MMIC SURFACE MOUNT

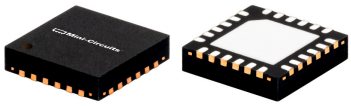
SP4T RF Switch

M4SWA4-34DR+

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

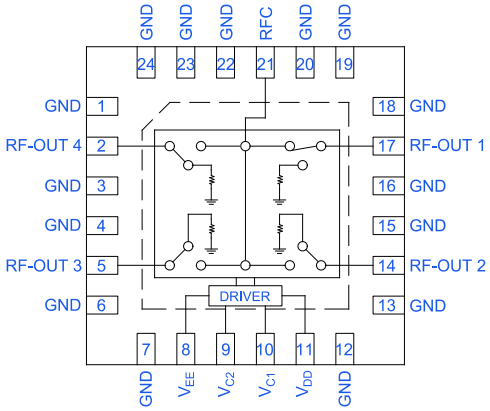
THE BIG DEAL

- Wideband, DC to 30 GHz
- Low Insertion Loss, Typ. 1.8 dB
- High Isolation, Typ. 47 dB
- High Input IP3, Typ. +46 dBm
- Fast Rise/Fall Time, Typ. 23.1 ns/6.4 ns
- 4x4 mm, 24-Lead QFN-Style Package



Generic photo used for illustration purposes only

FUNCTIONAL DIAGRAM



APPLICATIONS

- Radar, EW, and ECM Defense Systems
- Communication Infrastructure
- Test and Measurement Equipment

PRODUCT OVERVIEW

Mini-Circuits' M4SWA4-34DR+ is a GaAs MMIC SP4T absorptive switch with an internal driver designed for wideband operation from DC to 30 GHz. This switch enables fast, nano-second switching across a wide frequency range with minimal gate lag effects. This model provides excellent isolation, high linearity, and is capable of withstanding +24 dBm RF input power. It is packaged in a small 4x4 mm QFN-Style package for ease of integration in compact assemblies.

KEY FEATURES

Features	Advantages
Absorptive Design	Absorptive switch design enables excellent return loss on all ports, minimizing reflection at the unselected ports.
High Isolation: • 47 dB Typ. RFC to RF-OUT 1/2/3/4 • 45 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, +28.9 dBm Typ. • Input IP3, +46 dBm Typ. • Max RF Input Power, +30 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 signals 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/6.4 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.
Compact Size, 4x4 mm	Small footprint saves space in dense layouts, while providing low inductance, repeatable transitions, and excellent thermal contact to the PCB. Industry standard packaging allows for ease of assembly in high volume manufacturing processes.

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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	1.4	dB
	0.1		0.9	1.4	
	1.0		1.1	1.6	
	10		1.8	2.5	
	20		2.4	3.2	
	30		3.3	4.8	
Isolation Between Ports, RF-OUT 1/2/3/4	0.01	65	76		dB
	0.1	63	74		
	1.0	52	61		
	10	40	45		
	20	42	52		
	30	36	42		
Isolation Between RFC & RF-OUT 1/2/3/4 Ports	0.01	65	75		dB
	0.1	64	75		
	1.0	54	62		
	10	40	47		
	20	37	43		
	30	34	40		
Return Loss - RFC	0.01		22		dB
	0.1		22		
	1.0		18		
	10		15		
	20		19		
	30		15		
Return Loss – RF-OUT 1/2/3/4 (On & Off State)	0.01		15		dB
	0.1		16		
	1.0		17		
	10		17		
	20		15		
	30		17		
Input IP3 (P_{IN} = +5 dBm/Tone)	0.01		+33		dBm
	0.1		+44		
	1.0		+45		
	10		+46		
	20		+45		
	30		+37		
Input Power at P1dB Compression	0.01		+19.3		dBm
	0.1		+24.3		
	1.0		+27.4		
	10		+28.9		
	20		+28.2		
	30		+28.3		
Input Power at P0.1dB Compression	0.01		+13.5		dBm
	0.1		+21.0		
	1.0		+24.0		
	10		+25.2		
	20		+25.2		
	30		+24.7		

1. Tested on Mini-Circuits Characterization Test Board TB-M4SWA434DRC+. See Figure 2.
2. Bi-directional, refer to S-Parameters for actual performance.
3. All RF-ports must be DC blocked or held at 0 V DC.

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DC ELECTRICAL SPECIFICATIONS

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		nA
Control Current (I_{C1}) High		9	21	nA
Control Current (I_{C2}) Low		0		nA
Control Current (I_{C2}) High		7	16	nA

SWITCHING SPECIFICATIONS

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

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

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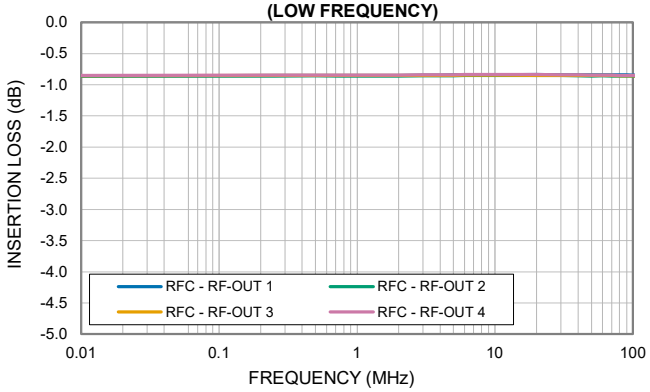
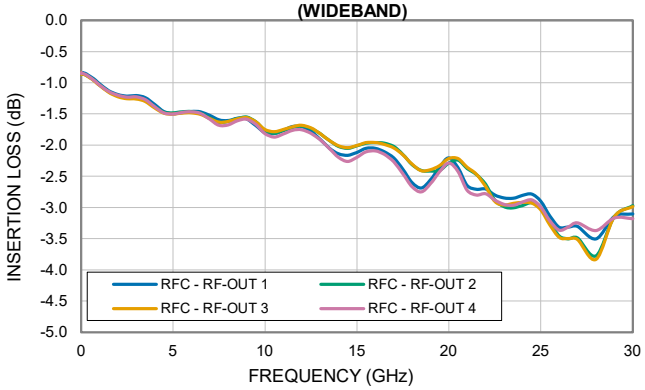
TYPICAL PERFORMANCE GRAPHS

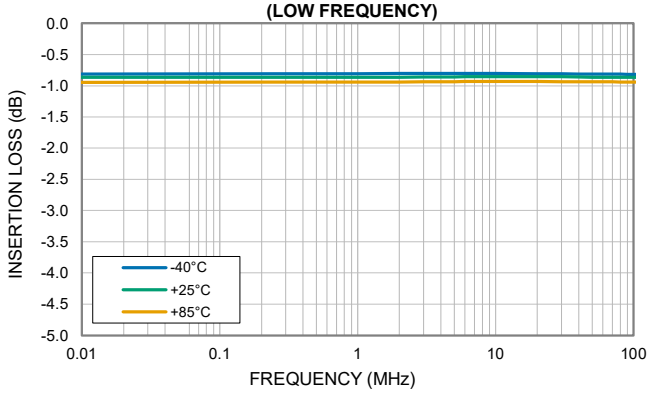
INSERTION LOSS RFC - RF-OUT[4]
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



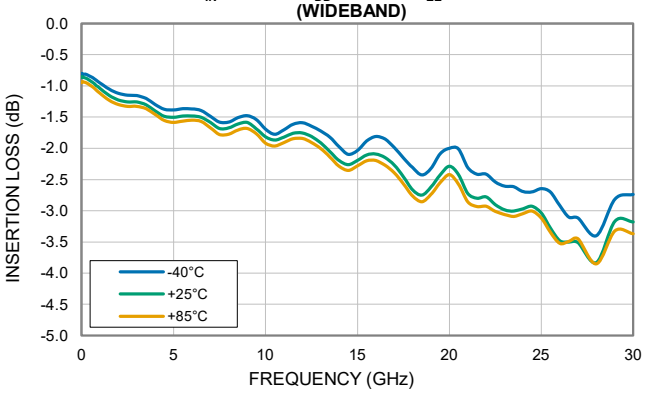
INSERTION LOSS RFC - RF OUT[4]
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



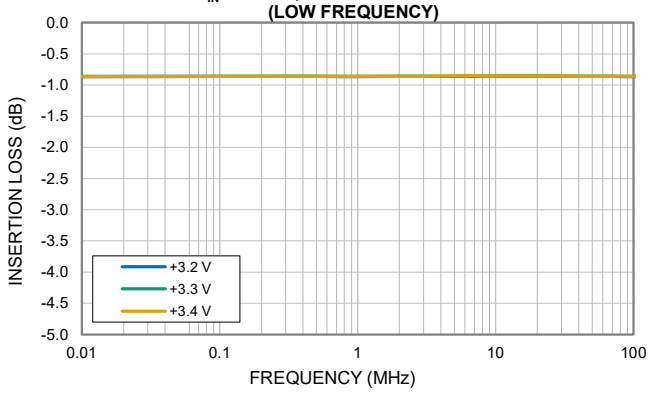
INSERTION LOSS RFC-RF OUT[5] vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



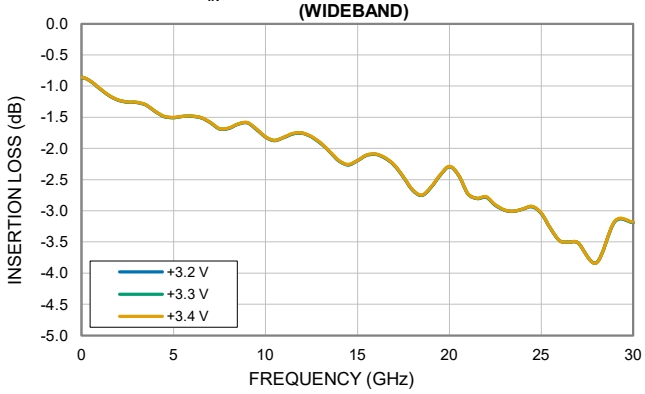
INSERTION LOSS RFC-RF OUT[5] vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



INSERTION LOSS RFC - RF OUT[5] vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(LOW FREQUENCY)



INSERTION LOSS RFC - RF-OUT[5] vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(WIDEBAND)



4. RF-OUT defined as either RF-OUT 1 (ON), RF-OUT 2 (ON), RF-OUT 3 (ON), or RF-OUT 4 (ON)
5. RF-OUT defined as the worst of RFC to RF-OUT 1 (ON), RF-OUT 2 (ON), RF-OUT 3 (ON), or RF-OUT 4 (ON)
6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.

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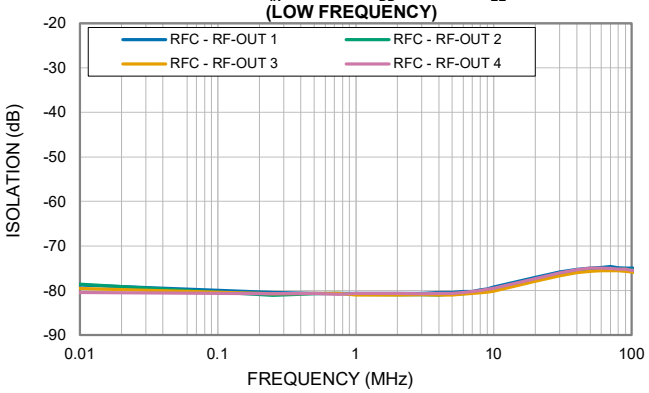
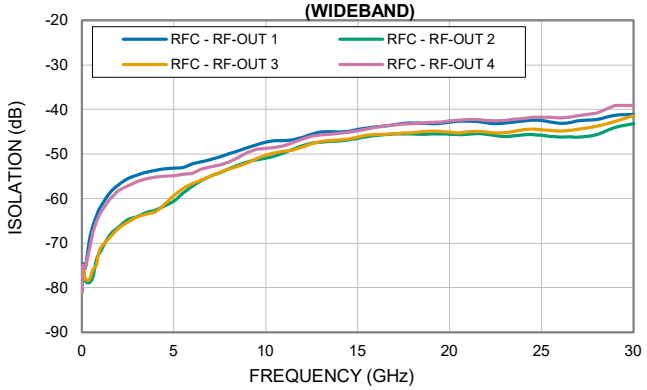
TYPICAL PERFORMANCE GRAPHS

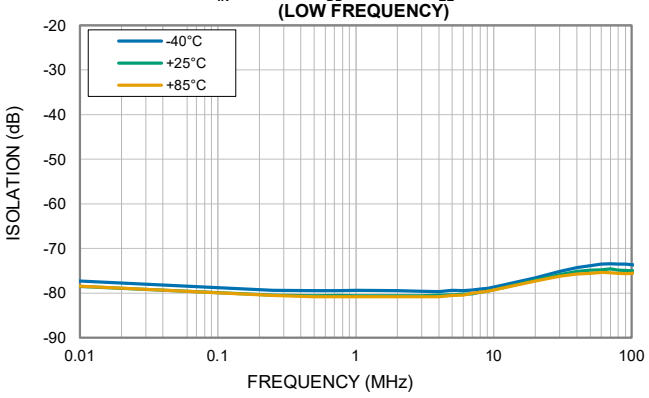
ISOLATION RFC - RF-OUT[7]
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



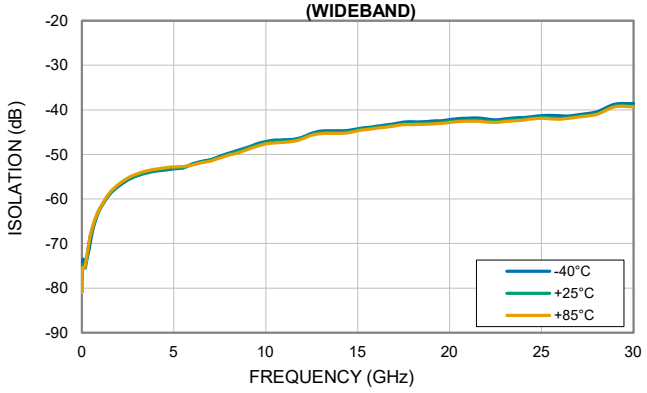
ISOLATION RFC - RF-OUT[7]
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



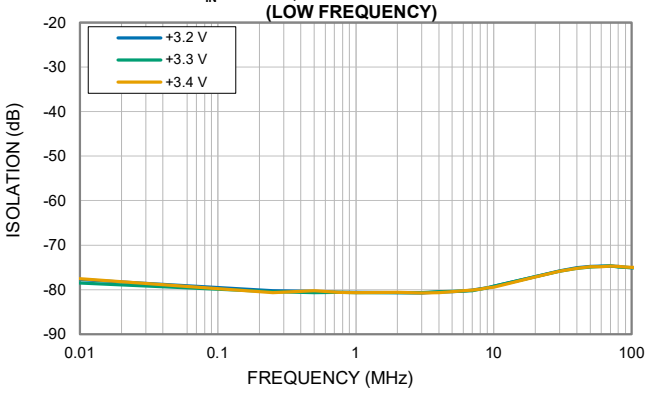
ISOLATION RFC - RF-OUT[8] vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



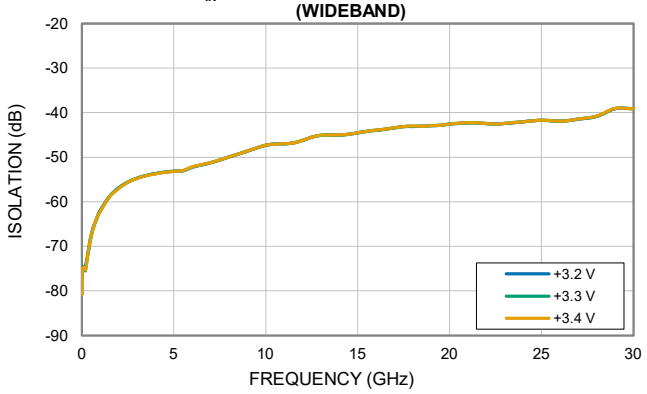
ISOLATION RFC - RF-OUT[8] vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



ISOLATION RFC - RF-OUT[8] vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(LOW FREQUENCY)



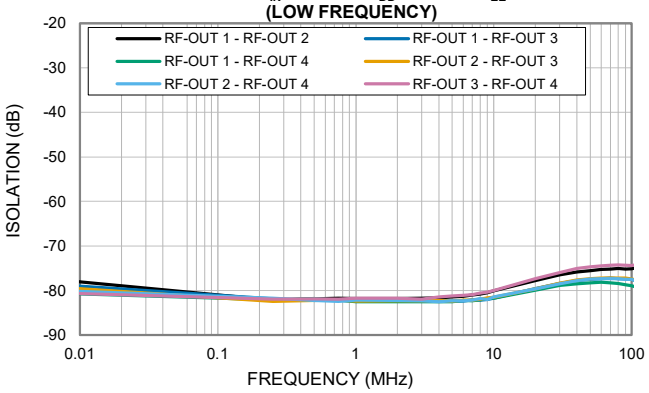
ISOLATION RFC - RF-OUT[8] vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(WIDEBAND)



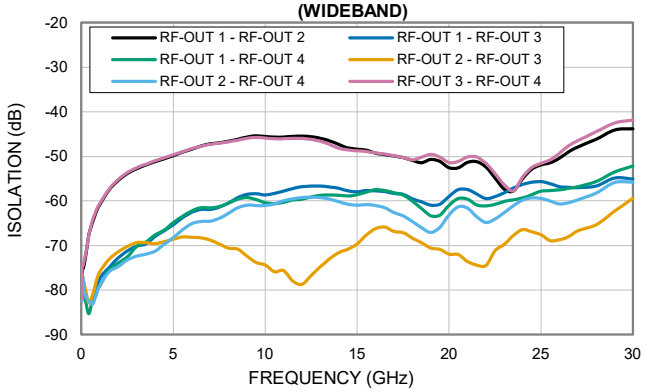
6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.
7. RF-OUT defined as either RF-OUT 1 (OFF), RF-OUT 2 (OFF), RF-OUT 3 (OFF), or RF-OUT 4 (OFF)
8. RF-OUT defined as the worst of RFC to RF-OUT 1 (OFF), RF-OUT 2 (OFF), RF-OUT 3 (OFF), or RF-OUT 4 (OFF)

TYPICAL PERFORMANCE GRAPHS

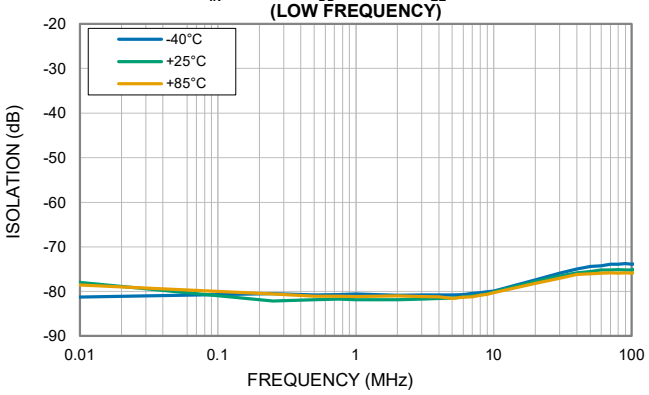
ISOLATION BETWEEN RF OUTPUTS
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



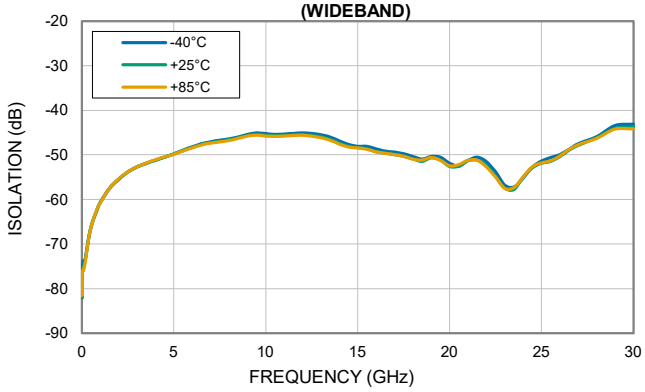
ISOLATION BETWEEN RF OUTPUTS
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



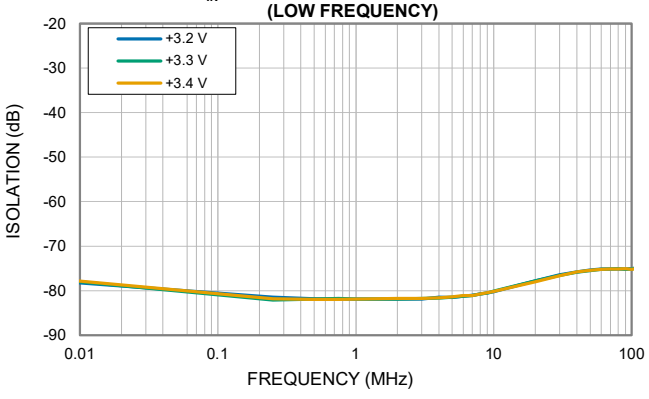
ISOLATION RF-OUT 1 - RF-OUT 2 vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



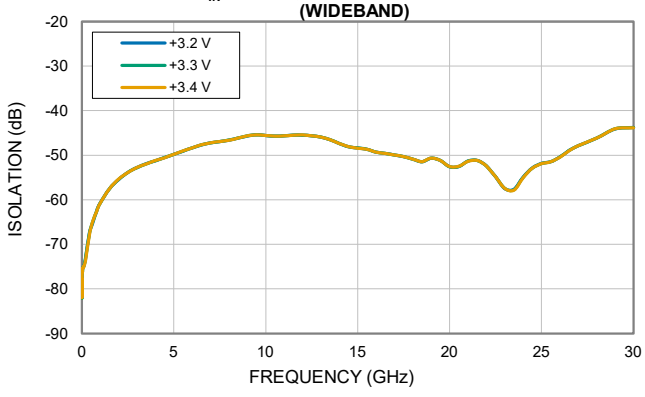
ISOLATION RF-OUT 1 - RF-OUT 2 vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



ISOLATION RF-OUT 1 - RF-OUT 2 vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(LOW FREQUENCY)



ISOLATION RF-OUT 1 - RF-OUT 2 vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(WIDEBAND)



6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.

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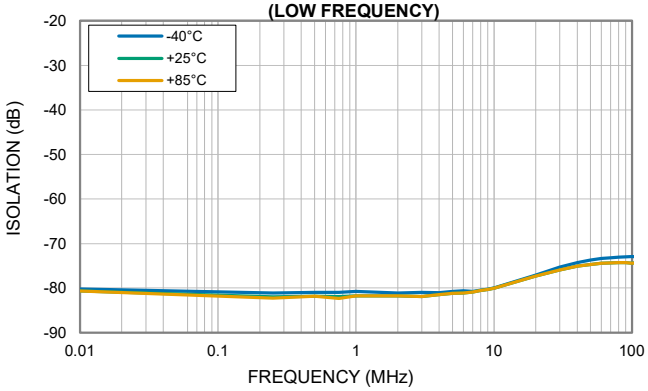
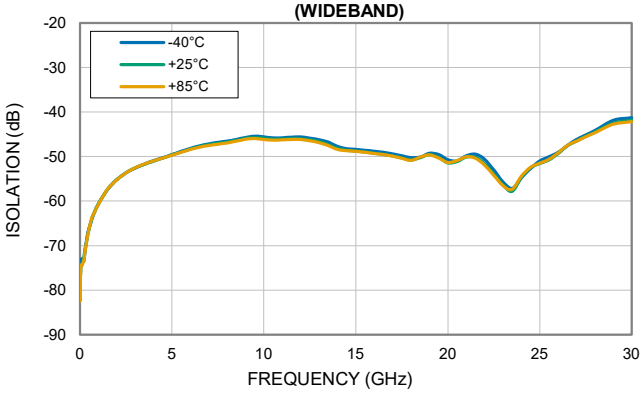
TYPICAL PERFORMANCE GRAPHS

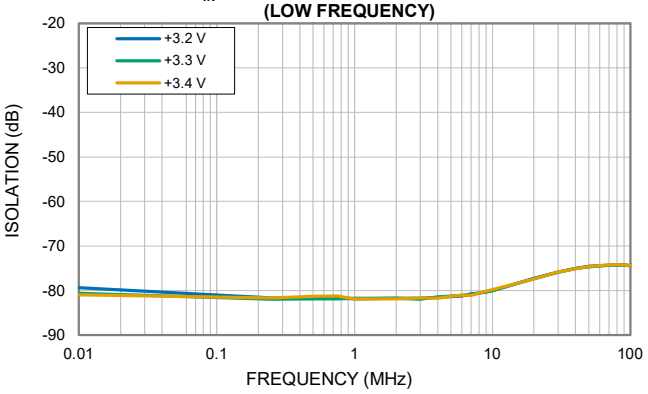
ISOLATION RF-OUT 3 - RF-OUT 4 vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



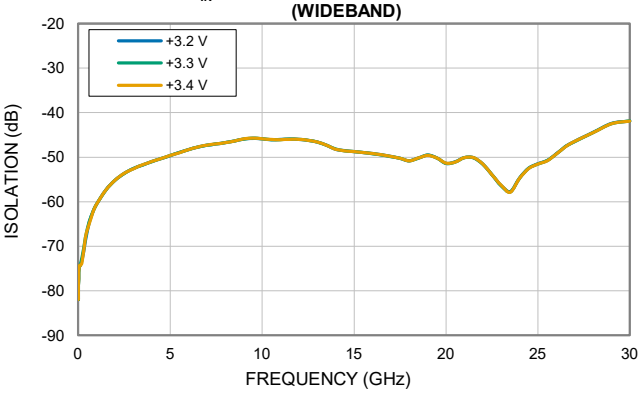
ISOLATION RF-OUT 3 - RF-OUT 4 vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



ISOLATION RF-OUT 3 - RF-OUT 4 vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(LOW FREQUENCY)



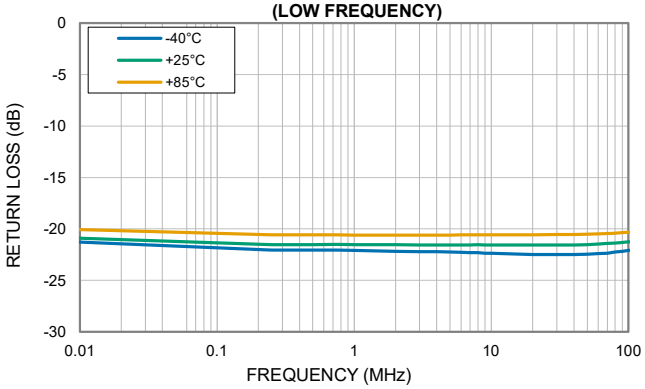
ISOLATION RF-OUT 3 - RF-OUT 4 vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(WIDEBAND)



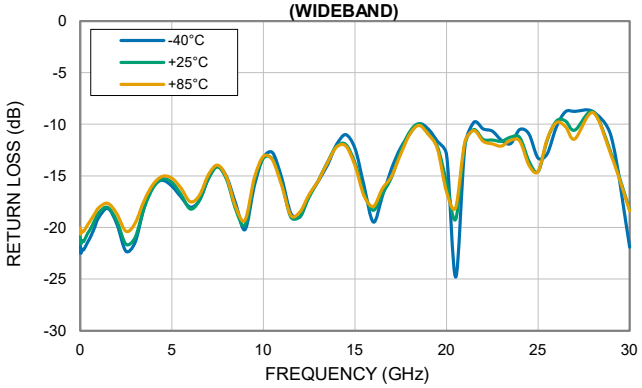
6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.

TYPICAL PERFORMANCE GRAPHS

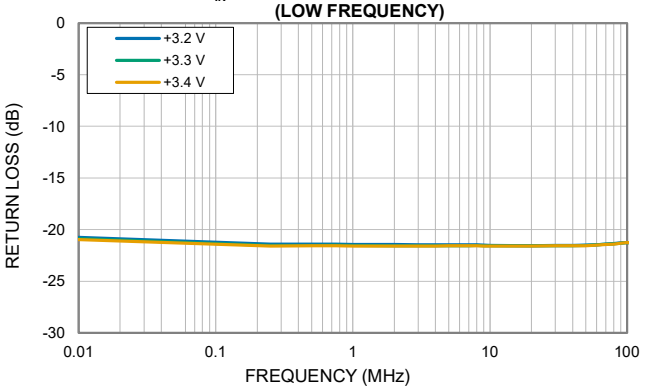
RFC INPUT RETURN LOSS vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



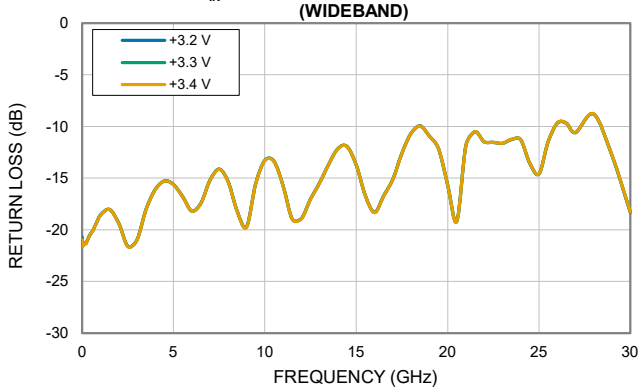
RFC INPUT RETURN LOSS vs. TEMPERATURE
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



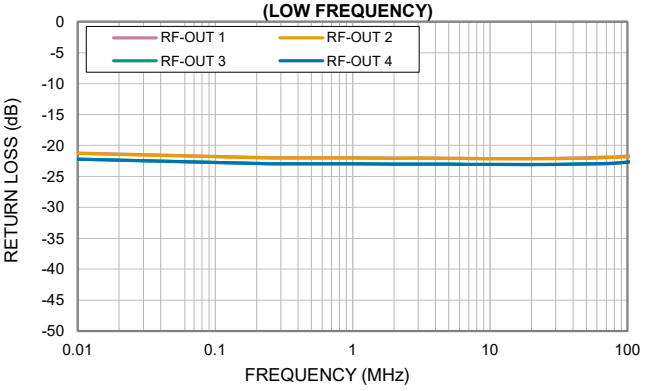
RFC INPUT RETURN LOSS vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(LOW FREQUENCY)



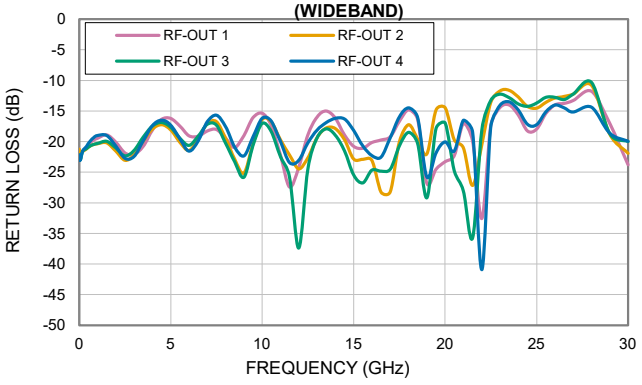
RFC INPUT RETURN LOSS vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(WIDEBAND)



RF (ON) OUTPUT RETURN LOSS
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



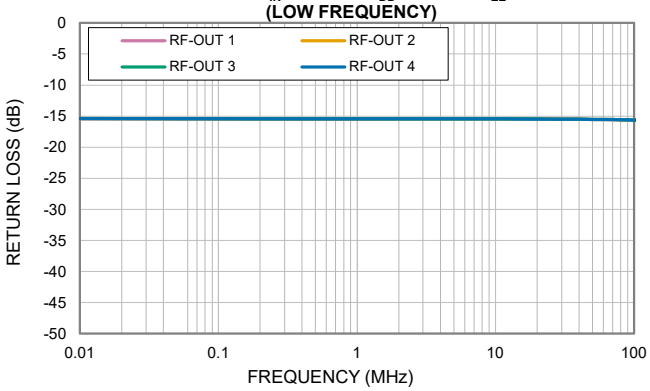
RF (ON) OUTPUT RETURN LOSS
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



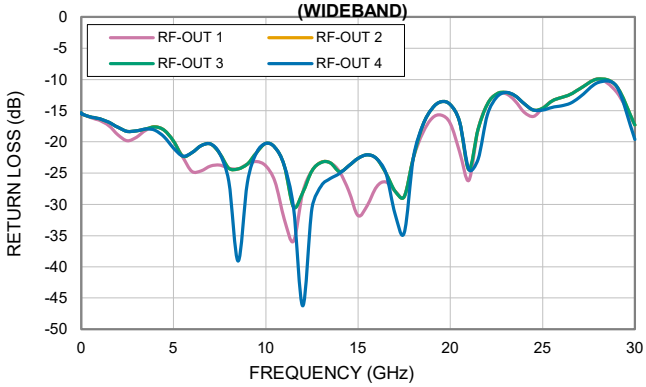
6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.

TYPICAL PERFORMANCE GRAPHS

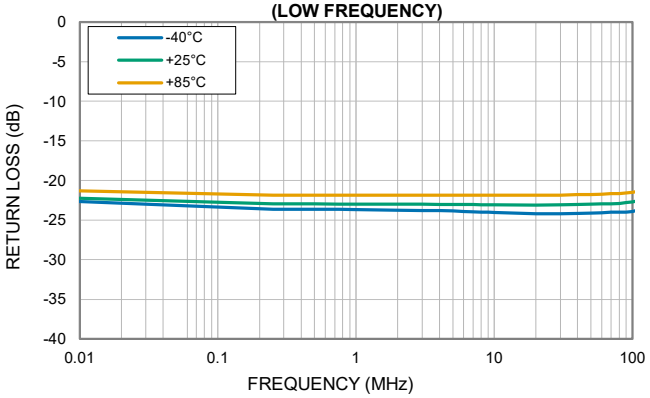
RF (OFF) OUTPUT RETURN LOSS
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



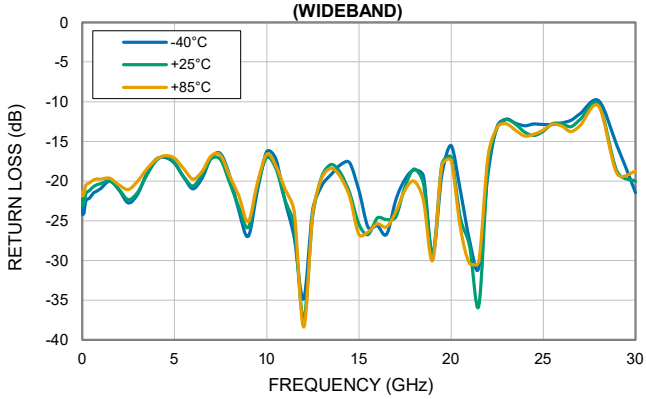
RF (OFF) OUTPUT RETURN LOSS
TEMP = +25°C, P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



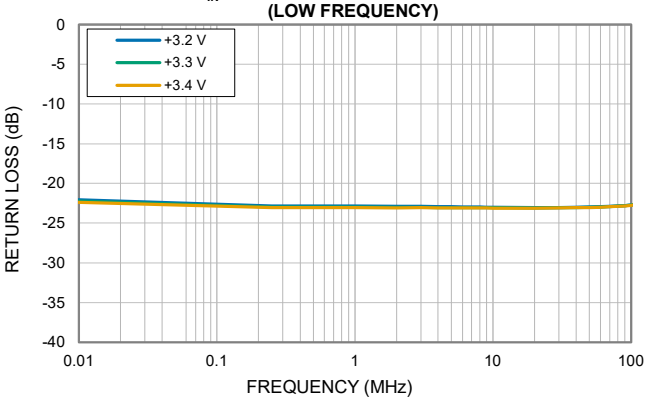
RF[9] (ON) OUTPUT RETURN LOSS vs. TEMP
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



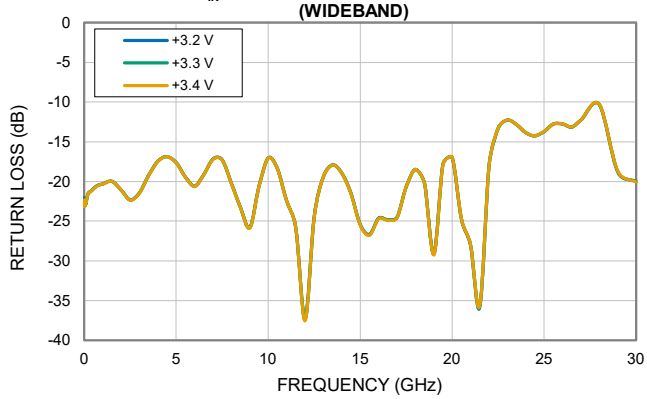
RF[9] (ON) OUTPUT RETURN LOSS vs. TEMP
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



RF[9] (ON) OUTPUT RETURN LOSS vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(LOW FREQUENCY)



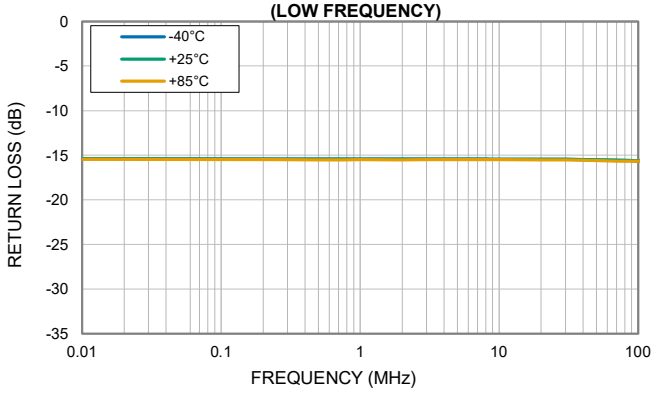
RF[9] (ON) OUTPUT RETURN LOSS vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(WIDEBAND)



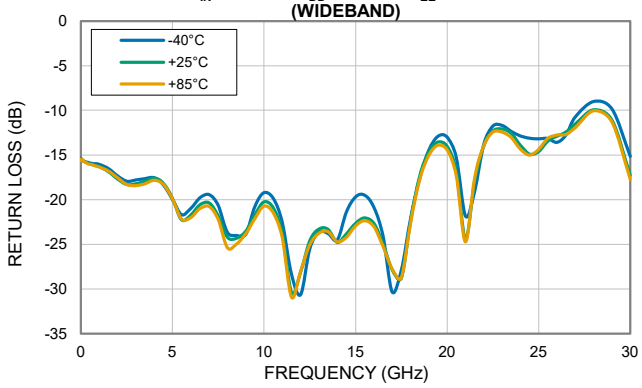
6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.
9. RF-OUT defined as the worst of RF-OUT 1 (ON), RF-OUT 2 (ON), RF-OUT 3 (ON), or RF-OUT 4 (ON)

TYPICAL PERFORMANCE GRAPHS

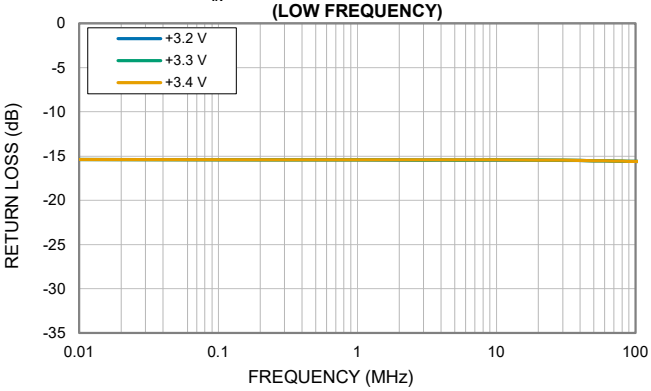
RF[10] (OFF) OUTPUT RETURN LOSS vs. TEMP
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



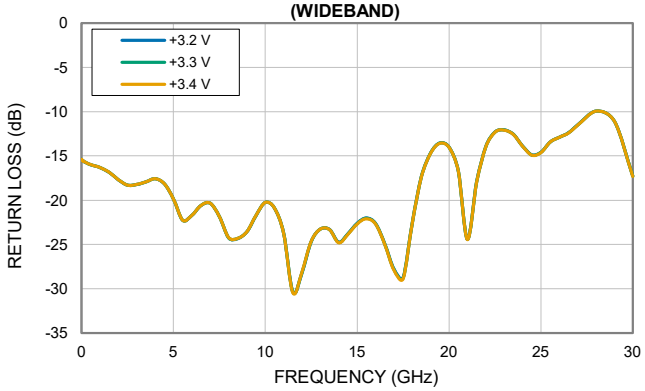
RF[10] (OFF) OUTPUT RETURN LOSS vs. TEMP
P_{IN} = 0 dBm, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



RF[10] (OFF) OUTPUT RETURN LOSS vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(LOW FREQUENCY)



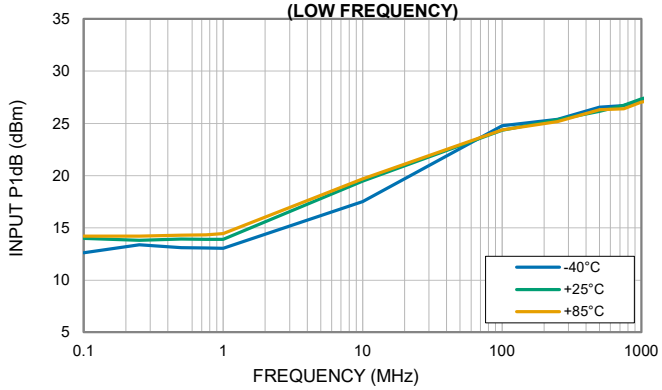
RF[10] (OFF) OUTPUT RETURN LOSS vs. V_{DD}[6]
P_{IN} = 0 dBm, TEMPERATURE = +25°C
(WIDEBAND)



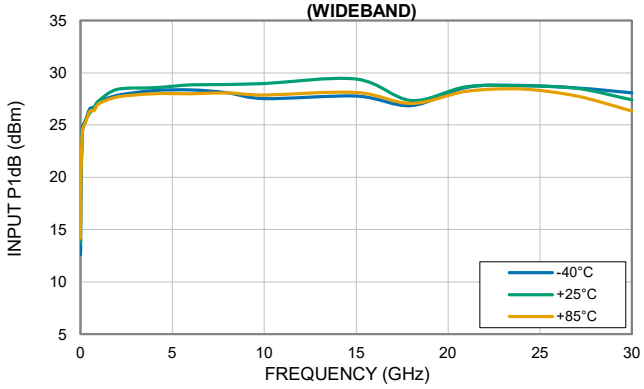
6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.
10. RF-OUT defined as the worst of RF-OUT 1 (OFF), RF-OUT 2 (OFF), RF-OUT 3 (OFF), or RF-OUT 4 (OFF)

TYPICAL PERFORMANCE GRAPHS

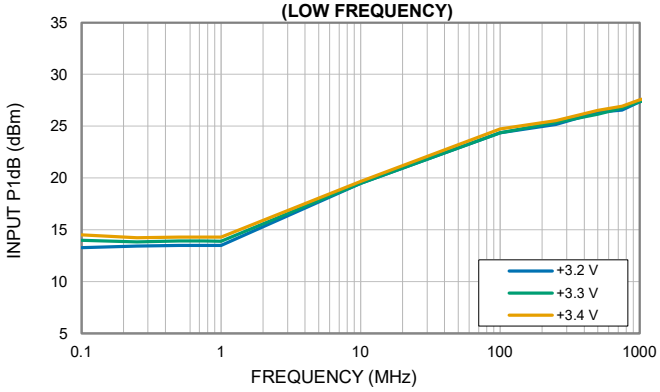
INPUT P1dB vs. TEMPERATURE
V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



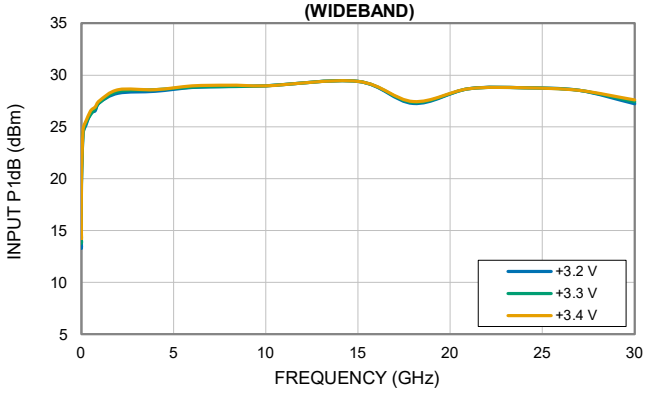
INPUT P1dB vs. TEMPERATURE
V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



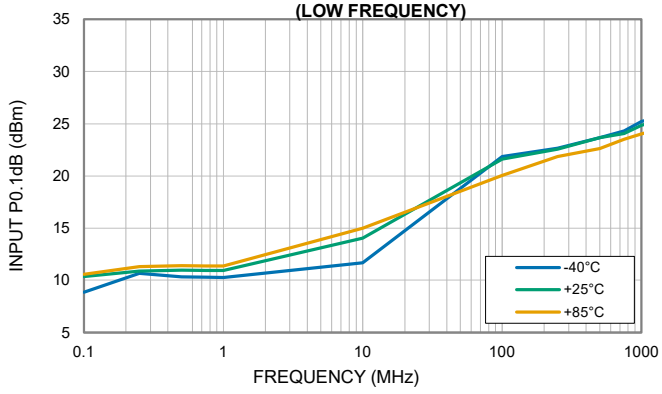
INPUT P1dB vs. V_{DD}[6]
TEMPERATURE = +25°C
(LOW FREQUENCY)



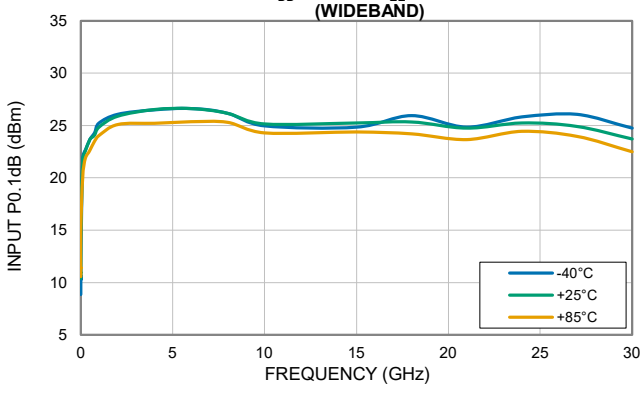
INPUT P1dB vs. V_{DD}[6]
TEMPERATURE = +25°C
(WIDEBAND)



INPUT P0.1dB vs. TEMPERATURE
V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



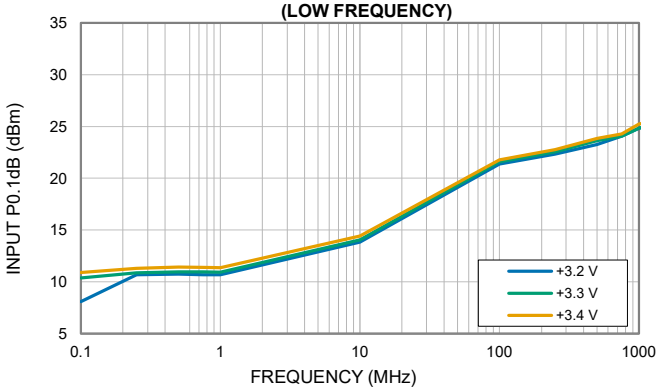
INPUT P0.1dB vs. TEMPERATURE
V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



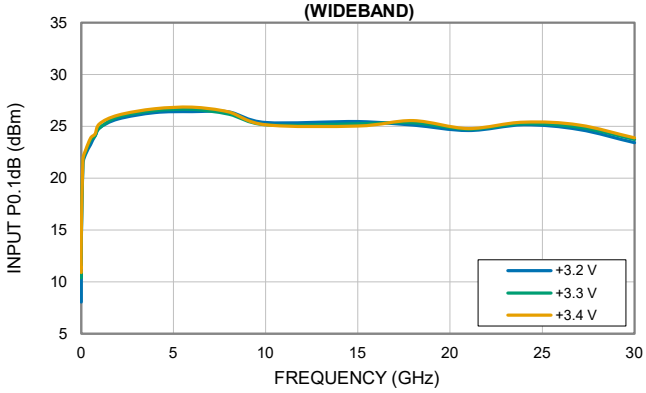
6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.

TYPICAL PERFORMANCE GRAPHS

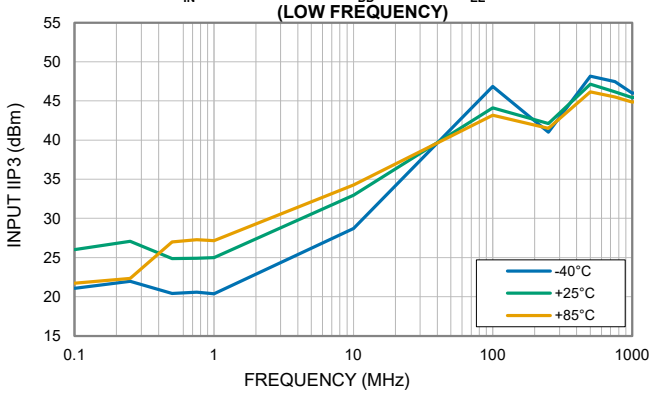
INPUT P0.1dB vs. V_{DD}[6]
TEMPERATURE = +25°C
(LOW FREQUENCY)



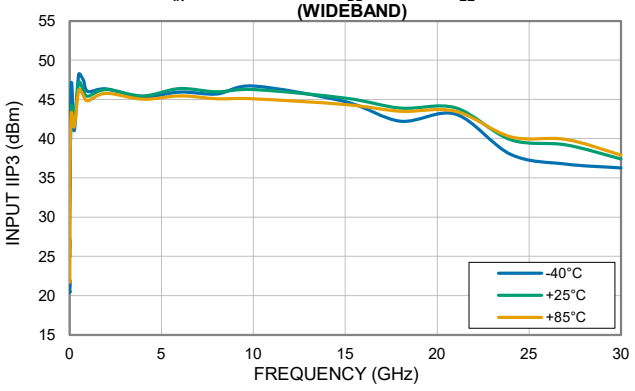
INPUT P0.1dB vs. V_{DD}[6]
TEMPERATURE = +25°C
(WIDEBAND)



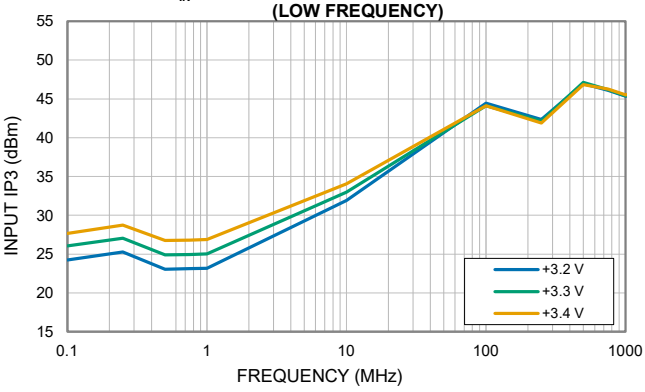
INPUT IP3 vs. TEMPERATURE
P_{IN} = +5 dBm/TONE, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(LOW FREQUENCY)



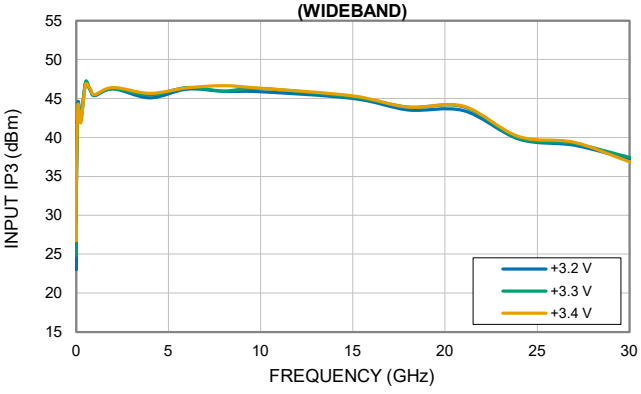
INPUT IP3 vs. TEMPERATURE
P_{IN} = +5 dBm/TONE, V_{DD} = +3.3 V, V_{EE} = -3.3 V
(WIDEBAND)



INPUT IP3 vs. V_{DD}[6]
P_{IN} = +5 dBm/TONE, TEMPERATURE = +25°C
(LOW FREQUENCY)



INPUT IP3 vs. V_{DD}[6]
P_{IN} = +5 dBm/TONE, TEMPERATURE = +25°C
(WIDEBAND)



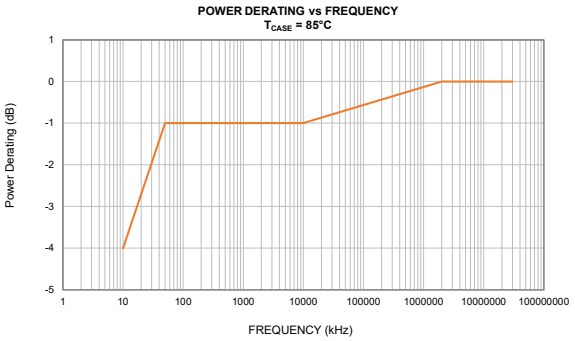
6. V_{EE} is the negative equivalent value to V_{DD}. Both V_{DD} and V_{EE} are varied.

ABSOLUTE MAXIMUM RATINGS[11]

Parameter	Ratings
Operating Temperature (ground lead)	-40°C to +85°C
Storage Temperature	-65°C to +150°C
Junction Temperature[12]	+150°C
Total Power Dissipation	0.33 W
Through Path @ +85°C[13] Input Power at RFC (CW), (V_{DD} = +3.3 V, V_{EE} = -3.3 V)	+30 dBm
Input Power at RF-OUT 1/2/3/4[13] (CW), RF Applied to one of the Unselected Ports (V_{DD} = +3.3 V, V_{EE} = -3.3 V)	+30 dBm
Input Power at RF-OUT 1/2/3/4[13] (CW), RF Applied to the Selected Port (V_{DD} = +3.3 V, V_{EE} = -3.3 V)	+30 dBm
Hot Switching @ +85°C[13] 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

11. Permanent damage may occur if any of these limits are exceeded. Maximum ratings are not intended for continuous normal operation.
12. Peak temperature on top of Die
13. See derating curve at right for power derating over frequency.

POWER DERATING VS. FREQUENCY



THERMAL RESISTANCE

Parameter	Condition	Ratings
Thermal Resistance (Θ_{JC})[14]	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

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

ESD RATING

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

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.

MSL RATING

Moisture Sensitivity: MSL1 in accordance with IPC/JEDEC J-STD-020E/JEDEC J-STD-033C

SP4T RF Switch

M4SWA4-34DR+

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

FUNCTIONAL DIAGRAM (TOP VIEW)

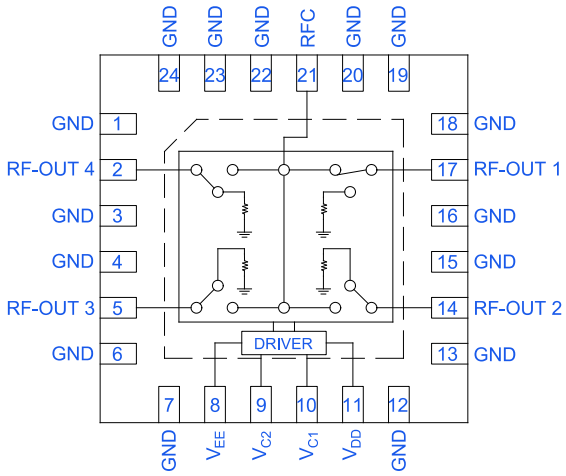


Figure 1. M4SWA4-34DR+ Functional Diagram

PAD DESCRIPTION

Function	Pad Number	Application Description (Refer to Fig 2)
RFC	21	RFC Pad connects to RF Input port.
RF-OUT 1	17	RF-OUT 1 Pad connects to RF Output port 1.
RF-OUT 2	14	RF-OUT 2 Pad connects to RF Output port 2.
RF-OUT 3	5	RF-OUT 3 Pad connects to RF Output port 3.
RF-OUT 4	2	RF-OUT 4 Pad connects to RF Output port 4.
V_{DD}	11	V_{DD} Pad connects to positive DC Input.
V_{EE}	8	V_{EE} Pad connects to negative DC Input.
V_{C1}	10	V_{C1} Pad connects to switch control voltage input 1.
V_{C2}	9	V_{C2} Pad connects to switch control voltage input 2.
GND	1, 3-4, 6-7, 12-13, 15-16, 18-20, 22-24, & Paddle	Connects to ground.

CHARACTERIZATION TEST BOARD[14]

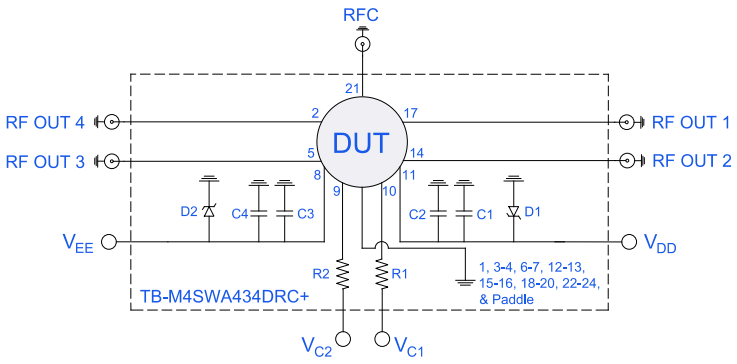


Figure 2. M4SWA4-34DR+ Characterization and Application Circuit

14. Support components are included on the evaluation board for filtering and protection of the device. Support circuitry may vary based on the user's application and may not be required in all cases if clean, known voltages are supplied.

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

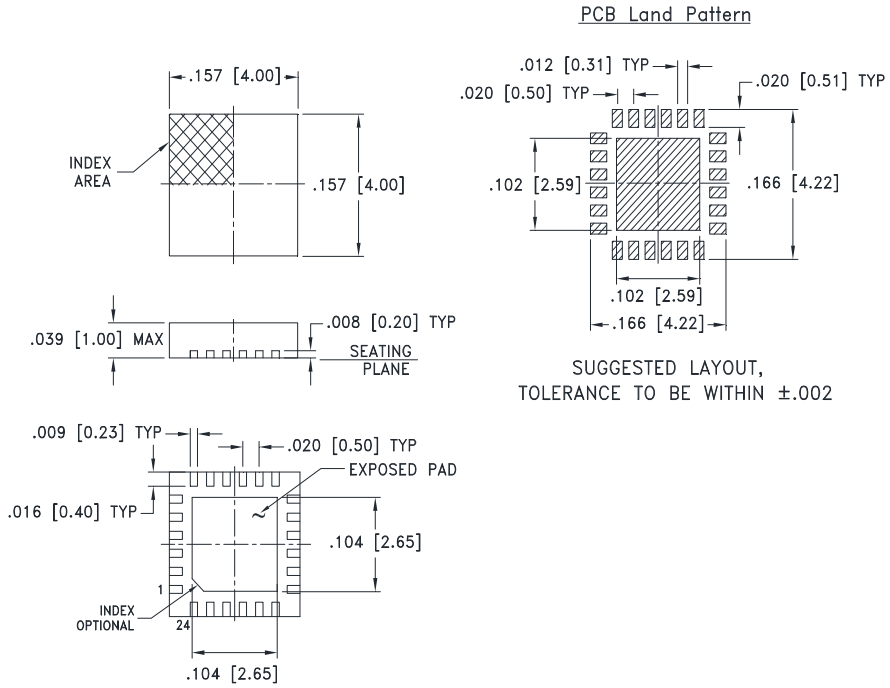
Conditions:
1. Insertion Loss, Isolation, and Return Loss: P_{IN} = 0 dBm
2. Input IP3 (IIP3): Two tones, spaced 1 MHz apart, +5 dBm/Tone at input.

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
D1, D2	V_Z = +5.1 V	SOD-123	MMSZ5231BT1G	ON Semiconductor

SP4T RF Switch M4SWA4-34DR+

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

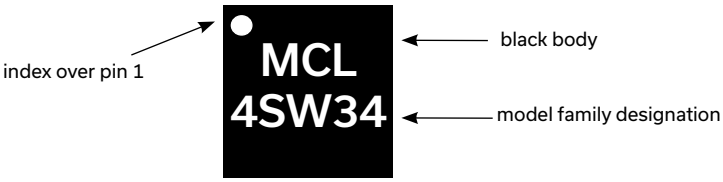
CASE STYLE DRAWING



Weight: .04 Grams

Dimensions are in inches [mm]. Tolerances in inches: 2 Pl. ± .01; 3 Pl. ± .005 inches

PRODUCT MARKING



Marking may contain other features or characters for internal lot control

SP4T RF Switch

M4SWA4-34DR+

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

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	DG1847. Plastic package, exposed paddle, Lead Finish: Matte-Tin
RoHS Status	Compliant
Tape & Reel **Standard quantities available on reel**	F68 7″ reels with 20, 50, 100, 200, 500, or 1000 devices 13″ reels with 2000, 3000, or 4000 devices
Suggested Layout for PCB Design	PL-830
Evaluation Board	TB-M4SWA434DRC+ Gerber File
Environmental Ratings	ENV08T1

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-Circuit's 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 therein. For a full statement of the standard terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/terms/viewterm.html