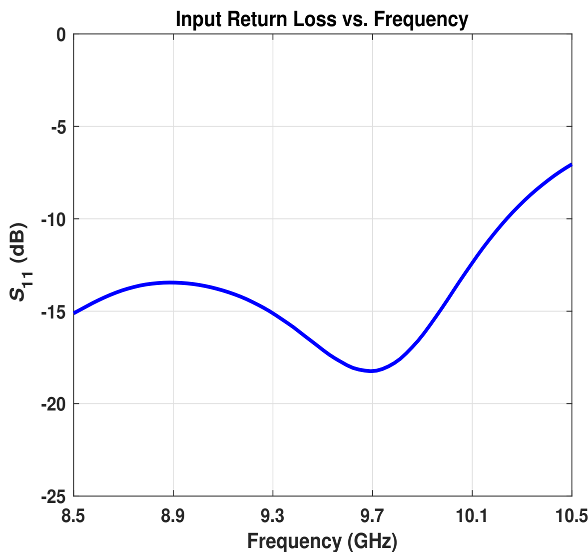
RX Performance Plots (Low Gain @ 25°C)

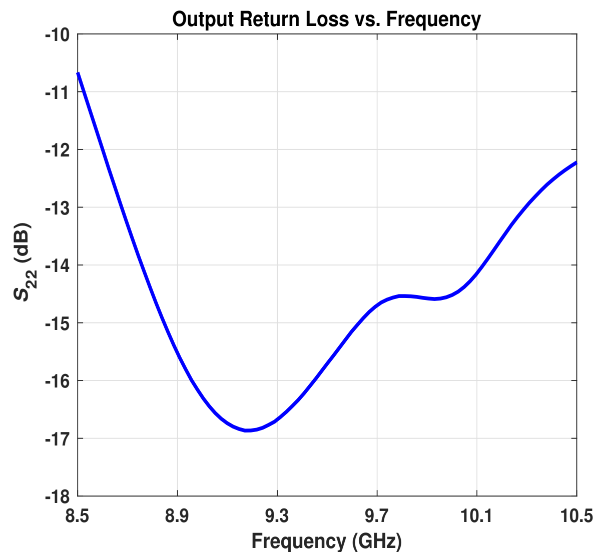




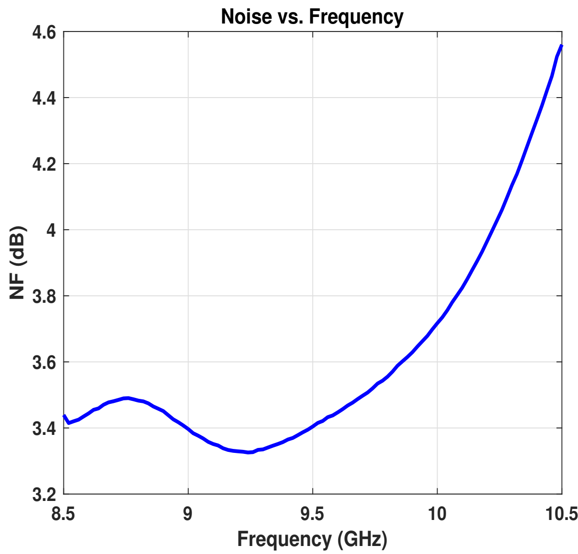


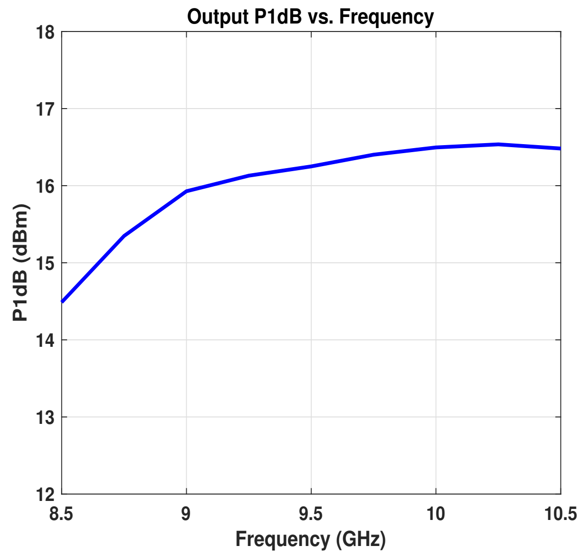


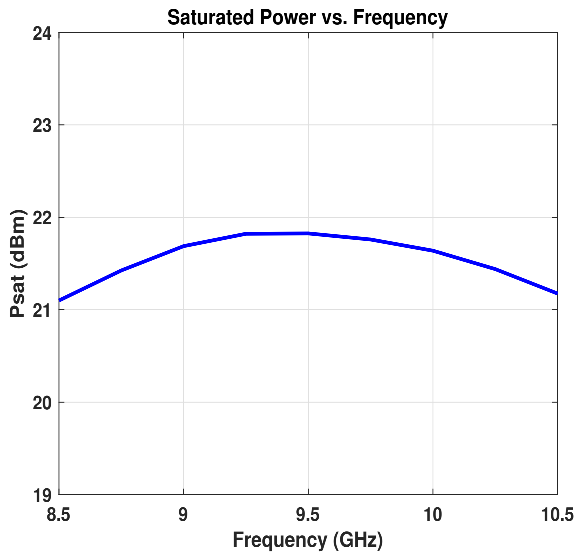


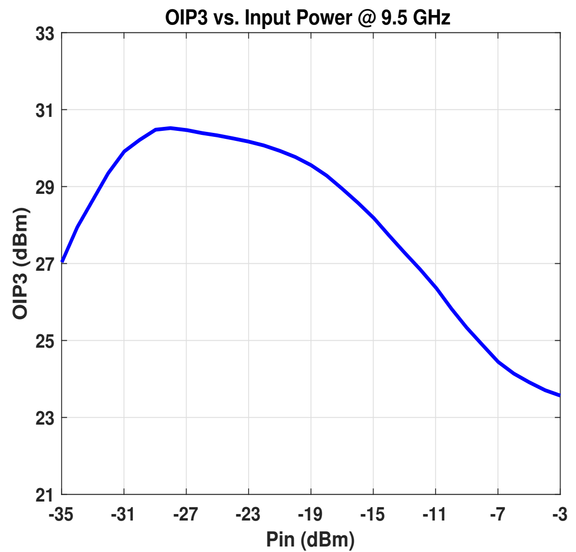


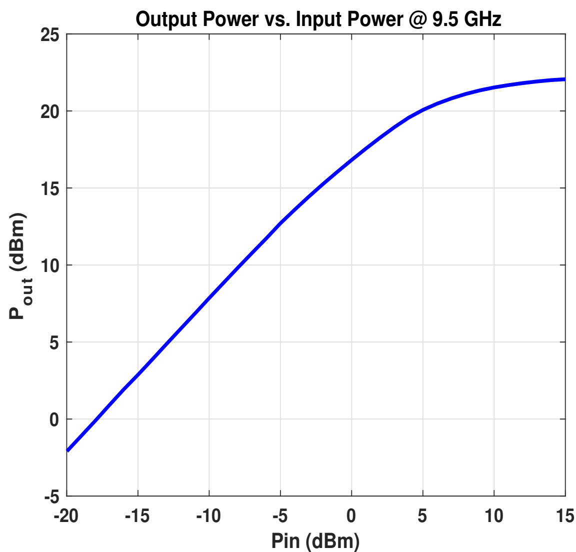
RX Performance Plots (Low Gain @ 25°C)

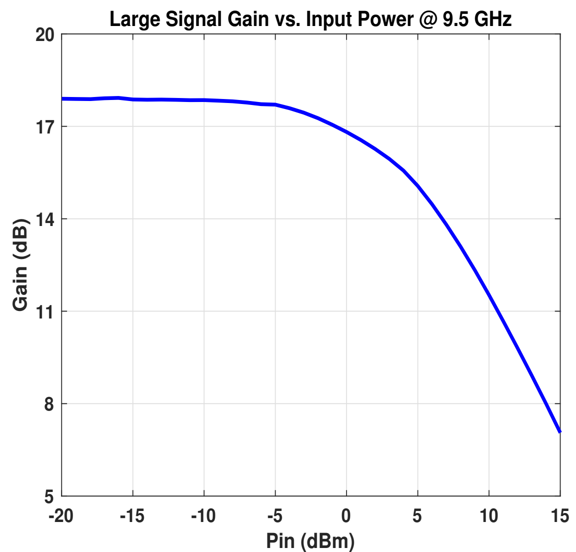


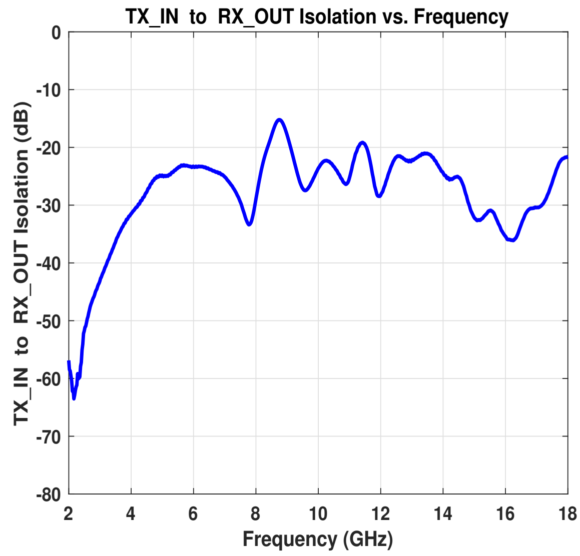




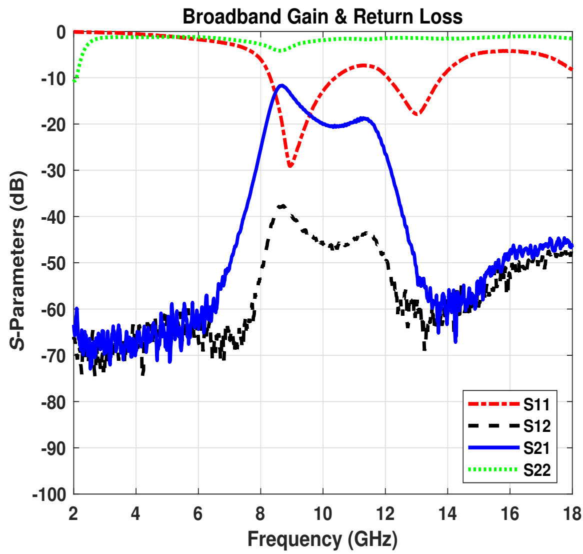


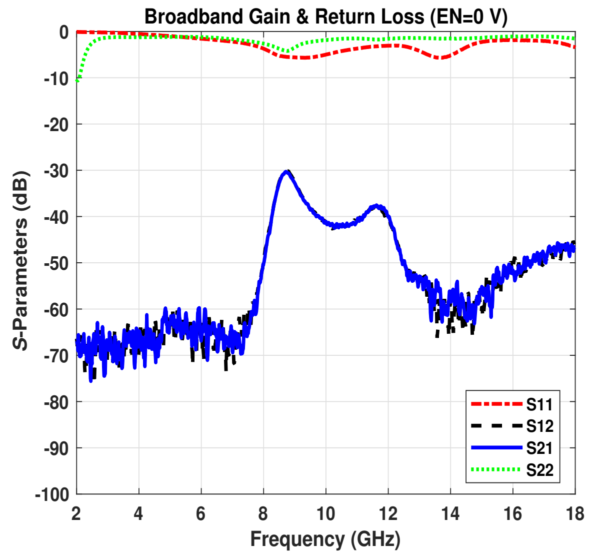


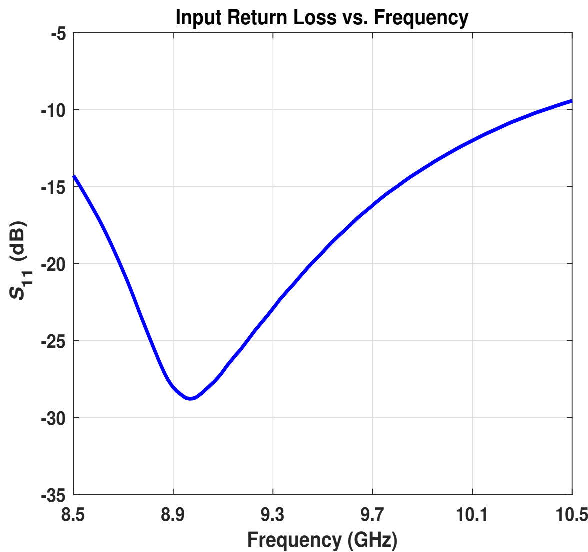


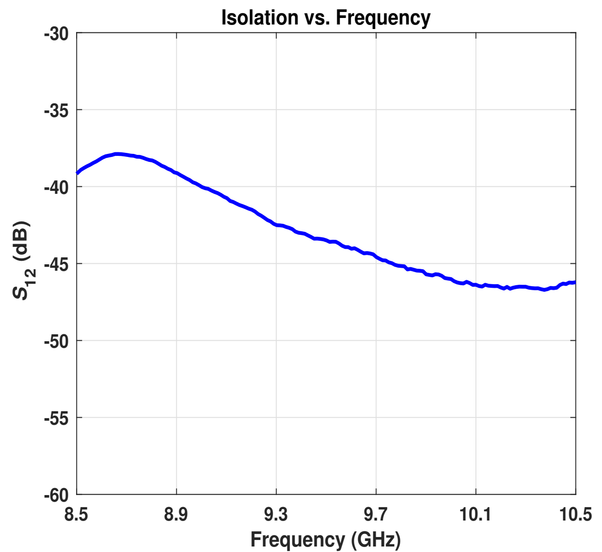

TX_IN to RX_OUT Isolation vs. Frequency
TX_IN to RX_OUT Isolation (dB)
0
-10
-20
-30
-40
-50
-60
-70
-80
2
4
6
8
10
12
14
16
18
Frequency (GHz)

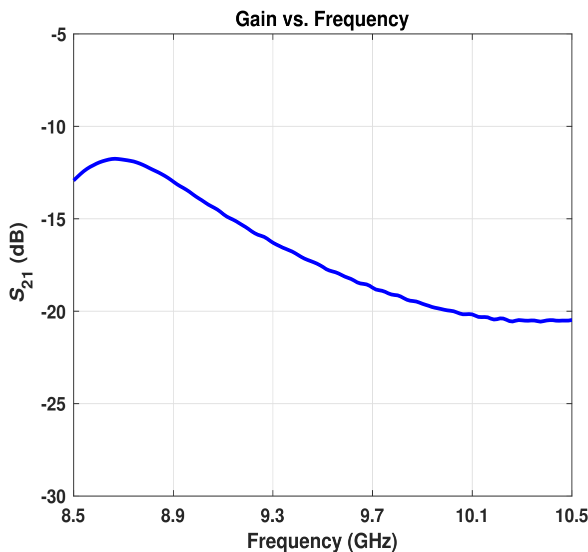
TX Performance Plots – Small Signal (TA = 25°C)

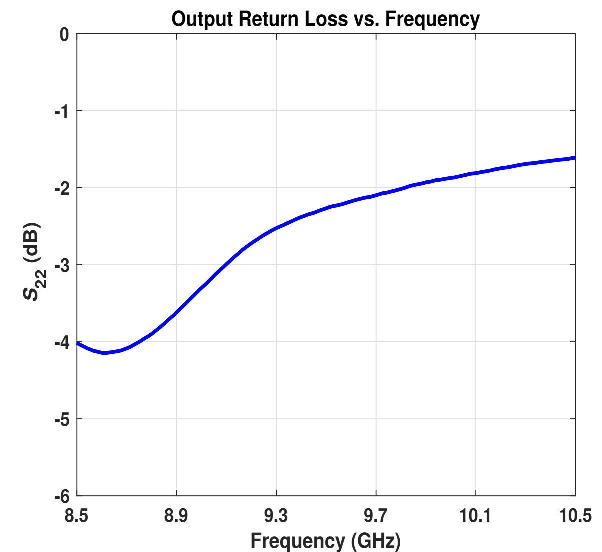


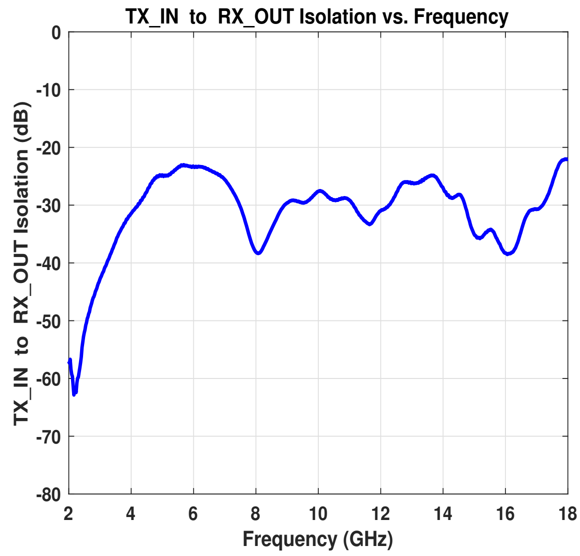






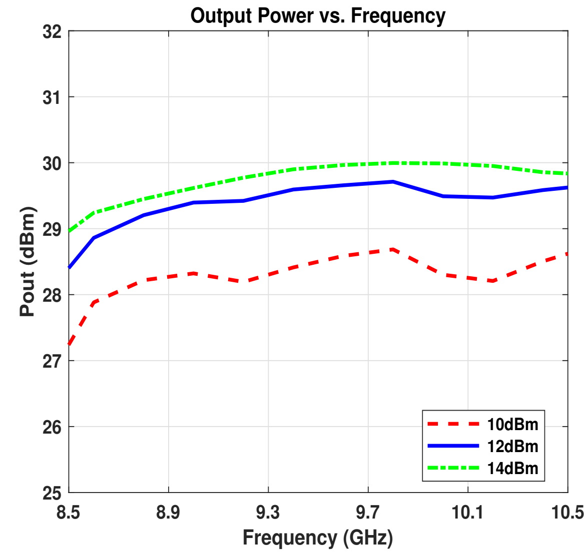


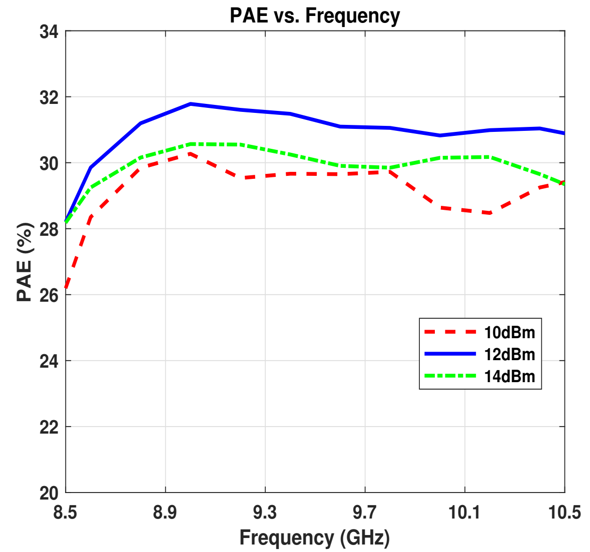


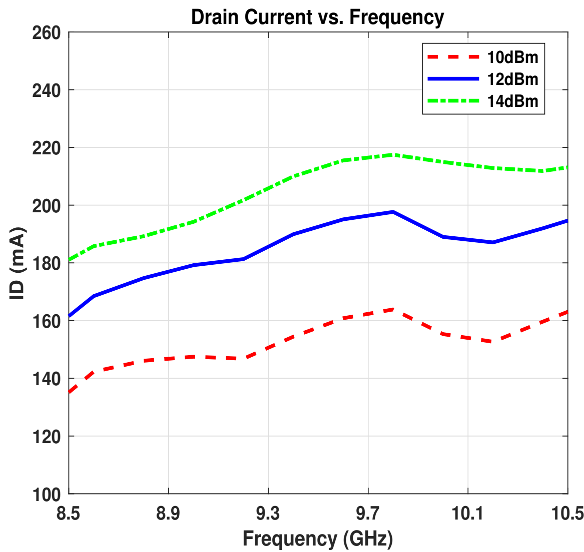

TX_IN to RX_OUT Isolation vs. Frequency
TX_IN to RX_OUT Isolation (dB)
Frequency (GHz)
0
-10
-20
-30
-40
-50
-60
-70
-80
2
4
6
8
10
12
14
16
18

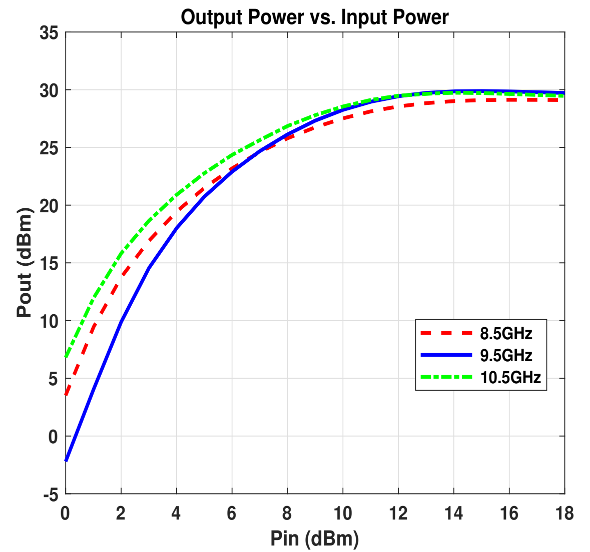
TX Performance Plots – Large Signal

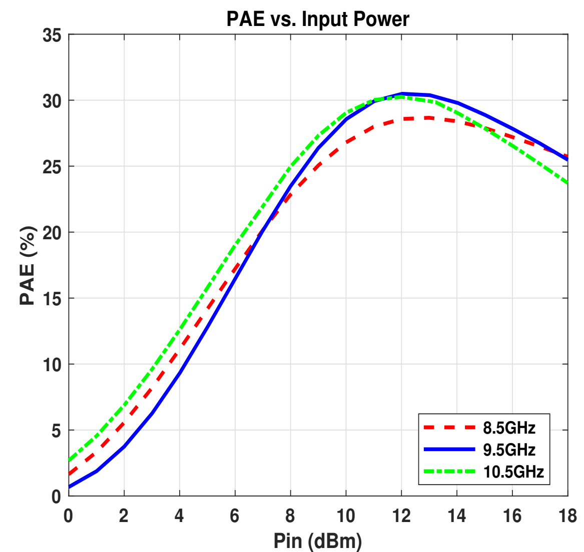
Test conditions unless otherwise noted:TA = 25°C, Pin = 12 dBm, CW

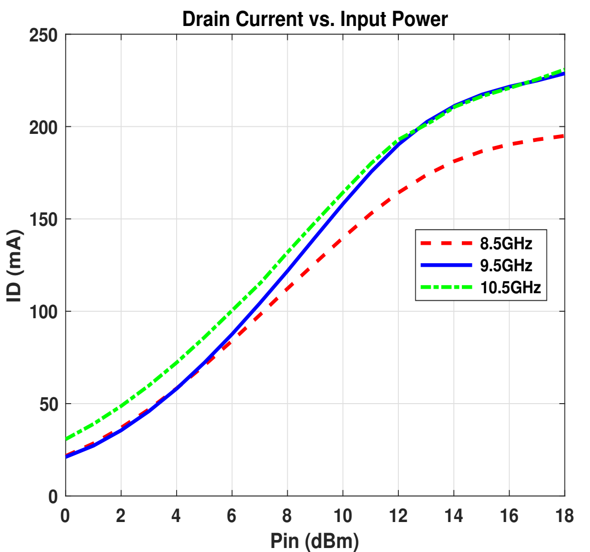


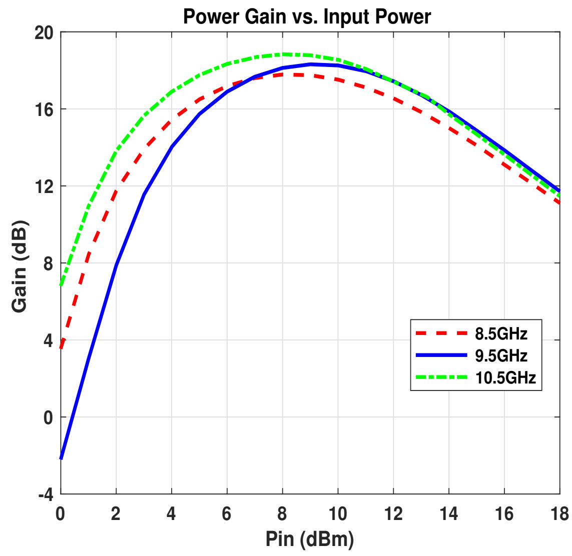






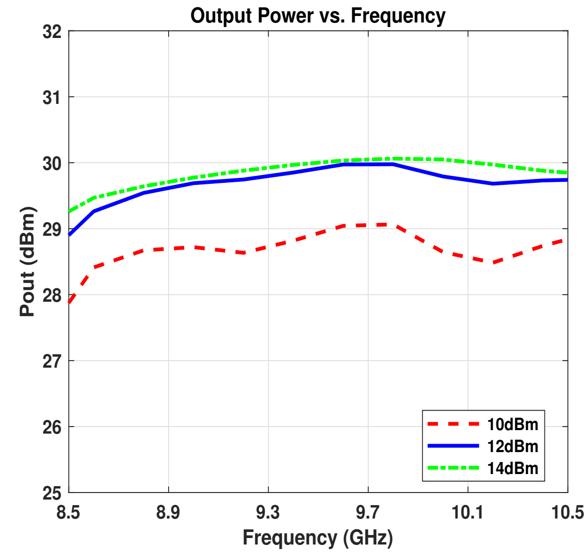


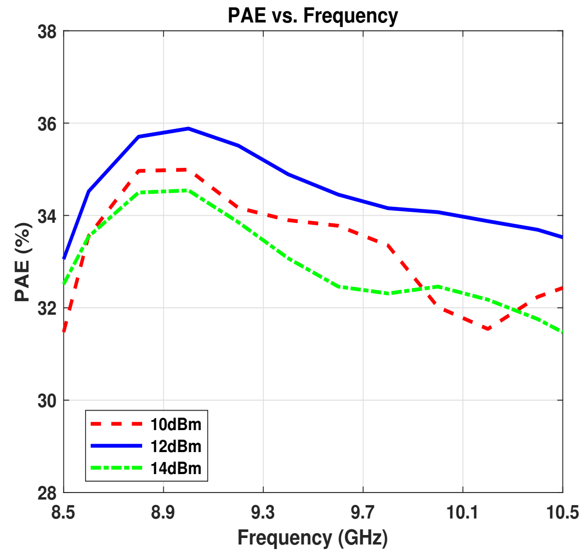


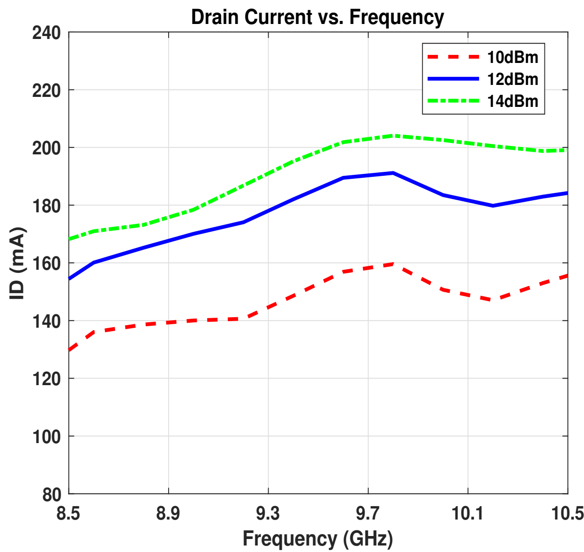

Power Gain vs. Input Power
Gain (dB)
Pin (dBm)
8.5GHz
9.5GHz
10.5GHz
20
16
12
8
4
0
-4
0
2
4
6
8
10
12
14
16
18

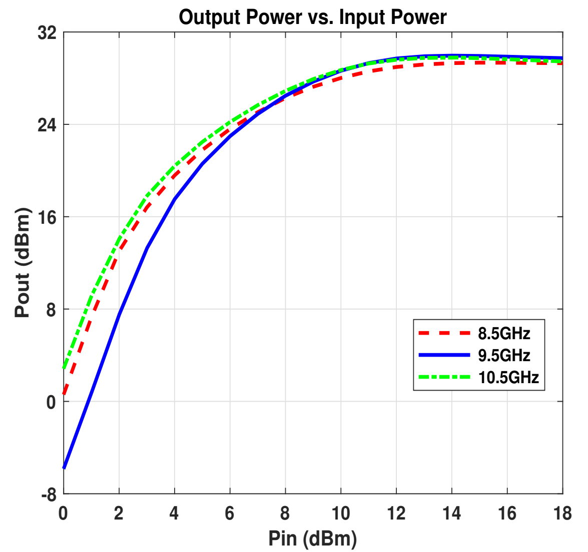
TX Performance Plots – Large Signal

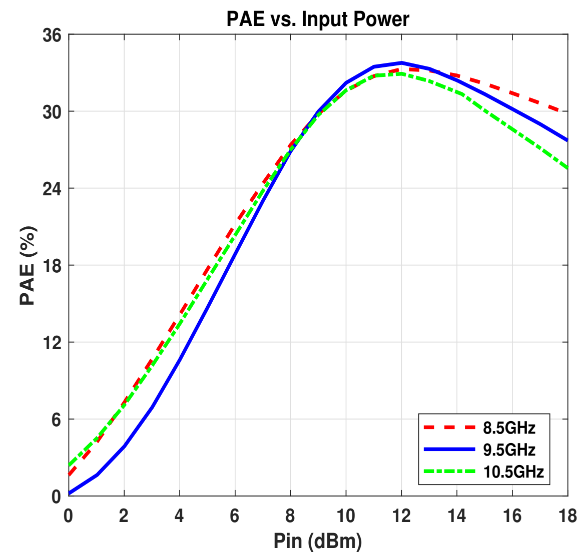
Test conditions unless otherwise noted:TA = 25°C, Pin = 12 dBm, 10 KHz Pulse 10 %

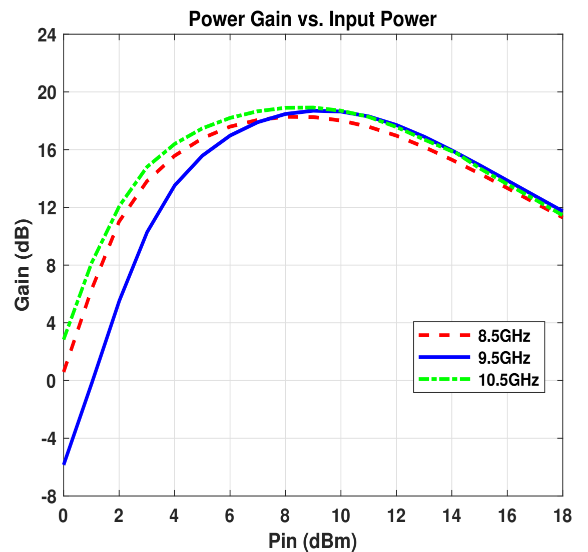


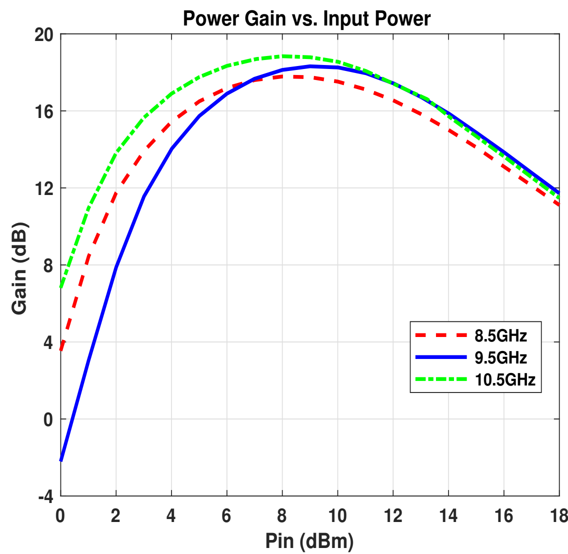












Absolute Maximum Rating

RX Drain Bias Voltage (VDD2)	+25 V
TX Drain Bias Voltage (VDD1)	25 V
Gate Bias Voltage (VSS)	-12 V
RX RF Input Power (CW, VDD2=10V)	30 dBm
TX RF Input Power (CW, VDD1=15V)	18 dBm
Channel Temperature	230 °C
TX Continuous Power Dissipation (T=85°C)	9 W
RX Continuous Power Dissipation (T=85°C)	9 W
Storage Temperature	-65 to +150 °C
Operating Temperature	-40 to +85 °C

ELECTROSTATIC SENSITIVE DEVICE OBSERVE HANDLING PRECAUTIONS

Bias-up Procedure

RX Mode:

1. Ground The Device
2. Set VSS to -6V
3. Set VDD1 to 15V
4. Set VDD2 to 10V
5. Set RTX to 0V
6. Set HL to 3.3V (High Gain) or 0V (Low Gain)
7. Set EN to 0V
8. Set ENB to 3.3V
9. Apply RF Input Signal

TX Mode:

1. Ground The Device
2. Set VSS to -6V
3. Set VDD1 to 15V
4. Set VDD2 to 10V
5. Set RTX to 3.3V
6. Set HL to 3.3V or 0V
7. Set ENB to 0V
8. Set EN to 3.3V
9. Apply RF input Signal

Bias-down Procedure

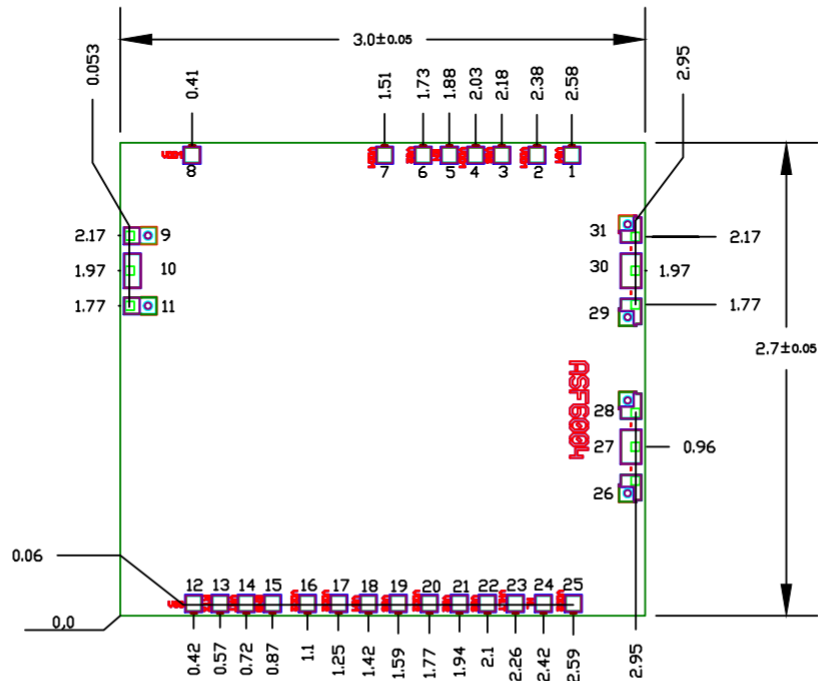
RX Mode:

1. Remove RF Input Signal
2. Set ENB to 0V
3. Set HL to 0V
4. Set VDD1 & VDD2 to 0V
5. Set VSS to 0V

TX Mode:

1. Remove RF Input Signal
2. Set EN to 0V
3. Set HL to 0V
4. Set RTX to 0V
5. Set VDD1 & VDD2 to 0V
6. Set VSS to 0V

Mechanical Information



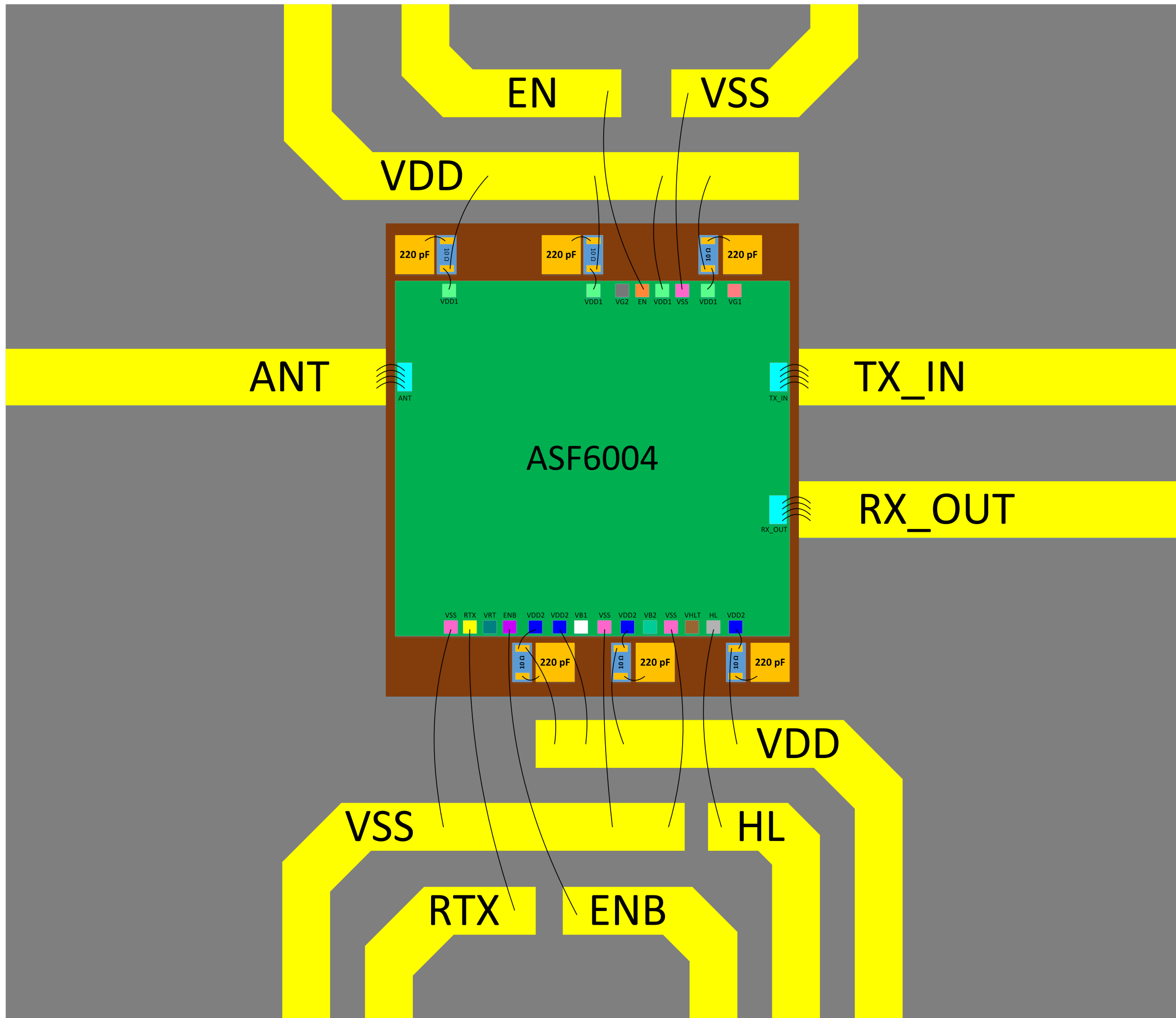
NOTES:

1. ALL DIMENSIONS IN MILLIMETERS
2. DIE THICKNESS IS 100 µm
3. DC PAD DIMENSIONS: 100 µm × 100 µm
4. RF PAD (10) DIMENSIONS: 100 µm × 200 µm
5. RF PAD (27, 30) DIMENSIONS: 122.5 µm × 200 µm
6. BACKSIDE METALLIZATION: GOLD
7. BACKSIDE METAL IS GROUND
8. BOND PAD METALIZATION: GOLD
9. NO CONNECTION REQUIRED FOR UNLABELED BOND PADS
10. OVERALL DIE SIZE ±50 µm

Bond Pad Description

30	TX-IN	This pad is AC coupled and matched to 50 Ohms.
10	ANT	This pad is AC coupled and matched to 50 Ohms.
27	RX-OUT	This pad is AC coupled and matched to 50 Ohms.
9,11,26,28,29,31,Die bottom	GND	These pads & die bottom are RF/DC ground. The die bottom must be connected to the RF/DC ground. Other pads connections are not required.
2,4,7,8	VDD1	TX Positive Supply Voltage. External Bypass Capacitors of 220 pF or 150 pF are required.
16,17,20,25	VDD2	RX Positive Supply Voltage. External Bypass Capacitors of 220 pF or 150 pF are required.
5	EN	This pad is for enabling/disabling of TX amplifier. (Active High)A digital signal 0/3.3V with minimum current of 2 mA. This pad is pulled down internally.
15	ENB	This pad is for enabling/disabling of TX amplifier. (Active High)A digital signal 0/3.3V with minimum current of 2 mA. This pad is pulled down internally.
13	RTX	This pad is for switching between receive and transmit path. For receive and transmit mode, RTX=0V and RTX=3.3V is needed, respectively with minimum current of 3 mA. Floating pad is not allowed.
24	HL	This pad is for gain switching in receive mode. For high gain and low gain, HL=3.3V and HL=0V is needed, respectively with minimum current of 3 mA. Floating pad is not allowed.
3, 12, 19, 22	VSS	Negative Supply Voltage for the amplifiers.
1,6,14,18,21,23	-	Not Connected

Assembly Diagram



Assembly Notes

Component Placement and Adhesive Attachment Assembly Notes:

1. Use vacuum collet to pick up the die.
2. The force should be controlled during placement and mounting specially no force should be applied to air bridges.

Reflow process assembly notes:

1. Use CMC or MoCu carrier to decrease thermal expansion mechanical stress
2. Use AuSn (80/20) solder and limit exposure to temperatures above 300 °C to 3-4 minutes, maximum.
3. An alloy station or conveyor furnace with reducing atmosphere should be used.
4. Do not use any kind of flux.
5. Devices must be stored in a dry nitrogen atmosphere.
6. Use Au bond wire.

Contact Information

For the latest specifications, additional product information:
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