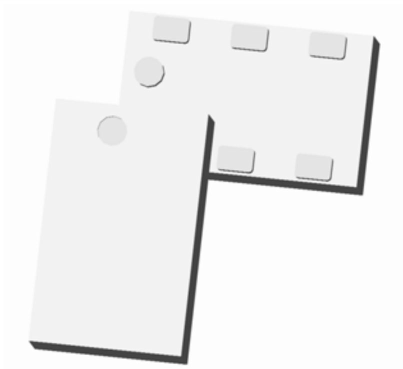
Model 2425B50-50J

Rev A

Ultra Low Profile 0805 Balun
50Ω to 100Ω Balanced



Description

The 2425B50-50J is a low profile sub-miniature balanced to unbalanced transformer designed for differential inputs and output locations on next generation wireless chipsets in an easy to use surface mount package covering 802.11b+g+n. The 2425B50-50J is ideal for high volume manufacturing and is higher performance than traditional ceramic and lumped element baluns. The 2425B50-50J has an unbalanced port impedance of 50Ω and a 100Ω balanced port impedance*. This transformation enables single ended signals to be applied to differential ports on modern semiconductors. The output ports have equal amplitude (-3dB) with 180 degree phase differential. The 2425B50-50J is available on tape and reel for pick and place high volume manufacturing.

Detailed Electrical Specifications*: Specifications subject to change without notice.

Features:

- **2.4 – 2.5 GHz**
- **0.7mm Height Profile**
- **50 Ohm to 2 x 50 Ohm**
- **802.11 b+g +n Compliant**
- **Low Insertion Loss**
- **Low Power**
- **Input to Output DC Isolation**
- **Surface Mountable**
- **Tape & Reel**
- **Non-conductive Surface**

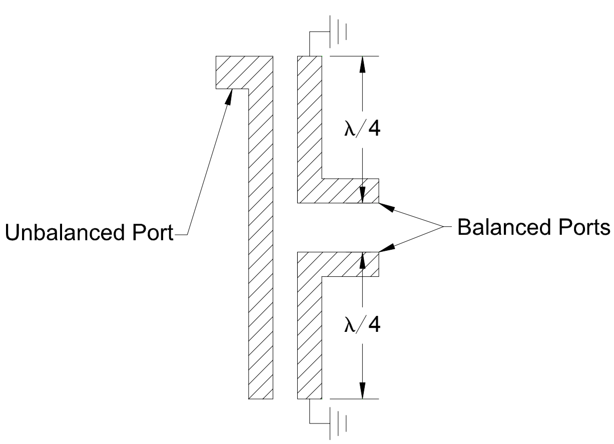
	ROOM (25°C)			
Parameter	**Min.**	**Typ.**	**Max**	**Unit**
Frequency	2.4		2.5	GHz
Unbalanced Port Impedance		50		Ω
Balanced Port Impedance**		100		Ω
Return Loss	14	22		dB
Insertion Loss***		0.55	0.65	dB
Amplitude Balance		±0.3	±0.5	dB
Phase Balance		±2	±5	Degrees
Power Handling			0.5	Watts
Thermal Resistance			TBD	ºC / Watt
Operating Temperature	-55		+85	ºC

*Specification based on performance of unit properly installed on micro-strip printed circuit boards with 50 Ω nominal impedance.

** 50Ω reference to ground. *** Insertion Loss stated at room temperature (0.75 dB Max at +85 ºC)

Pin Configuration

Balun Pin Configruation

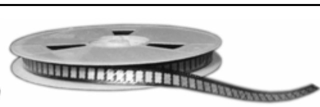


The internal configuration of the ultra-low profile balun is diagramed to the left; the unbalanced port is terminated in an open-circuit and the two balanced ports are connected to ground. The ground connection for the two balanced ports are connected together and brought out on a common pin of the balun. This pin is labeled "DC/RF ground". For many chipset applications there is an opportunity to use this configuration as a single bias point if applicable.

The use of differential circuits is increasing in highly integrated circuits, because of its inherent noise immunity properties. Differential circuits have superior performance when looking at properties like cross coupling, immunity to external noise sources and power supply noise. When designing power amplifiers differential circuits also help minimize 2nd and 3rd order intermodulation products.

The construction of the ultra-low profile balun is bonded multi-layered stripline made of low loss dielectric material with plated through vias connecting the internal circuitry to the external printed circuit board, similar to that of other Xinger® hybrids and directional couplers.

What'll we think of next?™

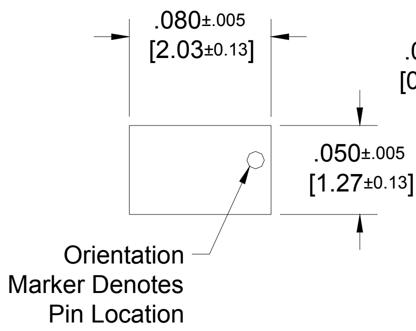


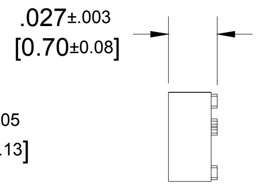
Available on Tape and Reel for Pick and Place Manufacturing.

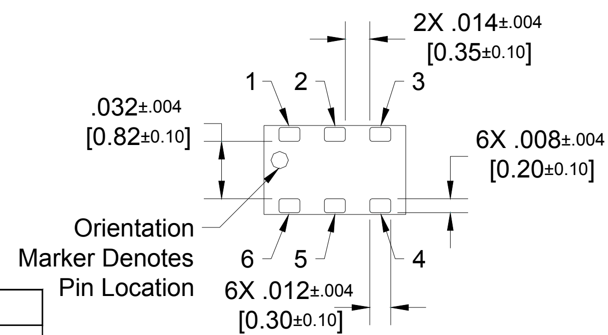
USA/Canada: (315) 432-8909
Toll Free: (800) 411-6596
Europe: +44 2392-232392

Outline Drawing

Top View (Near-side) Side View Bottom View (Far-side)





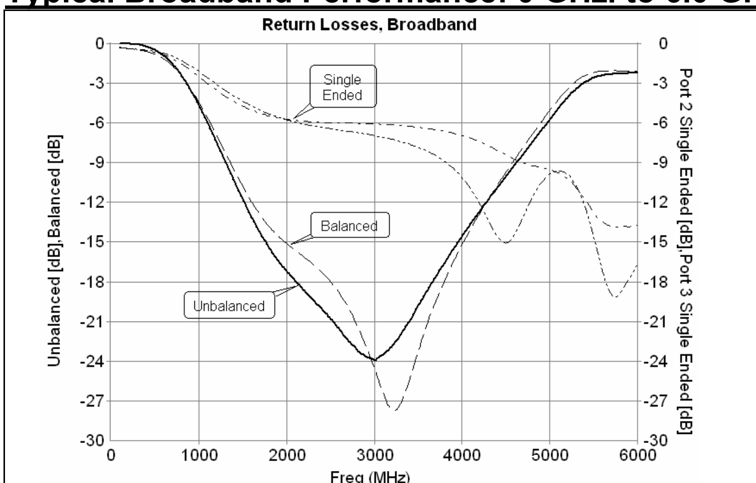


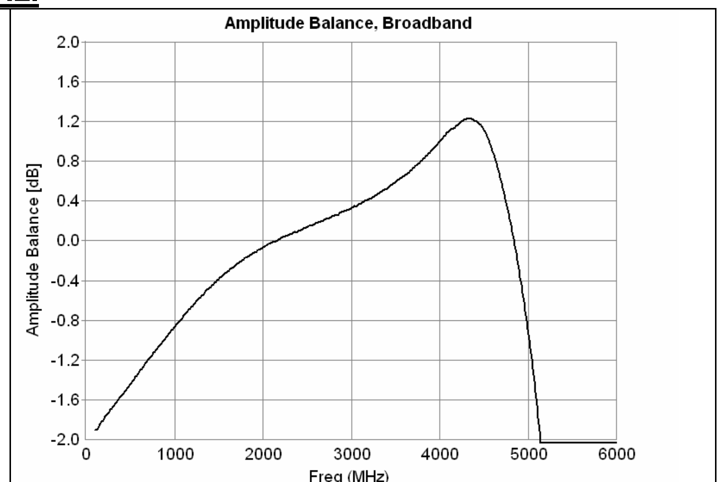
Pin	Designation
1	In
2	GND / DC Feed + RF GND
3	Out 1
4	Out 2
5	GND
6	NC

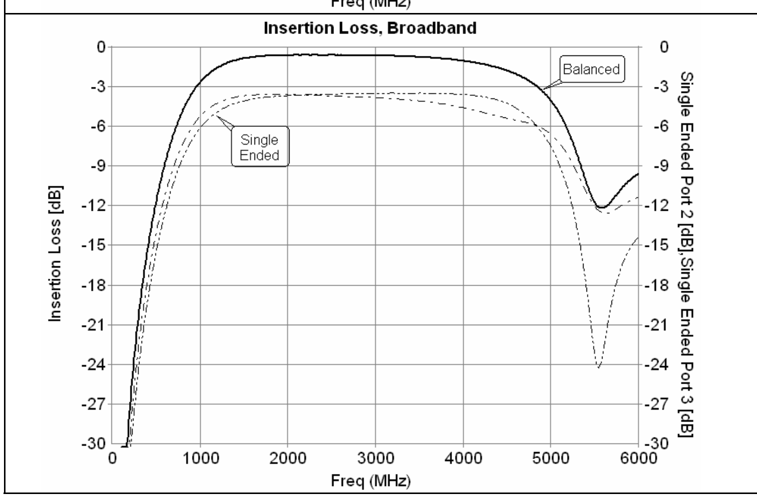
Dimensions are in Inches [Millimeters]
Mechanical Outline

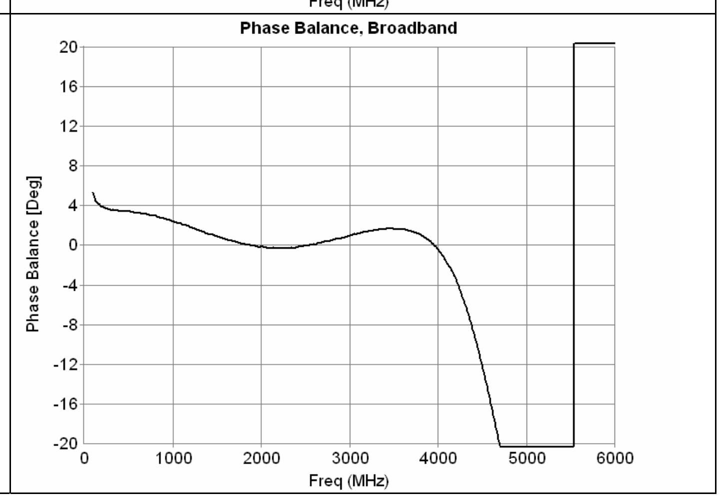
Tolerances are Non-Cumulative

Typical Broadband Performance: 0 GHz. to 6.0 GHz.









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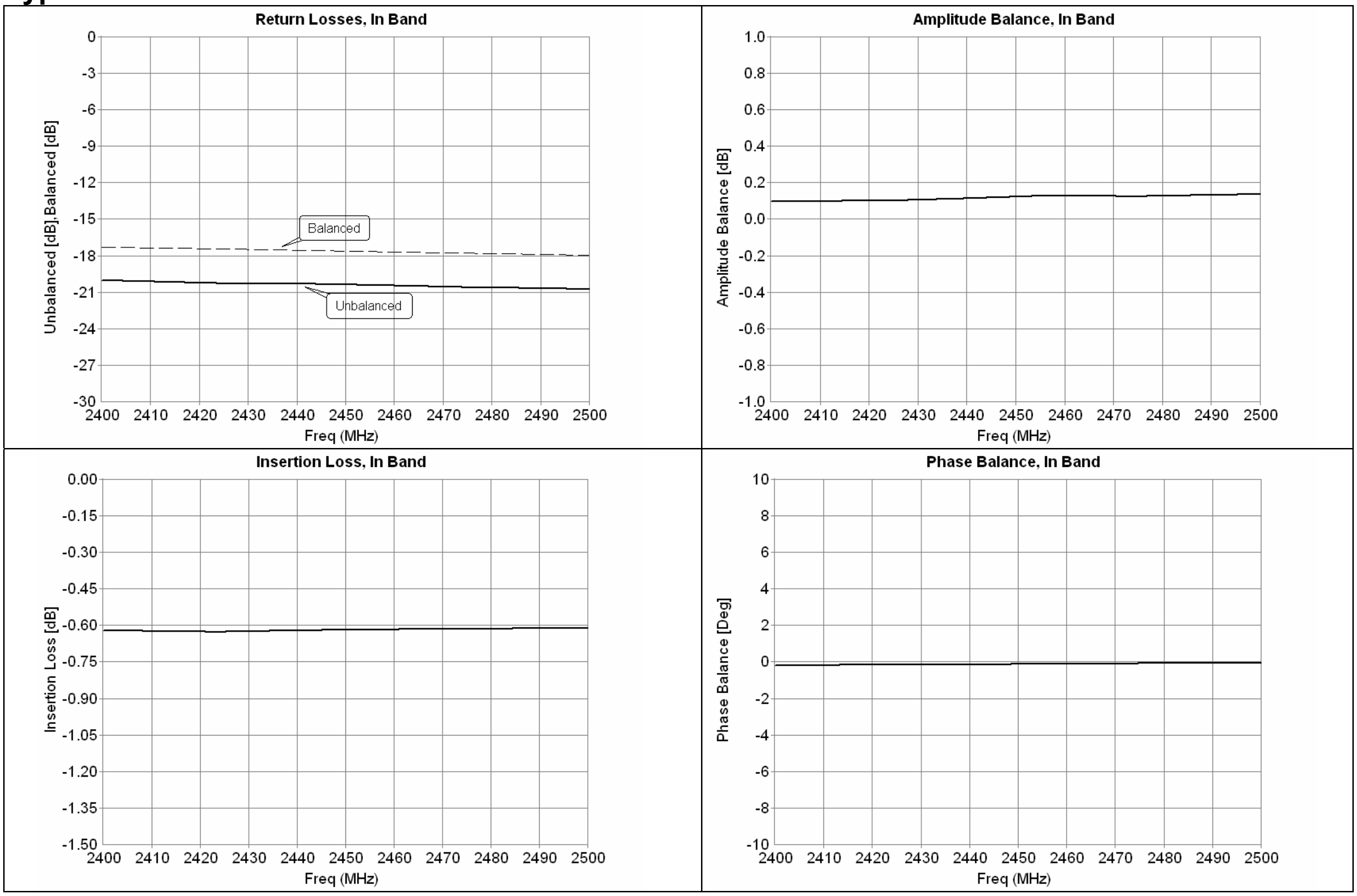
Typical Performance: 2.4 GHz. to 2.5 GHz.



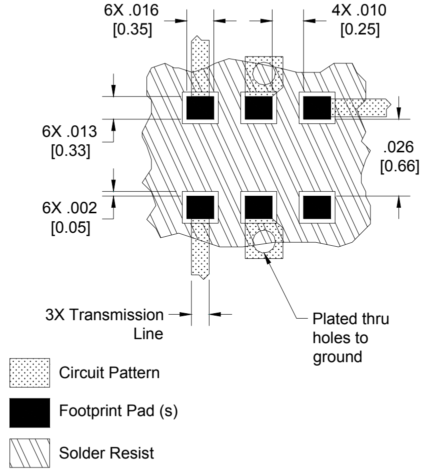
Mounting Configuration:

In order for Xinger surface mount components to work optimally, there must be a 50Ω transmission line to the unbalanced port and 50 Ω transmission lines from the balanced ports. If this condition is not satisfied, amplitude balance, insertion loss and VSWR may not meet published specifications.

All of the Xinger components are constructed from ceramic filled PTFE composites which possess excellent electrical and mechanical stability having X and Y thermal coefficient of expansion (CTE) of 17 ppm/^{o}C.

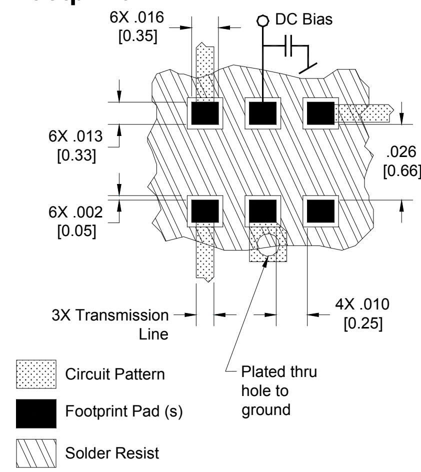
An example of the PCB footprint used in the testing of these parts is shown on the next page. An example of a DC-biased footprint is also shown on the next page. In specific designs, the transmission line widths need to be adjusted to the unique dielectric coefficients and thicknesses as well as varying pick and place equipment tolerances.

No Bias Footprint



Dimensions are in Inches [Millimeters]
Mounting Footprint

DC Bias Footprint



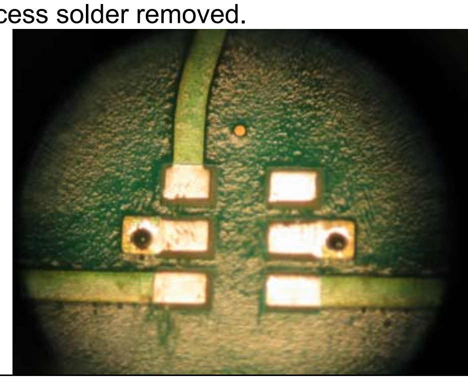
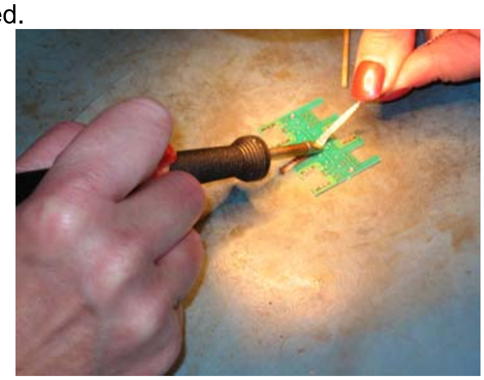
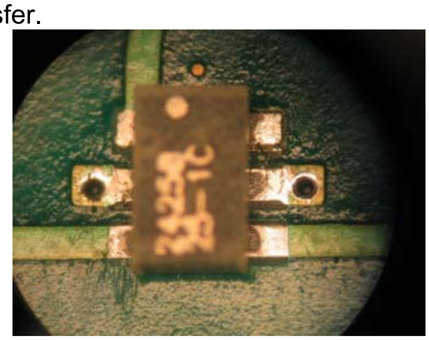
Dimensions are in Inches [Millimeters]
Mounting Footprint

Manufacturing Instructions

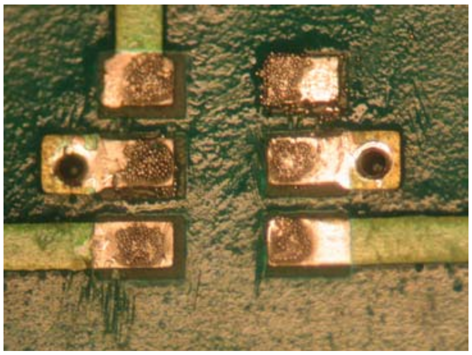
This section contains mounting instructions for hand soldering components in a lab environment and high volume pick and place operations.

Mounting parts in a lab environment

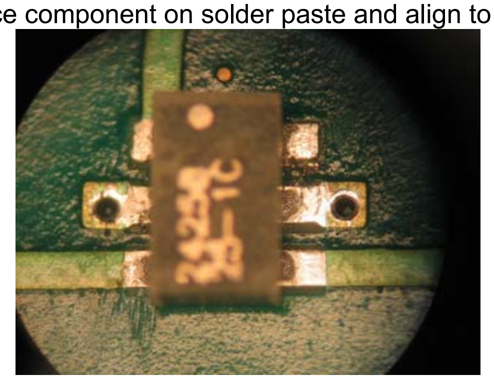
The following steps outline the process for hand soldering Anaren's components to pre-populated PWBs.

1. The picture to the right shows the mounting location for the component to be installed. 	3. The picture to the right shows the mounting location with excess solder removed. 
2. Using solder wick and water-soluble flux, remove excess solder from pads where component will be mounted. 	4. There needs to be exposed copper/plated area to place solder iron to transfer heat to the component pads. The picture to the right shows areas of exposed tin-lead plating where the soldering tip will be placed for heat transfer. 

5. Clean excess flux from board, and any other debris. Apply small amounts of solder paste (SN63PB37 or equivalent) to each pad on board.

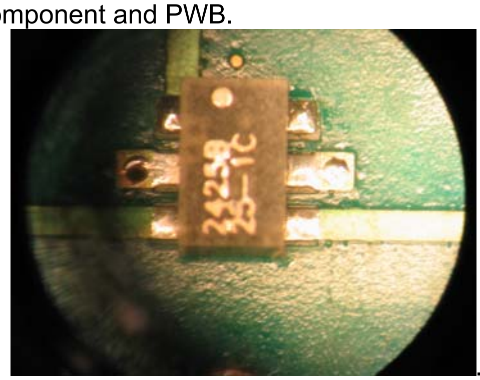


6. Place component on solder paste and align to pads.



7. Using a hand held soldering iron with Metcal solder tip STTC-042 or equivalent, place tweezers on top of component for support, place iron on exposed plated area reflowing solder paste and tin-lead plating on part. (Repeat for each pad) If necessary apply water-soluble liquid flux to each pad and touch solder iron to exposed plated area to complete the proper solder connection.

8. Inspect all pads to ensure solder connection to component pads and PWB pads. Clean excess flux from component and PWB.



Mounting parts in High Volume Pick and Place

Component Mounting Process

The process for assembling this component in a conventional surface mount process is shown below. This process is conducive to both low and high volume usage.

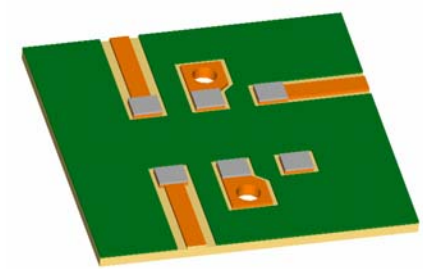
Clean Substrate → Apply Solder Paste to Substrate → Place component on substrate → Reflow component to substrate → Clean & Inspect

Surface Mounting Process Steps

Storage of Components: Commonly used storage procedures used to control oxidation should be followed for these surface mount components. The storage temperatures should be held between 15^{O}C and 60^{O}C.

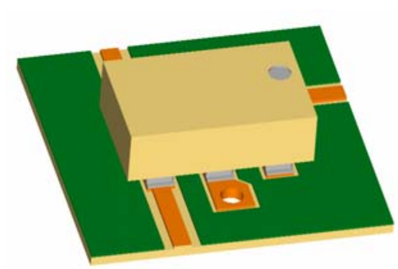
Substrate: Depending upon the particular component, the circuit material has an x and y coefficient of thermal expansion of between 17 and 25 ppm/°C. This coefficient minimizes solder joint stresses due to similar expansion rates of most commonly used board substrates such as RF35, RO4350, FR4, polyimide and G-10 materials. Mounting to “hard” substrates (alumina etc.) is possible depending upon operational temperature requirements. The solder surfaces of the coupler are all copper plated with a tin-lead exterior finish.

Solder Paste: All conventional solder paste formulations will work well with Anaren’s surface mount components. Solder paste can be applied with stencils or syringe dispensers. An example of a stenciled solder paste deposit is shown below. As shown in the figure solder paste is applied to the RF and ground pads.



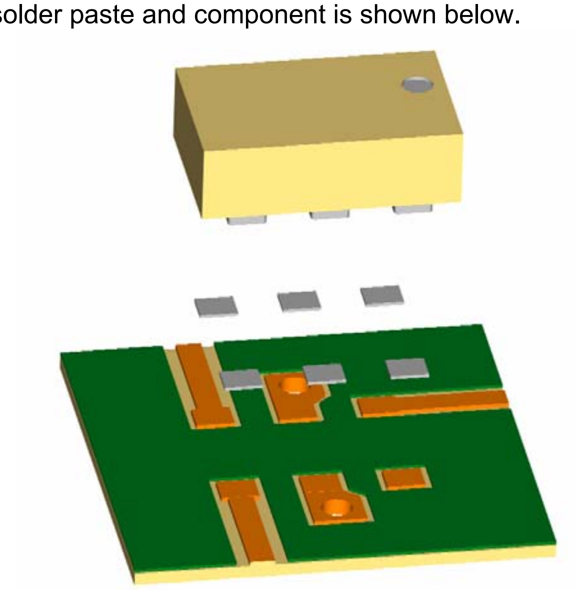
Solder Paste Application

Component Positioning: These surface mount components are placed with automatic pick and place mechanisms. A place component is shown below.



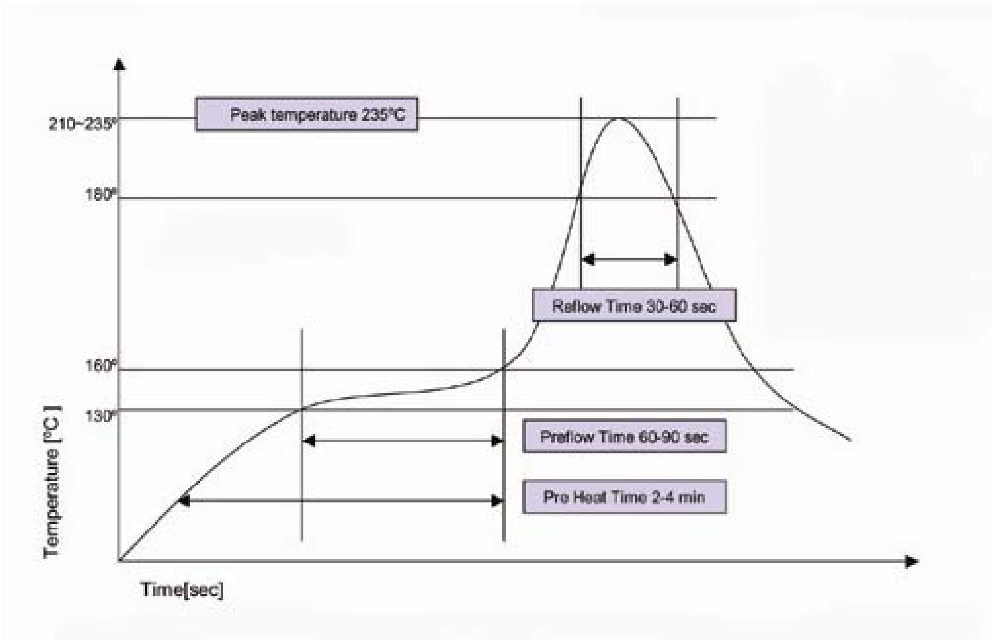
Component Placement

The exploded view of the PWB, solder paste and component is shown below.

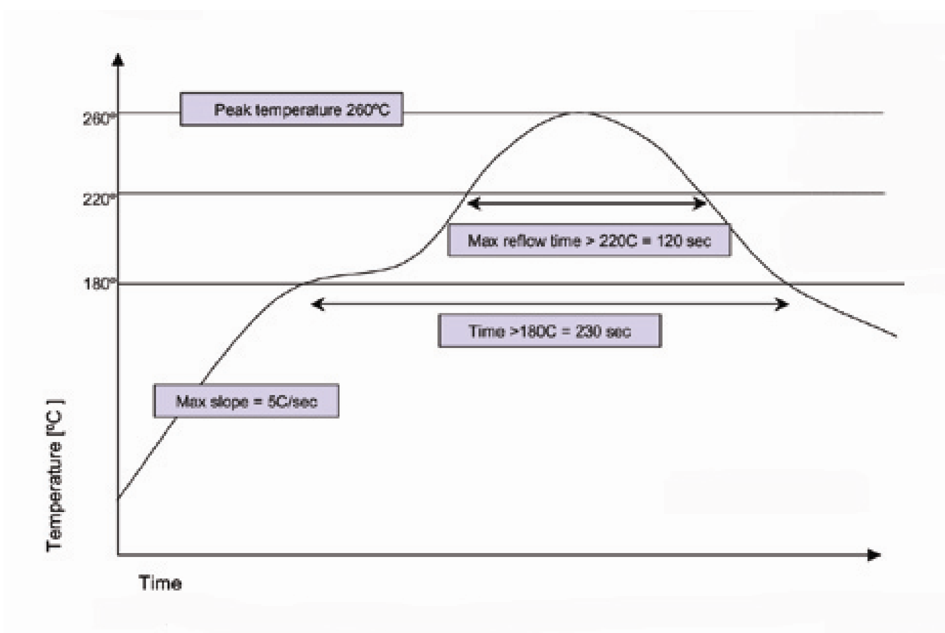


Exploded Mounting Features

Reflow: The surface mount component is conducive to most of today's conventional reflow methods. A low and high temperature thermal reflow profiles are shown in below.



Low Temperature Solder Reflow Thermal Profile



High Temperature Solder Reflow Thermal Profile

Test Instructions

A balun consists of an "unbalanced" port and two "balanced ports". The balun is a passive and reversible device. Therefore the "unbalanced" port can be used as either an input or an output; likewise the "balanced" ports can be used as inputs or outputs.

Baluns are also frequently used as impedance-transforming devices. For historical reasons the most commonly used impedances of the "unbalanced" ports are 50 Ω or 75 Ω and simple transformation ratios of 1:1, 1:2, and 1:4 are widely used. This creates components with impedances in the ranges of 50:50, 50:100 and 50:200 Ω for 50 Ω system impedance and 75:75, 75:150 and 75:300 Ω for 75 Ω system impedances.

This document discusses some of the issues involving evaluating the performance of general baluns on different types of equipment. The techniques and pitfalls identified are general for all types of baluns and not just for the stripline version described here. There are two basic frequency domain methods and one time-domain method.

The first section describes the preferred method, which enables the user to get full S-parameters of the entire balun. This allows the user to gain significant insight into the performance of all aspects of the balun. Most of the same results can be obtained using the other approaches.

2-ports analyzer techniques

Using a 2-port analyzer to evaluate the performance of a 3-port device involves some switching of cables and performing multiple measurements to gather enough information to perform the calculation to evaluate the true balanced performance.

In the following section the "unbalanced" port is labeled P1 and the corresponding return loss is labeled S11, consequently return loss measured on the two "balanced" ports (P2 and P3) are labeled S22 and S33. Furthermore the logical "balanced" port is labeled PD2 and its corresponding return loss is labeled SD22.

Return loss measurements using 2-port analyzers

Terminating the "balanced" ports with the correct loads and performing a straightforward return loss measurement on the "unbalanced" port one can evaluate the "unbalanced" return loss.

Evaluating the performance of the "balanced" port requires several measurements and some transformation of single ended S-parameters into balanced. The following equation describes the relationship between the single ended measurements and the balance port measurements.

$$SD22 = 20Log10\left|\frac{1}{2}\left(S22^2 + S33^2\right) - \frac{1}{2}\left(S23^2 + S32^2\right)\right| \quad (1)$$

Equation (1) transforms the 2 sets of single ended return loss measurements combined with insertion loss measurements into a balanced port impedance. Complex values of all the S-parameters must be used to make the equation valid, and is to be used with data that has been deembedded and renormalized to the goal impedances.

Due to way the balun works (any balun, both Flux coupled and stripline version) one will find 6 dB worth of return loss measured singled ended onto either port 2 or port 3 of any balun.

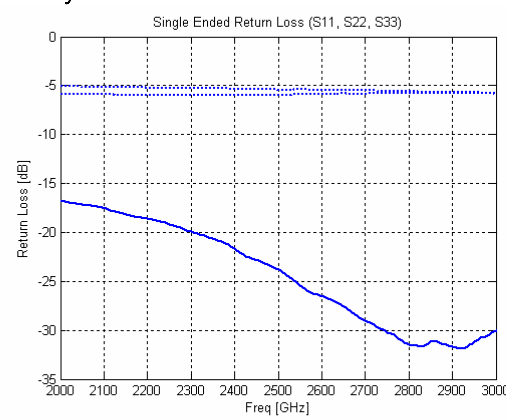


Figure 1a Return loss of balun measured as a 3 ports device

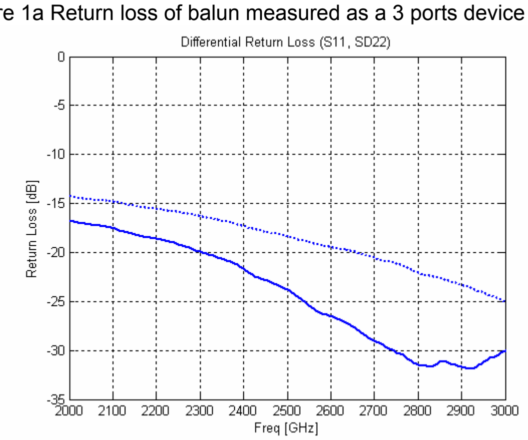


Figure 1b Return loss of balun measured as logical 2-port device

Figure (1a) and (1b) shows the return loss of a typical balun depicted in both single ended and differential modes. Combining the measurements of S22 and S33 from Figure (1a) with measurements of S23 and S32 using equation (1) the differential mode return loss is shown in Figure (1b)

Phase and amplitude measurements using a 2-port analyzer

To evaluate the phase and amplitude balance of a balun it is important to note that the system, in which it is measured, must be repeatable to within the tolerance of which the measurements are required.

So if a mechanical switch is employed to connect between the two differential ports and the analyzer it has to be repeatable enough not to perturb the results. Likewise, if a simple approach of manually unhooking and re-hooking coaxial lines, good RF-measurements techniques should be followed.

Amplitude and phase balance is evaluated using the following equation:

$$AB = 20Log10\left|\frac{S31}{S21}\right| \qquad (2)$$

$$PB = ang\left(\frac{S31}{S21}\right) \qquad (3)$$

It should be noted that if the parameters are used in the reverse order the results are still correct, but the balance will have an opposite sign. However, in most case the user is only interested in the absolute value and therefore the sign is of no importance.

Back-to-Back measurements

This technique involves mounting two identical units in a Back-to-Back configuration. This enables the user to evaluate the insertion loss of both units in series and calculate the loss by dividing the results by 2. The drawback in evaluating the insertion loss of baluns in this manor is that balun #1 is used to match into balun #2 and assuming good production tolerances the result will become "too" good. The Back-to-Back measurement technique gives valid results. However, the results are a measurement of insertion loss in the case of perfect match.

More representative insertion loss measurements are based on adding the measurements of S21 and S31 after each of the measurements have been deembedded and renormalized to the target impedances.

$$IL = 20Log10\left(\left|S12\right|^2 + \left|S13\right|^2\right) \qquad (4)$$

Equation (4) is used to determine the insertion loss of a balun. This Equation only looks at the transmitted energy and therefore the insertion loss due to miss-matched ports is accounted for.

Evaluating balun performance of non 50 Ohm units

The technique of deembedding is a significant obstacle in evaluating the actual performance of any microwave system. For microwave devices like baluns the test board must be deembedded correctly to achieve correct S-parameters when performing a renormalization of the port impedances.

If the impedance or line lengths are incorrect in the deembed files, the performance measured could differ from the performance of the part in an actual system. Here is a list of parameters that are directly affected by the deembed files:

1. For the phase and amplitude balance, the deembed files have to represent the test board used within the accuracy of the test being performed.
2. For the return loss, the correct length of the test board is crucial or the consequent renormalization will fail.
3. For overall insertion loss both the length and insertion loss of the test board is important to know accurately.

Anaren will inform any customer, upon request, of the deembed files and algorithms used in obtaining the published results.

<u>Multi-ports analyzer techniques</u>

Multi-port analyzers have made the evaluation of balun significantly easier, but still not without pitfalls. When evaluating the overall performance of a balun one can look at the balun as either a 3 ports device or a logical 2-port device, where one of the ports is balanced. The results that the analyzer will present are significantly different and will be covered in the following section.

Evaluating the performance of a balun as a 3 port device

On a multi-port analyzer this is a straightforward technique, which gives full S-parameters of the balun. Each of the measurements must be combined in the same fashion as described in the previous section. All the same discussions apply and the same equations should be used to evaluate performance parameters.

Evaluating the performance of a balun as logical 2-port device

Many of the newer Agilents multiport Network analyzer models have the capabilities to make balanced measurement by transforming the analyzer from a 3-port network analyzer into a 2-port analyzer with one or two balanced ports. The transformations described in the previous section are now done in firmware. This approach lets the user set up any type of measurements of the balun and evaluate the actual performance of the circuit in real-time on the screen of the analyzer.

Evaluating balun performance of non 50 Ohm units

The discussion about deembedding from the previous sections is also important for 3-port analyzers and will not be discussed any further here.

Time Domain techniques

Anaren does not use the time Domain technique very often, but some customers in their evaluations have employed it.

A part was tested using a 2.4 GHz source, driving an equal split power divider. One of the power divider outputs was connected to the trigger and the other was used to drive the balun circuit (mounted on the test board). The two outputs of the balun (two terminals of the differential port) were then connected to the two oscilloscope channels via phase and amplitude matched cables.

This technique is capable to get a indication of phase and amplitude balance, but this technique is not capable of measuring the return loss performance. Likewise, evaluating the insertion loss is cumbersome and potentially inaccurate.

The following figure shows actual measurements performed on a 2.45 GHz balun in a 50 Ohm system.

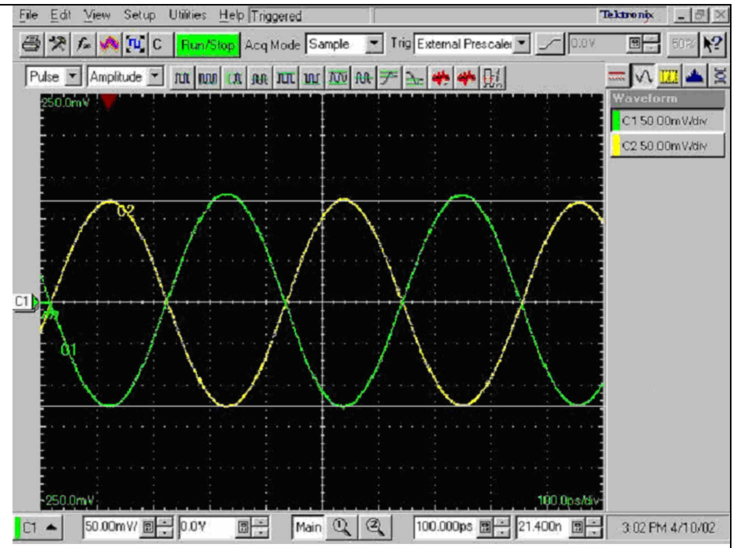
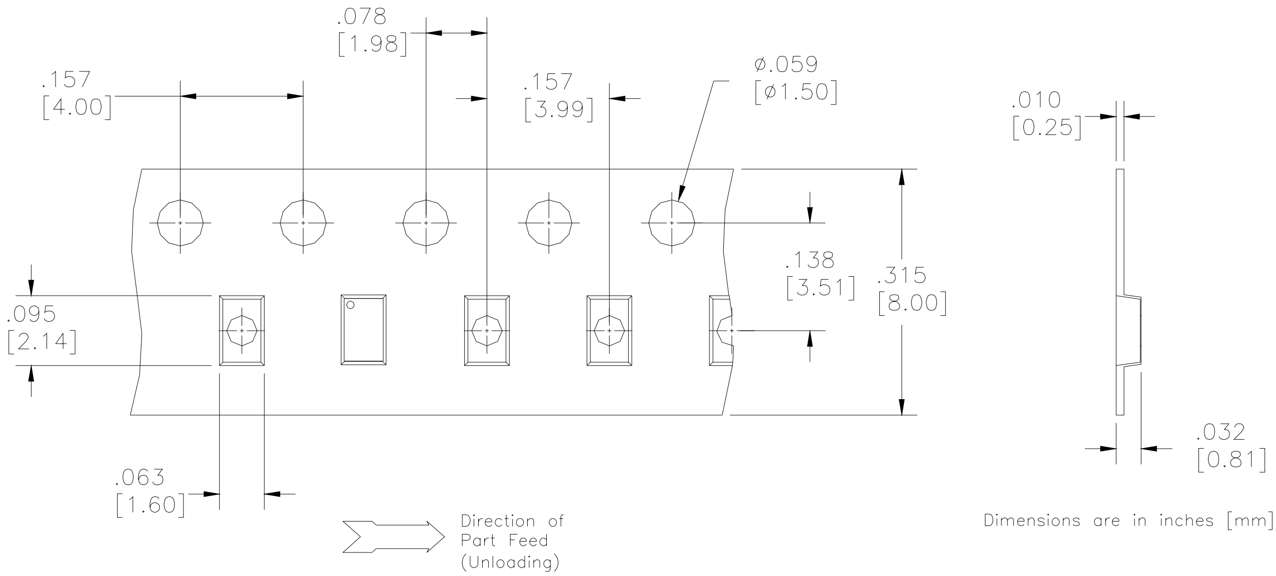


Figure 2 Time domain data taken on a Tektronix 20GS/s oscilloscope.

Packaging and Ordering Information

Parts are available in reel and are packaged per EIA 481-2. Parts are oriented in tape and reel as shown below. Minimum order quantities are 4000 per reel. See Model Numbers below for further ordering information.



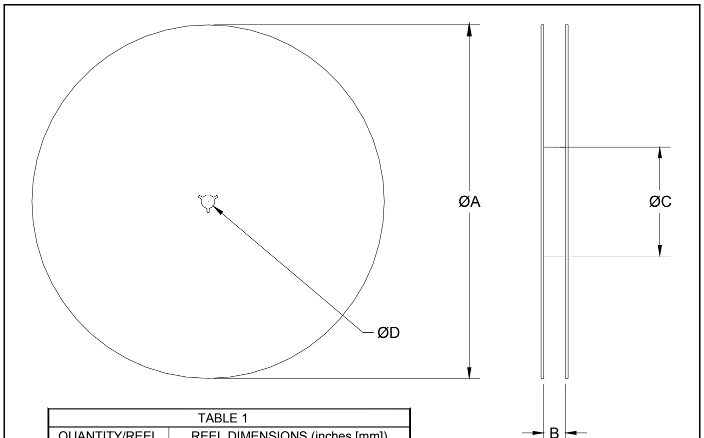


TABLE 1		
QUANTITY/REEL	REEL DIMENSIONS (inches [mm])	
4000	ØA	7.00 [177.8]
	B	0.32 [8.0]
	ØC	2.0 [50.8]
	ØD	0.512 [13.0]

Anaren®

2425 B 50-50 J P R

Frequency	Function	Input Impedance	Output Impedance + Coupling	Package Dimensions	Plating	Shipping Package
00550 = 50 – 500 MHz 0110 = 100 – 1000 MHz 0910 = 900 – 1000 MHz 0921 = 900 – 2100 MHz 1222 = 1200 – 2200 MHz 1416 = 1400 – 1500 MHz 1722 = 1700 – 2200 MHz 2022 = 2000 – 2200 MHz 2425 = 2400 – 2500 MHz 3436 = 3400 – 3600 MHz 4859 = 4800 – 5900MHz 5153 = 5100 – 5300 MHz 5159 = 5100 – 5900 MHz 5759 = 5700 – 5900 MHz 1414 = 14000– 14500 MHz 0819 = 800 + 1900 MHz 0826 = 800 - 2600 MHz	B = Balun F = Filter FB = Filter / Balun C = 3dB Coupler DC = Directional CR = Circulator DB = Dual Balun	50 = 50 Ohm 75 = 75 Ohm	12 = 12.5Ω to Ground 15 = 15Ω to Ground 25 = 25Ω to Ground 37 = 37.5Ω to Ground 50 = 50Ω to Ground 75 = 75Ω to Ground 100 = 100Ω to Ground 03 = 3dB Hybrid 10 = 10dB Directional 20 = 20dB Directional C = Clockwise AC = Anti Clockwise	A = 150 x 150 mils (4mm x 4mm) C = 120 x 120 mils (3mm x 3mm) D = 126 x 79 mils (3.2mm x 2mm) E = 100 x 80 mils (2.5mm x 2mm) G = 120 x 60 mils (3mm x 1.5mm) J = 80 x 50 mils (2mm x 1.25mm) K = 90 x 60 mils (2.25mm x 1.5mm) L = 60 x 30 mils (1.5mm x 0.75mm) N = 140 x 80 mils (3.5mm x 2mm)	P = Lead S = Tin	R = Reel B = Bulk