High Power Switch with Integrated Bias Controller 30 MHz - 6 GHz

Features

- Broadband Performance
- Low Loss:
  TX = 0.3 dB @ 2.7 GHz
  RX = 0.4 dB @ 2.7 GHz
- High Isolation:
  RX = 43 dB @ 2.7 GHz
- Up to 125 W CW Power Handling @ +85ºC
- Fast Switching Speed 350 ns
- Single +5 V DC Supply
- Compatible with 1.8 V and 3.3 V logic
- Lead-Free 5 mm 20-Lead HQFN Package
- RoHS* Compliant
- Suitable for High Power TDD-LTE applications

Applications

- TD-LTE Base Stations

Description

The MAMF-011070 is a high power broadband PIN diode SPDT switch with a 5 V power management chip designed for 30 MHz to 6 GHz high power applications.

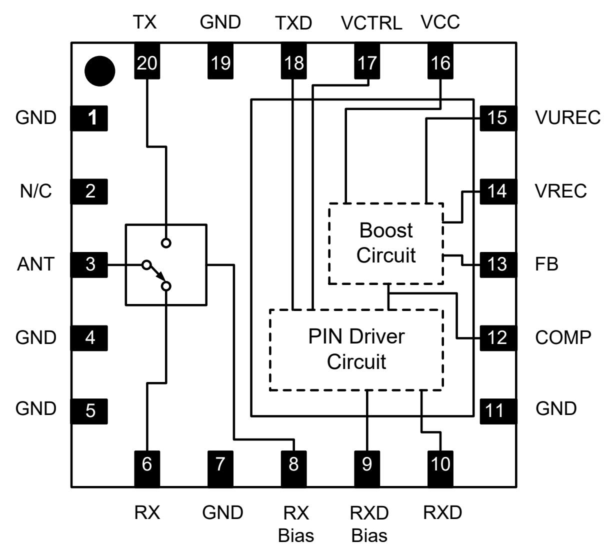
The device features low insertion loss, high isolation with low DC power consumption. It has an integrated bias controller utilizing a boost circuit. This switch requires only a single 5 V supply, and a single TX / RX control signal that is compatible with 1.8 V or 3.3 V logic.

Ordering Information[1,2]

Part Number	Package
MAMF-011070-TR3000	3000 Piece Reel
MAMF-011070-TR1000	1000 Piece Reel
MAMF-011070-001SMB	Sample Board

1. Reference Application Note M513 for reel size information.
2. Sample board includes 4 loose parts.

Functional Schematic



Pin Configuration[3]

Pin #	Pin Name	Function
1, 4, 5, 7, 11, 19	GND	Ground
2	N/C	No Connection[4]
3	ANT	RF Input
6	RX	RX Output/Series Bias
8	RX BIAS	RX Shunt Bias
9	RXD BIAS	RX Shunt Driver Output
10	RXD	RX Series Driver Output
12	COMP	DC-DC Comp
13	FB	DC-DC Feedback
14	VREC	DC-DC Boost Voltage
15	VUREC	DC-DC VUREC
16	VCC	5 V Supply
17	VCTRL	T/R Logic Control
18	TXD	TX Driver Output
20	TX	TX Output/Bias
21	Paddle	Ground[5]

3. MACOM recommends connecting unused package pins to ground.
4. Pin 2 may be connected to the ANT trace on a PCB without affecting the performance.
5. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

Electrical Specifications: Freq. = 2.7 GHz, T_A = +25°C, V_{CC} = 4.5 V, Z_0 = 50 Ω, TX mode: ANT to TX ON, V_{CTRL} = 1.2 V, V_{CC} Current = 170 mA[6]; RX mode: ANT to RX ON, V_{CTRL} = 0.6 V, V_{CC} Current = 100 mA[6]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	ANT to TX ON ANT to RX ON	dB	—	0.3 0.4	0.6 0.8
Isolation	ANT to RX (TX mode) ANT to TX (RX mode)	dB	37 —	43 15	—
ANT Input Return Loss	ANT to RX ON ANT to TX ON	dB	—	25 22	—
TX Output Return Loss	ANT to TX ON	dB	—	21	—
RX Output Return Loss	ANT to RX ON	dB	—	25	—
Input P-0.1 dB	ANT to TX ON @ VSWR = 1.2:1	dBm	—	50.5	—
IIP3 TX mode	ANT to TX, P_{IN} = 30 dBm	dBm	—	68	—
IIP3 RX mode	ANT to RX, P_{IN} = 30 dBm	dBm	—	68.5	—
RF Input Power C.W. ANT to TX ON	85°C @ 1.8, 2.7, 3.5 GHz; VSWR < 1.2:1 100°C @ 1.8, 2.7, 3.5 GHz; VSWR < 1.2:1 120°C @ 1.8, 2.7, 3.5 GHz; VSWR < 1.2:1	dBm / W	—	51.0 / 125 50.0 / 100 45.5 / 35	—
Switching Speed TX ON T_{RISE} T_{FALL}	DC ctrl Pulse Rate = 500 KHz, PW = 1 µs 10% to 90% RF 90% to 10% RF	ns	—	230 190	—
Switching Speed TX ON T_{ON} T_{OFF}	DC ctrl Pulse Rate = 500 KHz, PW = 1 µs 50% VCTRL to 90% RF 50% VCTRL to 10% RF	ns	—	350 310	—
Switching Speed RX ON T_{RISE} T_{FALL}	DC ctrl Pulse Rate = 500 KHz, PW = 1 µs 10% to 90% RF 90% to 10% RF	ns	—	170 90	—
Switching Speed RX ON T_{ON} T_{OFF}	DC ctrl Pulse Rate = 500 KHz, PW = 1 µs 50% VCTRL to 90% RF 50% VCTRL to 10% RF	ns	—	340 210	—
Group Delay	—	ns	—	50	—
In-band Ripple	20 MHz 200 MHz	dB	—	0.05 0.1	—

6. The average current is set with external resistors: R1, R2, R3, and R4 as shown in the sample board schematic. The resistor values can be adjusted higher to reduce the V_{CC} average current.

Maximum Operating Conditions

Parameter	Operating Maximum
RF Input Power C.W.	51 dBm @ +85°C, 3.5 GHz, VSWR = 1.2:1
V_{CC}	4.5 V to 5.5 V
Junction Temperature[7] Switch	+175°C
Junction Temperature[8,9] Integrated Bias Controller	+125°C
Case (Paddle) Temperature	-40°C to +120°C
Storage Temperature	-55°C to +150°C

7. Operating at nominal conditions with $T_J \leq +175°C$ will ensure MTTF > 1 x 10^6 hours.
8. Operating at nominal conditions with $T_J \leq +125°C$ will ensure MTTF > 1 x 10^5 hours.
9. Absolute maximum junction temperature of 150°C; exceeding this temperature may cause permanent damage to the device. MACOM does not recommend sustained operation near this temperature.

Truth Table

ANT – TX	ANT – RX	VCTRL
ON	OFF	HIGH (1.2 - 3.6 V)
OFF	ON	LOW (0 - 0.6 V)

Handling Procedures

Please observe the following precautions to avoid damage:

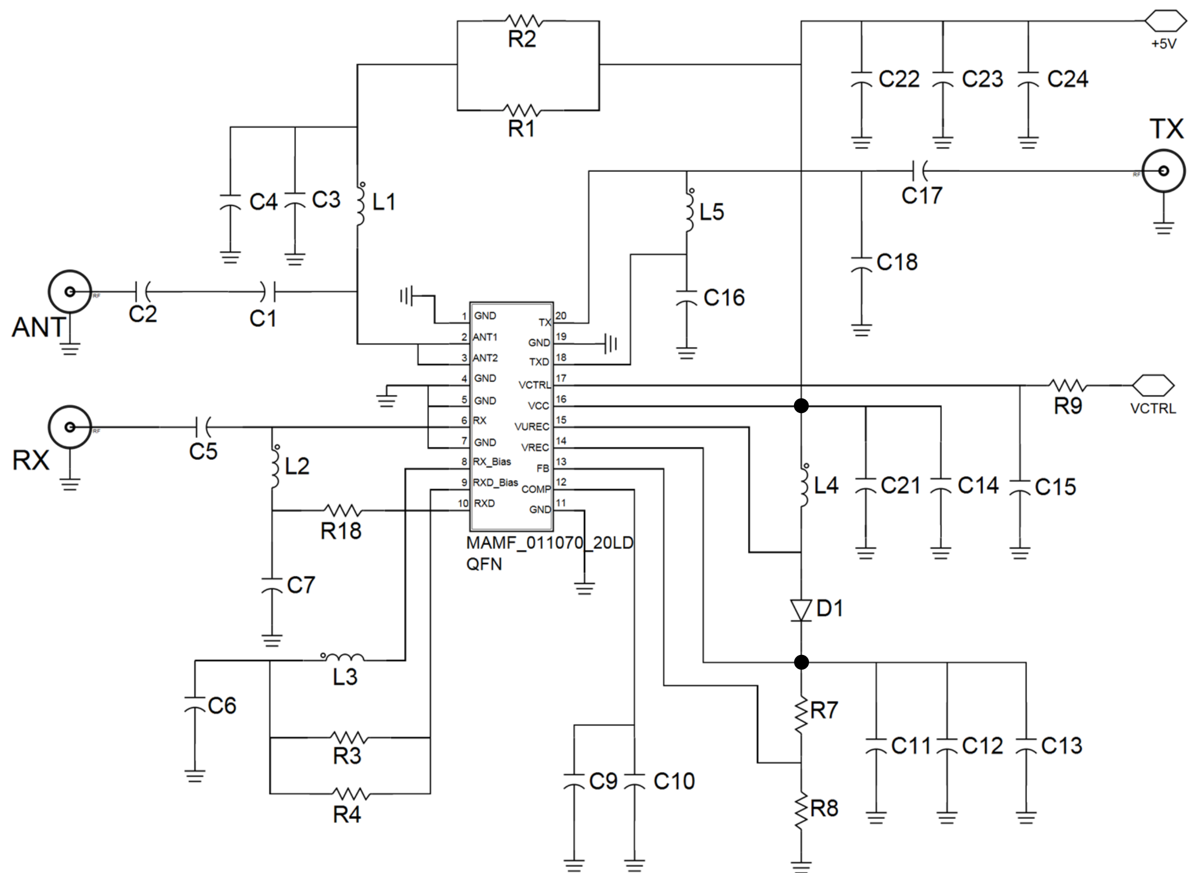
Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

Parameter	Rating	Standard
Human Body Model (HBM)	500 V (Class 1B)	ESDA / JEDEC JS-001
Charged Device Model (CDM)	1500 V (Class C3)	JEDEC JESD22-C101
IC Latch-up Test	Class II	JEDEC JESD78

Application Schematic

NOTE: Contact factory for sample board layout including considerations for thermal dissipation through the PCB.



Switch Biasing Information

R1 and R2 are used to set the forward bias current (I_F) of the TX or the RX series diode. The I_F controls the Insertion Loss of the ANT to TX or ANT to RX path respectively.
For R1 = R2 = 69.8 Ω the I_F = 0.1 A
R1 = R2 = 2 * (VCC - 1.52 V) / I_F.
R1 & R2 must meet the following power requirement:
$P_{R1/2} > (0.5 * I_F)^2 * R1$

R3 and R4 are used to set the forward bias current (I_{FShD}) in the RX shunt diode of the switch. The I_{FShD} controls the RX isolation.
For R3 = R4 = 3.6 kΩ the I_{FShD} = 0.01 A
R3 = R4 = 2* (18 V) / I_F
These resistors must meet the following power requirement: $P_{R3/4} > (0.5 * I_{FShD})^2 * R3$

Boost Biasing Information

D1 diode requirements: VB = 40 V, Forward Current = 200 mA, Forward Surge Current = 750 mA

During boost period, VUREC (Pin 15) transient peak voltage and current can be as high as 24 V and 750 mA. Use recommend components from Parts List for proper current handling.

R7 and R8 are a resistive divider used to set the boost voltage. Use recommended components from Parts List for proper boost performance.

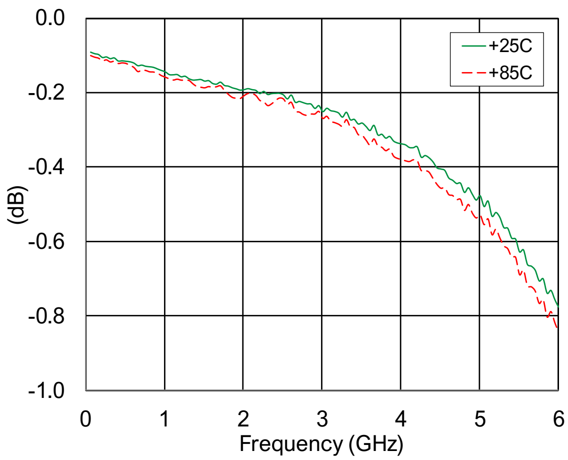
Parts List[10]

Component ID	Value	Package	Part Number	Manufacturer	Spec
MAMF-011070	—	HQFN-20LD 5 mm	MAMF-011070	MACOM	—
L1, L2	33 nH	1 x 0.5 mm	LQW15AN33NJ8ZD	Murata	620mA/125ºC
L3, L5	10 nH	1.6 x 0.8 mm	LQW18AN10NG00D	Murata	650mA/10nH
L4	10 µH	2.5 x 2 mm	IFSC1008ABER100M01	Vishay	750mA/0.41Ω
C1, C2, C17	10 pF	0505	800A100JT250X	ATC	250V/125ºC
C3, C7, C16	1 nF	0603	—	—	50V/125ºC
C4	1 µF	0805	CL21B105KBFNNNG	Samsung Electro-Mechanics	50V/125ºC
C5	5.6 pF	0603	600S5R6AT250XT	ATC	250V/125ºC
C6	100 pF	0603	—	—	250V/125ºC
C9, C13	2.2 µF	1210	—	—	35V/125ºC
C10	470 pF	0402	—	—	50V/125ºC
C11	100 nF	0805	—	—	50V/125ºC
C12	10 nF	0805	—	—	50V/125ºC
C14, C24	10 µF	0603	—	—	10V/125ºC
C15	10 pF	0402	—	—	50V/125ºC
C18	0.3 pF	0603	600S0R3AT250XT	ATC	250V/±0.05pF/125ºC
C21, C22, C23	10 nF	0603	—	—	50V/125ºC
R1, R2	69.8 Ω	1206	—	—	0.25W/0.1%/155ºC
R3, R4	3.6 KΩ	0603	—	—	0.2W/0.1%/155ºC
R18	0 Ω	0402	—	—	125ºC
R7	1.6 MΩ	0402	—	—	0.063W/1%/155ºC
R8	115 KΩ	0402	—	—	0.063W/1%/155ºC
R9	100 Ω	0402	—	—	125ºC
D1	—	SOT23-3	CMPSH-3CE TR	Central Semiconductor	750mA/40V/155ºC
ANT, RX, TX	RF CONN	SMA	142-0761-821	Cinch Connectivity Solutions	—
DC CONN	DC CONN	10PIN	—	—	10 pin header

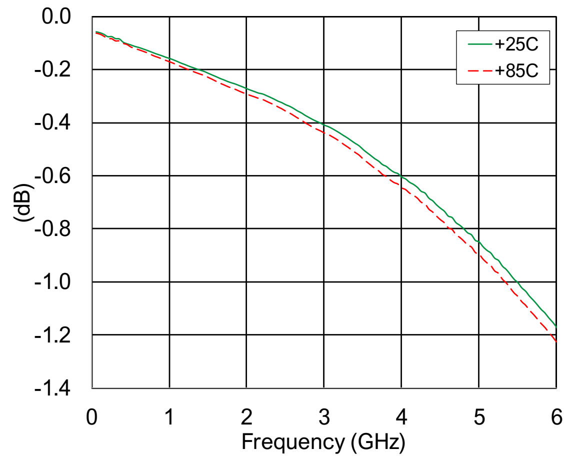
10. MACOM datasheet performance was captured using components from manufacturers shown. These parts are critical to meet specified performance. All other parts must meet ratings specified but do not have specific manufacturer recommendations.

Typical Performance Curves - Probed on the Sample Board (no PCB Bias Components)

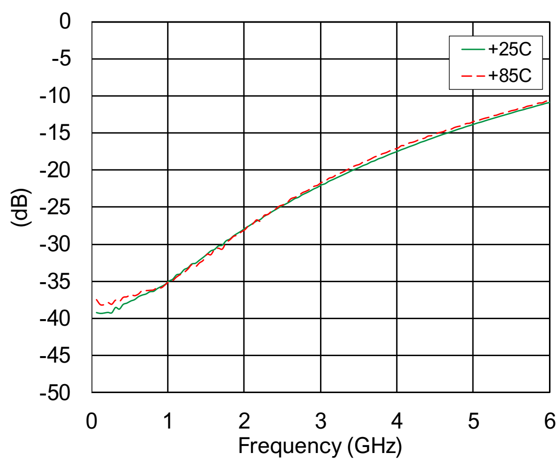
ANT to TX Insertion Loss



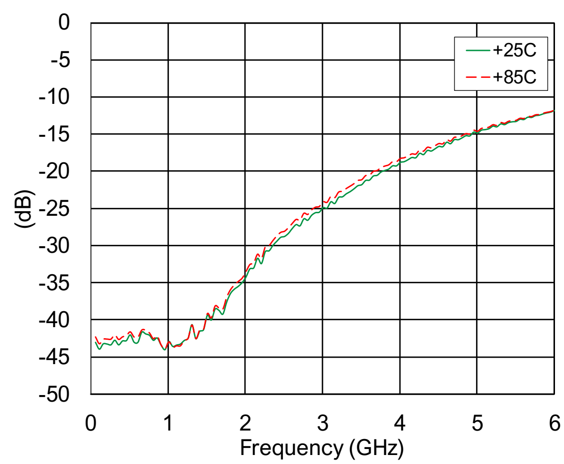
ANT to RX Insertion Loss



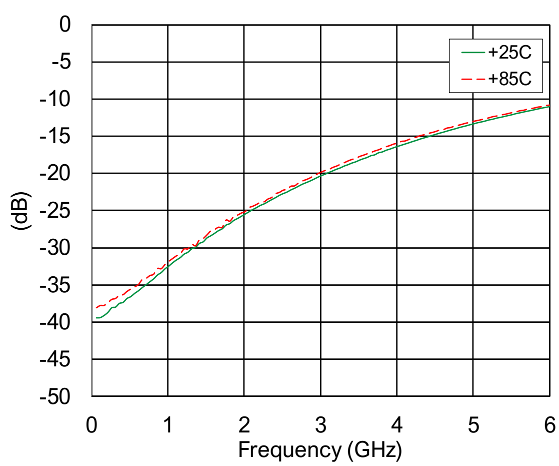
ANT Return Loss in TX ON state



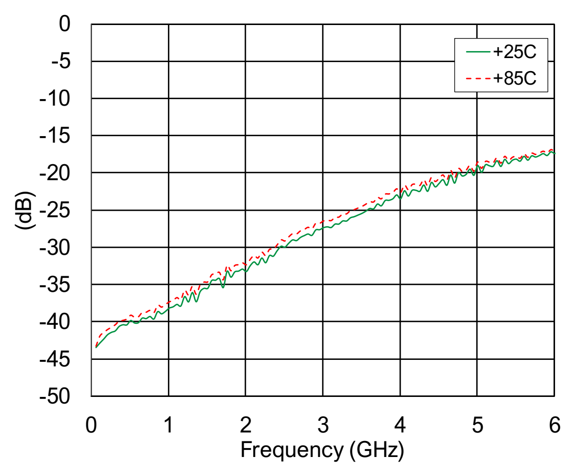
ANT Return Loss in RX ON state



TX Return Loss in TX ON state

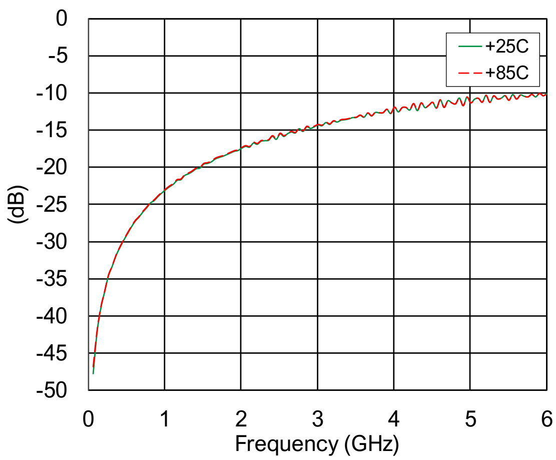


RX Return Loss in RX ON state

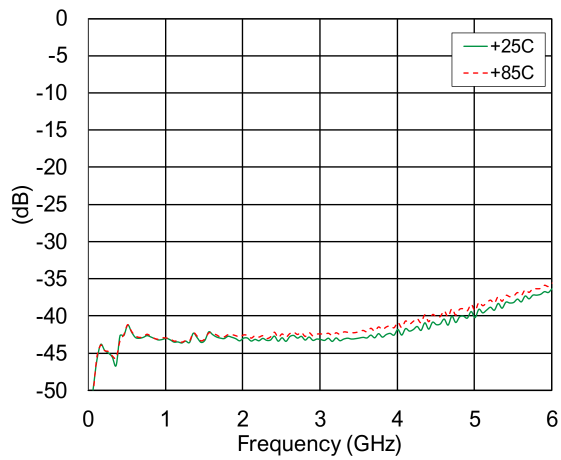


Typical Performance Curves - Probed on the Sample Board (no PCB Bias Components)

ANT to TX Isolation

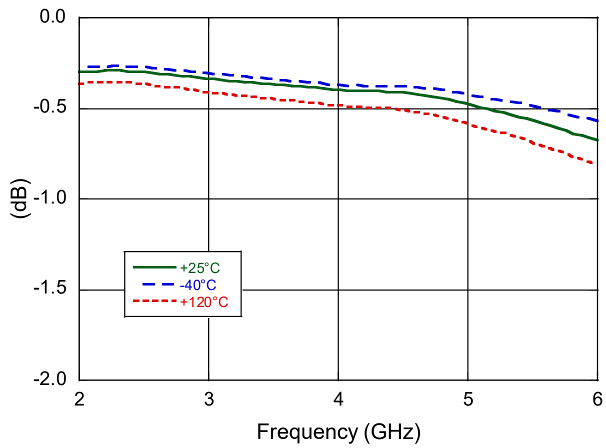


ANT to RX Insertion

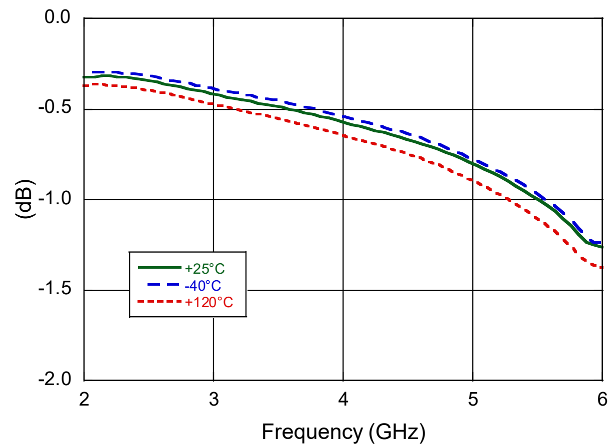


Typical Performance Curves on the Sample Board optimized for 2 - 6 GHz performance

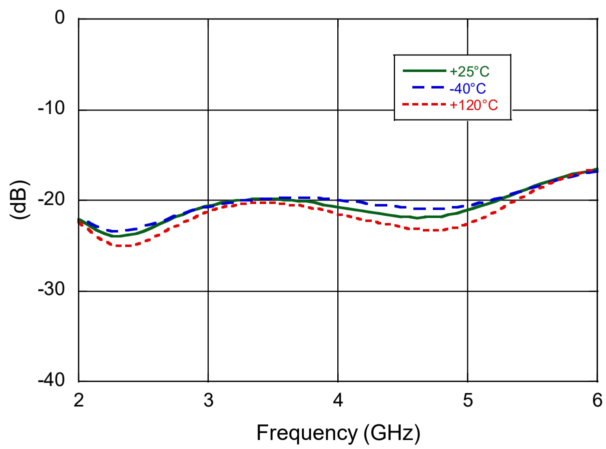
ANT to TX Insertion Loss (PCB loss de-embedded)



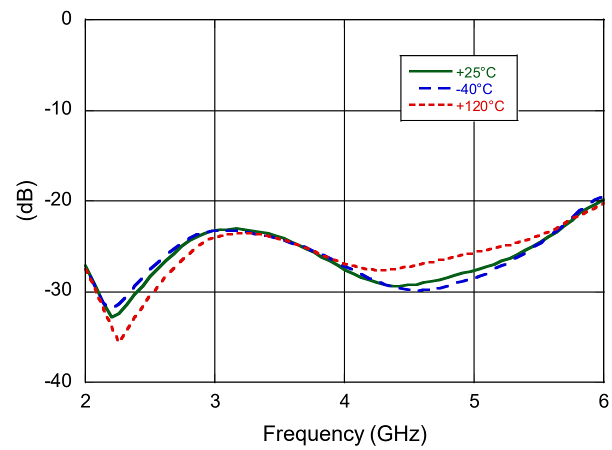
ANT to RX Insertion (PCB loss de-embedded)



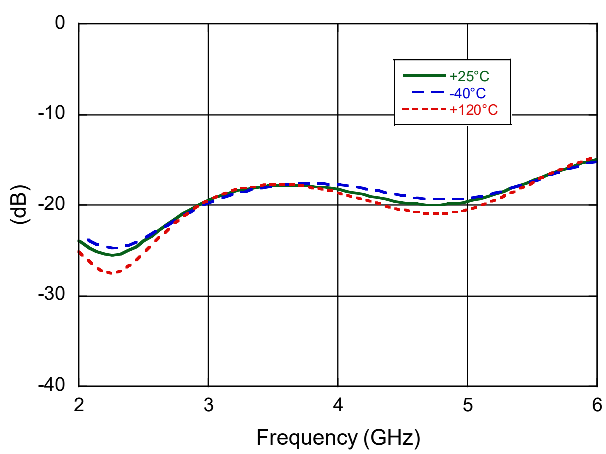
ANT Return Loss in TX ON state



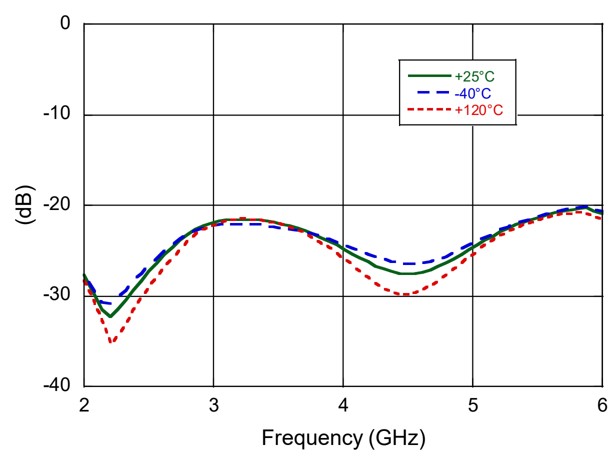
ANT Return Loss in RX ON state



TX Return Loss in TX ON state

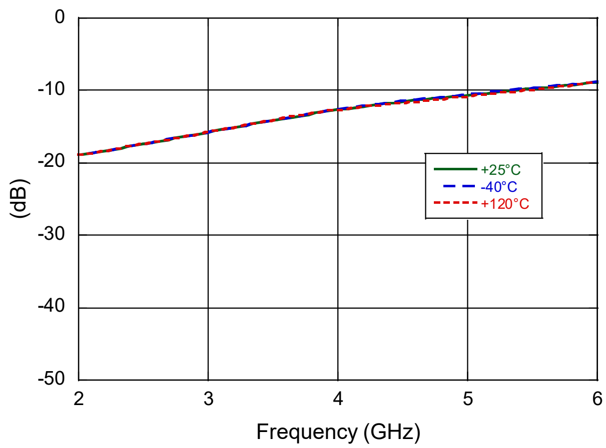


RX Return Loss in RX ON state

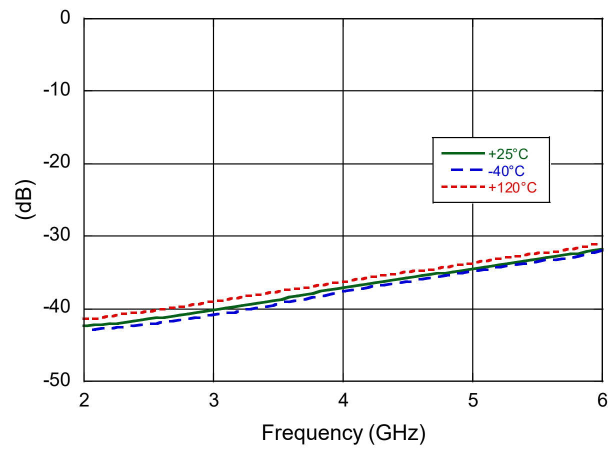


Typical Performance Curves on the Sample Board optimized for 2 - 6 GHz performance

ANT to TX Isolation

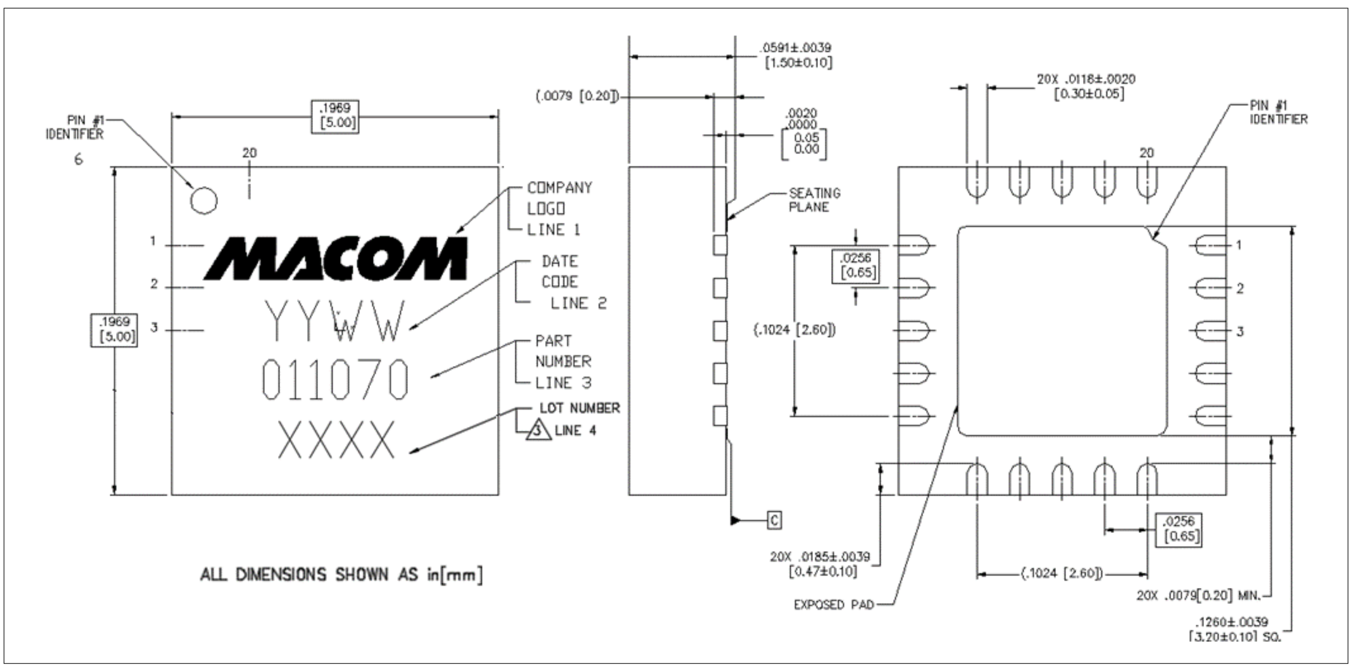


ANT to RX Isolation[10]



10. ANT to RX isolation has strong dependence on board layout.

Lead-Free 5 mm 20-Lead HQFN†



† Reference Application Note M538 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is NiPdAuAg