LEAD-FREE / RoHS-COMPLIANT

HIGH POWER SURFACE-MOUNT BALUN — BALH-0009SMG

Features

- 500 kHz to 9 GHz Balun (Balanced to Unbalanced Transformer)
- High 37 dBm 1-dB compression enables high power applications
- Tuned for Optimal Phase/Amplitude Balance
- Applications: Balanced Amplifiers, Baseband Digital Modulation, Signal Integrity
- BALH-0009SMG.s3p

Electrical Specifications - Specifications guaranteed from -55 to +100°C, measured in a 50Ω system.

Parameter	Frequency Range	Min	Typ	Max
Insertion Loss (dB)			2.5	4
Input 1 dB Compression (dBm)			37	
Nominal Phase Shift (Degrees)			180	
Amplitude Balance (dB)			0.8	1.6
Phase Balance (Degrees)	500 kHz to 9 GHz		5	12
Common Mode Rejection (dB)		17	25	
Isolation (dB)			6	
VSWR (Input) VSWR (Output)			2.1 1.3	
Risetime /Falltime (ps)[1]			25	

[1]Specified as 90%/10%. Calculated from $\tau_{balun}^2 = (\tau_{out}^2 - \tau_{in}^2)$

Model Number	Description
BALH-0009SMG	500 kHz to 9 GHz Balun, High Power, Surface Mount, LEAD-FREE/RoHS COMPLIANT
EVAL-BALH-0009	Connectorized Evaluation Board, LEAD-FREE/RoHS COMPLIANT

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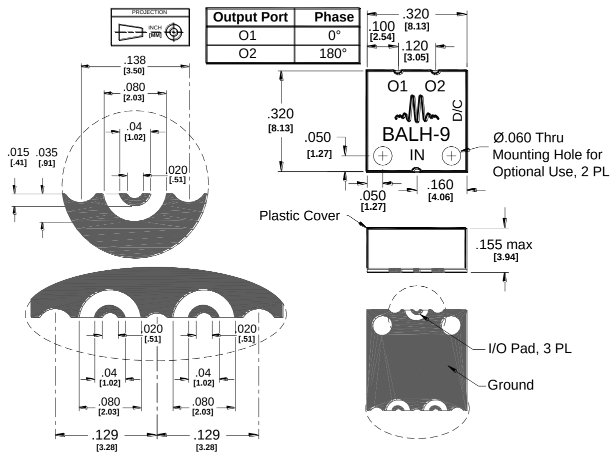
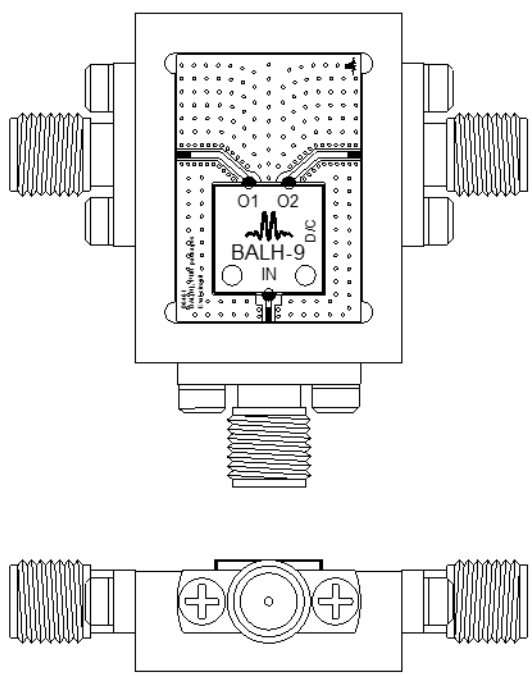
HIGH POWER SURFACE-MOUNT BALUN BALH-0009SMG

Output Port	Phase
O1	0°
O2	180°



Substrate material is 8-mil thick Rogers 4003, 1 Oz Electrodeposited Cu. I/O Pads & Ground Plane Finish is ENIG: 2-8 µ-inches, over Nickel, 100-200 µ-inches, over Cu. See BALSMG-PCB for suggested PCB layout.



Evaluation Board outline

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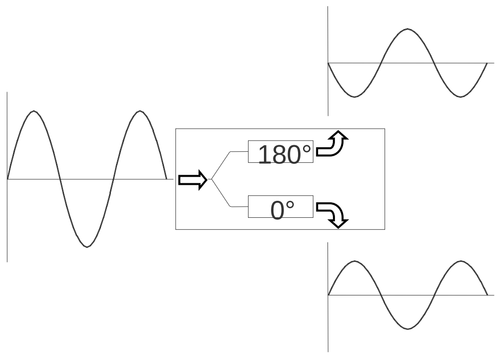
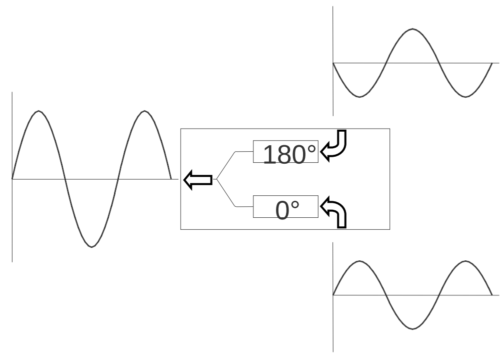
Block Diagram



Single ended to differential



Differential to single ended

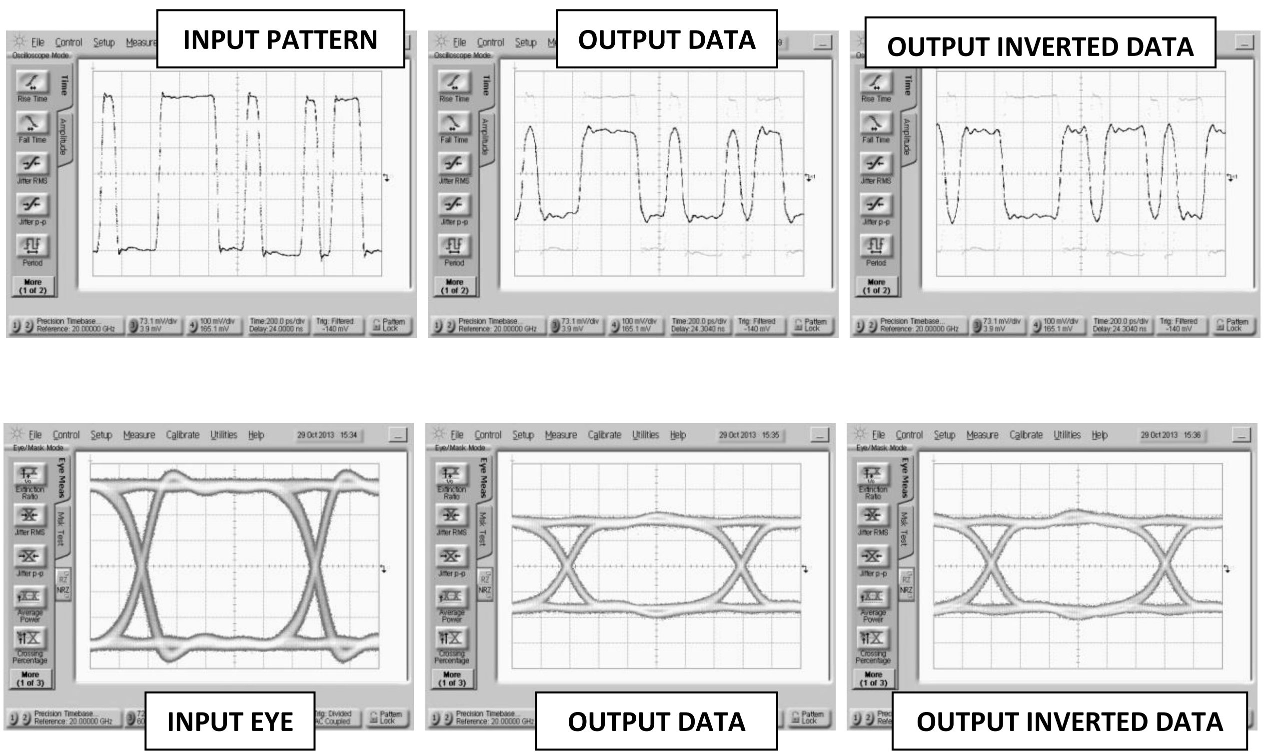


Fig. 1. Oscilloscope measurements of the BALH-0009SMG with a 10 Gb/s PRBS pattern. Bit pattern is measured with a 2^7-1 PRBS input demonstrating extremely good pulse fidelity for both inverted and non-inverted output. Eye diagrams are taken with a 2^{31}-1 PRBS input demonstrating minimal eye distortion/closure afforded by the extremely low frequency operation of the balun (<500 kHz).

Mixed Mode Scattering Parameters

Mixed mode scattering parameters are used to characterize differential circuits. For baluns, this means that the 0° and 180° ports become a single 100Ω differential port and the common port remains the same 50Ω common port. The two-port s-parameters of the balun are then characterized based on differential (d), common mode (c), or single-ended (s) signals. For example: Sds12 is the differential output response given a single ended input.

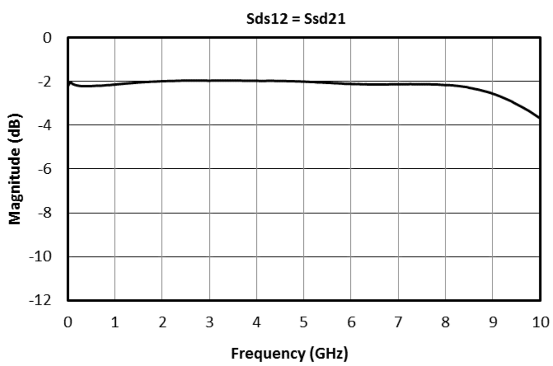


Fig. 2. Insertion loss as a mode converter

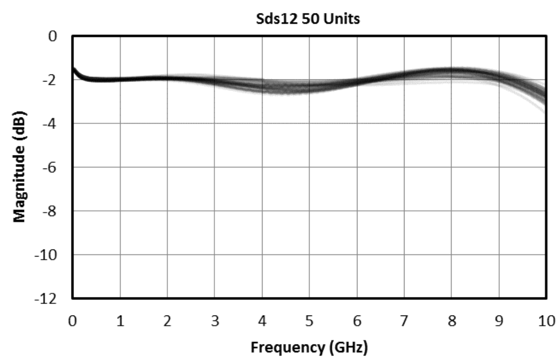


Fig. 3. Insertion loss as a mode converter across 50 units

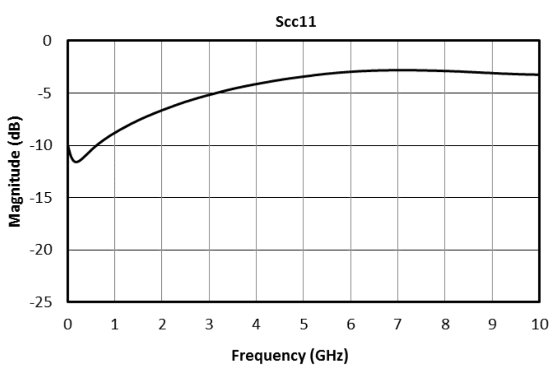


Fig. 4. Return loss of a common mode signal

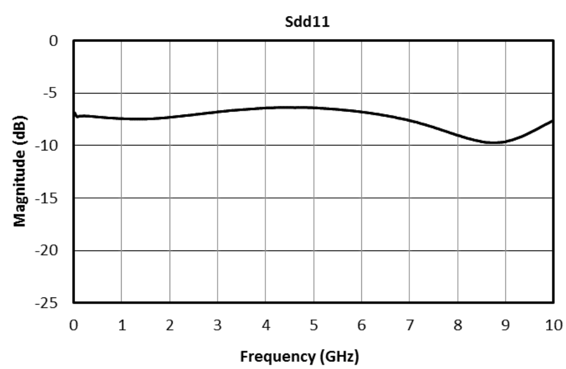


Fig. 5. Return loss of a differential signal

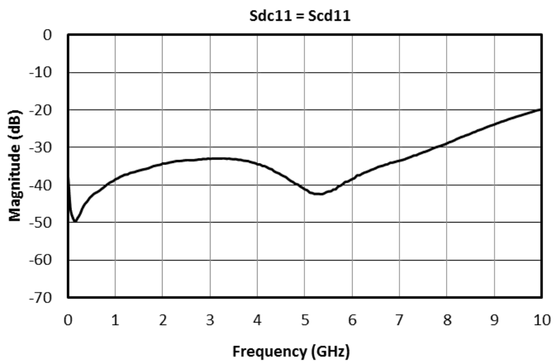


Fig. 6. Reflection converted between differential and common modes

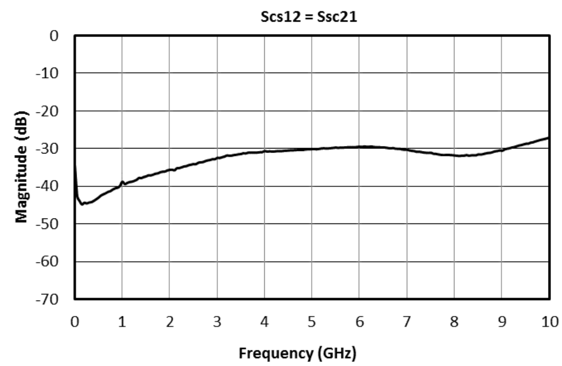


Fig. 7. Insertion loss of a common mode signal

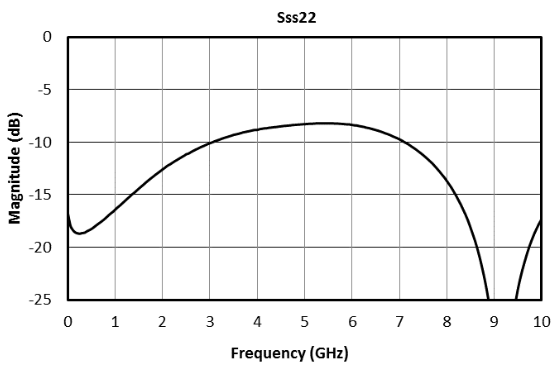


Fig. 8. Unbalanced port return loss

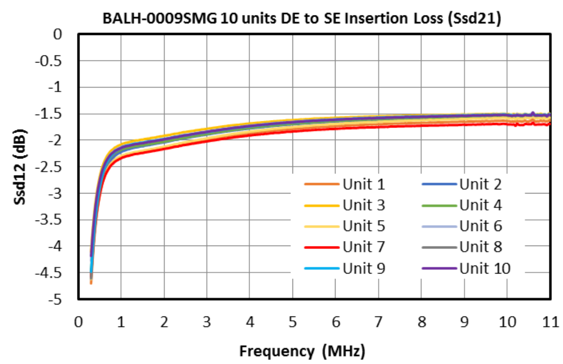


Fig. 9. Low frequency Insertion loss as a mode converter across 10 units

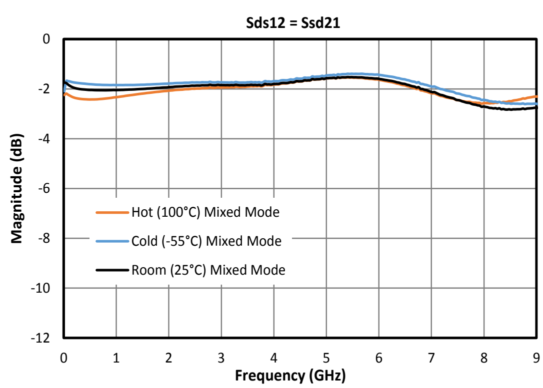


Fig. 10. Insertion Loss as Mode Converter vs Temperature

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Typical Performance Scattering Parameters

Three port scattering parameters measured as three single-ended 50Ω ports showing relationship between any two ports. For example: S21 and S31, often referred to as insertion loss of a balun, is the output response on ports 2 and 3 with an input stimulus on port 1.

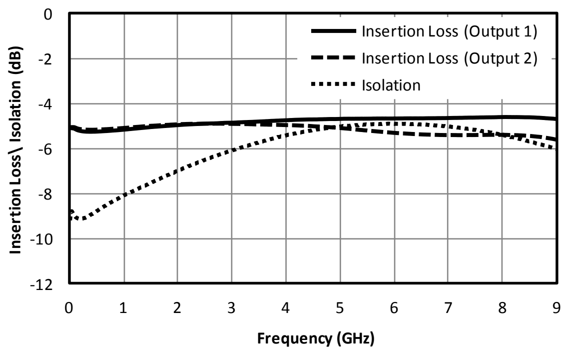


Fig. 11. Common to output port insertion loss and output to output port Isolation.

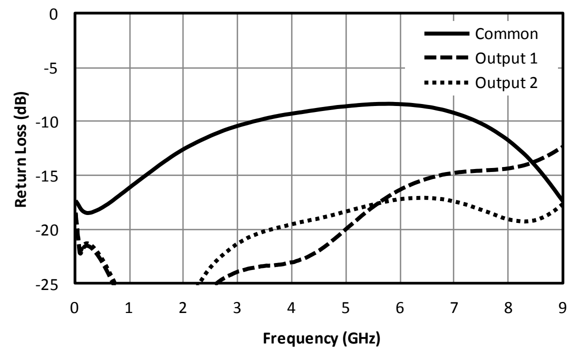


Fig. 12. Return loss for output and common ports.

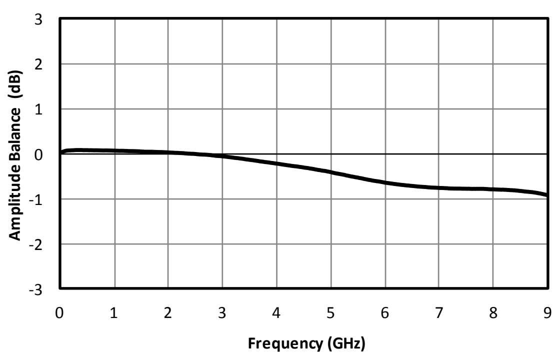


Fig. 13. Amplitude balance between output ports.

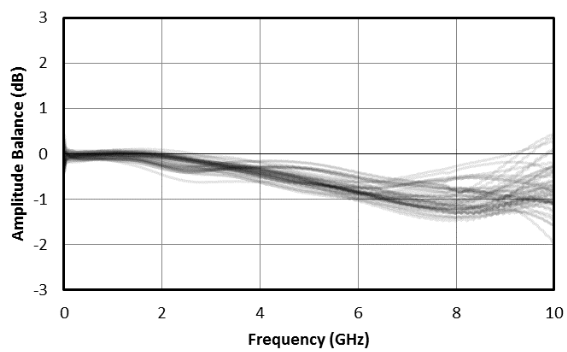


Fig. 14. Amplitude balance between output ports.

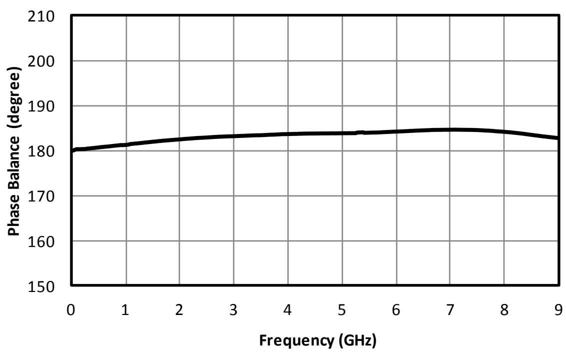


Fig. 15. Phase balance between output ports.

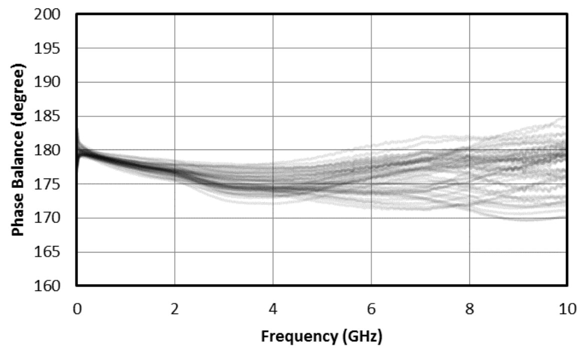


Fig. 16. Phase balance, 50 unit spread.

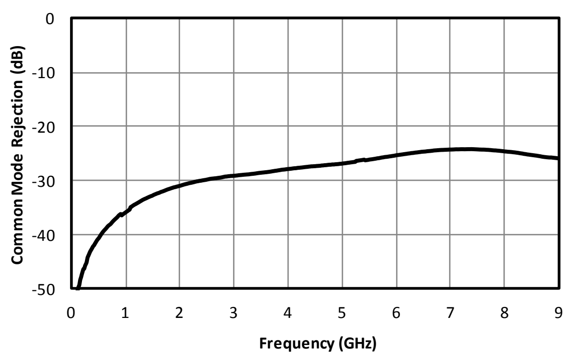


Fig. 17. Common mode rejection.

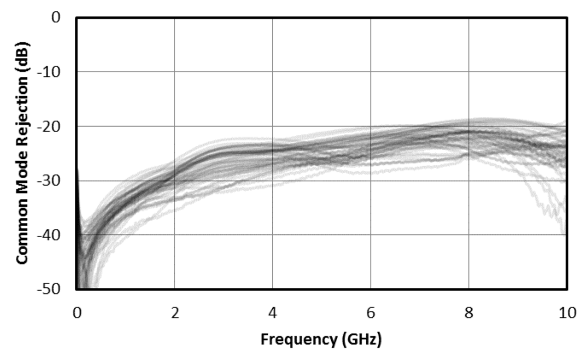


Fig. 18. Common mode rejection, 50 unit spread.

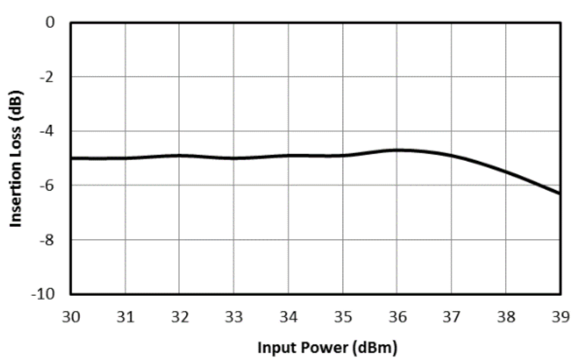
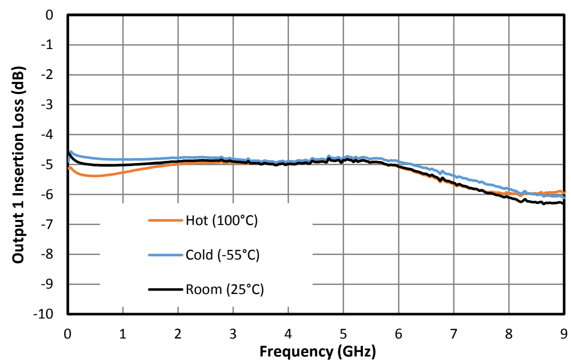
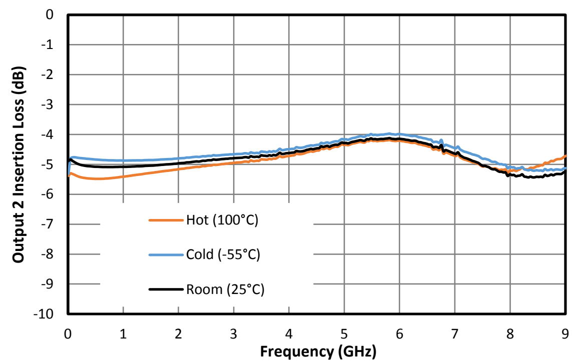


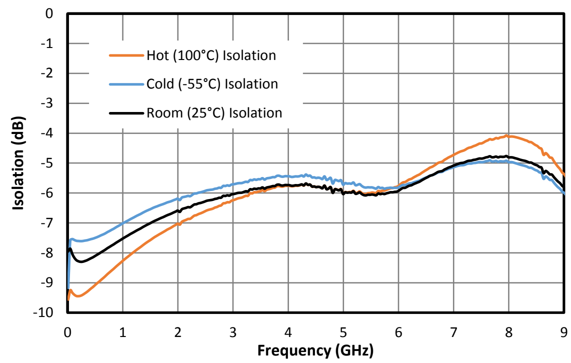
Fig. 19. Output Compression.



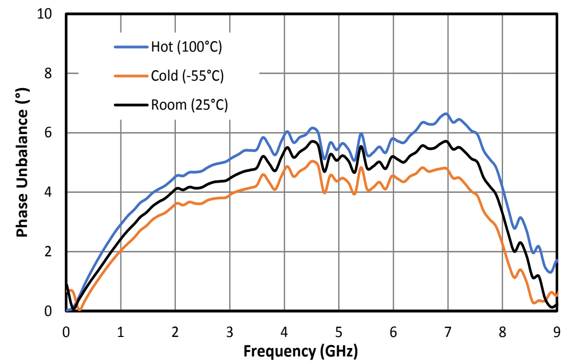
Fig, 20. Output 1 Insertion Loss vs Temperature.



Fig, 21. Output 2 Insertion Loss vs Temperature.



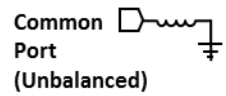
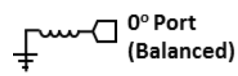
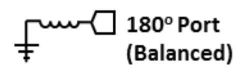
Fig, 22. Isolation vs Temperature.



Fig, 23. Phase Deviation vs Temperature.[1]

[1] Measured as phase deviation from 180° between output 1 and output 2

DC Interface

Port	Description	DC Interface Schematic
Common Port / In (Unbalanced)	The common port is DC short to ground.	
Out 1 / 0° Port (Balanced)	The 0° port is DC short to ground.	
Out 2 / 180° Port (Balanced)	The 180° port is DC short to ground.	

Absolute Maximum Ratings	
Parameter	**Maximum Rating**
DC Current	1A
RF Power Handling	33 dBm
Operating Temperature	$-55^{\circ}C$ to $+100^{\circ}C$
Storage Temperature	$-65^{\circ}C$ to $+125^{\circ}C$

DATASHEET NOTES:

1. Sdd22: differential return loss of the differential port driven with a differential signal
   Sdc22: differential return loss of the differential port driven with a common signal
   Sds21: insertion loss from a single ended input to a differential output
   Scc22: common mode return loss of the differential port driven with a common signal
   Scd22: common mode return loss of the differential port driven with a differential signal
   Scs21: insertion loss from a single ended input to a common output
   Sss11: single ended return loss
   Ssd12: insertion loss from a differential signal to single ended output
   Ssc12: insertion loss from a common signal to single ended output

Revision History

Revision code	Revision Date	Comment
-	February 2013	Datasheet Initial Release
A	March 2019	Evaluation Board Outline Added
B	October 2019	Mixed Mode Scattering Parameters added
C	April 2020	Unit Spread Graphs Added
D	July 2020	Specs Table Update
E	October 2020	Specs Table Update
F	May 2022	Max DC current update, Ground Plane Finish Update
G	August 2022	Over Temperature Performance Plots Added

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