MMIC DIE

SP4T RF Switch

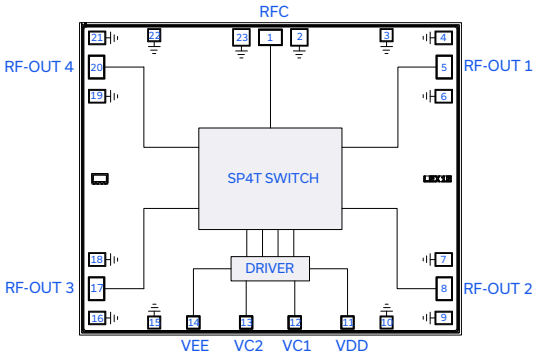
M4SWA4-34DR-D+

50Ω DC to 30 GHz Absorptive RF Switch with Internal Driver

THE BIG DEAL

- Wideband, DC to 30 GHz
- Low Insertion Loss, Typ. 1.7 dB
- High Isolation, Typ. 48 dB
- High Input IP3, Typ. +46 dBm
- Fast Rise / Fall Time, Typ. 23.1 ns / 6.7 ns

FUNCTIONAL DIAGRAM



SEE ORDERING INFORMATION ON THE LAST PAGE

APPLICATIONS

- Radar, EW and ECM Defense Systems
- Communication Infrastructure
- Test and Measurements

PRODUCT OVERVIEW

Mini-Circuits' M4SWA4-34DR-D+ is a GaAs MMIC SP4T absorptive switch with an internal driver designed for wideband operation from DC to 30 GHz. This switch has fast, nano-second switching across a wide frequency range with exceptional settling time. This model provides excellent isolation, high linearity, and is capable of withstanding +24 dBm RF input power. The M4SWA4-34DR-D+ die is suitable for chip and wire assemblies.

KEY FEATURES

Features	Advantages
Absorptive Design	Absorptive switch design enables excellent return loss on all ports, minimizing reflection at the unselected port.
High Isolation: • 48 dB Typ. RFC to RF-OUT 1/2/3/4 • 48 dB Typ. Between RF-OUT 1/2/3/4	High isolation significantly reduces leakage of power into OFF ports.
High linearity and Input Power: • Input Power at P1dB, +28.0 dBm Typ. • Input IP3, +46 dBm Typ. • Max RF Input Power, +24 dBm CW	High linearity minimizes unwanted intermodulation products which are difficult or impossible to filter in multi-carrier environments, or in the presence of strong interfering signal from adjacent circuitry. High RF input power tolerance protects the device from damage due to unexpected spikes in signal level.
Fast RF Switching Time: • Rise/Fall Time, Typ. 23.1 ns / 6.7 ns • On/Off Time, Typ. 67 ns / 37 ns • Settling to 0.05 dB, Typ. 104 ns	Fast switching makes this model suitable for applications where extremely fast transition between ports is required, such as automated switching networks.
Unpackaged Die	Suitable for chip and wire hybrid assemblies.

REV. OR
ECO-026894
M4SWA4-34DR-D+
MCL NY
250909

SP4T RF Switch M4SWA4-34DR-D+

50Ω DC to 30 GHz Absorptive RF Switch with Internal Driver

ELECTRICAL SPECIFICATIONS[1,2,3] AT +25° C, V_{DD}= +3.3 V, V_{EE} = -3.3 V UNLESS NOTED OTHERWISE

Parameter	Condition (GHz)	Min.	Typ.	Max.	Units
Frequency Range		DC		30	GHz
Insertion Loss	0.01		0.9		dB
	0.1		0.9		
	1.0		1.0		
	10		1.7		
	20		2.3		
	30		2.8		
Isolation Between Ports, RF-OUT 1/2/3/4	0.01		76		dB
	0.1		75		
	1.0		63		
	10		48		
	20		45		
	30		48		
Isolation Between RFC & RF-OUT 1/2/3/4 Ports	0.01		76		dB
	0.1		75		
	1.0		64		
	10		48		
	20		49		
	30		48		
Return Loss - RFC	0.01		21		dB
	0.1		21		
	1.0		20		
	10		16		
	20		16		
	30		19		
Return Loss – RF-OUT 1/2/3/4 (On & Off State)	0.01		15		dB
	0.1		16		
	1.0		16		
	10		19		
	20		15		
	30		9		
Input Power at P1dB	0.01		+19.9		dBm
	0.1		+24.5		
	1.0		+26.8		
	10		+28.0		
	20		+28.1		
	30		+28.4		
Input Power at P0.1 dB	0.01		+13.9		dBm
	0.1		+21.3		
	1.0		+24.1		
	10		+25.0		
	20		+25.5		
	30		+24.9		
Input IP3[4] (P_{IN} = +5 dBm/Tone)	0.01		+33		dBm
	0.1		+44		
	1.0		+45		
	10		+46		
	20		+45		
	30		+37		

1. Tested on Mini-Circuits Die Characterization Test Board. See Figure 3.
2. Bi-directional, refer to S-Parameters for actual performance.
3. All RF-ports must be DC blocked or held at 0 V DC.
4. Input IP3 was measured on packaged model M4SWA4-34DR+ on its Mini-Circuits Characterization Test Board TB-M4SWA434DRC+

SP4T RF Switch M4SWA4-34DR-D+

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DC ELECTRICAL SPECIFICATIONS[5]

Parameter	Min.	Typ.	Max.	Units
Positive Supply Voltage, V_{DD}	+3.2	+3.3	+3.4	V
Negative Supply Voltage, V_{EE}	-3.4	-3.3	-3.2	V
Positive Supply Current, I_{DD}		1.2	1.8	mA
Negative Supply Current, I_{EE}		0.8	1.4	mA
Control Voltage Low		0	+0.8	V
Control Voltage High	+1.6	+2	V_{DD}	V
Control Current (I_{C1}) Low		0		µA
Control Current (I_{C1}) High		9	21	mA
Control Current (I_{C2}) Low		0		µA
Control Current (I_{C2}) High		7	16	mA

5. DC electrical performance was measured on packaged model M4SWA4-34DR+ on its Mini-Circuits Characterization Test Board TB-M4SWA434DRC+.

SWITCHING SPECIFICATIONS[6]

Parameter	Condition	Min.	Typ.	Max.	Units
ON Time, 50% Control to 90% RF output	RF P_{IN} at RFC = 0 dBm RF Frequency = 150 MHz Control Frequency = 1 kHz Control High = +2 V Control Low = 0 V		67		ns
OFF Time, 50% Control to 10% RF output			37		ns
Video Leakage			+4.5		mV
Rise Time, 10% to 90% of RF output			23.1		ns
Fall Time, 90% to 10% of RF output			6.7		ns
Settling time (50% VCTRL to 0.05 dB of final RF output)			104		ns
Settling time (50% VCTRL to 0.02 dB of final RF output)			446		ns

6. Switching performance was measured on packaged model M4SWA4-34DR+ on its Mini-Circuits Characterization Test Board TB-M4SWA434DRC+.

TRUTH TABLE

State of V_{C1}	State of V_{C2}	RFC to RF-OUT 1	RFC to RF-OUT 2	RFC to RF-OUT 3	RFC to RF-OUT 4
Low	Low	ON	OFF	OFF	OFF
High	Low	OFF	ON	OFF	OFF
Low	High	OFF	OFF	ON	OFF
High	High	OFF	OFF	OFF	ON

SP4T RF Switch M4SWA4-34DR-D+

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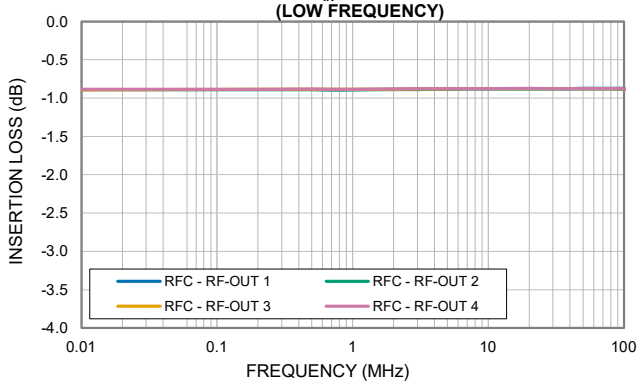
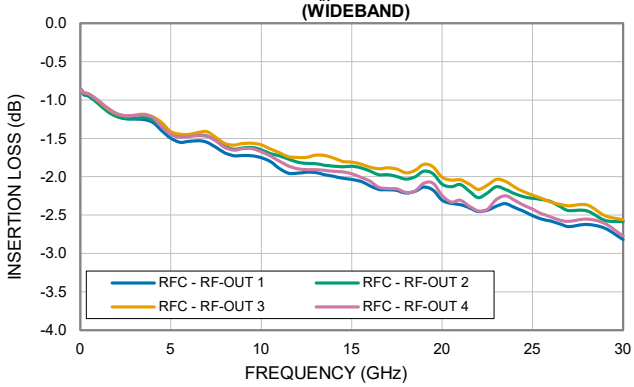
TYPICAL PERFORMANCE GRAPHS

Temperature = +25° C, V_{DD} = +3.3 V, V_{EE} = -3.3 V

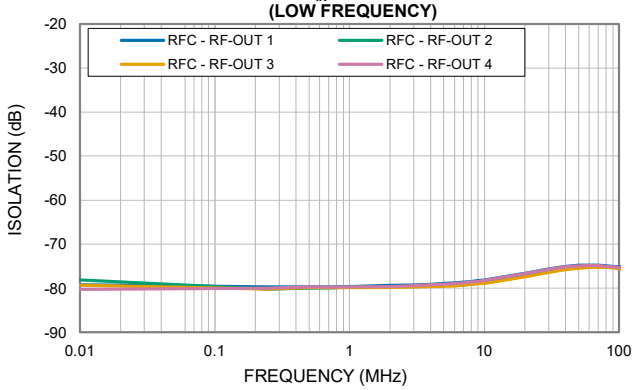
INSERTION LOSS RFC - RF-OUT[7]
P_{IN} = 0 dBm
(LOW FREQUENCY)



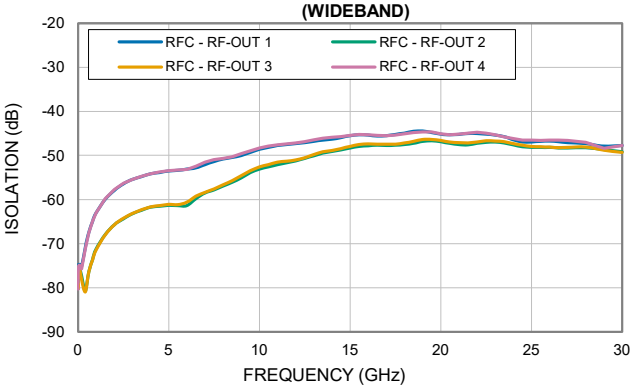
INSERTION LOSS RFC - RF OUT[7]
P_{IN} = 0 dBm
(WIDEBAND)



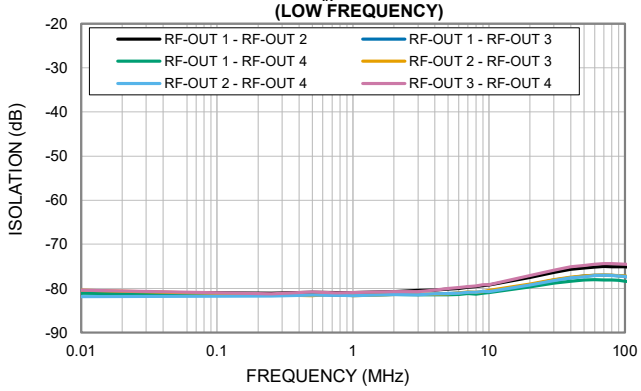
ISOLATION RFC - RF-OUT[8]
P_{IN} = 0 dBm
(LOW FREQUENCY)



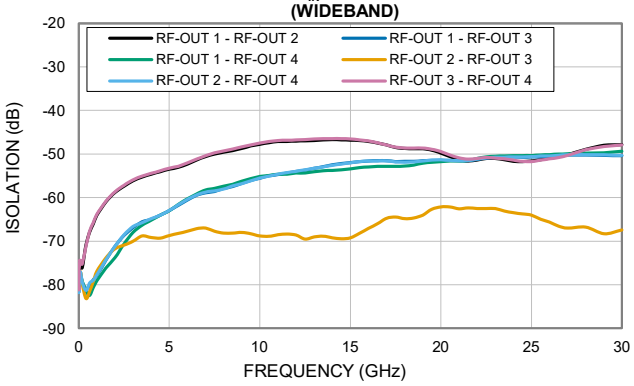
ISOLATION RFC - RF-OUT[8]
P_{IN} = 0 dBm
(WIDEBAND)



ISOLATION BETWEEN RF OUTPUTS
P_{IN} = 0 dBm
(LOW FREQUENCY)



ISOLATION BETWEEN RF OUTPUTS
P_{IN} = 0 dBm
(WIDEBAND)



7. RF-OUT defined as either RF-OUT 1 (ON), RF-OUT 2 (ON), RF-OUT 3 (ON), or RF-OUT 4 (ON)
8. RF-OUT defined as either RF-OUT 1 (OFF), RF-OUT 2 (OFF), RF-OUT 3 (OFF), or RF-OUT 4 (OFF)

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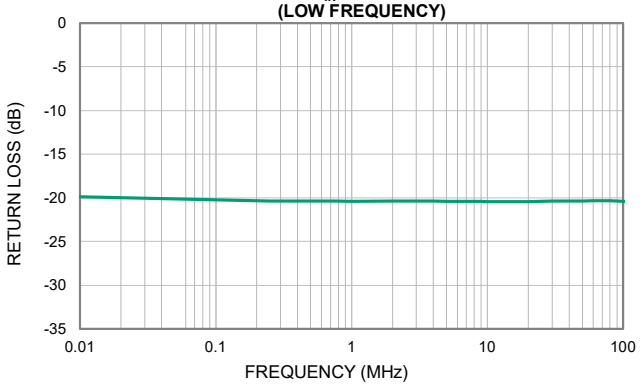
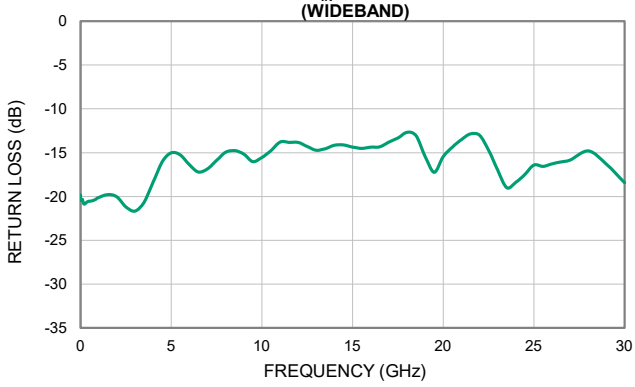
Temperature = +25°C, V_{DD} = +3.3 V, V_{EE} = -3.3 V

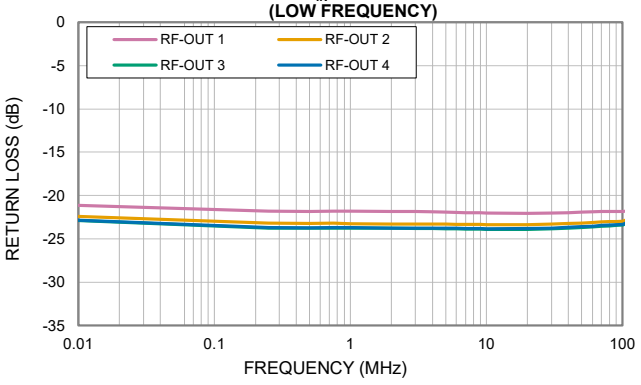
RFC INPUT RETURN LOSS
P_{IN} = 0 dBm
(LOW FREQUENCY)



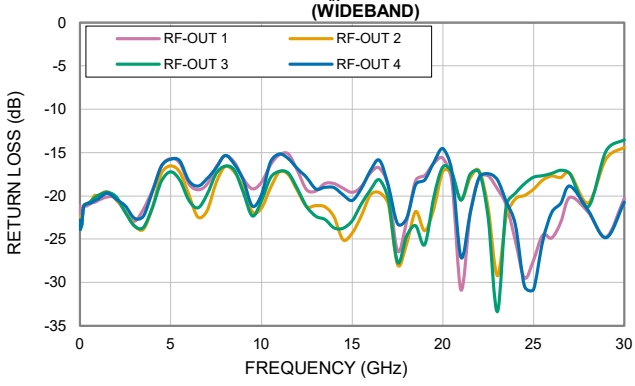
RFC INPUT RETURN LOSS
P_{IN} = 0 dBm
(WIDEBAND)



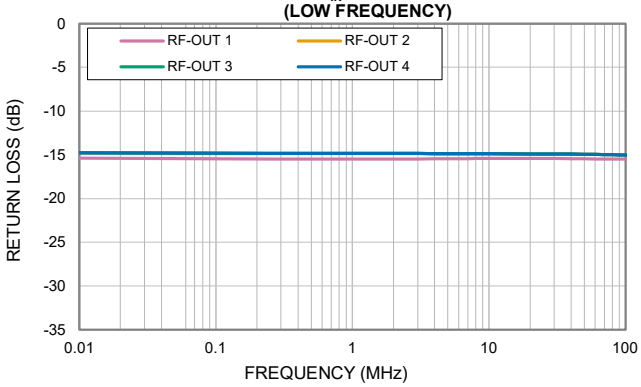
RF (ON) OUTPUT RETURN LOSS
P_{IN} = 0 dBm
(LOW FREQUENCY)



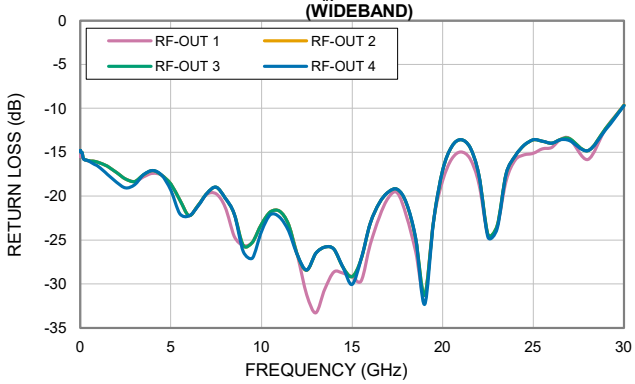
RF (ON) OUTPUT RETURN LOSS
P_{IN} = 0 dBm
(WIDEBAND)



RF (OFF) OUTPUT RETURN LOSS
P_{IN} = 0 dBm
(LOW FREQUENCY)



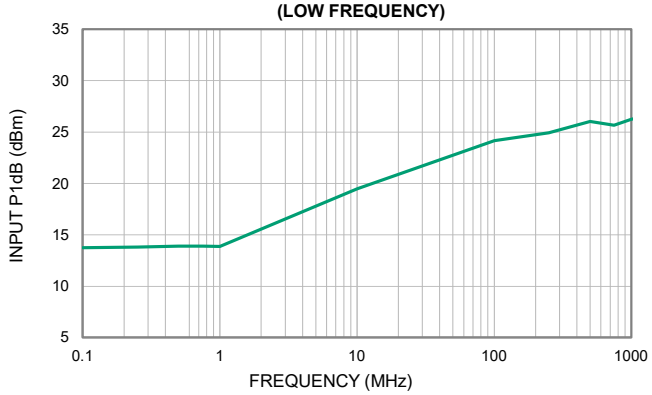
RF (OFF) OUTPUT RETURN LOSS
P_{IN} = 0 dBm
(WIDEBAND)



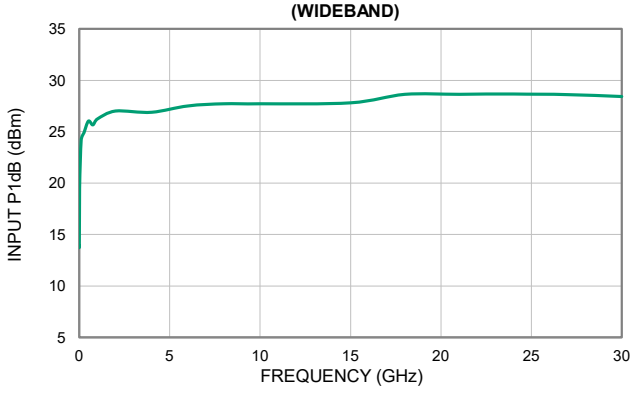
TYPICAL PERFORMANCE GRAPHS

Temperature = +25°C, V_{DD} = +3.3 V, V_{EE} = -3.3 V

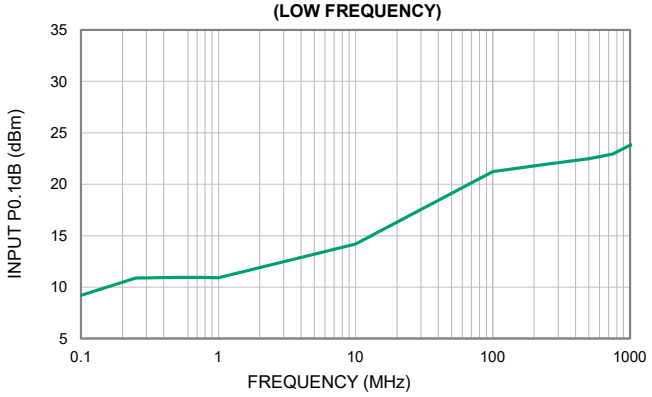
INPUT P1dB (LOW FREQUENCY)



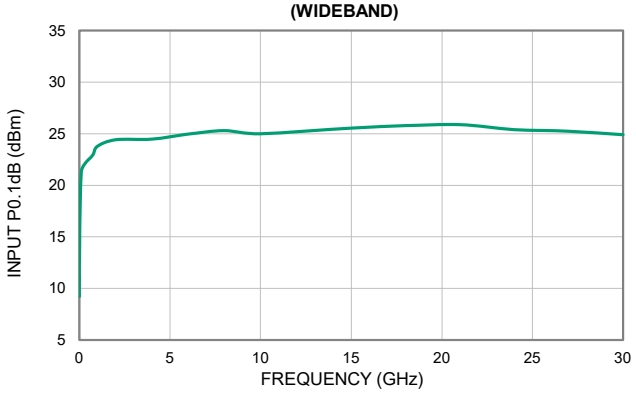
INPUT P1dB (WIDEBAND)



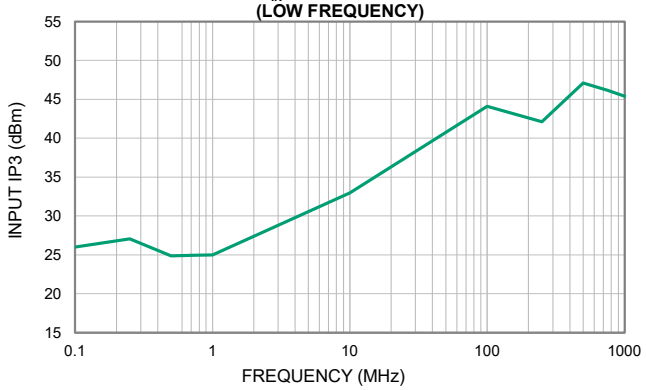
INPUT P0.1dB (LOW FREQUENCY)



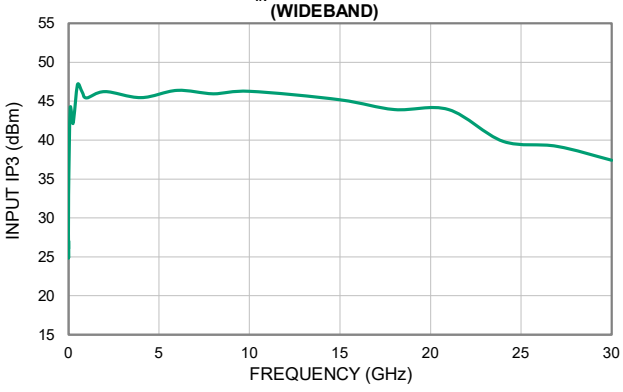
INPUT P0.1dB (WIDEBAND)



INPUT IP3[9] P_{IN} = +5 dBm/TONE (LOW FREQUENCY)



INPUT IP3[9] P_{IN} = +5 dBm/TONE (WIDEBAND)



9. Input IP3 was measured on packaged model M4SWA4-34DR+ on its Mini-Circuits Characterization Test Board TB-M4SWA434DRC+

SP4T RF Switch M4SWA4-34DR-D+

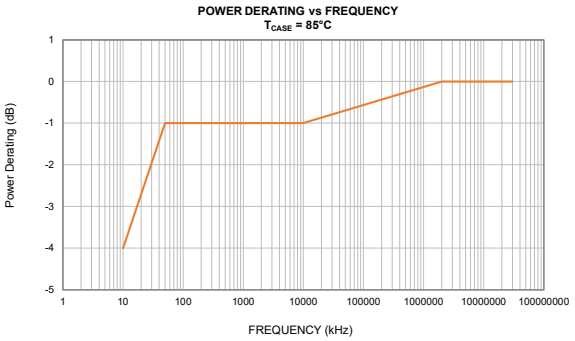
50Ω DC to 30 GHz Absorptive RF Switch with Internal Driver

ABSOLUTE MAXIMUM RATINGS[10]

Parameter	Ratings
Operating Temperature[11]	-40°C to +85°C
Storage Temperature (for Die)[12]	-65°C to +150°C
Junction Temperature[13]	+150°C
Total Power Dissipation	0.33 W
Through Path @ +85°C[14, 15] Input Power at RFC (CW), (V_{DD} = +3.3 V, V_{EE} = -3.3 V) Input Power at RF-OUT 1/2/3/4 (CW), RF Applied to Selected Port (V_{DD} = +3.3 V, V_{EE} = -3.3 V) Input Power at RF-OUT 1/2/3/4 (CW), RF Applied to Unselected Port V_{DD} = +3.3 V, V_{EE} = -3.3 V)	 +30 dBm +30 dBm +30 dBm
Hot Switching @ +85°C[14, 15] Input Power at RFC (CW), (V_{DD} = +3.3 V, V_{EE} = -3.3 V)	 +30 dBm
DC Voltage (V_{DD})	0 V to +5 V
DC Voltage (V_{EE})	-5 V to 0 V

10. Permanent damage may occur if any of these limits are exceeded. Maximum ratings are not intended for continuous normal operation.
11. Bottom of Die.
12. For die shipped in Gel-Pak see ENV-80 (limited by packaging).
13. Peak temperature on top of Die.
14. Max. Input Power was measured on packaged model M4SWA4-34DR+ on its Mini-Circuits Characterization. Test Board TB-M4SWA434DRC+ and validated at +85°C.
15. See derating curve at right for power derating over frequency.

POWER DERATING VS. FREQUENCY



THERMAL RESISTANCE

Parameter	Condition	Ratings
Thermal Resistance (Θ_{JC})[16]	Through Path RFC to RF-OUT 1	86.9°C/W
	Through Path RF-OUT 1 to RFC	55.7°C/W
	Termination Path	77.1°C/W

16. Θ_{JC} = (Hot Spot Temperature on Die - Temperature at Ground Lead)/Dissipated Power

ESD RATING[17]

	Class	Voltage Range	Reference Standard
HBM	1B	500 V to < 1000 V	ANSI/ESDA/JEDEC JS-001-2023
CDM	C2A	500 V to < 750 V	ANSI/ESDA/JEDEC JS-001-2022

ESD HANDLING PRECAUTION: This device is designed to be Class 1B for HBM. Static charges may easily produce potentials higher than this with improper handling and can discharge into DUT and damage it. As a preventive measure Industry standard ESD handling precautions should be used at all times to protect the device from ESD damage.

17. Tested in 4x4 mm 24-Lead QFN style package.

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FUNCTIONAL DIAGRAM

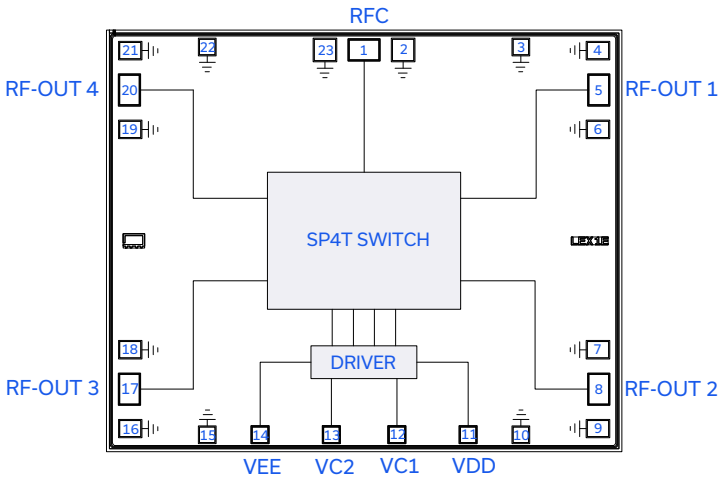

Figure 1. M4SWA4-34DR-D+ Functional Diagram

PAD DESCRIPTION

Function	Pad Number	Application Description (Refer to Fig. 2)
RFC	1	RF Input Port.
RF-OUT 1	5	RF Output Port 1.
RF-OUT 2	8	RF Output Port 2.
RF-OUT 3	17	RF Output Port 3.
RF-OUT 4	20	RF Output Port 4.
V_{DD}	11	Positive DC Input Port.
V_{EE}	14	Negative DC Input Port.
V_{C1}	12	Switch control DC Input Port 1.
V_{C2}	13	Switch control DC Input Port 2.
GND	2-4, 6-7, 9-10, 15-16, 18-19, 21-23, & Bottom of Die	Connected to die backside through vias. Bond wires to ground are optional.

DIE OUTLINE: inches [mm], Typical

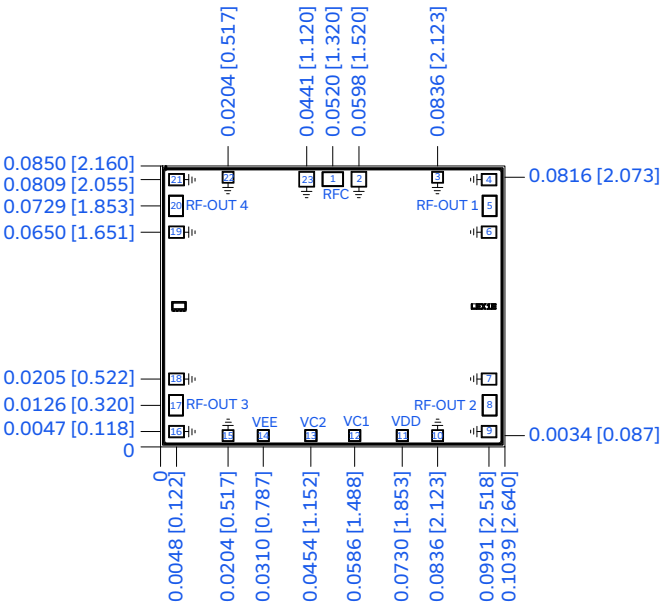

Figure 2. M4SWA4-34DR-D+ Die Outline

DIMENSIONS: inches [mm], Typical

Die Size	0.1039 x 0.0850 [2.640 x 2.160]
Die Thickness	0.0040 [0.100]
Bond Pad Sizes:	
Pads 1	0.0060 x 0.0040 [0.152 x 0.102]
Pad 2 & 23	0.0043 x 0.0043 [0.110 x 0.110]
Pads 3, 10, 11, 12, 13, 14, 15, & 22	0.0031 x 0.0031 [0.080 x 0.080]
Pads 4, 6, 7, 9, 16, 18, 19, & 21	0.0043 x 0.0033 [0.110 x 0.084]
Pads 5, 8, 17, & 20	0.0040 x 0.0060 [0.102 x 0.152]
Plating (Pads & Bottom of Die)	Gold

CHARACTERIZATION AND APPLICATION CIRCUIT

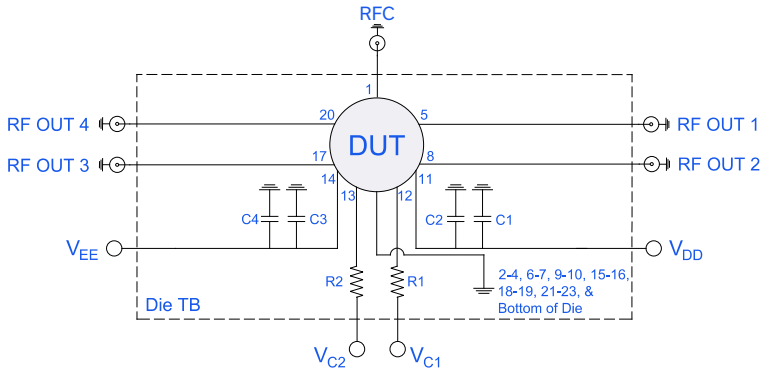

Figure 3. M4SWA4-34DR-D+ Characterization and Application Circuit

Electrical Parameters and Conditions
Insertion Loss, Isolation, Return Loss, Input Power at 1dB Compression (P1dB), & Input IP3 tested using PNA-X N5247B microwave network analyzer and P5022A vector network analyzer.

Conditions:
1. Insertion Loss, Isolation, & Return Loss: P_{IN} = 0 dBm
2. Input IP3 (IIP3): Two tones, spaced 1 MHz apart, +5 dBm/Tone at input

Component	Value	Size	Part Number	Manufacturer
C2, C3	100 pF	0402	GRM1555C1H101JA01D	Murata
C1, C4	0.1 uF	0402	GRM155R71C104KA88D	Murata
R1, R2	100 Ω	0402	RK73H1ETTP1000F	KOA Speer

ASSEMBLY DIAGRAM

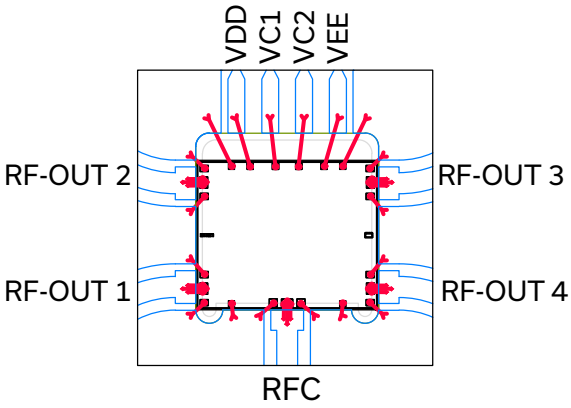

Figure 4. M4SWA4-34DR-D+ Assembly Diagram

- Bond wire diameter: 1 mil
- Bond wire lengths from Die Pad to PCB at:
  - RFC & RF-OUT ports: 22 ± 2 mils
- Typical Gap from Die edge to PCB edge: 3 mils
- PCB thickness and material: 6.6 mil Rogers RO4350B (Thickness: 1 oz copper on each side)

ASSEMBLY AND HANDLING PROCEDURE

1. Storage
   Die should be stored in a dry nitrogen purged desiccator or equivalent.
2. ESD Precautions
   MMIC die are susceptible to electrostatic and mechanical damage. Die are supplied in anti-static protected material, which should be opened only in clean room conditions at an appropriately grounded anti-static workstation.
3. Die Handling and Attachment
   Devices require careful handling using tools appropriate for manipulating semiconductor chips. It is recommended to handle the chips along the edges with a custom designed collet.

   The die mounting surface must be clean and flat. Using conductive silver-filled epoxy, apply sufficient adhesive to meet the required bond line thickness, fillet height and coverage around the total periphery of the device. The recommended epoxy is Ablebond 84-1LMISR4 or equivalent. Parts should be cured in a nitrogen-filled atmosphere per manufacturer's recommended cure profile.
4. Wire Bonding
   Openings in the surface passivation above the gold bond pads are provided to allow wire bonding to the die. Thermosonic bonding is recommended with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. The suggested interconnect is pure gold, 1 mil diameter wire. Bonds are recommended to be made from the bond pads on the die to the package or substrate. All bond wire length and bond wire height should be kept as short as possible, unless specified by design, to minimize performance degradation due to undesirable series inductance.

MMIC DIE

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ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASHBOARD. CLICK HERE

Performance Data & Graphs	Data Graphs S-Parameter (S5P Files) Data Set (.zip file)	
Case Style	Die	
RoHS Status	Compliant	
Die Ordering and Packaging Information	Quantity, Package	Model No.
	Gel - Pak: 5, 10, 50, or 100 KGD*	M4SWA4-34DR-DG+
	Medium†, Partial wafer: KGD* <418	M4SWA4-34DR-DP+
	Full wafer†	M4SWA4-34DR-DF+
	†Available upon request contact sales representative. Refer to AN-60-067	
Die Marking	LEX1E	
Environmental Ratings	ENV-80	

* Known Good Die ("KGD") means that the die in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such die fall within a predefined range. While DC testing is not definitive, it does provide a high degree of confidence that die are capable of meeting typical RF electrical parameters specified by Mini-Circuits.

Notes

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.

B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuits' applicable established test performance criteria and measurement instructions.

C. The parts covered by this specification document are subject to Mini-Circuits' standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained there in. For a full statement of the standard. Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/MCLStore/terms.jsp

D. Mini-Circuits does not warrant the accuracy or completeness of the information, text, graphics and other items contained within this document and same are provided as an accommodation and on an As is basis, with all faults.

E. Purchasers of this part are solely responsible for proper storing, handling, assembly and processing of known good die (KGD) (including, without limitation, proper ESD preventative measures, die preparation, die attach, wire bonding and related assembly and test activities), and Mini-Circuits assumes no responsibility therefor or for environmental effects on KGD.