Voltage Variable Attenuator, 31 dB
0.6 - 60 GHz

Features

- Attenuation Range: 31 dB
- Analog Control
- Insertion Loss: 3 dB
- Input IP3: 42 dBm
- Supply Voltage: 5 V
- Low DC Power Consumption
- Lead-Free 3 mm 20-Lead Package
- RoHS* Compliant

Applications

- ISM/MM

Description

The MAAV-011016 is a wide band voltage variable attenuator with analog control. It is assembled in a lead-free 3 mm, 20 lead laminate package. This device is ideally suited for use where high accuracy, very low power consumption, and low intermodulation products are required.

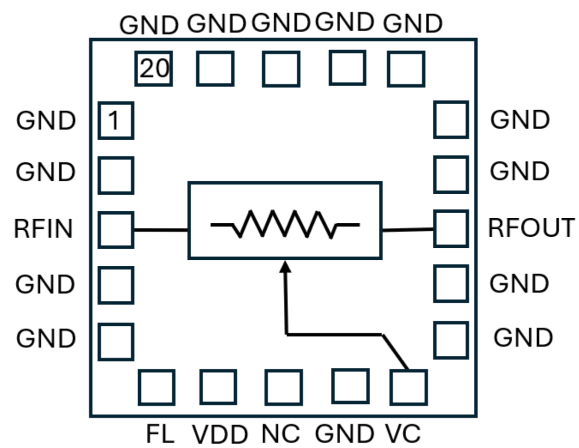
No external DC blocks on RF pins are needed.

Ordering Information[1,2]

Part Number	Package
MAAV-011016-TR0500	500 pc Tape & Reel
MAAV-011016-TR3000	3000 pc Tape & Reel
MAAV-011016-SMB	Sample Board

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

Block Diagram



Pin Configuration[3,4]

Pin #	Pin Name	Function
1,2,4,5,9,11,12,14-20	GND	Ground
3	RF_{IN}	RF Input
13	RF_{OUT}	RF Output
10	V_C	Control Voltage
7	V_{DD}	Supply Voltage
8	NC	Non Connect
6	FL	Reference Filter

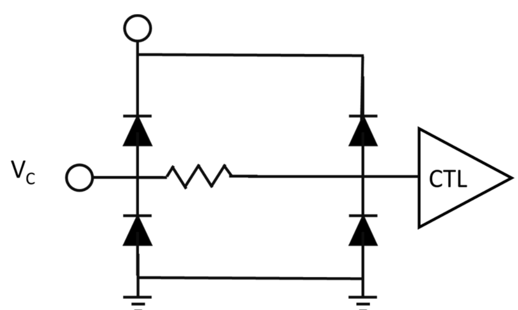
3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

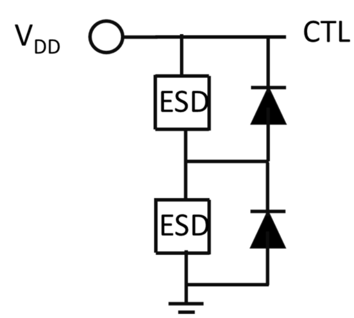
* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

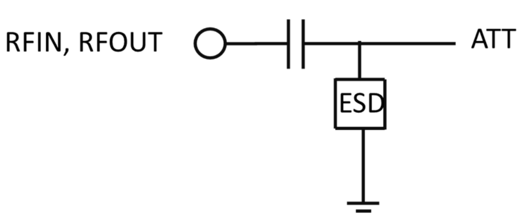
Pin Description

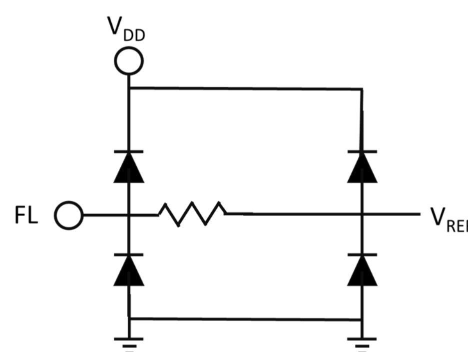
Pin #	Name	Description
1,2,4,5,9,11, 12,14-20	GND	Ground these pins. They are also internally grounded.
3	RF_{IN}	RF 50 Ohm input. DC blocked internally. Limit DC voltage to -4 V to +6 V.
13	RF_{OUT}	RF 50 Ohm output. DC blocked internally. Limit DC voltage to -4 V to +6 V.
10	V_C	Control voltage for attenuation change. Standard diode ESD protection at the input. An external RC low pass filter is recommended to reduce noise.
7	V_{DD}	5V supply voltage. Bypass with 1nF close to the pin.
8	NC	Not connected internally but we recommend grounding.
6	FL	Add optional capacitor to ground to filter the reference voltage noise. This can reduce AM noise around the carrier.
	E_P	Exposed paddle. This is where our reference case temperature is measured. Ground with as many vias as practical for electrical and thermal performance (see sample board layout)[1]

Interface schematics









RF Electrical Specifications:
Freq. = 30 GHz, T_C = 25°C, Z_0 = 50 Ω, V_{DD} = +5 V, V_C = +2.5 V, P_{IN} = 0 dBm (small signal)

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss[5]	2 GHz 10 GHz 30 GHz 50 GHz	dB	—	2.0 2.6 3.5 4.5	3.5 4.1 5.0 7.0
Maximum Attenuation (relative to IL state)	2 GHz 10 GHz 30 GHz 50 GHz	dB	27.5 28.0 28.5 33.0	30.0 30.0 30.5 35.5	32.0 32.5 33.0 42.0
Mid-VC Attenuation (relative to IL state)	VC = 1.3 V 2 GHz 10 GHz 30 GHz 50 GHz	dB	10.5 10.8 11.0 13.5	12.0 12.5 13.0 15.5	14.5 14.8 15.5 18.0
Input Return Loss	Full control voltage range	dB	—	15	—
Output Return Loss	Full control voltage range	dB	—	15	—
Input P1dB[6]	All V_C values	dBm	—	33 ±1	—
IIP_3	10 dBm/tone, 50 MHz Spacing (Full control voltage range)	dBm	—	42 ±4	—
IIP_2	10 dBm/tone, 50 MHz Spacing, F1+F2 (Full control voltage range)	dBm	—	78 ±15	—
Settling Time[7]	50% V_C to ±0.1 dB of final value, for any 1 dB change in attenuation	µs	—	1	—

5. The test board loss is removed from the measurements.
6. Reaching the P1dB point for Tc>50°C is not recommended. Keep maximum CW power below 30 dBm per the Absolute Maximum Table.
7. Valid for linear part of attenuation curve. At the V_C extremes settling time can be up to 10 µs.

DC Electrical Specifications: T_C = 25°C, V_{DD} = +5 V

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Supply Voltage	—	V	4.75	5.0	5.25
Supply Current	V_C = 2.5 V	mA	—	3	5
Control Voltage	P_{IN} V_C	V	0	—	2.5
Control Current	P_{IN} V_C, V_C = 1.3 V	µA	-1	0.1	1
Reference voltage	read voltage on pin 6 (FL)	V	—	2	—

Recommended Operating Conditions[8,9]

Parameter	Symbol	Unit	Min	Typ	Max
Input/Output RF Power F>1.7 GHz[10]	RF_{IN}, RF_{OUT}	dBm	—	—	27
RF pins DC voltage	RF_{IN}, RF_{OUT}	V	-3	—	5
Control pin DC voltage	V_C	V	0	—	2.5
DC Supply	V_{DD}	V	4.75	5.0	5.25
Junction Temperature[12]	T_J	°C	—	—	125
Operating Temperature[11]	T_C	°C	-55	—	105

Absolute Maximum Ratings[8,9]

Parameter	Symbol	Unit	Min	Max
Input/Output RF Power F>1.7 GHz[10]	RF_{IN}, RF_{OUT}	dBm	—	30
RF pins DC voltage	RF_{IN}, RF_{OUT}	V	-5	6
Control pin DC voltage	V_C	V	-0.5	4
DC Supply	V_{DD}	V	—	5.5
Junction Temperature[12]	T_J	°C	—	150
Operating Temperature[11]	T_C	°C	-55	120
Storage Temperature	T_{STG}	°C	-60	150

8. Exceeding any one or combination of these limits may cause permanent damage to this device.
9. MACOM does not recommend sustained operation near these survivability limits.
10. Derate power by 6 dB at 1 GHz.
11. Operating at nominal conditions with $T_J \leq +125°C$ will ensure MTTF > 1×10^6 hours. T_C is the exposed paddle temperature.
12. Junction Temperature (T_J) = T_C + Ѳjc * (P_{RF}/2).
    Typical thermal resistance (Ѳjc) = 150°C/W.
    a) For T_C = +25°C,
       T_J = 62.5°C @ P_{RF} = 27 dBm
    b) For T_C = +85°C,
       T_J = 122.5°C @ P_{RF} = 27 dBm

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 HBM class 1A and CDM class C5 devices.

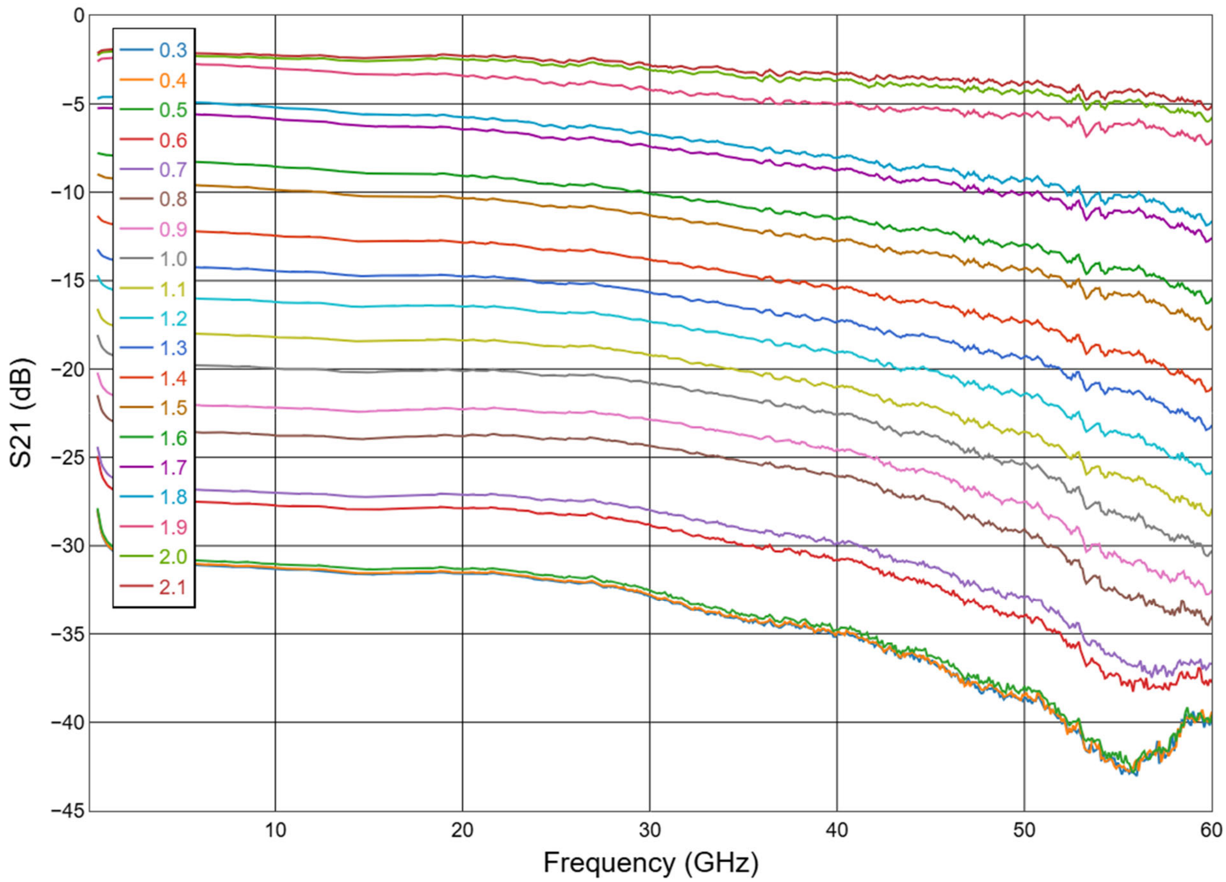
Power Supply Sequencing

Pin V_C should be 0 V when V_{DD} is ramped up or down. V_{DD} should not ramp faster than 1 V / 4 µs.

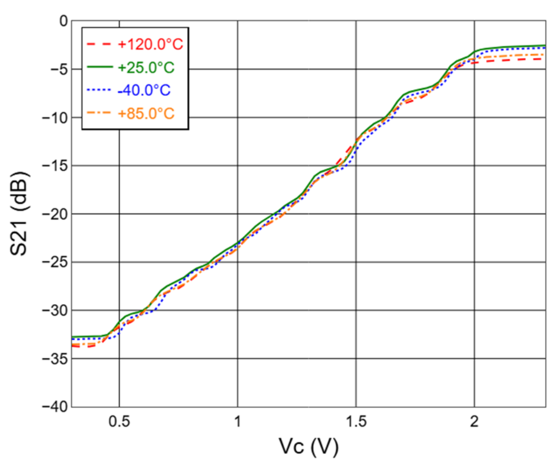
Pin V_C should be set to 0 before V_{DD} is ramped down.

Typical Performance: V_{DD} = 5 V, T_C = +25°C, V_C from 0.3 to 2.1 V, step 0.1 V 50 Ω connectors, de-embedded

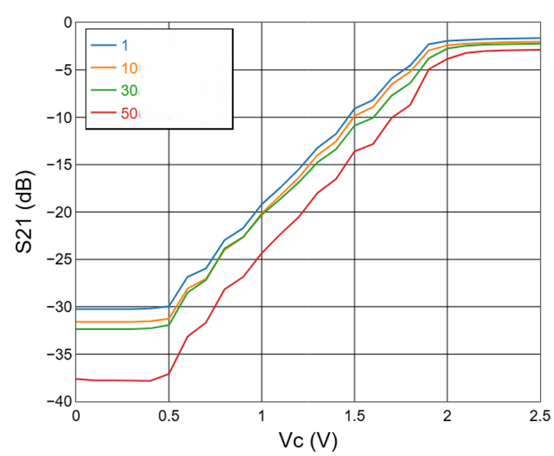
S21 vs Frequency



S21 vs Vcontrol over Temperature @ 30 GHz

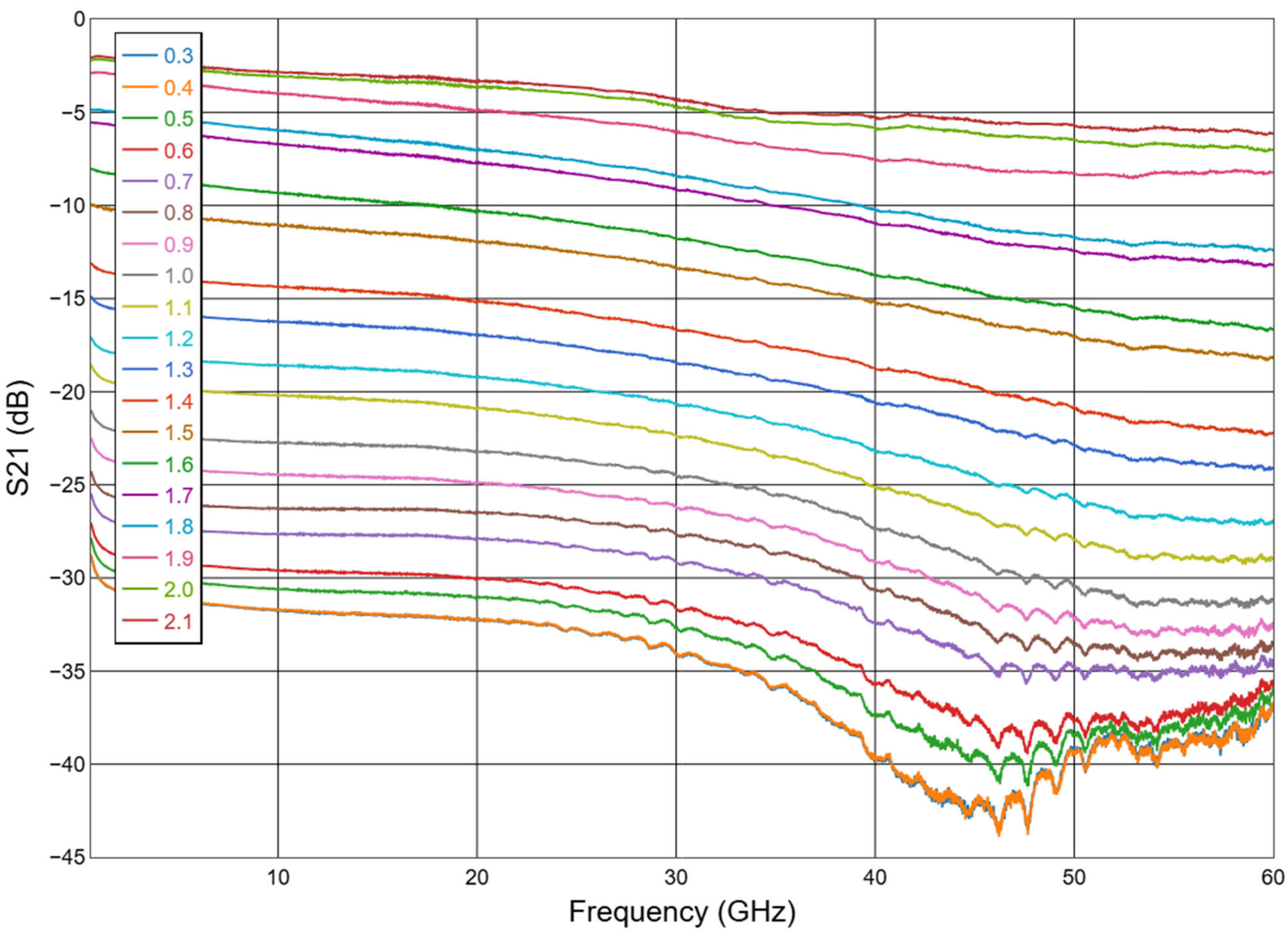


S21 vs Vcontrol @ 1,10,30 & 50 GHz



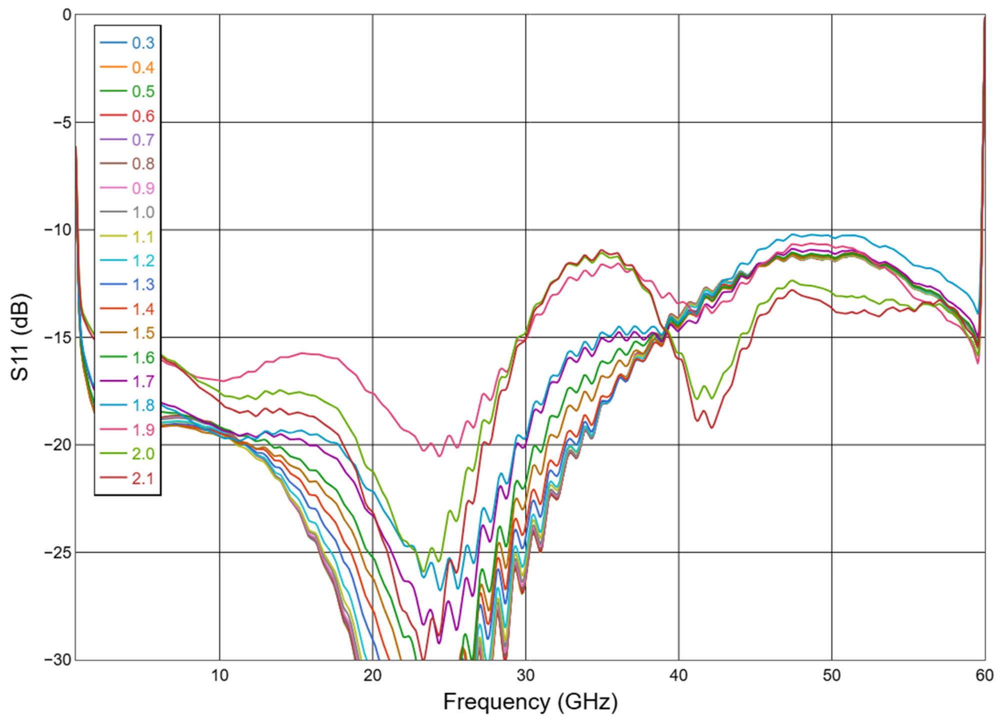
Typical Performance: V_{DD} = 5 V, T_C = +25°C, V_C from 0.3 to 2.1 V, step 0.1 V
Probed on board, not de-embedded, 0.8 mm in/out lines

S21 vs Frequency

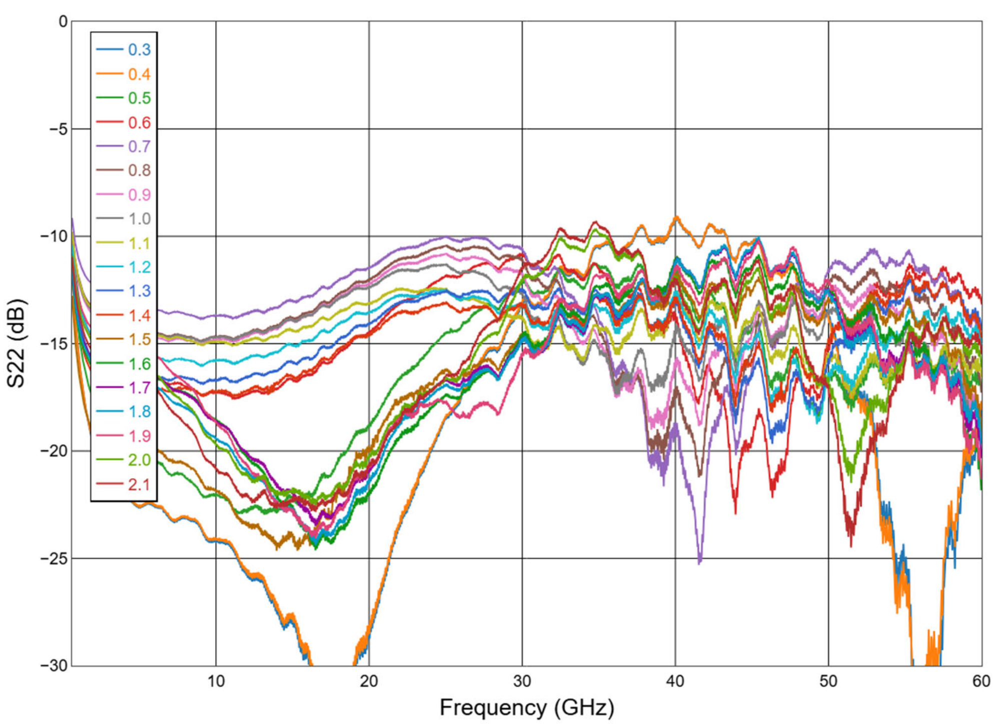


Typical Performance: V_{DD} = 5 V, T_C = +25°C, V_C from 0.3 to 2.1 V, step 0.1 V
Probed on board, not de-embedded, 0.8 mm in/out lines

Input Return Loss vs Frequency

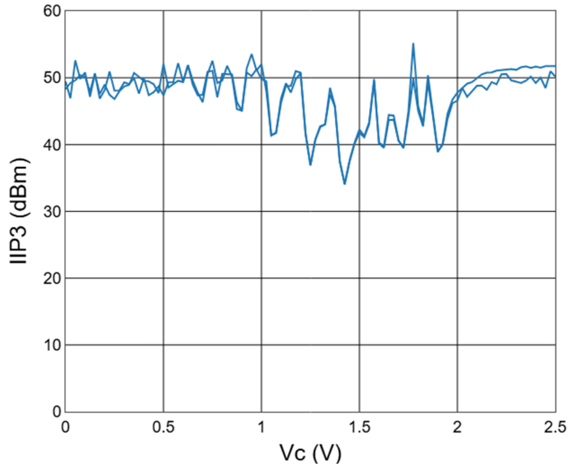


Output Return Loss vs Frequency

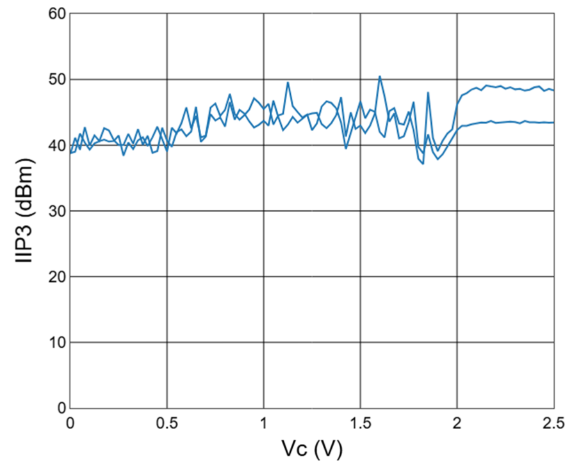


Typical Performance: de-embedded,
V_{DD} = 5 V, P_{RF} = 10 dBm/tone, 50 MHz spacing, T_C = +25°C, V_C from 0 to 2.4 V, step 0.1 V

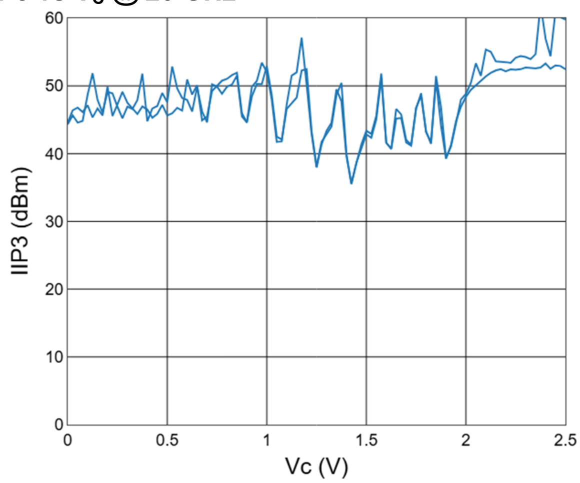
IIP3 vs V_C @ 10 GHz



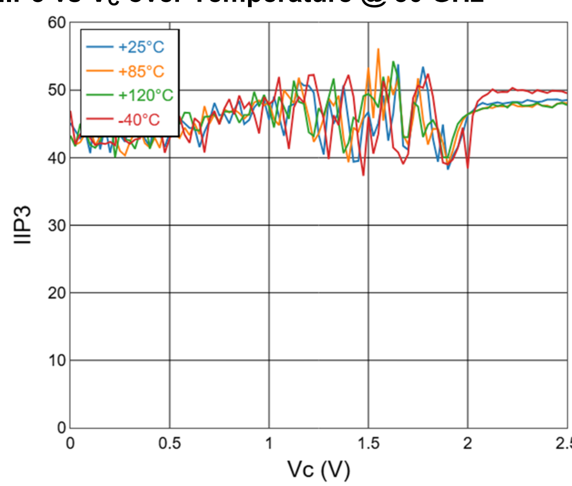
IIP3 vs V_C @ 40 GHz



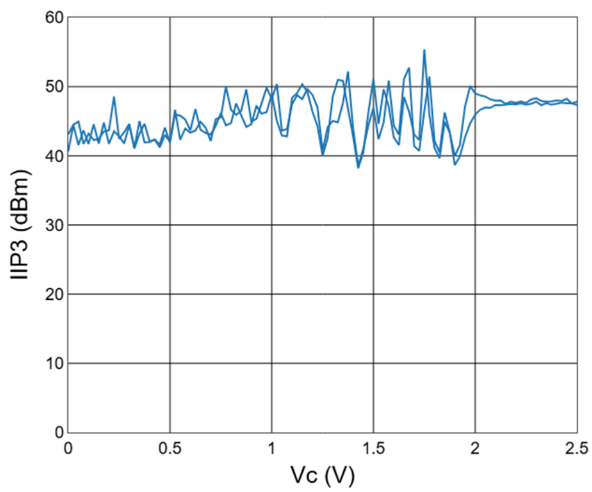
IIP3 vs V_C @ 20 GHz



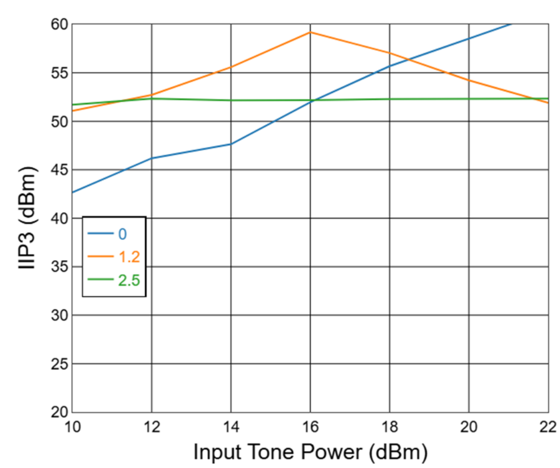
IIP3 vs V_C over Temperature @ 30 GHz



IIP3 vs V_C @ 30 GHz

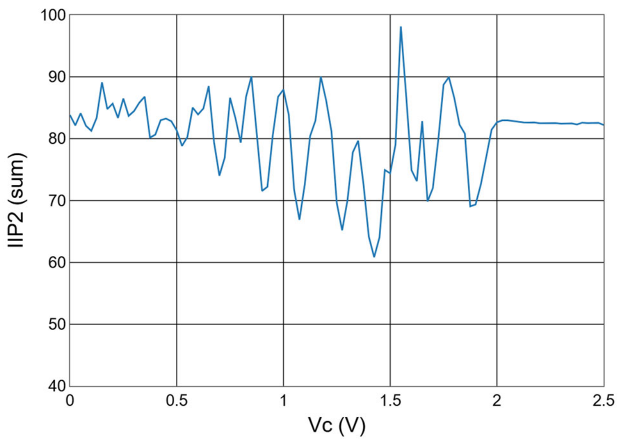


IIP3 vs Input Power @ 30 GHz, V_C = 0,1.2, 2.5 V

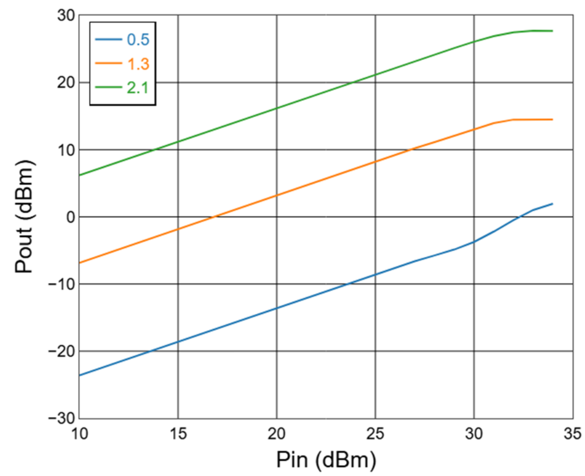


Typical Performance: de-embedded, V_{DD} = 5 V, P_{RF} = 10 dBm/tone, 50 MHz spacing, T_C = +25°C

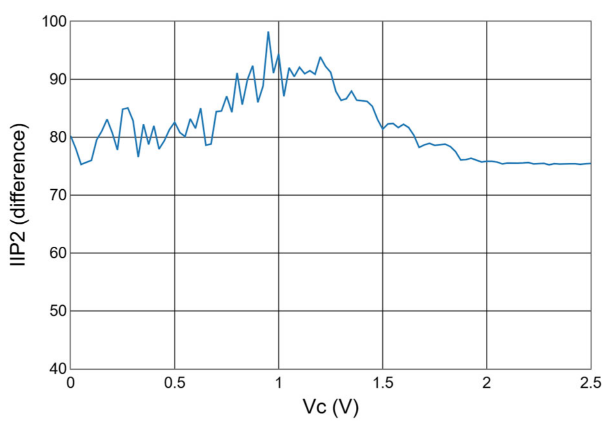
IIP2 (sum) vs V_C @ 2 GHz



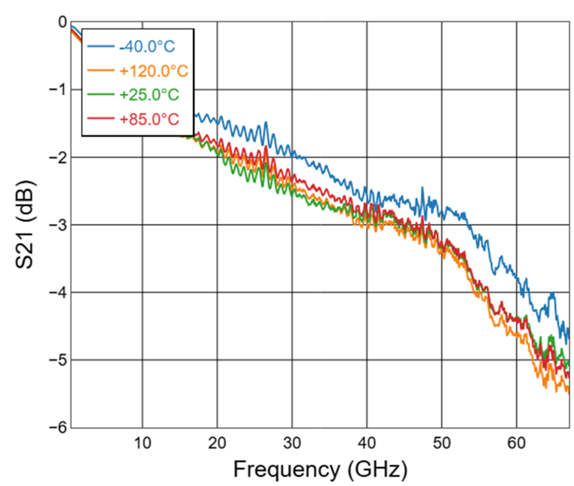
P_{OUT} vs P_{IN} @ 30 GHz, V_C = 0.5,1.3, 2.1 V



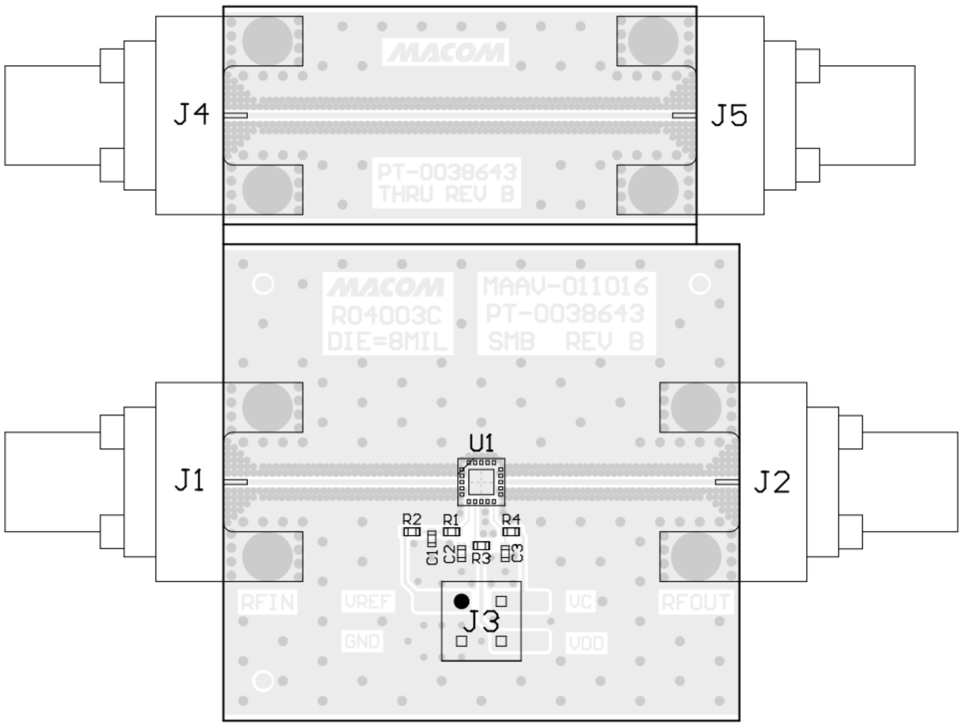
IIP2 (difference) vs V_C @ 2 GHz

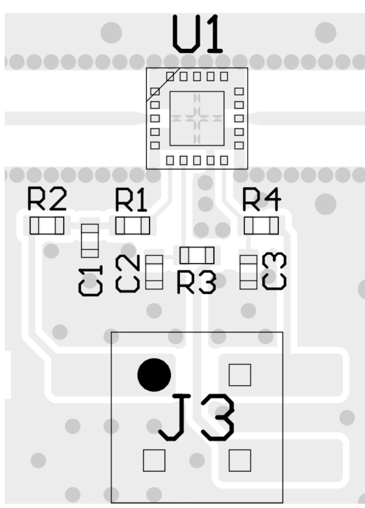


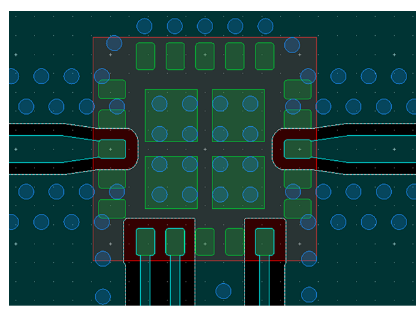
Evaluation PCB Thru Loss vs Frequency over Temperature



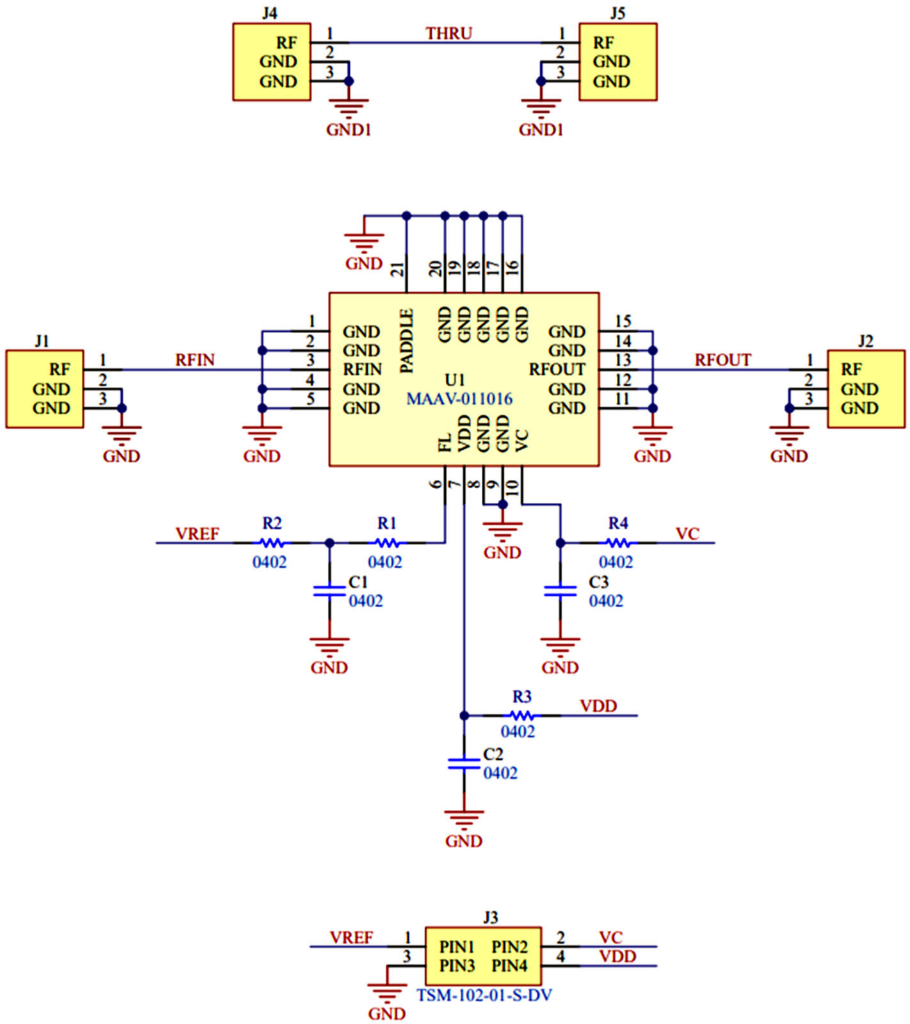
PCB Layout


J4
J5
MACOM
PT-0038643
THRU REV B
MACOM
RO4003C
DIE=8MIL
MAAV-011016
PT-0038643
SMB REV B
J1
J2
U1
R2
R1
R4
C1
C2
R3
C3
RFIN
VREF
VC
RFOUT
J3
GND
VDD


U1
R2
R1
R4
C1
C2
R3
C3
J3



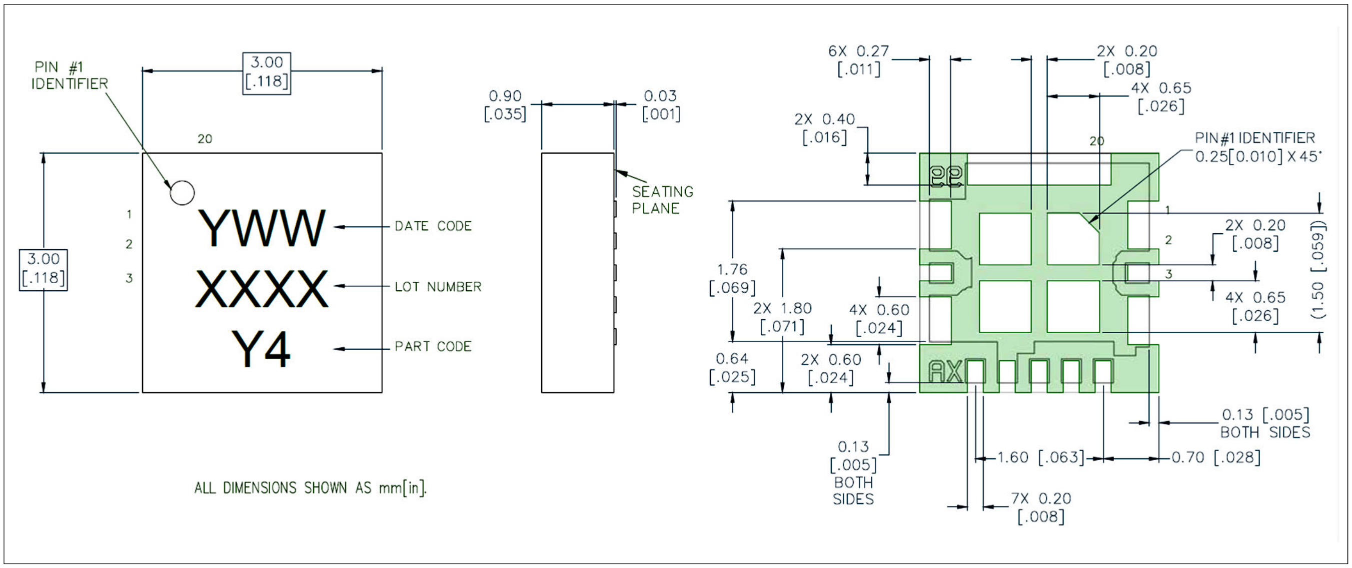
Application Schematic



Parts List

Part	Value	Case Style
C1	1 nF	0402
C2	100 µF	0402
C3	200 pF	0402
R1	100 Ω	0402
R2, R4	1000 Ω	0402
R3	20 Ω	0402
J1,J2	2.4 mm	SW 1492-02A

Lead-Free 3mm 20-Lead Laminate†



† Reference Application Note S2083 lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.
Plating is ENEPIG.

Revision History

Rev	Date	Change Description
V1	12/19/2025	Release to production