NPT2010

GaN Wideband Transistor 48 V, 100 W
DC - 2.2 GHz

Rev. V1

Features

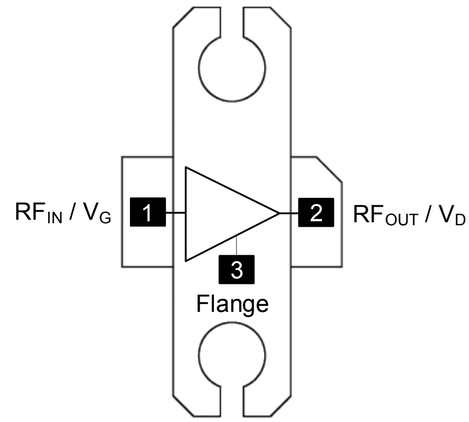
- GaN on Si HEMT D-Mode Transistor
- Suitable for linear and saturated applications
- Tunable from DC - 2.2 GHz
- 48 V Operation
- 15 dB Gain @ 2.15 GHz
- 61 % Drain Efficiency @ 2.15 GHz
- 100 % RF Tested
- Industry standard metal-ceramic package
- RoHS* Compliant

Description

The NPT2010 GaN HEMT is a wideband transistor optimized for DC - 2.2 GHz operation. This device supports CW, pulsed, and linear operation with output power levels to 100 W (50 dBm) in an industry standard metal-ceramic package with bolt down flange.

The NPT2010 is ideally suited for defense communications, land mobile radio, avionics, wireless infrastructure, ISM applications and VHF/ UHF/L/S-band radar.

Functional Schematic



Pin Configuration

Pin No.	Pin Name	Function
1	RF_{IN} / V_G	RF Input / Gate
2	RF_{OUT} / V_D	RF Output / Drain
3	Flange[1]	Ground / Source

1. The Flange must be connected to RF and DC ground. This path must also provide a low thermal resistance heat path.

Ordering Information

Part Number	Package
NPT2010	bulk quantity
NPT2010-SMBPPR	sample

* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

RF Electrical Specifications: T_C = +25°C, V_{DS} = 48 V, I_{DQ} = 600 mA

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	CW, 2.15 GHz	G_{SS}	-	17	-	dB
Saturated Output Power	CW, 2.15 GHz	P_{SAT}	-	50.5	-	dBm
Drain Efficiency at Saturation	CW, 2.15 GHz	η_{SAT}	-	64	-	%
Power Gain	2.15 GHz, P_{OUT} = 95 W	G_P	13.5	15	-	dB
Drain Efficiency	2.15 GHz, P_{OUT} = 95 W	η	52.5	61	-	%
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 10:1, No Device Damage			

DC Electrical Characteristics: T_C = +25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 160 V	I_{DLK}	-	-	24	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	12	mA
Gate Threshold Voltage	V_{DS} = 48 V, I_D = 24 mA	V_T	-2.5	-1.5	-0.5	V
Gate Quiescent Voltage	V_{DS} = 48 V, I_D = 600 mA	V_{GSQ}	-2.1	-1.2	-0.3	V
On Resistance	V_{DS} = 2 V, I_D = 180 mA	R_{ON}	-	0.2	-	Ω
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 μs	$I_{D,MAX}$	-	14	-	A

Absolute Maximum Ratings[2,3,4]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	160 V
Gate Source Voltage, V_{GS}	-10 to 3 V
Gate Current, I_G	48 mA
Junction Temperature, T_J	+200°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

2. Exceeding any one or combination of these limits may cause permanent damage to this device.
3. MACOM does not recommend sustained operation near these survivability limits.
4. Operating at nominal conditions with $T_J \leq 200°C$ will ensure MTTF > 1 x 10^6 hours.

Thermal Characteristics[5]

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance	V_{DS} = 48 V, T_J = 200°C	$R_{\theta JC}$	1.75	°C/W

5. Junction temperature (T_J) measured using IR Microscopy. Case temperature measured using thermocouple embedded in heat-sink.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

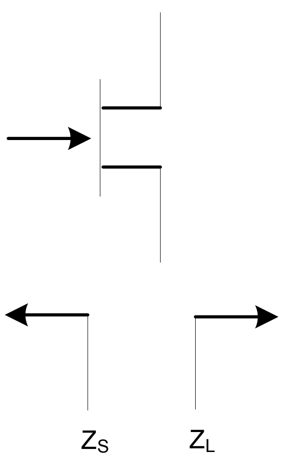
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A devices.

Load-Pull Performance: V_{DS} = 48 V, I_{DQ} = 600 mA, T_C = 25°C

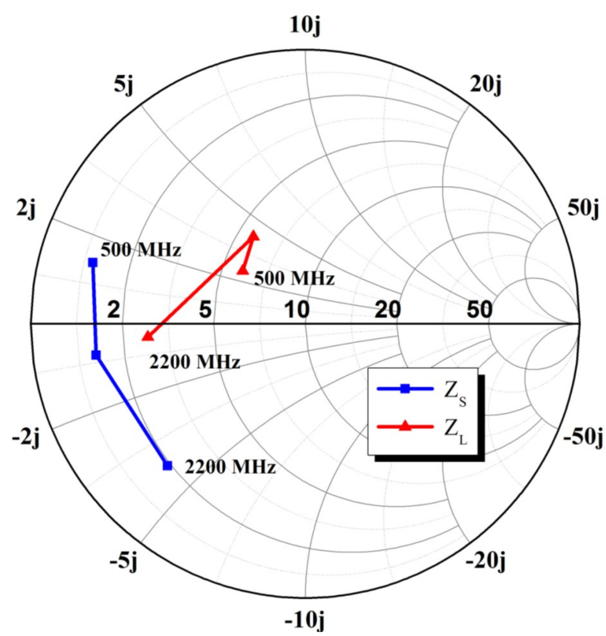
Reference Plane at Device Leads, CW Drain Efficiency and Output Power Tradeoff Impedance

Frequency (MHz)	Z_S (Ω)	Z_L (Ω)	P_{SAT} (W)	G_{SS} (dB)	Drain Efficiency @ P_{SAT} (%)
500	1.1 + j1.4	5.9 + j2.5	140	25.9	70
900	1.3 - j0.7	5.7 + j4.2	130	21.5	69
2200	1.9 - j4.1	2.7 - j0.4	115	16.1	64

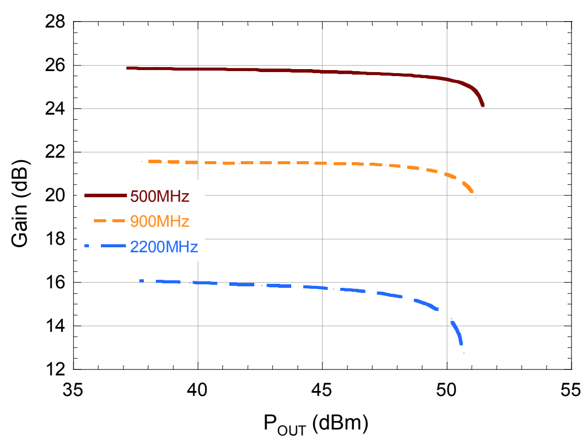
Impedance Reference



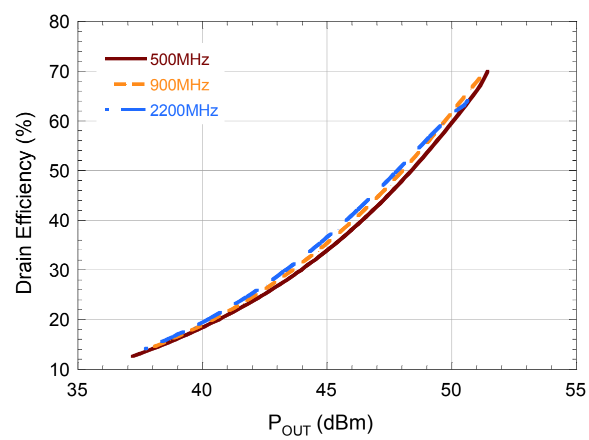
Z_S and Z_L vs. Frequency



Gain vs. Output Power

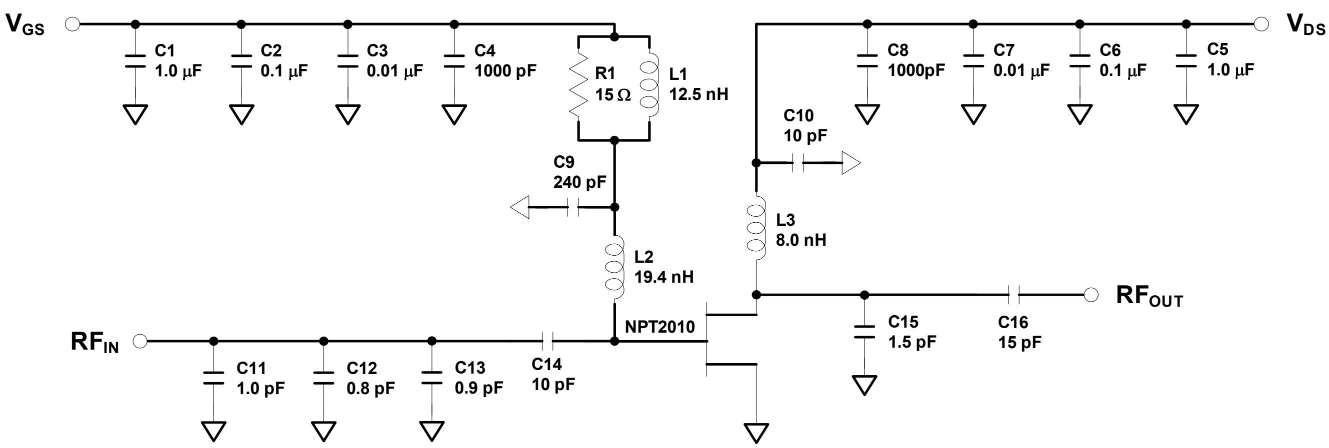


Drain Efficiency vs. Output Power



Evaluation Board and Recommended Tuning Solution

2.15 GHz Narrowband Circuit



Description

Parts measured on evaluation board (20-mil thick RO4350). Matching is provided using a combination of lumped elements and transmission lines as shown in the simplified schematic above. Recommended tuning solution component placement, transmission lines, and details are shown on the next page.

Bias Sequencing

Turning the device ON

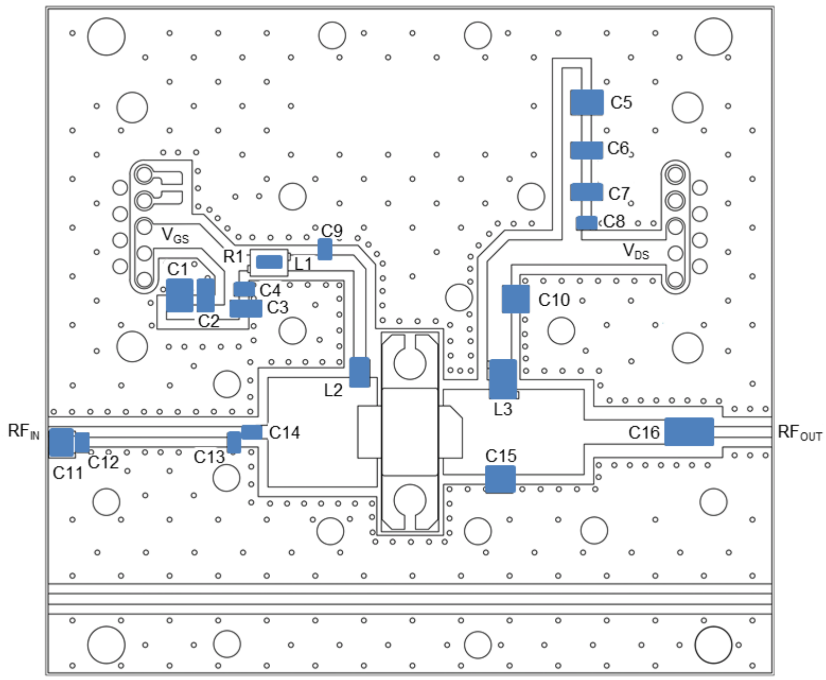
1. Set V_{GS} to the pinch-off (V_P), typically -5 V.
2. Turn on V_{DS} to nominal voltage (48 V).
3. Increase V_{GS} until the I_{DS} current is reached.
4. Apply RF power to desired level.

Turning the device OFF

1. Turn the RF power off.
2. Decrease V_{GS} down to V_P.
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}.

Evaluation Board and Recommended Tuning Solution

2.15 GHz Narrowband Circuit

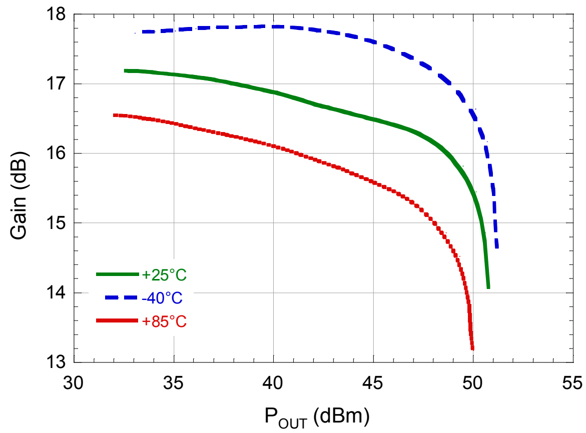


Parts list

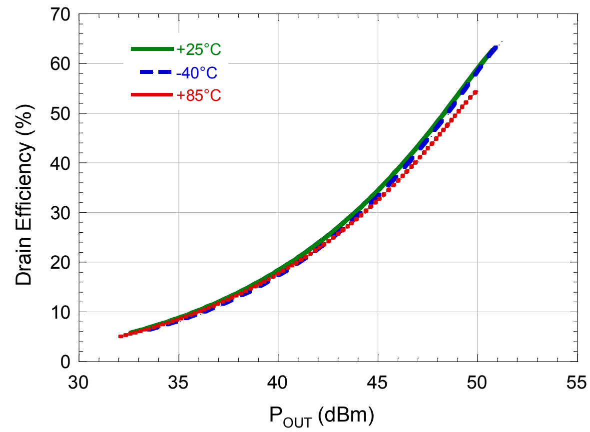
Reference	Value	Tolerance	Manufacturer	Part Number
C1, C5	1.0 µF	10%	AVX	12101C105KAT2A
C2, C6	0.1 µF	10%	Kemet	C1206C104K1RACTU
C3, C7	0.01 µF	10%	AVX	1206C103KAT2A
C4, C8	1000 pF	10%	Kemet	C0805C102K1RACTU
C9	240 pF	0.1 pF	ATC	ATC600F241B
C10	10 pF	0.1 pF	ATC	ATC800B100B
C11	1.0 pF	0.1 pF	ATC	ATC800B1R0B
C12	0.8 pF	0.1 pF	ATC	ATC600F0R8B
C13	0.9 pF	0.1 pF	ATC	ATC600F0R9B
C14	10 pF	0.1 pF	ATC	ATC600F100B
C15	1.5 pF	0.1 pF	ATC	ATC800B1R5B
C16	15 pF	0.1 pF	ATC	ATC800B150B
L1	12.5 nH	5%	CoilCraft	A04TJL
L2	19.4 nH	5%	CoilCraft	0806SQ-19NJL
L3	8.0 nH	5%	CoilCraft	A03TJL
R1	15 Ω	1%	Panasonic	ERJ-2RKF15R0X
PCB	Rogers RO4350, ε_r = 3.5, 20 mil			

Typical Performance as measured in the 2.15 GHz evaluation board: CW, V_{DS} = 48 V, I_{DQ} = 600 mA (unless noted)

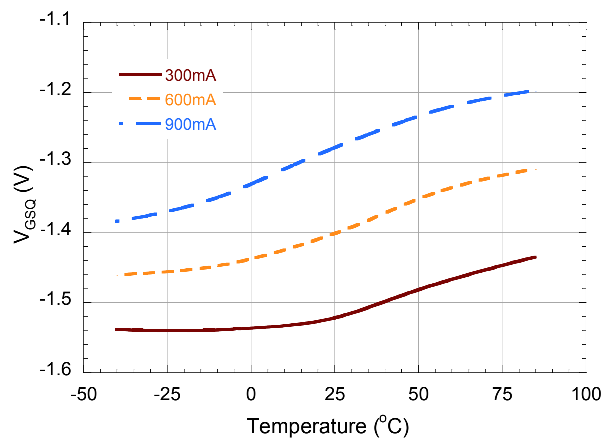
Gain vs. Output Power over Temperature



Drain Efficiency vs. Output Power over Temperature

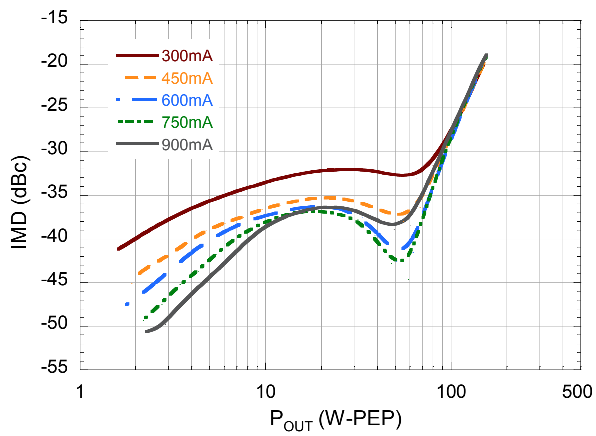


Quiescent V_{GS} vs. Temperature

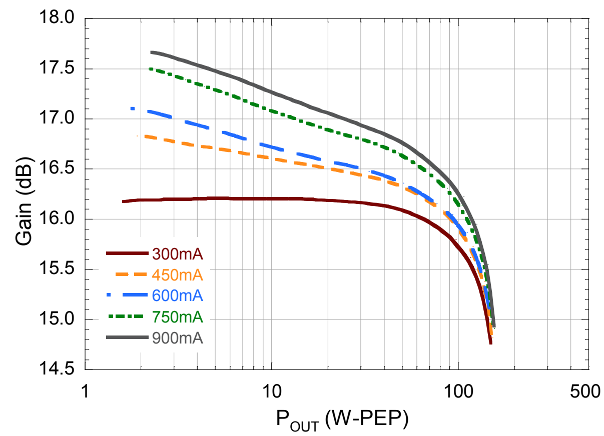


Typical 2-Tone Performance as measured in the 2.15 GHz evaluation board: 1 MHz Tone Spacing, V_{DS} = 48 V, I_{DQ} = 600 mA, T_C = 25°C (unless noted)

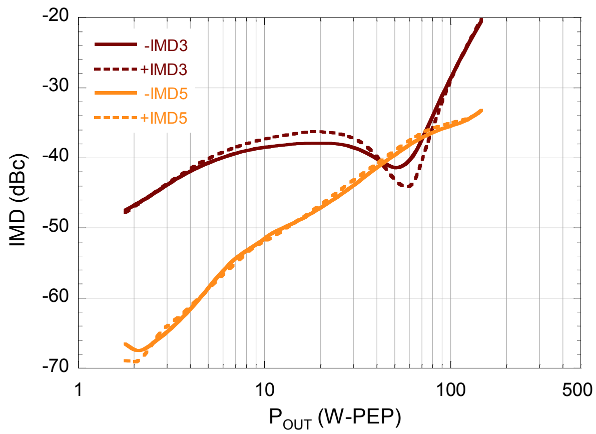
2-Tone IMD3 vs. Output Power vs. Quiescent Current



2-Tone Gain vs. Output Power vs. Quiescent Current

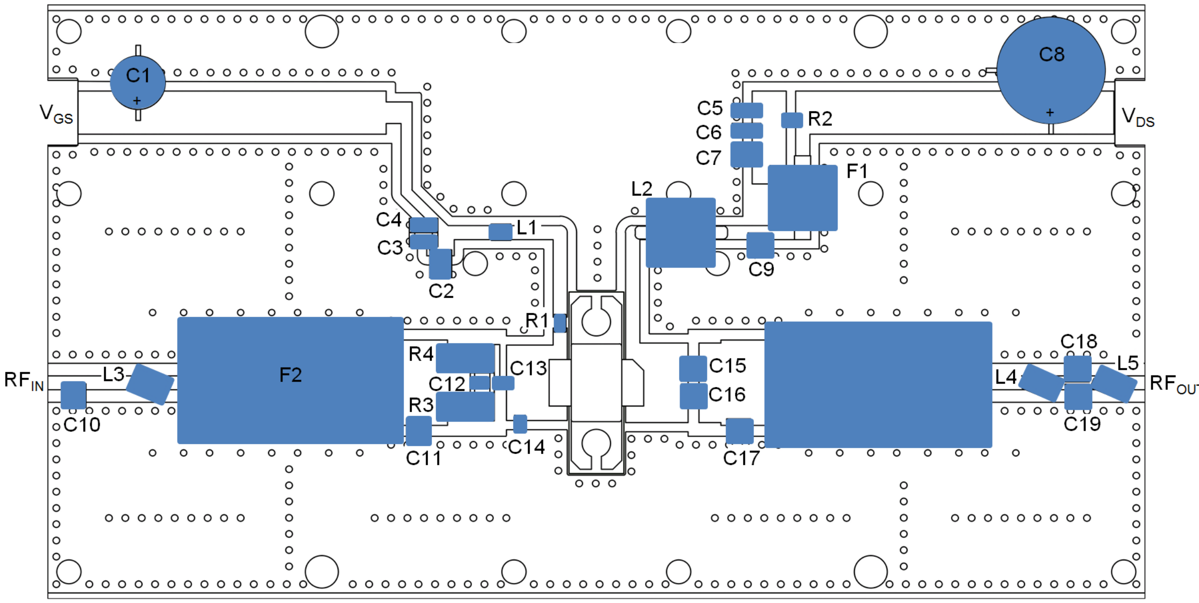


2-Tone IMD vs. Output Power



Evaluation Board and Recommended Tuning Solution

100 - 700 MHz Broadband Circuit

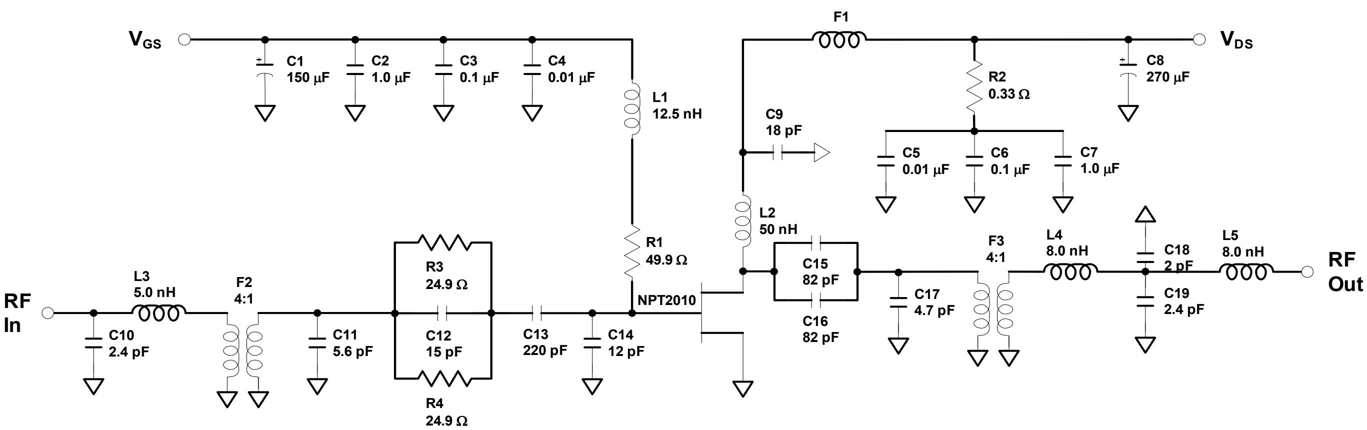


Parts list

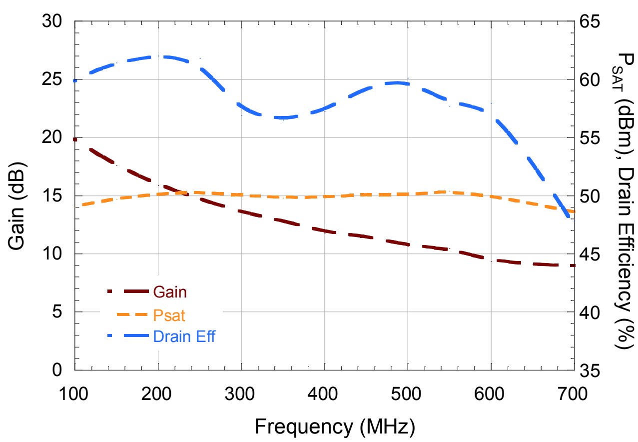
Reference	Value	Tolerance	Manufacturer	Part Number
C1	150 µF	20%	Nichicon	UPW1C151MED
C2, C7	1.0 µF	10%	AVX	12101C105KAT2A
C3, C6	0.1 µF	10%	Kemet	C1206C104K1RACTU
C4, C5	0.01 µF	10%	AVX	12061C103KAT2A
C8	270 µF	20%	United Chemi-Con	ELXY 630ELL271MK25S
C9	18 pF	1%	ATC	ATC100B180FT
C10, C19	2.4 pF	0.1 pF	ATC	ATC100B2R4BT
C11	5.6 pF	0.1 pF	ATC	ATC100B5R6BT
C12	15 pF	1%	ATC	ATC600F150FT
C13	220 pF	1%	ATC	ATC600F221FT
C14	12 pF	1%	ATC	ATC600F120FT
C15, C16	82 pF	1%	ATC	ATC100B820FT
C17	4.7 pF	0.1 pF	ATC	ATC100B4R7BT
C18	2.0 pF	0.1 pF	ATC	ATC100B2R0BT
R1	49.9 Ω	1%	Panasonic	ERJ-6ENF49R9V
R2	0.33 Ω	1%	Panasonic	ERJ-6RQFR33V
R3, R4	24.9 Ω	1%	Panasonic	ERJ-1TNF24R9U
F1	Material 73	-	Fair-Rite	2673000801
F2, F3	4:1 Transformer	-	Anaren	XMT031B5012
L1	12.5 nH	5%	Coilcraft	A04TJL
L2	~50 nH	-	16 AWG Cu Wire	5 turn, 0.2"ID
L3	5.0 nH	5%	Coilcraft	A02TJL
L4, L5	8.0 nH	5%	Coilcraft	A03TJL
PCB	Rogers RO4350, ε_r=3.5, 20mil			

Evaluation Board and Recommended Tuning Solution

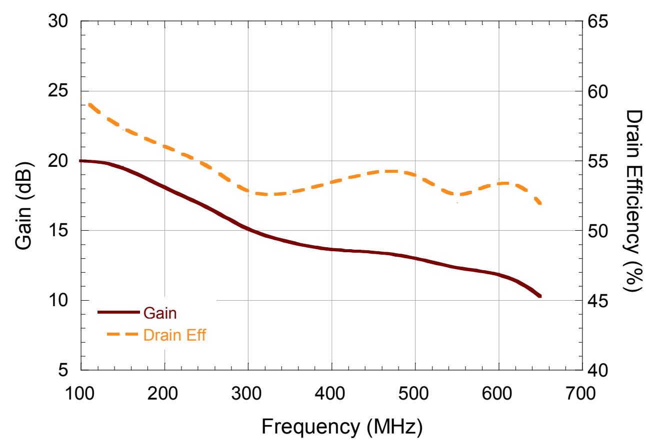
100 - 700 MHz Broadband Circuit



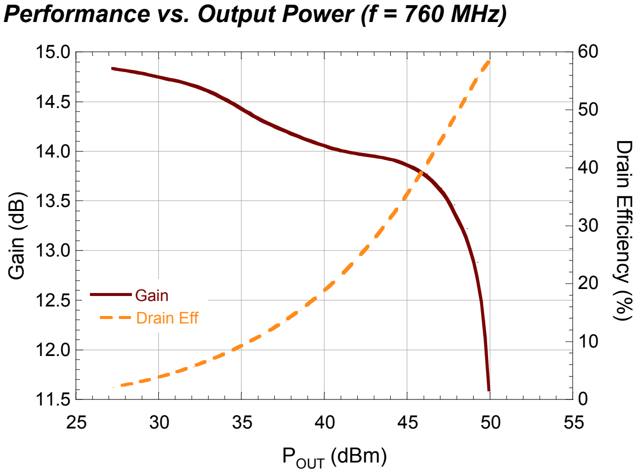
Performance vs. Frequency at P_{OUT}= P_{SAT}



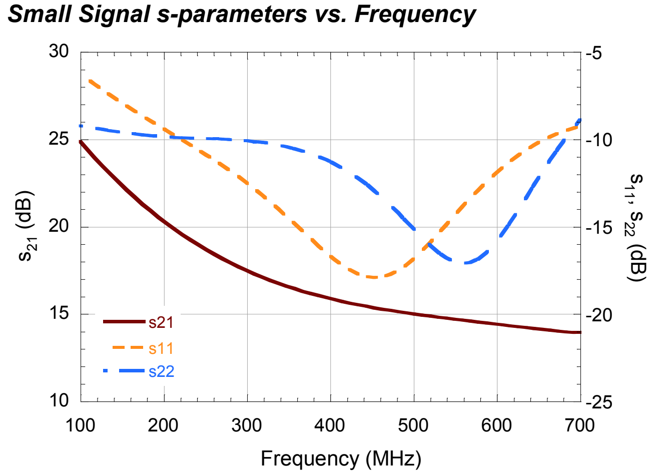
Performance vs. Frequency at P_{OUT} = 49 dBm



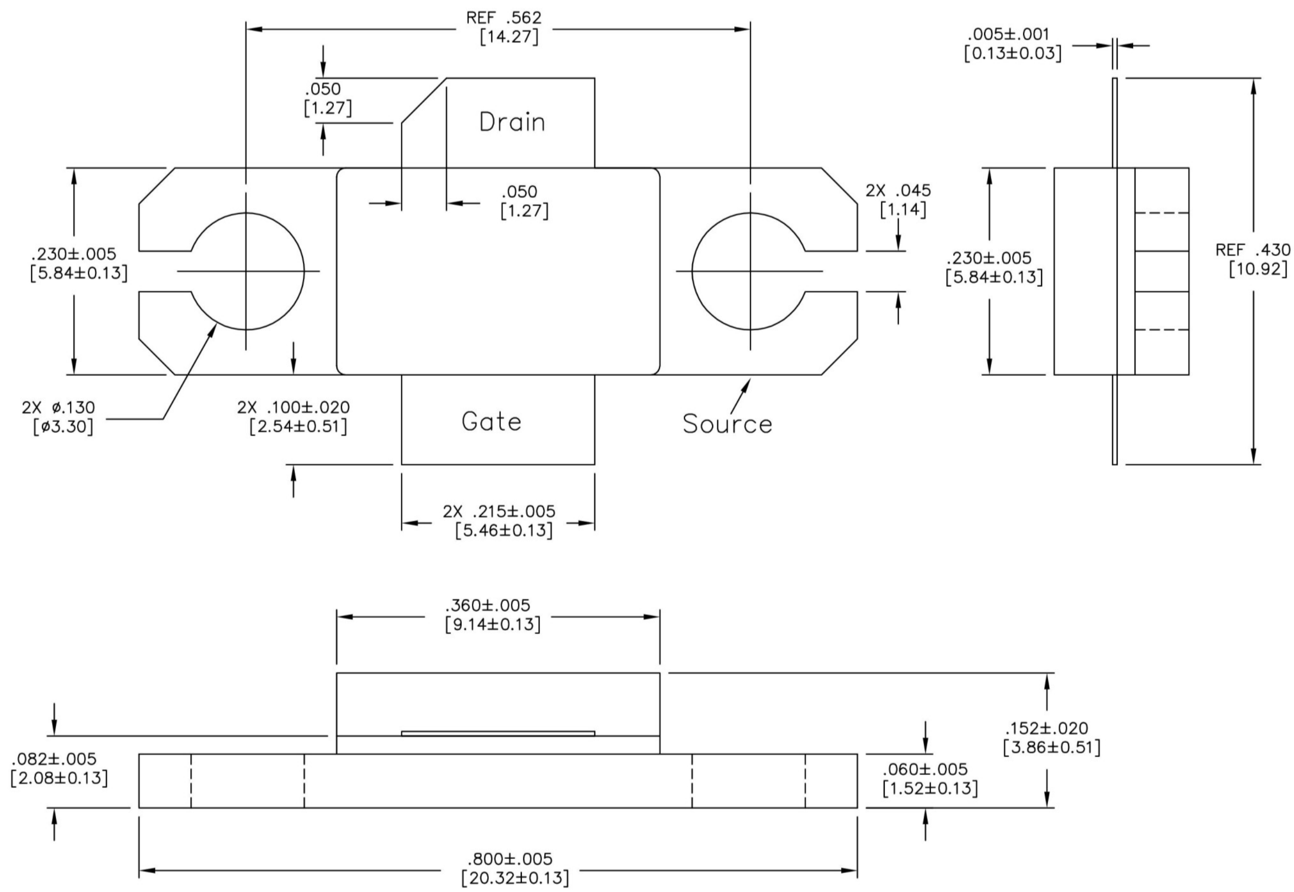
Performance vs. Output Power (f = 760 MHz)



Small Signal s-parameters vs. Frequency



AC360B-2 Metal-Ceramic Package



All dimensions shown as inches [millimeters].

† Plating is Ni / Au.