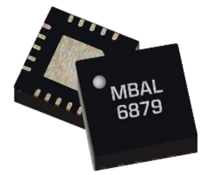
MMIC 14-45GHz Isolation Balun **MBAL-1445SM**

1 Device Overview



QFN

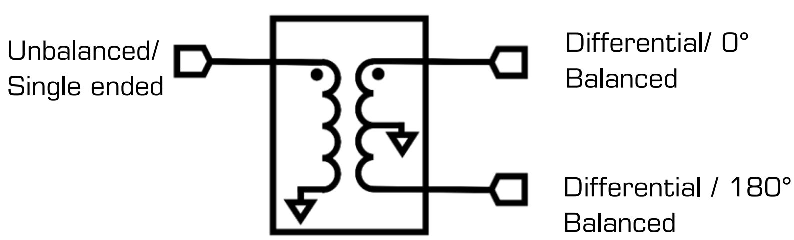
1.1 General Description

MBAL-1445 is a high isolation MMIC balun. Passive GaAs MMIC technology allows production of smaller constructions that replace larger form factor circuit board constructions. Tight fabrication tolerances result in less unit to unit variation than traditional balun technologies, allowing for accurate simulations using the provided S3P file taken from measured production units. Baluns are passive reciprocal devices allowing either single ended to differential or differential to single ended conversion. Applications include high-speed track-.and-hold amplifiers, analog-to-digital converters, digital-to-analog converters, balanced amplifiers, and signal integrity. The MBAL-1445SM is available as a 4 X 4 mm QFN package. Evaluation boards are also available.

1.2 Features

- 14GHz to 45GHz Balun (Balanced to Unbalanced Transformer)
- High Isolation
- High CMRR
- 1:2 Impedance Ratio
- RoHS Compliant
- S3P data MBAL-1445.zip

1.3 Functional Block Diagram



1.4 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MBAL-1445SM	4 X 4 mm QFN	SM	RoHS	Active	EAR99
EVAL-MBAL-1445	Connectorized Evaluation Fixture	Eval	RoHS	Active	EAR99

[1] Refer to our website for a list of definitions for terminology presented in this table.

Table of Contents

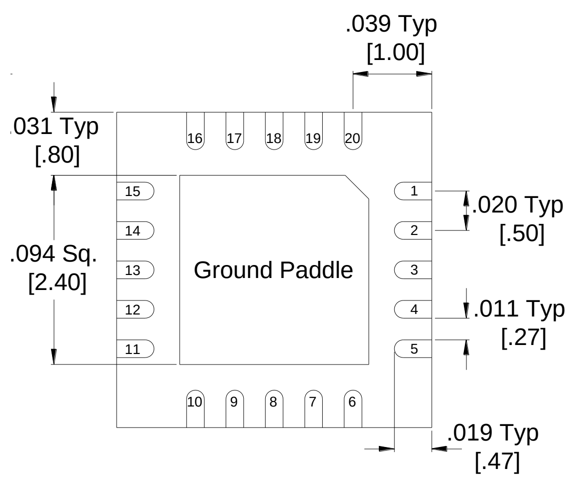
Revision History

Revision Code	Revision Date	Comment
-	June 2020	Initial Datasheet Release
A	December 2020	Performance over Temperature plots

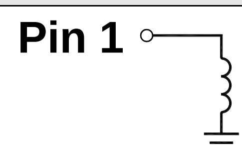
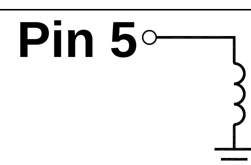
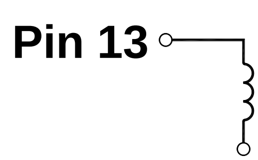
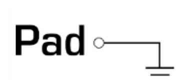
2 Port Configurations and Functions

2.1 Port Diagram

A bottom-up view of the MBAL-1445SM's SM package outline drawing is shown below. The MMIC baluns are passive reciprocal devices allowing either single ended to differential or differential to single ended conversion.



2.2 Port Functions

Port	Function	Description	Equivalent Circuit
Pin 1	Differential/ 0° Balanced	The 0° port is DC short to ground.	
Pin 5	Differential / 180° Balanced	The 180° port is DC short to ground.	
Pin 13	Unbalanced/ Single ended	The common port is DC open to ground.	
Pad	Ground	SM package ground path is provided through the ground paddle.	

3 Specifications

3.1 Absolute Maximum Ratings

The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. If these limits are exceeded, the device may be inoperable or have a reduced lifetime.

Parameter	Maximum Rating	Units
Common Port DC Current	N/A	mA
Differential Port 1 DC Current	TBD	mA
Differential Port 2 DC Current	TBD	mA
Power Handling, at any Port	TBD	dBm
Operating Temperature	-55 to +100	°C
Storage Temperature	-65 to +125	°C

3.2 Package Information

Parameter	Details	Rating
ESD	Human Body Model (HBM), per MIL-STD-750, Method 1020	N/A

3.3 Electrical Specifications[1]

The electrical specifications apply at T_A=+25°C in a 50Ω system.

Min and Max limits are guaranteed at T_A=+25°C.

Parameter	Frequency (GHz)	Min	Typ.	Max	Units
Mode conversion Loss	14-45		4.5		dB
Nominal Phase Shift			180		Degrees
Amplitude Balance	14-40		0.2	1	dB
	40-45		0.5		
Phase Balance	14-45		2.5	10	Degrees
Common Mode Rejection		19	33		dB
Isolation between differential ports		10	18		dB
VSWR			1.6		
Impedance			50		Ω

[1] All measured data is taken from the eval board without de-embedding of the connectors and traces.

3.4 Typical Performance Plots

3.4.1 Mixed Mode Scattering Parameters[2]

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: Scs21 is the Common output response given a single ended input.

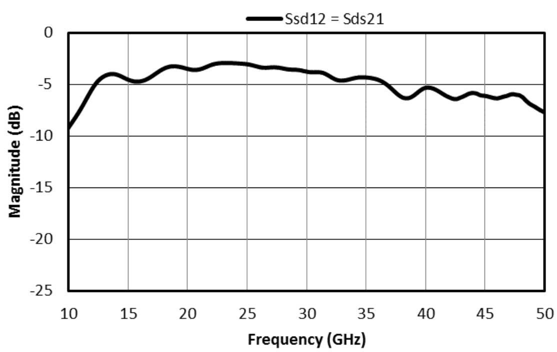


Fig. 1. Insertion loss as a mode converter

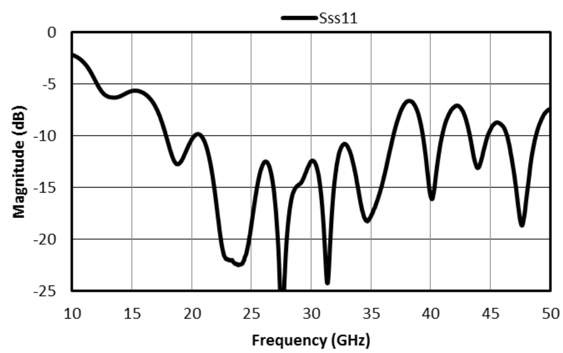


Fig. 2. Unbalanced port return loss

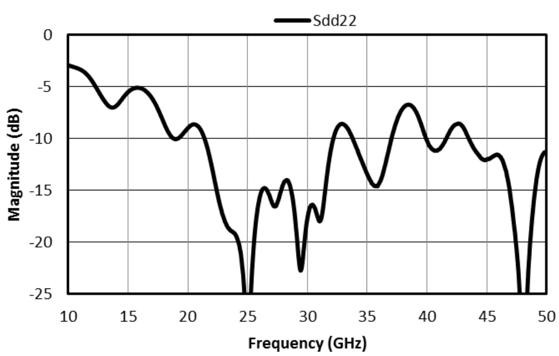


Fig. 3. Return loss of differential Signal

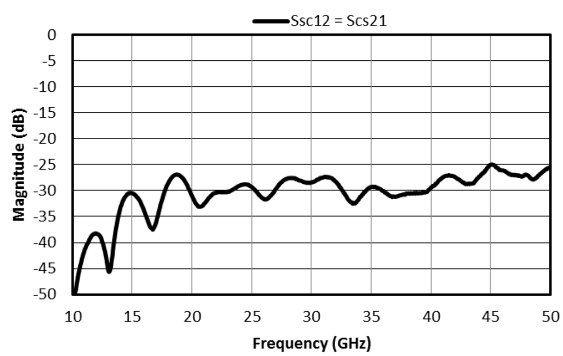


Fig. 4. Insertion loss of a common mode signal

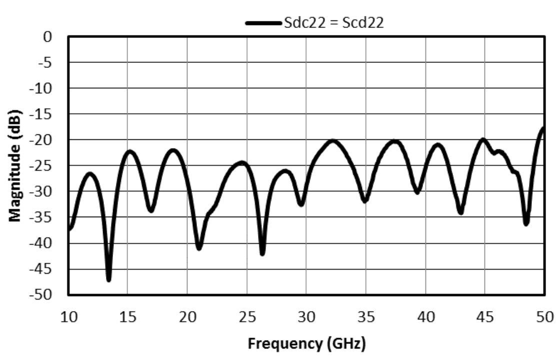


Fig. 5. Reflection converted between differential and common modes

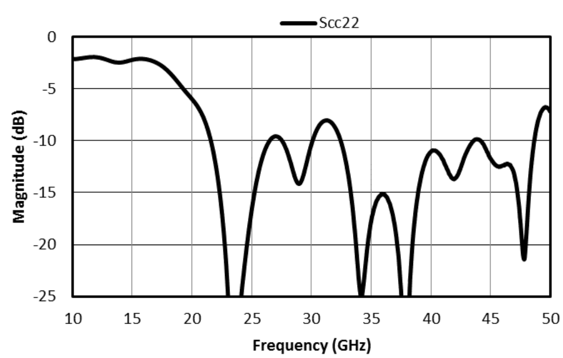


Fig. 6. Return loss of a common mode signal

3.4.2 Typical Performance Scattering Parameter

Three port scattering parameters measured as three single-ended 50Ω ports showing relationship between any two ports.

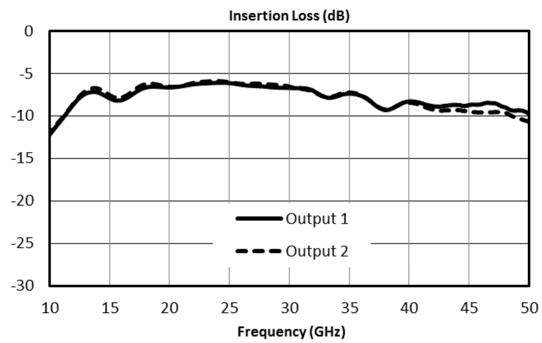


Fig. 7. Common to output port insertion loss

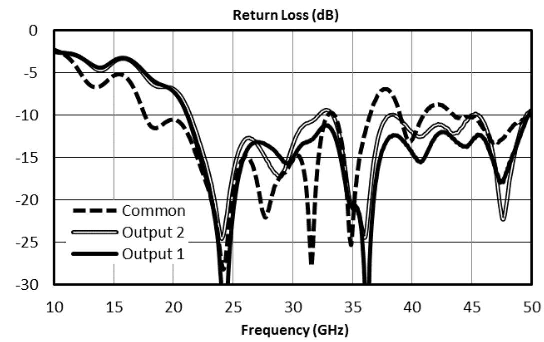


Fig. 8. Return loss for common port and output ports.

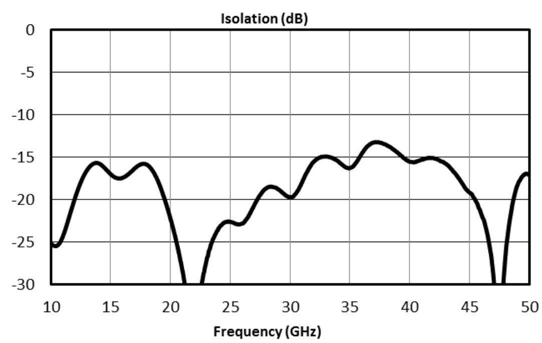


Fig. 9. Isolation between differential ports

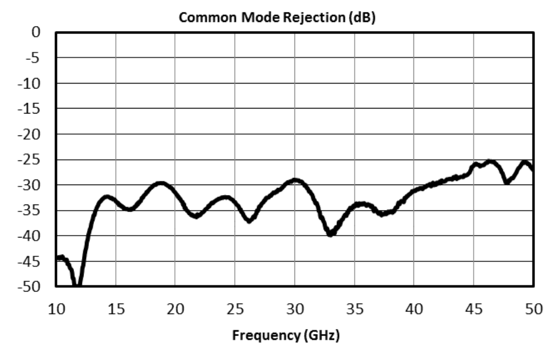


Fig. 10. Common Mode Rejection Ratio.

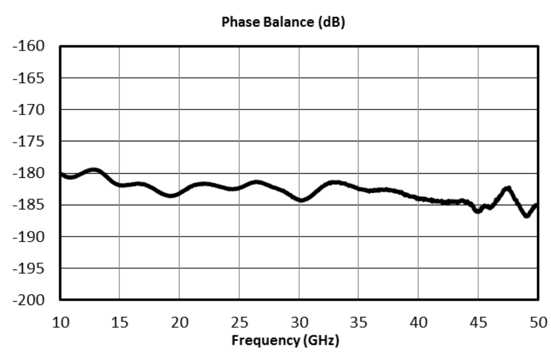


Fig. 11. Phase balance between output ports.

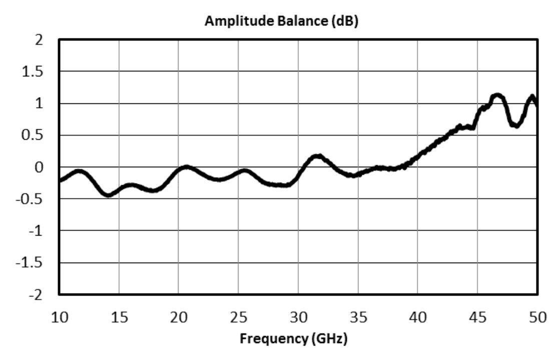
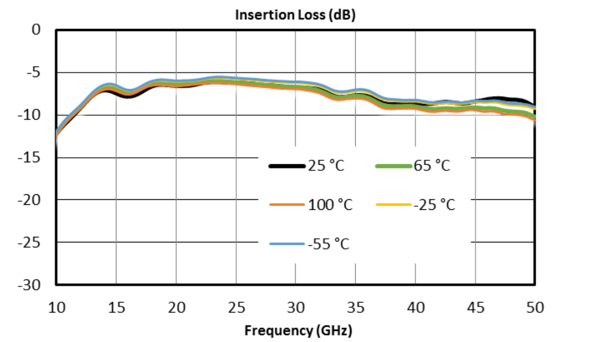
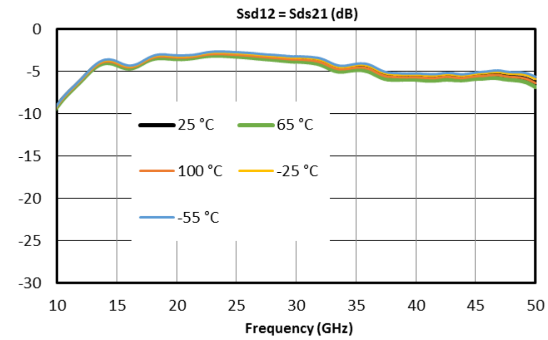
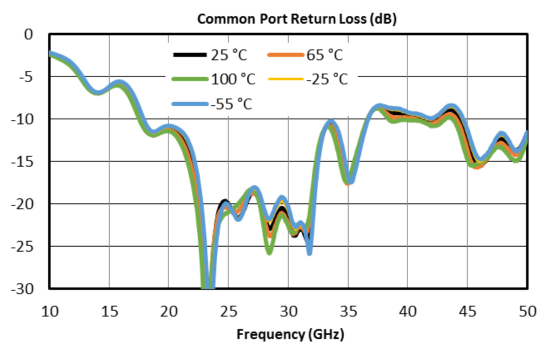


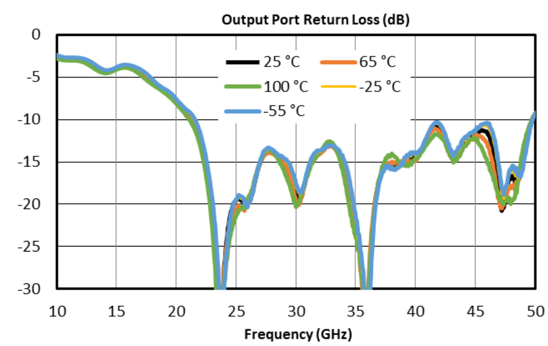
Fig. 12. Amplitude balance between output ports.

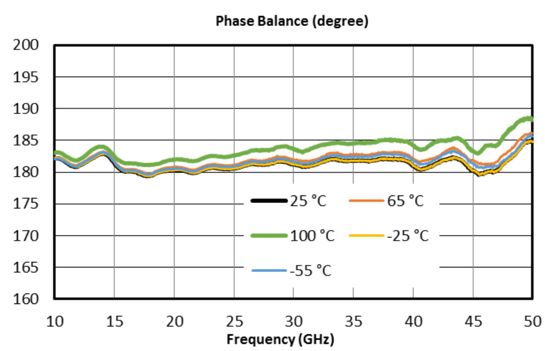
3.4.3 Typical Performance Over Temperature

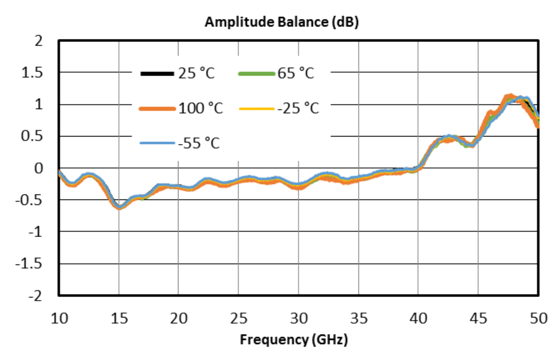


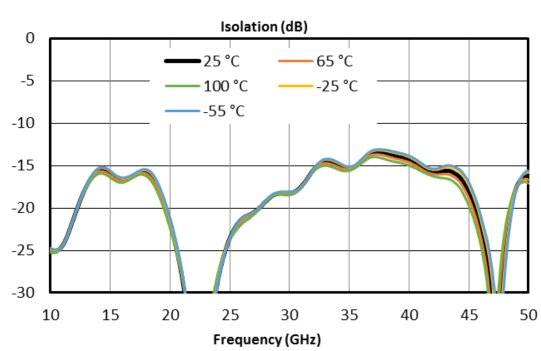


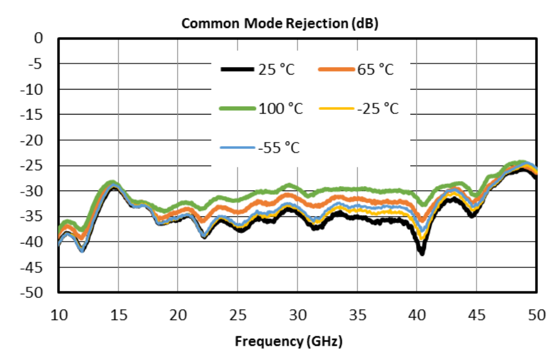






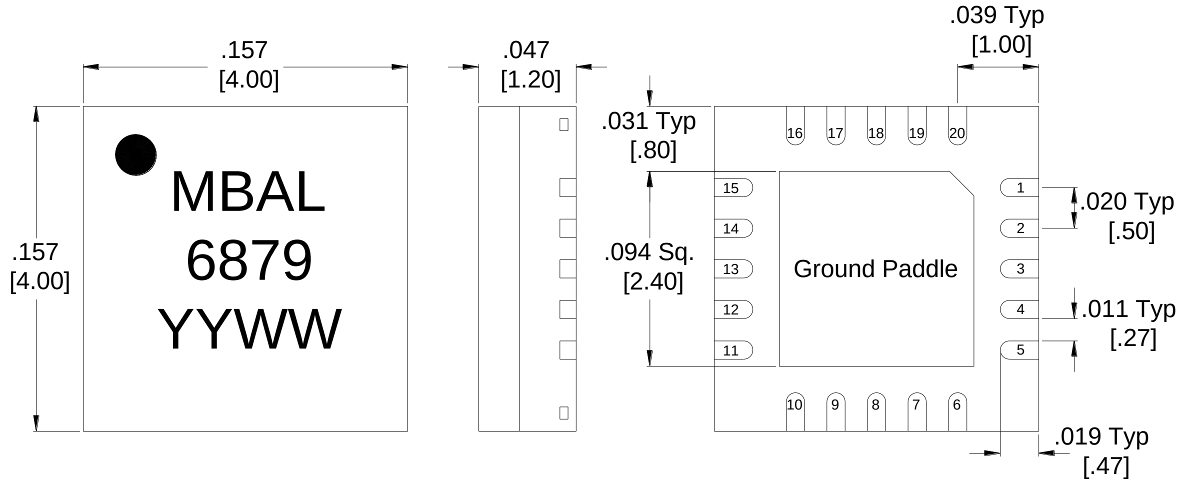






4 Mechanical Data

4.1 SM Package Outline Drawing

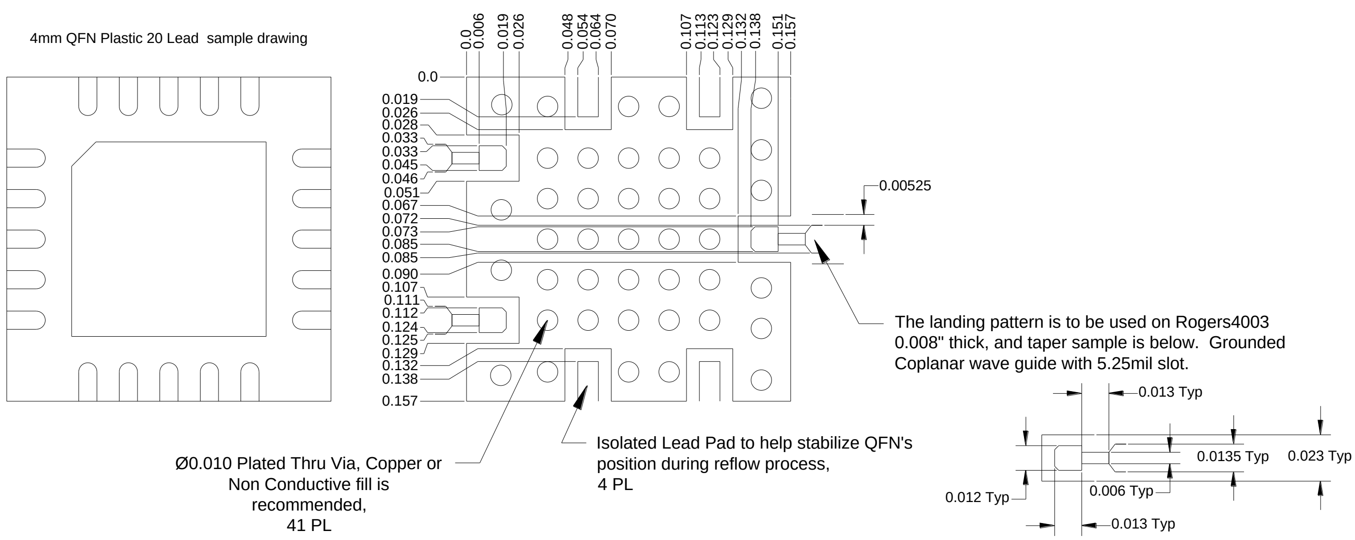


Pad #	Function
1	O1
2	N/C
3	N/C
4	N/C
5	O2
6	N/C
7	N/C
8	N/C
9	N/C
10	N/C
11	N/C
12	N/C
13	IN
14	N/C
15	N/C
16	N/C
17	N/C
18	N/C
19	N/C
20	N/C

Notes:

1. Substrate material is LCP.
2. I/O Leads and Ground Paddle plating is (from base to finish):
   Ni: 0.5um MIN
   Pd: 0.02um MIN
   Au: 0.05um MAX
3. All unconnected pins should be connected to PCB RF ground.

4.2 SM Package Footprint



QFN-Package Surface-Mount Landing Pattern

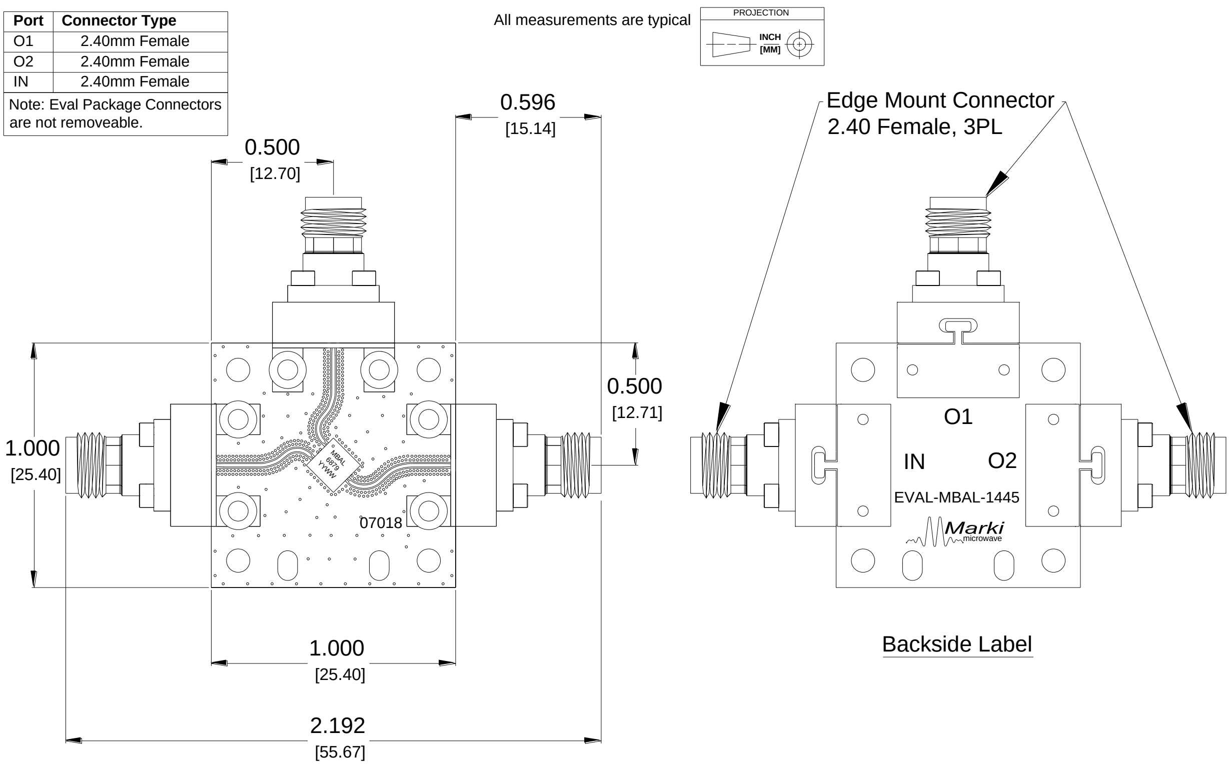
Click here for a DXF of the above layout.

Click here for leaded solder reflow. Click here for lead-free solder reflow.

4.3 Evaluation Board outline

Port	Connector Type
O1	2.40mm Female
O2	2.40mm Female
IN	2.40mm Female

Note: Eval Package Connectors are not removeable.



DATASHEET NOTES:

2. 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