QPA9154

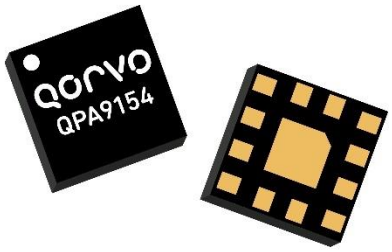
2.3 – 3.8 GHz 100Ω Differential Output Gain Block

Product Overview

The QPA9154 is a 50Ω single-ended input to 100Ω differential output, wideband gain block. It is well suited as the 5G m-MIMO BTS Rx path final gain stage, to directly interface with the ADC of the transceiver, eliminating the need for a discrete balun.

This amplifier delivers exceptional performance with 19 dB of small signal gain and 35 dBm output 3rd order intercept (OIP3). The amplifier has excellent gain flatness of 0.5 dB over any 400 MHz bandwidth and a CMRR of 35 dB. The amplifier features a shut-down function through V_{PD} pin control.

The QPA9154 is optimized over 2.3-3.8 GHz band and is housed in a compact 2 x 2 mm SMT package.

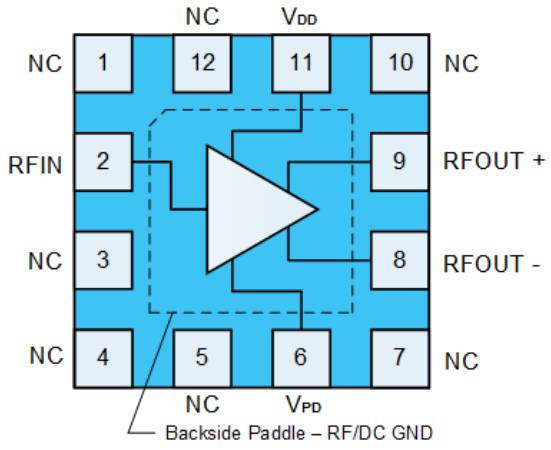


12-pin, 2 x 2 mm SMT Package

Key Features

- 2.3 – 3.8 GHz Operational Frequency
- 100 Ohm Differential Output
- 50 Ohm Single-Ended Input
- 19 dB Gain at 2.6 GHz
- +34 dBm OIP3
- +18.5 dBm P1dB
- Small 2 x 2 mm SMT Package

Functional Block Diagram



Top View

Applications

- 5G m-MIMO
- Mobile Infrastructure
- General Purpose Wireless
- TDD / FDD System

Ordering Information

Part No.	Description
QPA9154TR7	2500 pcs on 7” reel (standard)
QPA9154EVB-01	Differential Output Evaluation Board

Absolute Maximum Ratings

Parameter	Rating
Storage Temperature	-65 to +150°C
RF Input Power, CW, 50 Ω, T=25 °C	22 dBm
Device Voltage (V_{DD})	7 V

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
Device Voltage (V_{DD})	+3.3	+5	+5.25	V
T_{CASE}	−40		+105	°C
Tj for >10^6 hours MTTF			+190	°C

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

Electrical Specifications

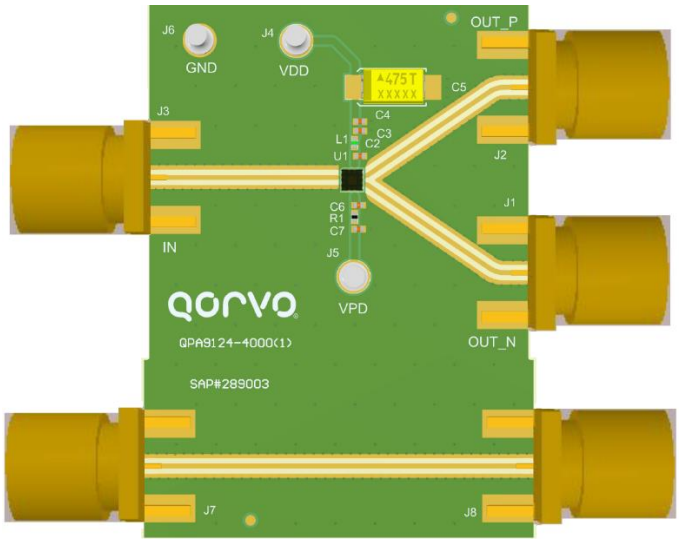
Parameter	Conditions (1)	Min	Typ	Max	Units
Operational Frequency Range		2300		3800	MHz
Test Frequency			2600		MHz
Small Signal Gain		16.5	19	20.5	dB
Gain Flatness	Any 400 MHz BW		0.5		dB
CMRR			35		dB
Input Return Loss			13		dB
Output Return Loss	100 Ω differential		17		dB
Output P1dB		+16	+19		dBm
Output IP3	Pout 0 dBm/tone combined, Δf = 1 MHz	+29	+34		dBm
Differential Output Impedance			100		ohm
Noise Figure			1.5		dB
Device Current, ON	V_{PD} = 0.63 V		70	110	mA
Device Current, OFF	V_{PD} = 1.17 V		4		mA
V_{PD}, Logic Low		0		0.63	V
V_{PD}, Logic High		1.17		V_{DD}	V
Switching Time	50% V_{PD} to 10/90% RF		100		nsec
Thermal Resistance, θ_{jc}	Junction to case		50		°C/W

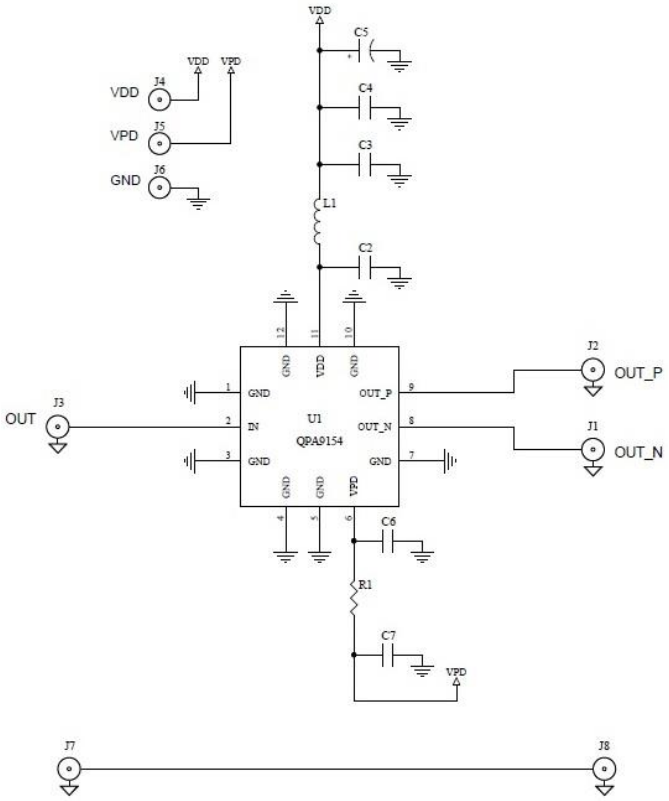
Notes:
1. Test conditions unless otherwise noted: V_{DD} +5.0 V, V_{PD} +0.63 V, Temp +25 °C, 50 Ω system. Differential output conversion with ideal balun

Logic Table

Parameter, V_{PD}	High	Low
Device State	OFF	ON

2300 to 3800MHz Differential Evaluation Board - QPA9154EVB-01



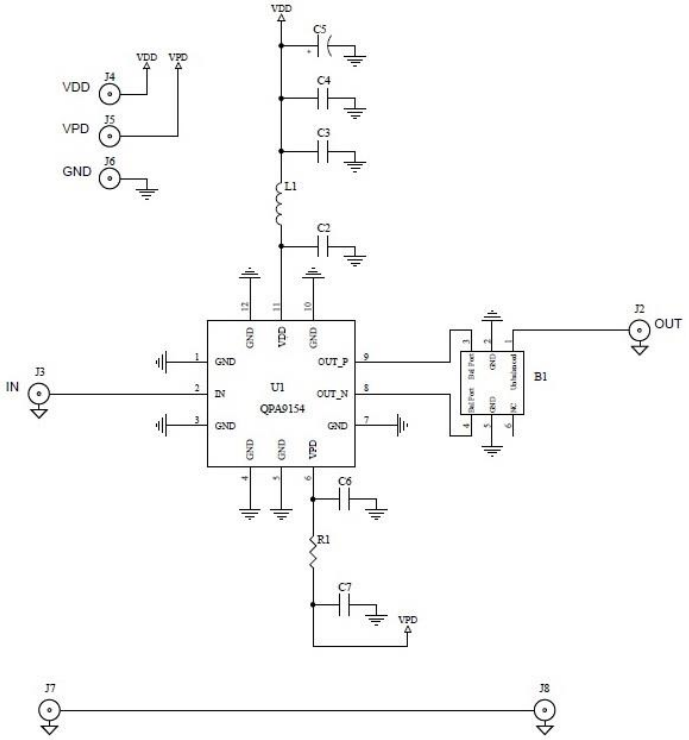


Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
-	-	Printed Circuit Board	Qorvo	
U1	-	Differential Output Rx Gain Block	Qorvo	QPA9154
C5	10 µF	CAP, 10 µF, 20%, 25V, Tantalum, 6032	Cal-Chip	TCMIE106CT
C3	1000 pF	CAP, 1000 pF, 10%, 50V, X7R, 0402	Various	
C4	0.1 µF	CAP, 0.1 µF, 10%, 50V, X5R, 0402	Various	
R1	0 Ω	RES, 0 Ω, 1/10W, 0402	Various	
L1 (1)	3.9 nH	IND, 3.9 nH, Thin Film, 0402	Various	
J1, J2, J3	-	Conn, SMA F STRT .062”	Cinch Connectivity	142-0701-851

Notes:
1. For optimum performance replace L1 with 6.8 nH inductor for 2.3GHz to 2.7GHz band, or 2.0 nH for 3.3GHz to 3.8GHz band.

2300 to 3800MHz Evaluation Board with Output Balun



Bill of Materials

Reference Des.	Value	Description	Manuf.	Part Number
-	-	Printed Circuit Board	Qorvo	
U1	-	Differential Output Rx Gain Block	Qorvo	QPA9154
B1	-	BALUN, 3.1GHZ-5GHZ, 50/100, 0404	Anaren	BD3150N50100AHF
C5	10 µF	CAP, 10 µF, 20%, 25V, Tantalum, 6032	Cal-Chip	TCMIE106CT
C3	1000 pF	CAP, 1000 pF, 10%, 50V, X7R, 0402	Various	
C4	0.1 µF	CAP, 0.1 µF, 10%, 50V, X5R, 0402	Various	
R1	0 Ω	RES, 0 Ω, 1/10W, 0402	Various	
L1 (1)	3.9 nH	IND, 3.9 nH, Thin Film, 0402	Various	
J1, J2, J3	-	Conn, SMA F STRT .062”	Cinch Connectivity	142-0701-851

Notes:
1. For optimum performance replace L1 with 6.8 nH inductor for 2.3GHz to 2.7GHz band, or 2.0 nH for 3.3GHz to 3.8GHz band.

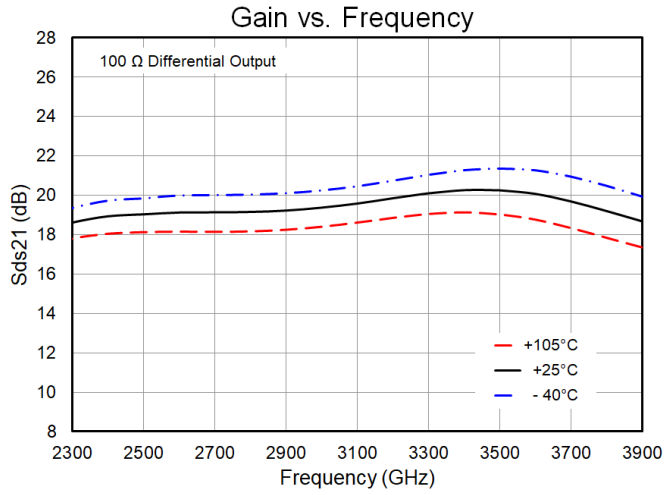
Typical Performance – QPA9154EVB-01

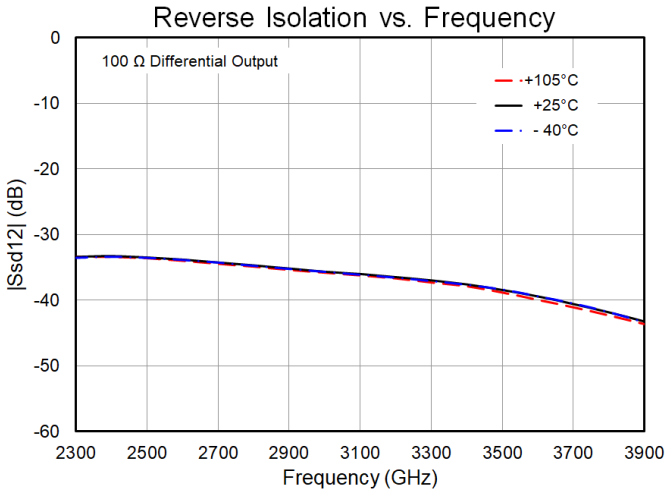
Parameter	Conditions (1)	Typical Value						Units
Frequency		2300	2600	2700	3200	3600	3800	MHz
Gain		18.6	19.1	19.1	19.8	20.0	19.1	dB
Input Return Loss		12.5	14.1	13.8	12.7	16.7	20.2	dB
Output Return Loss	100 Ω differential	7.5	12.9	16.2	13.1	8.1	7.2	dB
Output P1dB		18.7	18.4	18.2	18.1	17.3	16.9	dBm
Output IP3	Pout 0 dBm/tone combined, Δf 1 MHz	36.1	35.0	36.3	34.7	32.7	31.3	dBm
Device Current	V_{DD}	70						mA

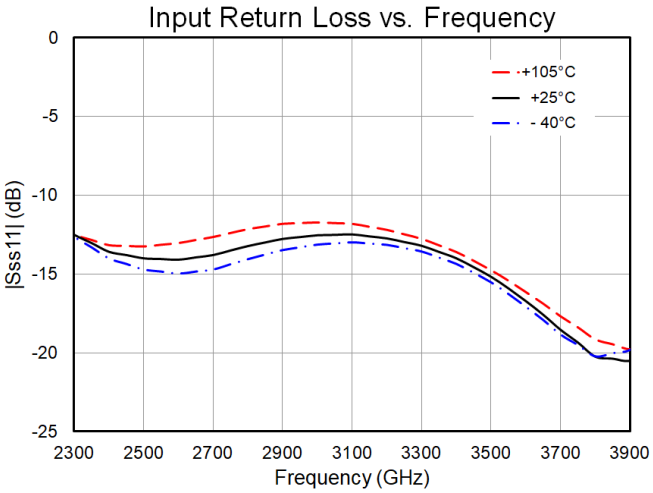
Notes:
1. Test Conditions unless otherwise noted: V_{DD} +5.0 V, V_{PD} +0.63 V, Temp.+25 °C. L1 3.9 nH. Differential output conversion with ideal balun

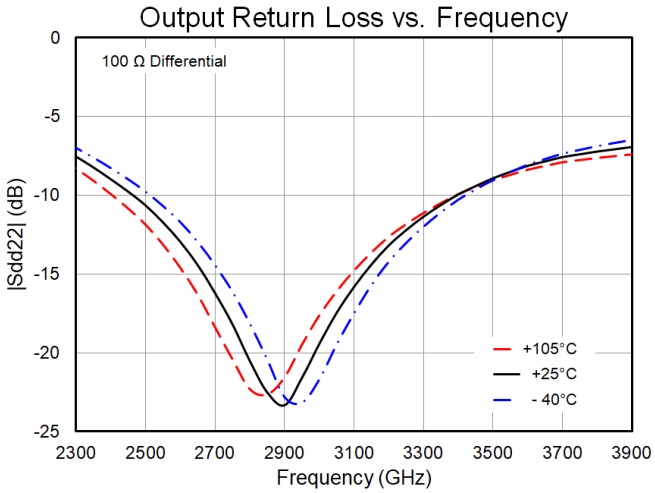
Performance Plots – QPA9154EVB-01

Test conditions unless otherwise noted: V_{DD} = +5.0 V, I_{DD} = 70 mA, V_{PD} = +0.63 V, 50 Ω system





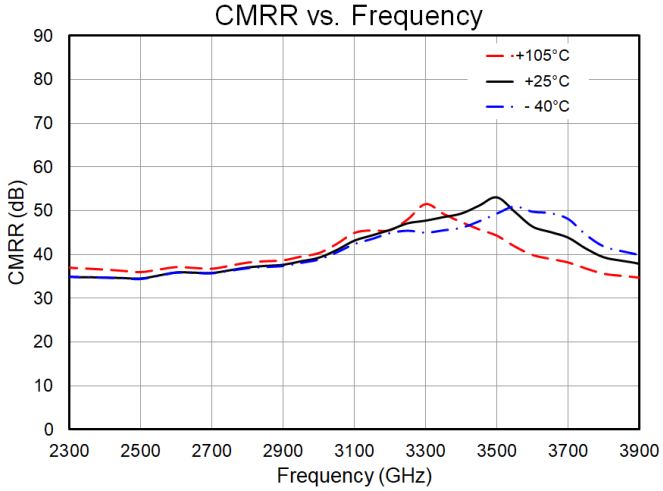




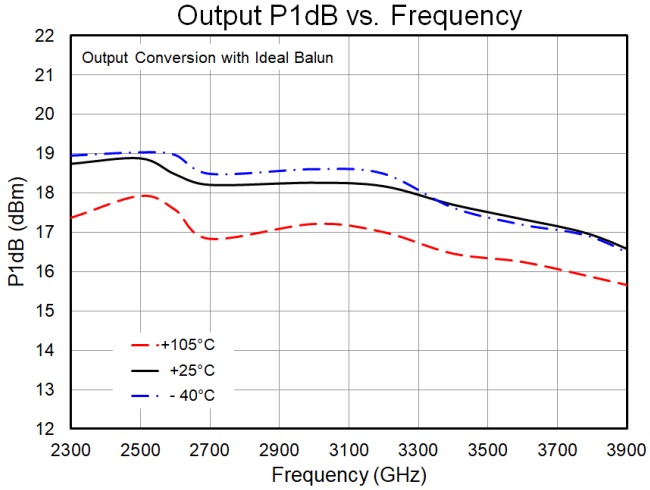
Performance Plots – QPA9154EVB-01 (Continue)

Test conditions unless otherwise noted: V_{DD} = +5.0 V, I_{DD} = 70 mA, V_{PD} = +0.63 V, 50 Ω system

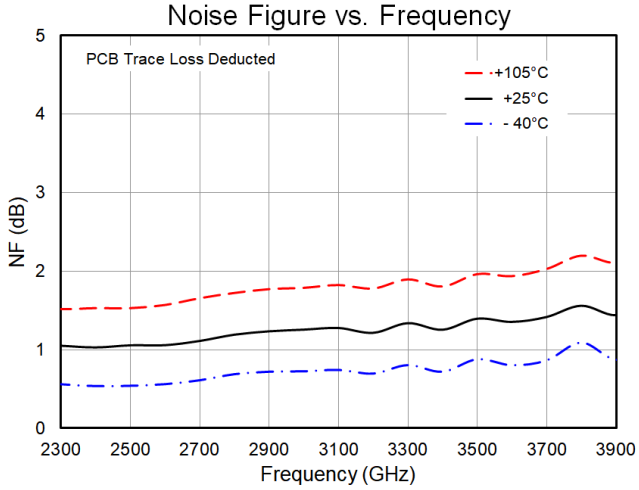
CMRR vs. Frequency



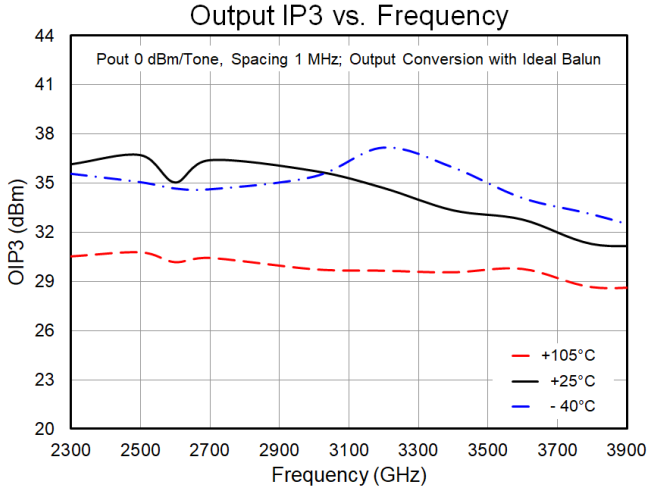
Output P1dB vs. Frequency



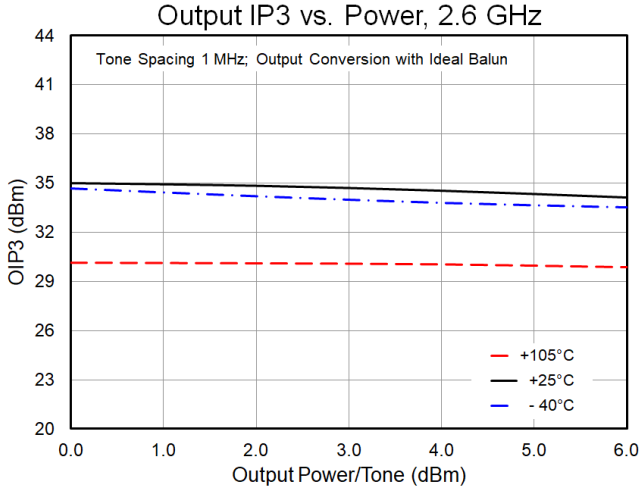
Noise Figure vs. Frequency



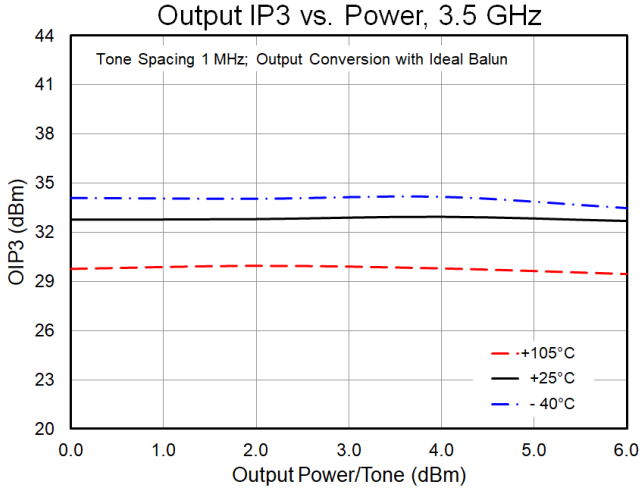
Output IP3 vs. Frequency



Output IP3 vs. Power, 2.6 GHz



Output IP3 vs. Power, 3.5 GHz



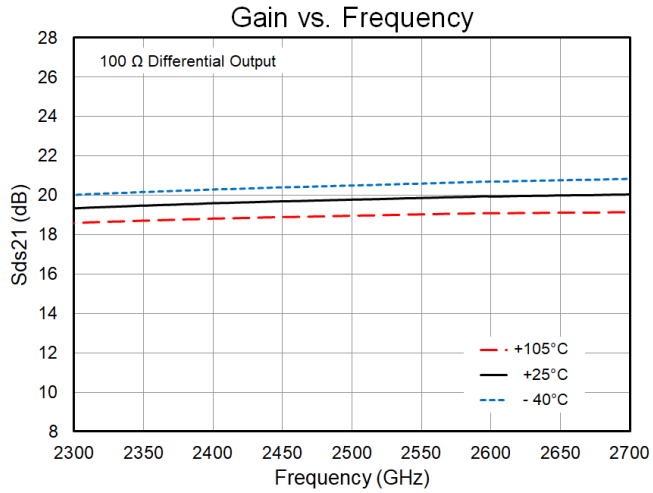
Typical Performance – EVB with L1 6.8 nH for 2.3-2.7 GHz

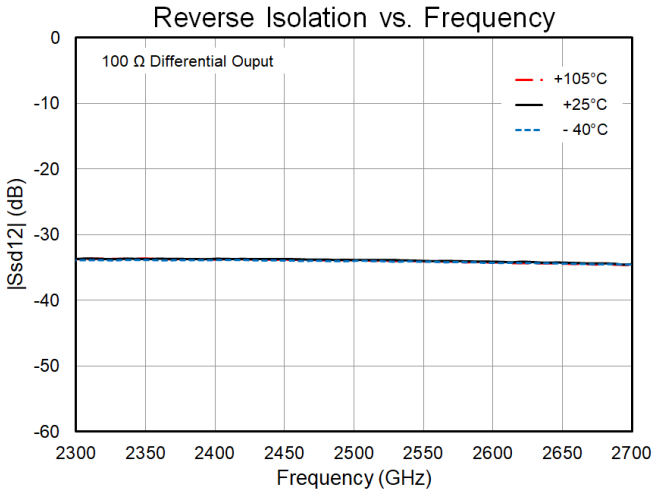
Parameter	Conditions (1)	Typical Value			Units
Frequency		2300	2600	2700	MHz
Gain		19.3	19.9	20.0	dB
Input Return Loss		14.1	13.0	12.3	dB
Output Return Loss	100 Ω differential	9.6	17.6	18.3	dB
Output P1dB		18.9	18.9	18.9	dBm
Output IP3	Pout 0 dBm/tone combined, Δf 1 MHz	35.5	34.9	35.8	dBm
Device Current	V_{DD}	70			mA

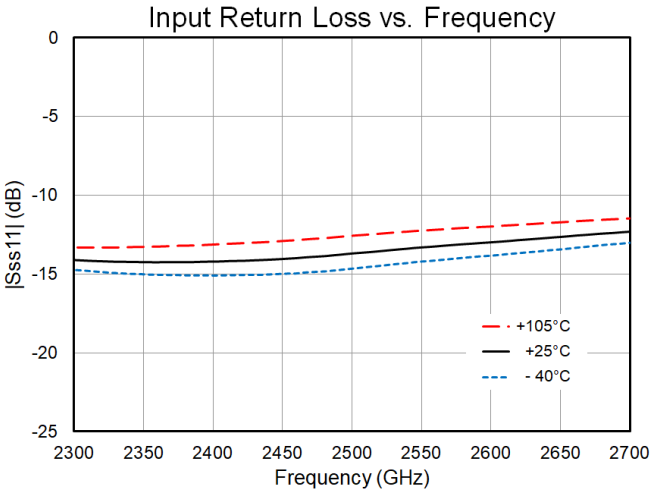
Notes:
1. Test Conditions unless otherwise noted: V_{DD} +5.0 V, V_{PD} +0.63 V, Temp. +25 °C. L1 = 6.8nH. Differential output conversion with ideal balun

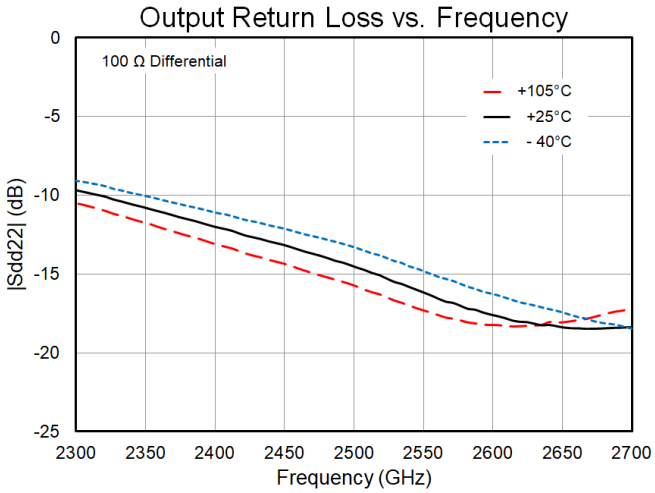
Performance Plots – EVB with L1 6.8 nH for 2.3-2.7 GHz

Test conditions unless otherwise noted: V_{DD} = +5.0 V, I_{DD} = 70 mA, V_{PD} = +0.63 V, 50 Ω system



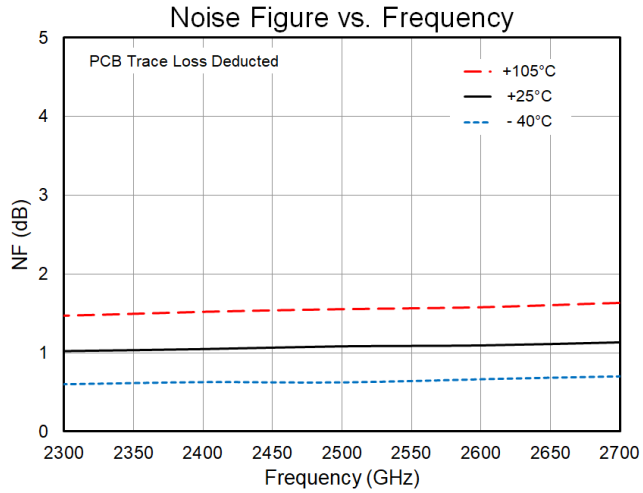


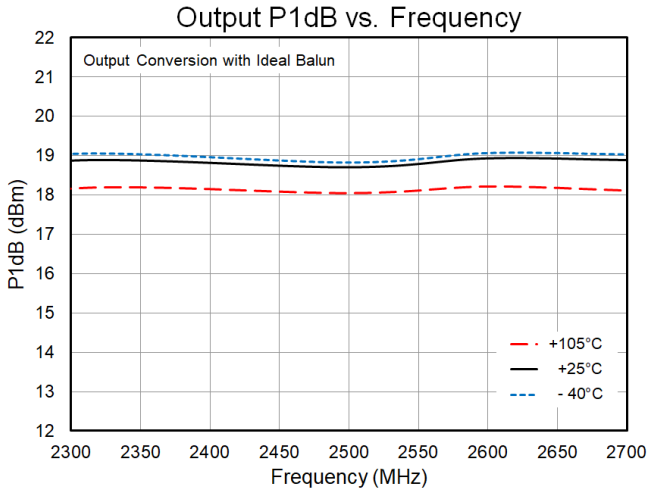


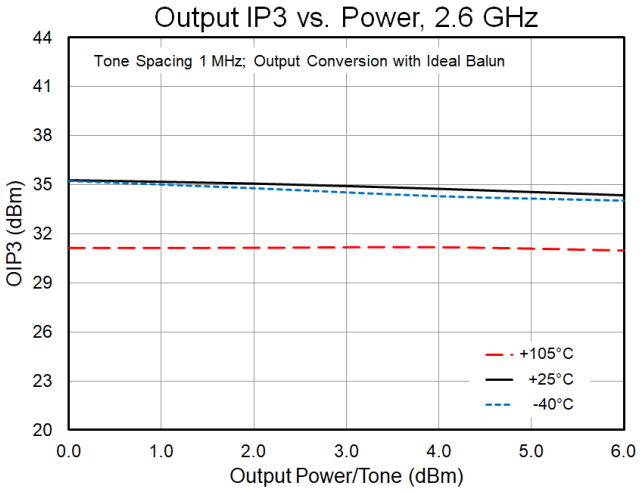


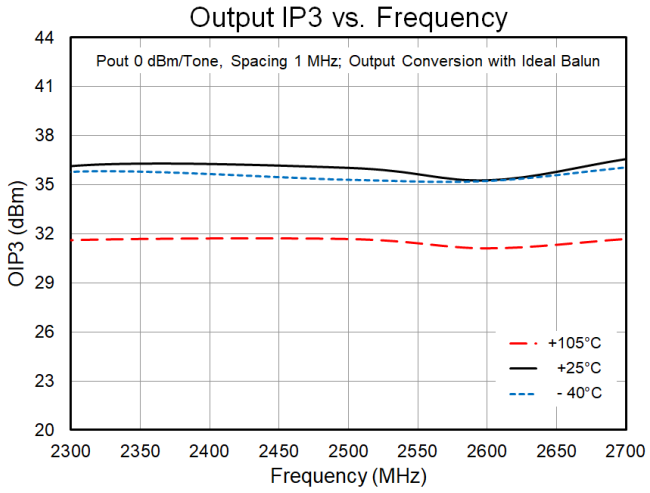
Performance Plots – EVB with L1 6.8 nH for 2.3-2.7 GHz (Continue)

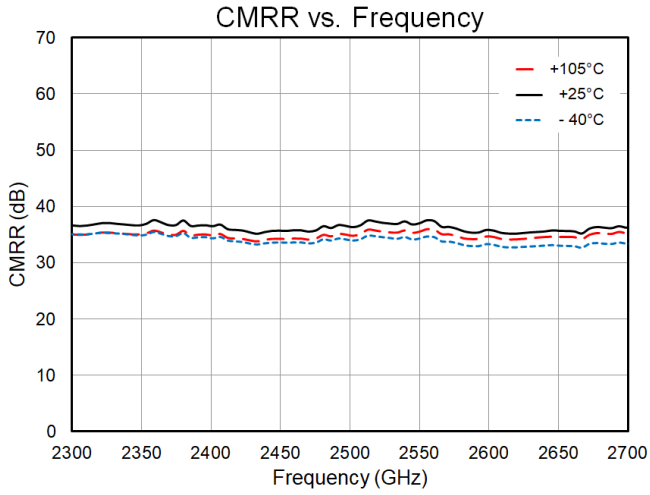
Test conditions unless otherwise noted: V_{DD} = +5.0 V, I_{DD} = 70 mA, V_{PD} = +0.63 V, 50 Ω system











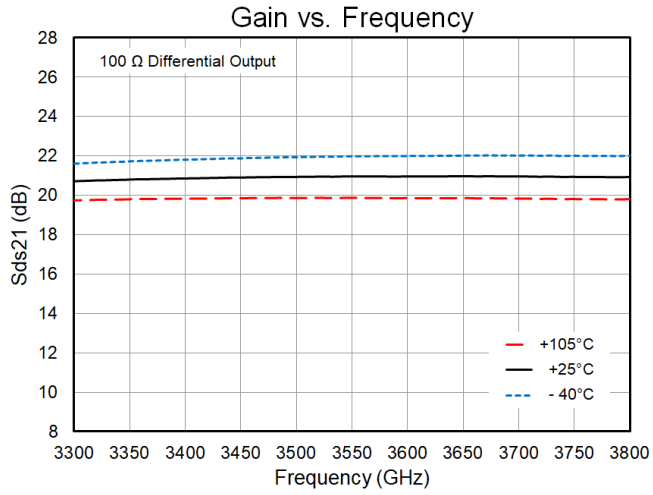
Typical Performance – EVB with L1 2.0 nH for 3.3-3.8 GHz

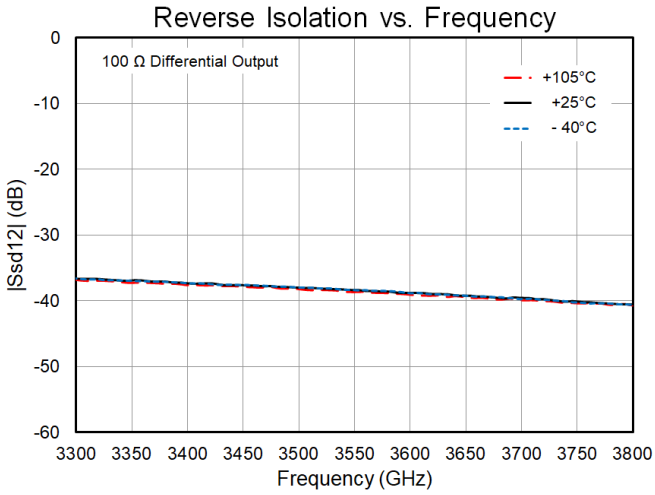
Parameter	Conditions (1)	Typical Value			Units
Frequency		3200	3500	3800	MHz
Gain		20.5	20.9	20.9	dB
Input Return Loss		15.7	16.6	19.7	dB
Output Return Loss	100 Ω differential	27.2	12.9	7.8	dB
Output P1dB		18.5	19.1	18.6	dBm
Output IP3	Pout 0 dBm/tone combined, Δf 1 MHz	34.9	36.1	35.4	dBm
Device Current	V_{DD}		70		mA

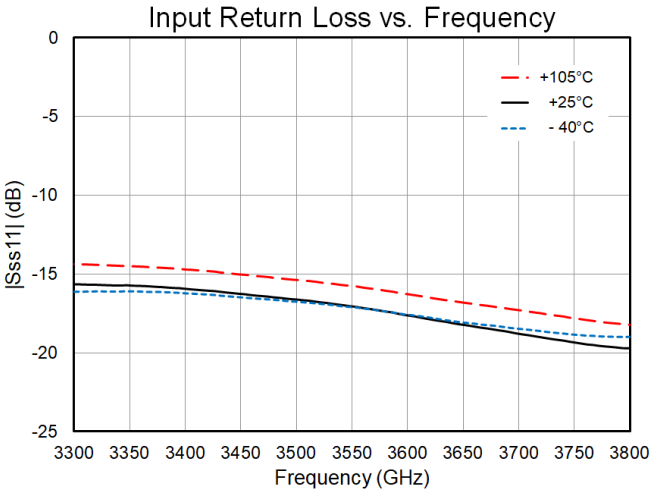
Notes:
1. Test Conditions unless otherwise noted: V_{DD} +5.0 V, V_{PD} +0.63 V, Temp. +25 °C, L1 2.0 nH. Differential output conversion with ideal balun

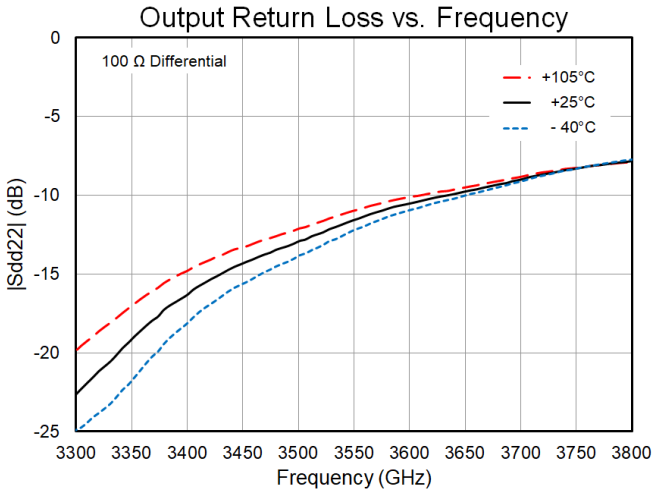
Performance Plots – EVB with L1 2.0 nH for 3.3-3.8 GHz

Test conditions unless otherwise noted: V_{DD} = +5.0 V, I_{DD} = 70 mA, V_{PD} = +0.63 V, 50 Ω system



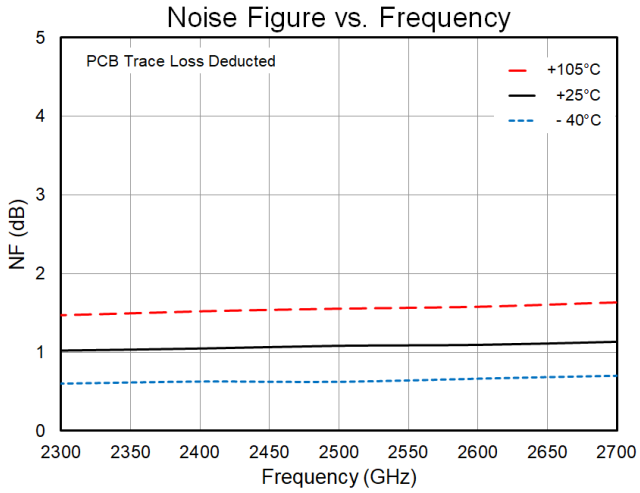


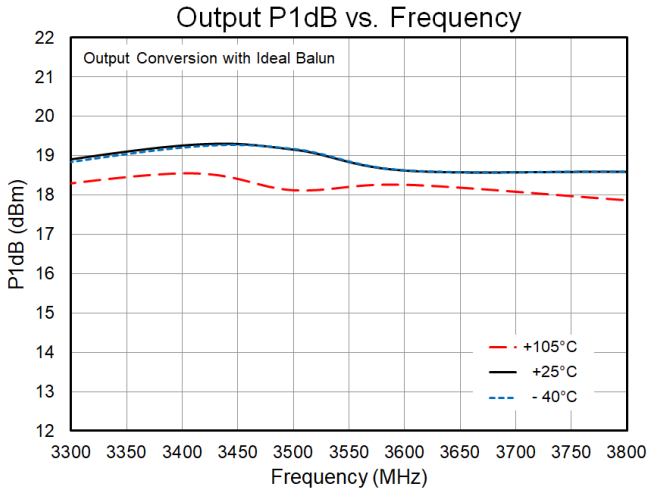


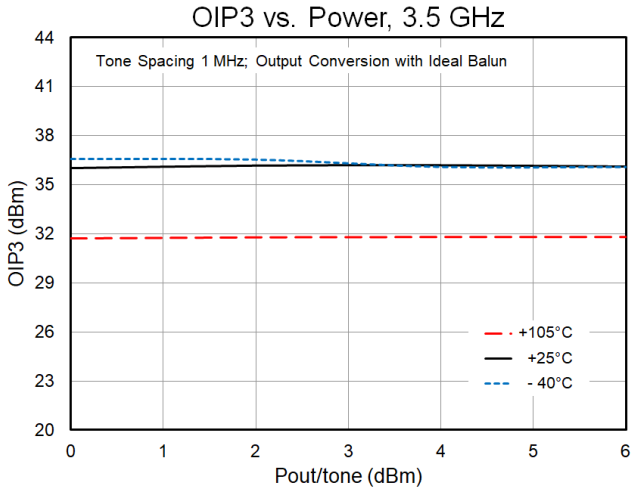


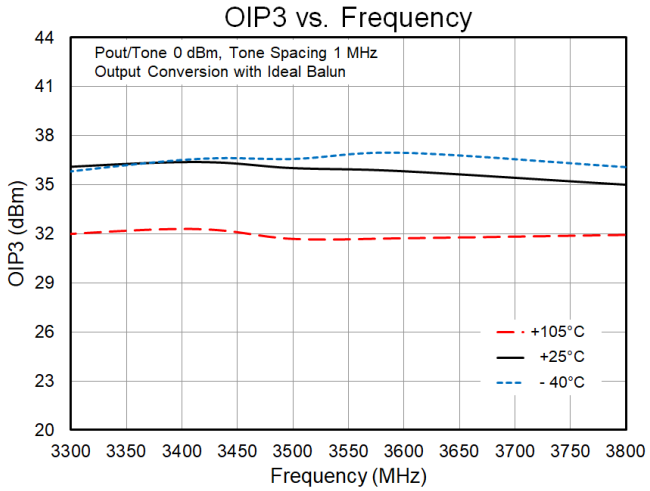
Performance Plots – EVB with L1 2.0 nH for 3.3-3.8 GHz (Continue)

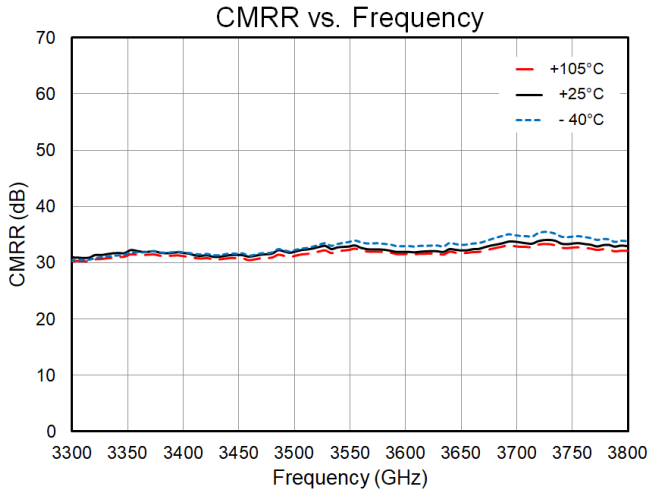
Test conditions unless otherwise noted: V_{DD} = +5.0 V, I_{DD} = 70 mA, V_{PD} = +0.63 V, 50 Ω system



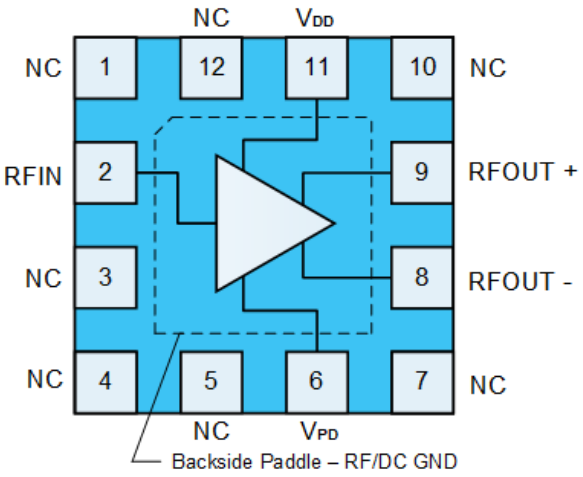








Pad Configuration and Description

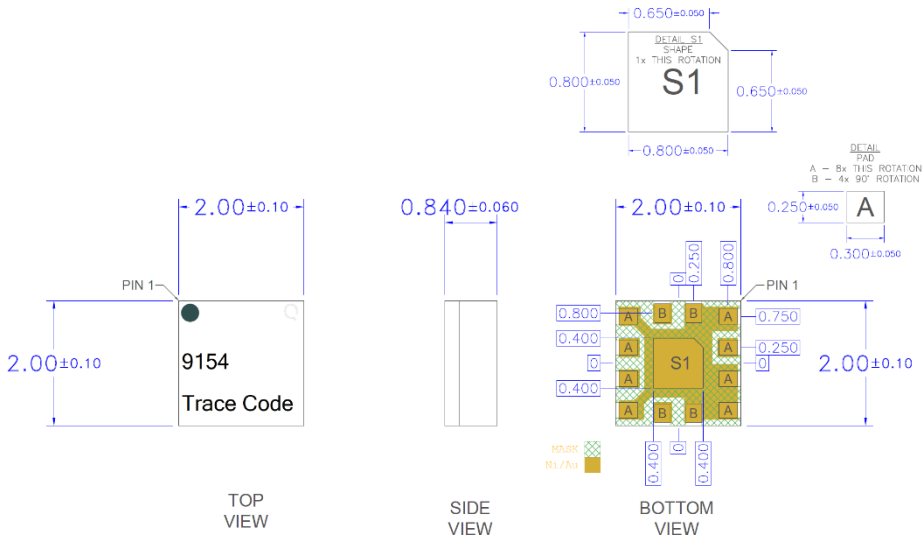


Top View

Pad No.	Label	Description
1, 3, 4, 5, 7, 10, 12	NC	No electrical connection internally. It may be left floating or connected to ground. Land pads should be provided for PCB mounting integrity.
2	RFIN	RF input. Internally matched to 50Ohm.
6	V_{PD}	Power down control input, Turn down amplifier bias.
8	RFOUT-	Differential output –. Requires external DC blocking capacitor if DC is present on this pin.
9	RFOUT+	Differential output +. Requires external DC blocking capacitor if DC is present on this pin.
11	V_{DD}	DC Power input, supply voltage for amplifier.
Backside Paddle	GND	RF/DC ground. Use recommended via hole pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint.

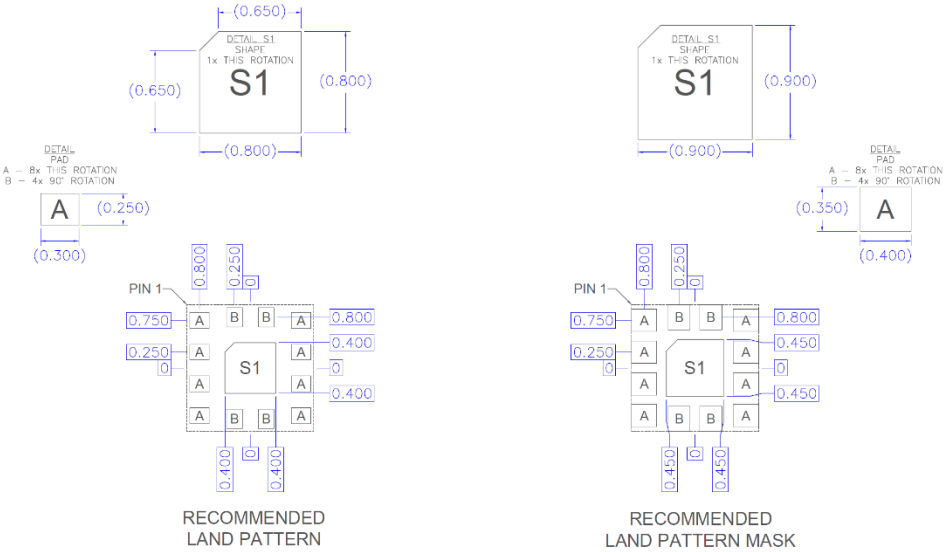
Package Marking and Dimensions

Marking: Part Number – 9154
Trace Code – to be assigned by sub-contractor



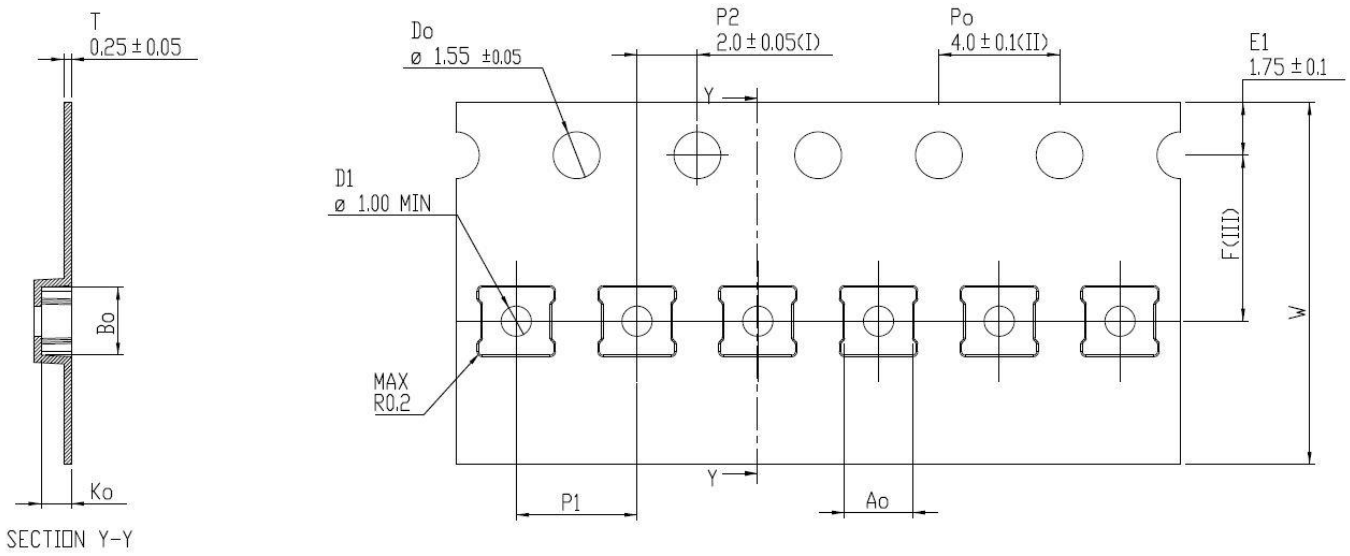
Notes:
1. All dimensions are in millimeters. Angles are in degrees.
2. The terminal #1 identifier and terminal numbering conform to SPE-000677.
3. Contact plating: ENEPIG

Recommended PCB Layout Pattern

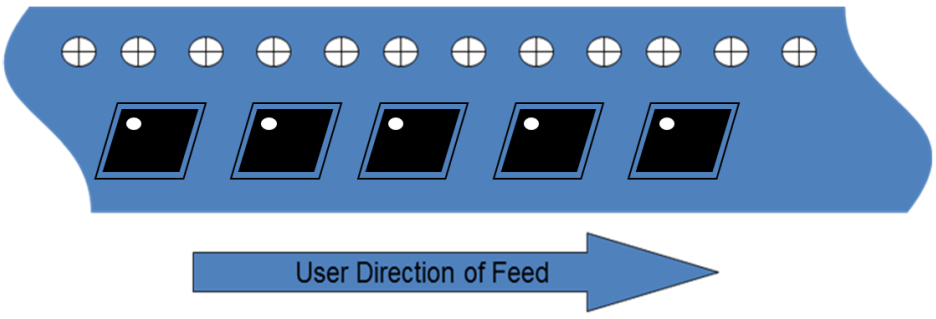


Notes:
1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layer metal.
3. Via holes are required under the backside paddle of this device for proper RF/DC grounding and thermal dissipation. We recommend a 0.35mm (#80/.0135") diameter bit for drilling via holes and a final plated thru diameter of 0.25 mm (0.01").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

Tape and Reel Information – Carrier and Cover Tape Dimensions

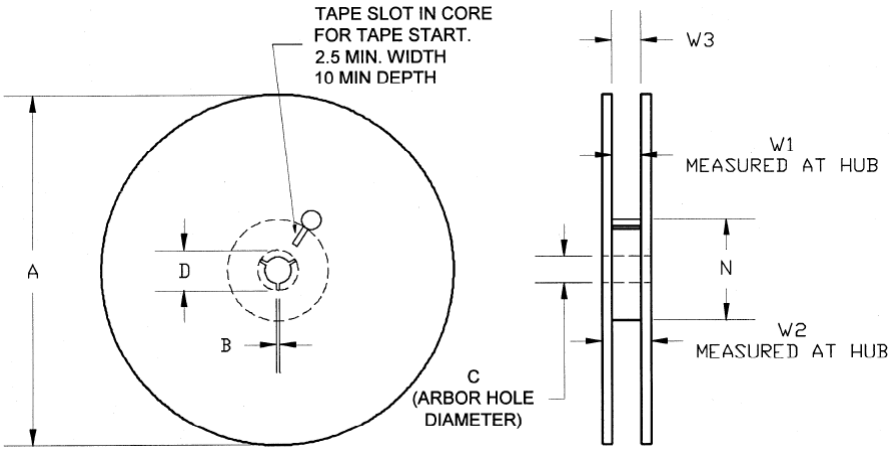


Feature	Measure	Symbol	Size (in)	Size (mm)
Cavity	Length	A0	0.087	2.20
	Width	B0	0.087	2.20
	Depth	K0	0.037	0.95
	Pitch	P1	0.157	4.00
Centerline Distance	Cavity to Perforation - Length Direction	P2	0.079	2.00
	Cavity to Perforation - Width Direction	F	0.217	5.50
Cover Tape	Width	C	0.362	9.20
Carrier Tape	Width	W	0.472	12.00



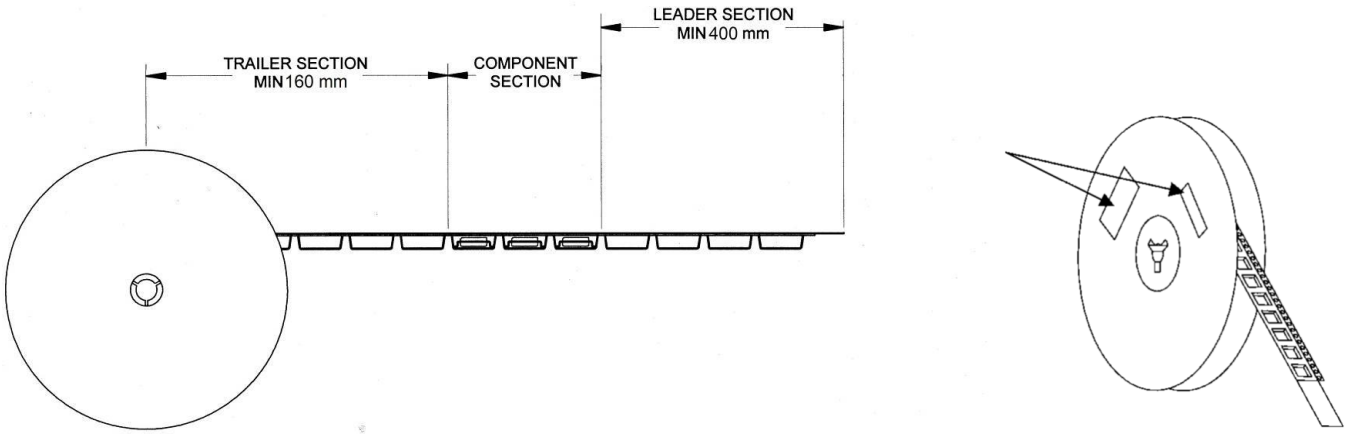
Tape and Reel Information – Reel Dimensions

Standard T/R size = 2,500 pieces on a 7” reel.



Feature	Measure	Symbol	Size (in)	Size (mm)
Flange	Diameter	A	6.969	177.0
	Thickness	W2	0.717	18.2
	Space Between Flange	W1	0.504	12.8
Hub	Outer Diameter	N	2.283	58.0
	Arbor Hole Diameter	C	0.512	13.0
	Key Slit Width	B	0.079	2.0
	Key Slit Diameter	D	0.787	20.0

Tape and Reel Information – Tape Length and Label Placement



Notes:
1. Empty part cavities at the trailing and leading ends are sealed with cover tape. See EIA 481-1-A.
2. Labels are placed on the flange opposite the sprockets in the carrier tape.

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1C	ESDA / JEDEC JS-001-2017
ESD – Charged Device Model (CDM)	Class C3	JEDEC JESD22-C101F
MSL – Moisture Sensitivity Level	Level 3	IPC/JEDEC J-STD-020E

Caution!
ESD-Sensitive Device

Solderability

Compatible with both lead-free (260°C max. reflow temperature) and tin/lead (245°C max. reflow temperature) soldering processes. Solder profiles available upon request.

Contact plating: ENEPIG *(Ni 0.40 ± 0.10 µm, Pd 0.145 ± 0.035 µm, Au 0.095 ± 0.025 µm)*

RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free

Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

Web: www.qorvo.com

Tel: 1-844-890-8163

Email: customer.support@qorvo.com

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