Ka-Band High Power Terminated SPDT PIN Switch with Integrated Driver, 20 - 44 GHz

MAMF-011146
Rev. V2

Features

- Broadband Performance, 20 to 44 GHz
- Low Loss <1.0 dB
- High Isolation >34 dB
- Up to 13 W CW Power, +85°C
- 23 dBm Power Handling in Terminated Port
- TTL Compatible Driver
- -20 V to -50 V Back Bias
- 25 mA Sinking / Sourcing Current
- Quiescent Currents <1 mA
- Lead-Free 5 x 4 mm PQFN package
- RoHS* Compliant

Applications

- 5G
- Point-to-Point
- Radar
- Radiometers
- Test & Instrumentation
- High Frequency Applications

Description

The MAMF-011146 is a high power SPDT PIN diode switch with integrated driver in 5 x 4 mm PQFN package. This broadband, high linearity, SPDT switch with 50 Ω terminated RF ports was developed for Ka–Band applications that require up to 13 W CW power handling at an environmental temperature of +85°C while maintaining low insertion loss and high isolation.

The SPDT MMIC utilizes MACOM's proven AlGaAs PIN diode technology.

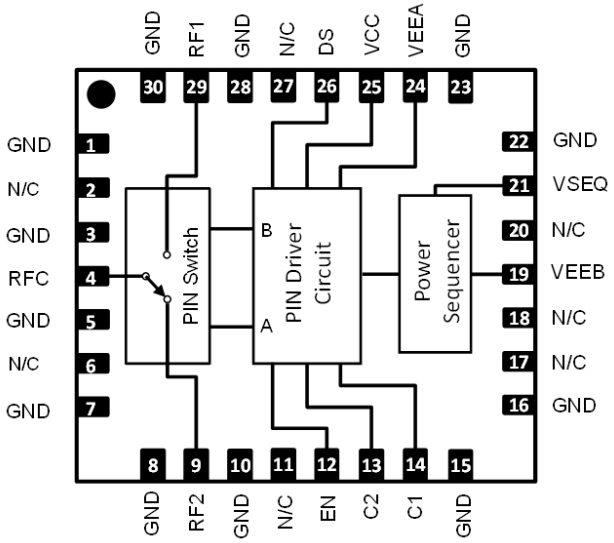
The included driver utilize MACOM developed PIN diode driver MADR-011020 and has all characteristic of this driver.

Ordering Information[1]

Part Number	Package
MAMF-011146-TR0500	500 piece reel
MAMF-011146-SMB	Sample Board

1. All sample boards include 5 loose parts.

Functional Schematic



Pin Configuration[2]

Pin #	Function	Description
1, 3, 5, 7,	GND	Ground
2, 6, 11, 17,	N/C	No Connection
4	RFC	RF Common Port
9	RF2	Terminated RF Port 2
12	EN	Enable
13	C1	Logic Control Input
14	C2	Logic Control Input
19	VEEB	Negative Sequencer Bias
21	VSEQ	Power Sequencer Output
24	VEEA	Negative Driver Bias
25	VCC	Positive Bias
26	DS	Driver Select
29	RF1	Terminated RF Port 1
31	Paddle[3]	RF, DC & Thermal Ground

2. MACOM recommends connecting unused package pins to ground.
3. 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. = 20 - 44 GHz, T_A = 25°C, V_{CC} = +5 V @ 34 mA / -20 V @ 0 mA, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	21 - 35 GHz 35 - 41 GHz	dB	—	1.0 1.3	1.7 —
Isolation[4]	21 - 35 GHz 35 - 41 GHz	dB	—	39 36	-32 —
Input / Output Return Loss On state	21 - 35 GHz 35 - 41 GHz	dB	—	15 15	—
RF1, 2 Return Loss, Off state	21 - 35 GHz 35 - 41 GHz	dB	—	10 15	—
Switching Speed-T_{ON}	50% DC to 90% RF	ns	—	49	—
Switching Speed-T_{OFF}	50% DC to 10% RF	ns	—	55	—
Rise Time -T_{RISE}	10% to 90% RF	ns	—	9	—
Fall Time - T_{FALL}	90% to 10% RF	ns	—	14	—
CW Input Power[5]	-25 V @ +85°C	dBm	—	41.2	—
V_{CC} Quiescent Current (I_{CC})	C1 = 5 V, C2 = DS = EN = 0 V	mA	—	0.1	0.15
V_{EEB} Quiescent Current (I_{EEB})	C1 = 5 V, C2 = DS = EN = 0 V	mA	—	0.3	0.35
Control Input Leakage Current (I_{CTL})[6]	Control = 5 V	µA	—	20	25
$R_{PULL-UP}$, Output Pull-up On Resistance	43 mA Load	Ω	—	12	15
$R_{PULL-DOWN}$, Output Pull-down On Resistance	43 mA Load	Ω	—	12	15
Power Sequencer Threshold Voltage	Note 7	V	—	2.5	—
Power Sequencer Power On Time	Note 8	µs	—	25	—
Driver Die Power Up Time	Note 9	µs	—	25	—
Driver Die Power Down Time	Note 10	µs	—	25	—

4. Isolation defined with 1 port in low loss state.
5. Reverse bias voltage V_{EEB} should be determined based on working conditions. For example, -25 V @ 41.2 dBm input power. For lower power applications, a less negative voltage can be used. R. Caverly and G. Hiller, "Establishing the Minimum Reverse Bias for a P-I-N Diode in a High Power Switch," IEEE Transactions on Microwave Theory and Techniques, Vol.38, No.12, December 1990.
6. This leakage current is due to an active pull-down NMOS FET at the control input.
7. When V_{CC} is below this threshold, the internal power sequencer will pull its output V_{SEQ} to ground.
8. This is the delay between the moment when V_{CC} is above the power sequencer threshold to V_{SEQ} reaches 90% of steady state value. This is measured with a 47 pF shunt capacitor off pin V_{EEA}.
9. This is the time needed for the driver to function properly after V_{CC} and V_{EEA} reach 90% of their stable value.
10. This is the time needed for the internal bias voltages to discharge to 10% of their steady state value after V_{CC} and V_{EEA} are powered down.

Recommended Operating Conditions[11]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
V_{CC}	—	V	4	4.5	5
I_{CC}	RF1=ON, RF2=OFF & RF1=OFF, RF2=ON	mA	20	28	36
I_{CC}	RF1=RF2=OFF	mA	40	56	72
V_{EEA} and V_{EEB}	—	V	-50	—	-20
C1, C2, EN, DS	Logic “0” Logic “1”	V	0.0 2.0	0.0 V_{CC}	0.8 V_{CC}
Rise / Fall Time of V_{CC} And V_{EEB}	—	µs	50	—	—
Temperature	—	°C	-40	+25	+85

11. Negative bias should be applied to V_{EEB} (pin 6) (see note 5). The sequencer output V_{SEQ} should be connected to the driver negative bias V_{EEA}. A 47 pF shunt capacitor shall be placed close to pin 11 (V_{EEA}).

Absolute Maximum Ratings[12,13]

Parameter	Absolute Maximum
V_{EEA}, V_{EEB}	-55 V ≤ V_{EEA},V_{EEB} ≤ +0.5 V
V_{CC}	-0.5 V ≤ V_{CC} ≤ +6.5 V
C1, C2, EN, DS	-0.5 V ≤ V_{CC} ≤ +6 V
CW Incident Power (Low Loss Port)	41.2 dBm @ +85°C 43.0 dBm @ +25°C
CW Incident Power (Terminated Port)	23 dBm @ +85°C 26 dBm @ +25°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +150°C

12. Exceeding any one or combination of these limits may cause permanent damage to this device.
13. MACOM does not recommend sustained operation near these survivability limits.

Truth Table

Inputs				Outputs	
EN	DS	C2	C1	RF1	RF2
1	X	X	X	OFF	OFF
0	0	0	0	ON	OFF
0	0	0	1	OFF	ON
0	0	1	0	OFF	OFF
0	0	1	1	OFF	OFF
0	1	0	0	OFF	OFF
0	1	0	1	OFF	OFF
0	1	1	0	ON	OFF
0	1	1	1	OFF	ON

Handling Procedures

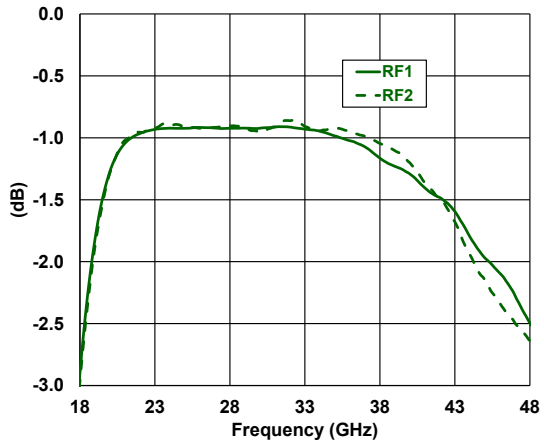
Please observe the following precautions to avoid damage:

Static Sensitivity

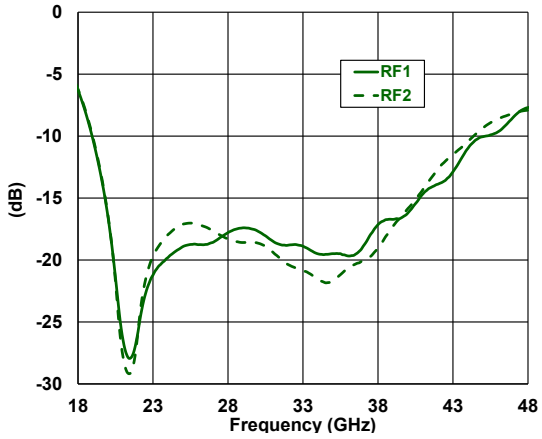
Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM class 1A devices.

Typical Performance Curves @ +25°C

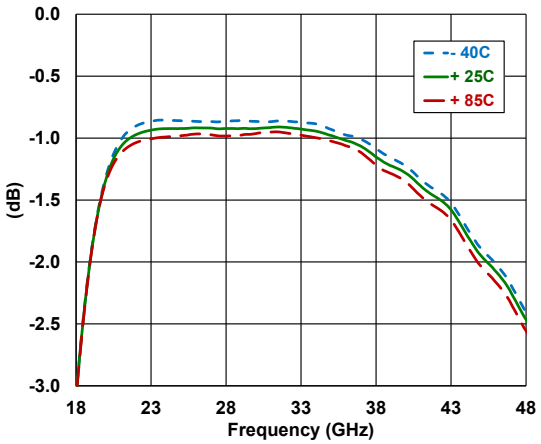
Insertion Loss (On State)



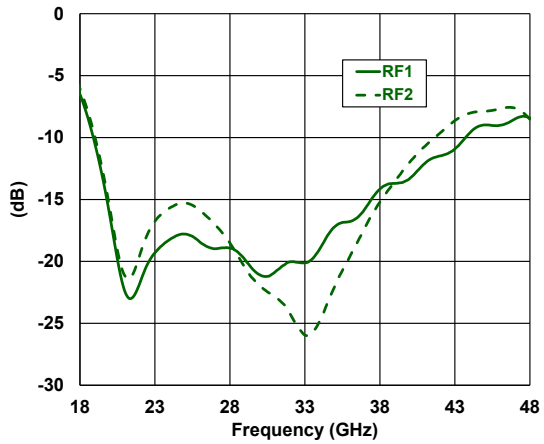
RF_{COMMON} Return Loss (On State)



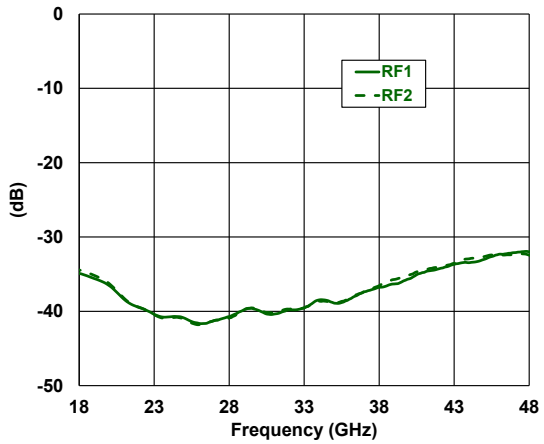
Insertion Loss (On State) over Temp



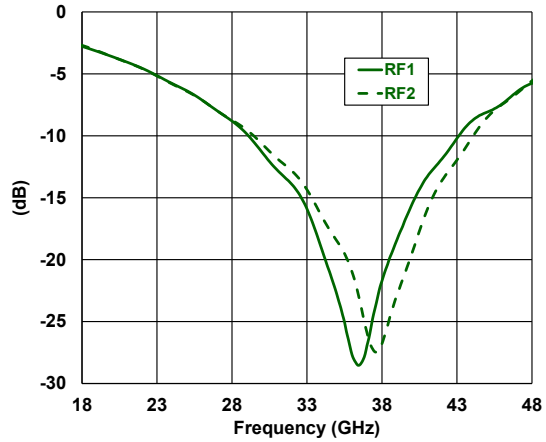
RF1 & RF2 Return Loss (On State)



Isolation (Off State)

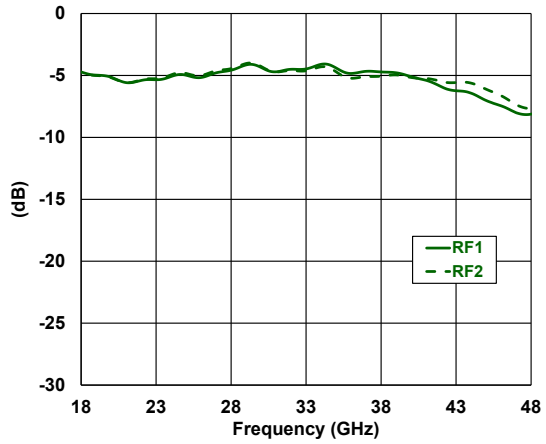


RF1 & RF2 Return Loss (Off State) Terminated Port

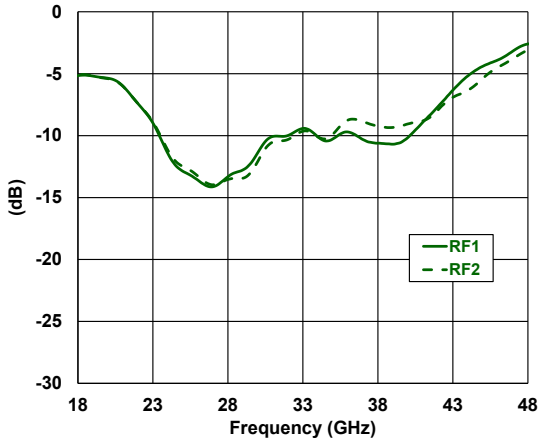


Typical Performance Curves @ +25°C

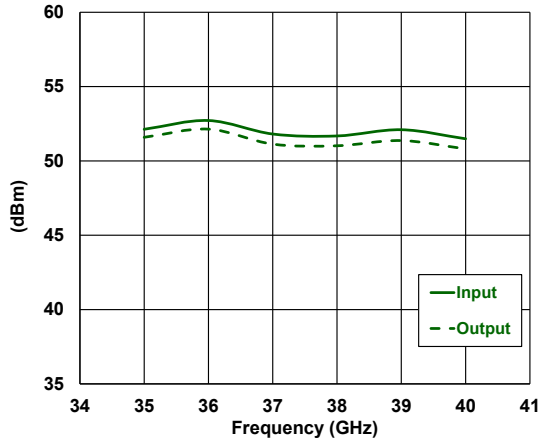
Insertion Loss (Unbiased)



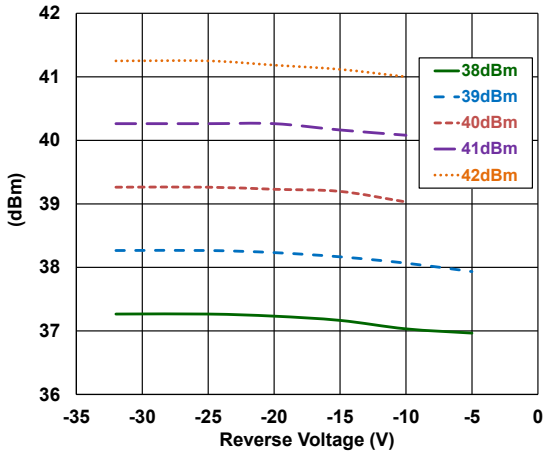
Return Loss (Unbiased)



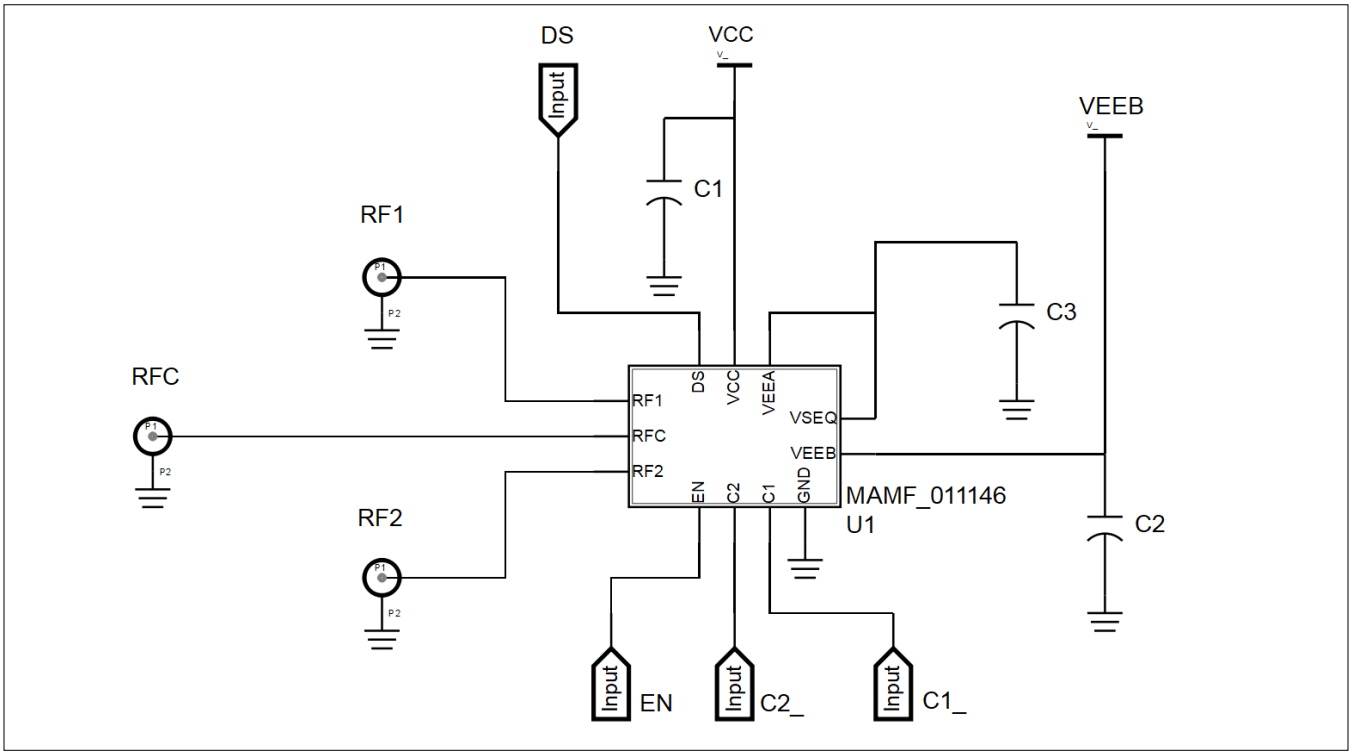
Input Output IP3



Output Power over Reverse Bias Voltage @ +85°C, 29 GHz



MAMF-011146 Application Schematic[14]

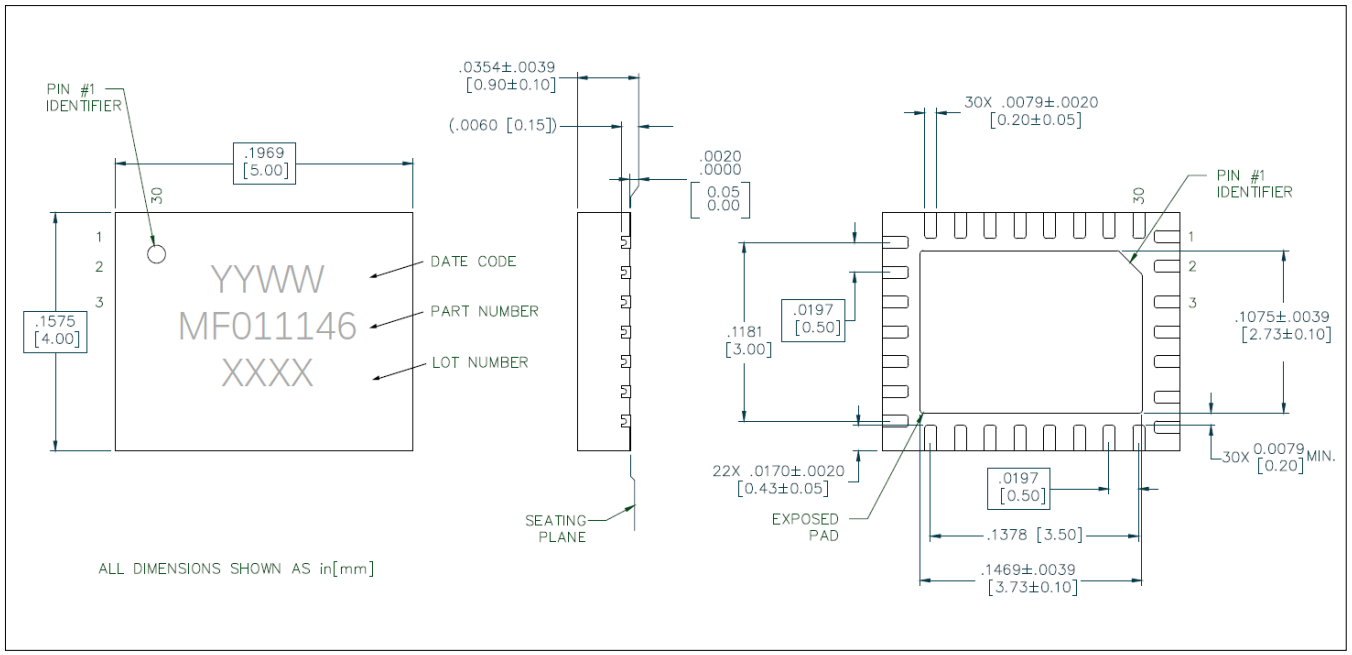


14. VEEB - recommended -25V, see note 5.

Parts List

Part	Value
C1, C2	0.1 µF
C3	47 pF

Outline *Lead-Free* 5 x 4 mm 30-Lead PQFN†



† This is not a JEDEC standard package
Reference Application Note M538 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is NiPdAuAg