

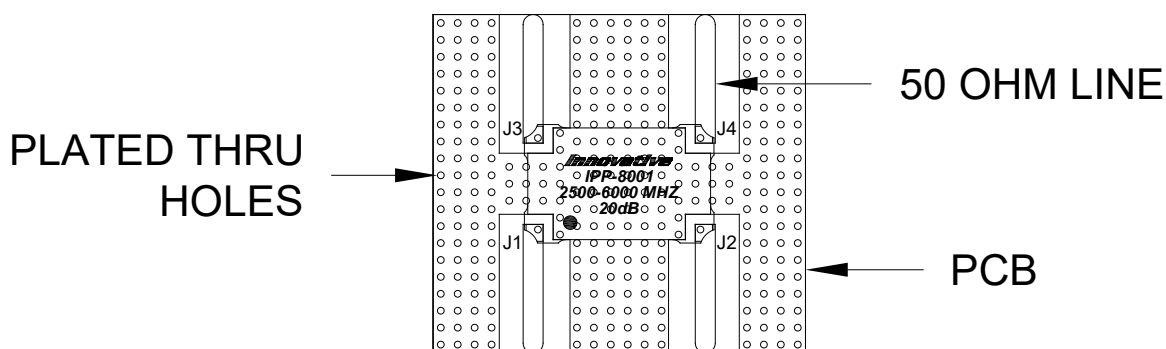
IPP Directional Coupler, SMD, Application Notes

❖ General Notes:

- o Data and specifications apply when part is mounted in IPP test fixture and terminated into a good 50 Ohm Load.
- o Keep un-copper clad channel between RF port contact pads and ground plane clean for high peak power applications to prevent voltage arcing.
- o To ensure proper grounding and heat-sinking the bottom ground plane surface of coupler must lay flat on mounting surface with good solder contact across the full ground plane.
- o Assure good solder attach of the RF port pads to the RF pcb 50 ohm lines using a lead free or lead baring solder alloy.
- o Operating temperature is -55°C to +85°C base plate.
- o Humidity: Up to 95% non-condensing.
- o Storage Temperature is 10°C to 60°C. The moisture sensitivity level (MSL) is 1. Normal precautions should be taken to prevent surface oxidation.

Input Output Relationships for Bi-Directional Couplers

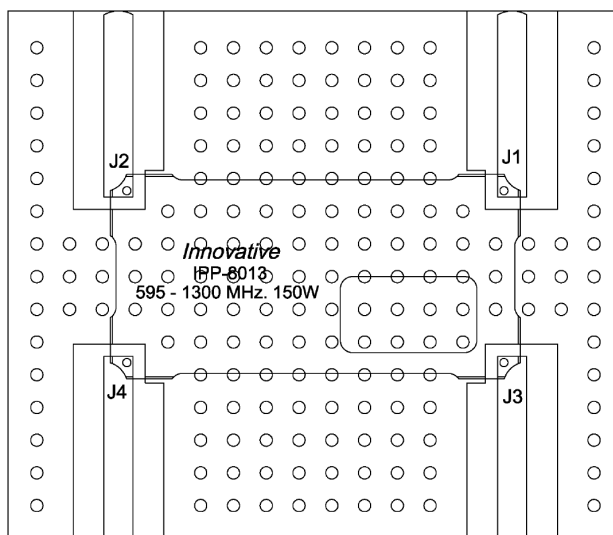
INPUT				
	J1	J2	J3	J4
J1	Input	Output	Forward Coupled	Add 50 Ohm Load
J2	Output	Input	Add 50 Ohm Load	Forward Coupled
J1	Input	Output	Add 50 Ohm Load	Reverse Coupled
J2	Output	Input	Reverse Coupled	Add 50 Ohm Load



MOUNTING, TOP VIEW

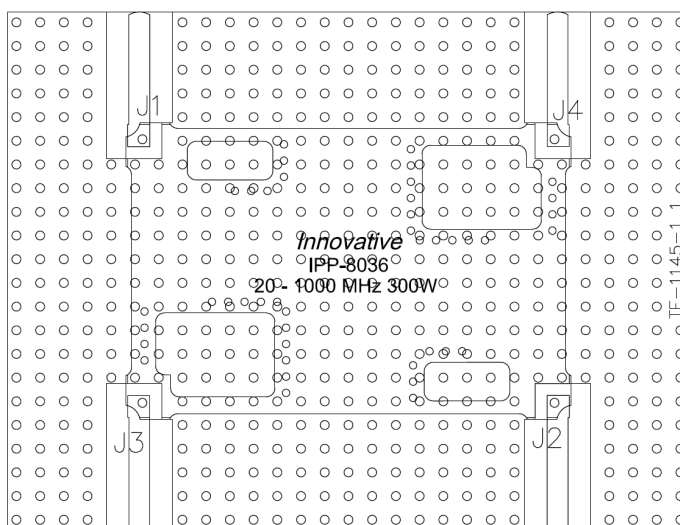
Input Output Relationships for Single-Directional Couplers

INPUT				
	J4	J1	J2	J3
J1	Add 50Ω Termination	Input	Output	Forward Coupled
J2	Add 50Ω Termination	Output	Input	Reverse Coupled



Input Output Relationships for Dual-Directional Couplers

INPUT				
	J1	J2	J3	J4
J1	Input	Output	Forward Coupled	Reverse Coupled
J2	Output	Input	Reverse Coupled	Forward Coupled



Electrical Specifications

❖ VSWR (Voltage Standing Wave Ratio)

- The voltage standing wave ratio is a measure of how well a load is impedance-matched to a source. The value of VSWR is always expressed as a min/max voltage ratio with 1 in the denominator (2:1, 3:1, 10:1, etc.)
- VSWR is a scalar measurement only (no angle). A perfect impedance match corresponds to a VSWR 1:1 meaning you will get all the power Transferred from source to load.
- Typically, the VSWR specification relates to the input and output ports of the coupler.
 - $VSWR (V) = V_{max}/V_{min}$

❖ Insertion Loss (IL)

- The insertion loss is the amount of power (P) lost when transmitted through the coupler from the input port to the output port.
- The power loss from input to output includes power transferred to the coupled port which can be significant for lower coupling values.
 - $IS(dB) = 10 \log(P_{in}/P_{out})$

❖ Isolation (ISO)

- The isolation is the amount of power at the input port divided by the amount of power at the reflected (isolated) port when the other ports are terminated into 50 Ohms.
 - $ISO (dB) = 10 \log(P_{in}/P_{iso})$

❖ Directivity (Dir)

- Directivity is a measure of the quality of the directional
 - $Dir(dB) = Coupling - Isolation$

❖ Coupling (Cpl)

- At any given frequency (f) the coupling value is the ratio of the power levels from the input port to the coupled port. The coupling specification refers to the average of the coupling values (N) at each (f) in the band. Where N is the number of frequencies in the band.
 - $Cpl(f) (dB) = 10 \log(P_{in}(f) / P_{cpl}(f))$
 - $Cpl (dB) = \left[\sum_{n=1}^N Cpl(f) \right] / N$

Electrical Specifications

❖ Coupled Flatness (CF)

- The coupling specification refers to the difference in coupling (dB) between the maximum coupling (MaxCpl) value at (f1) and the minimum coupling (MinCpl) value at (f2) for the specified frequency band.
 - $CF(\pm dB) = (MaxCpl(f1) - MinCpl(f2)) / 2$

❖ Power (P)

- The maximum CW power allowed into the coupler is the sum of the CW input power at each port.
 - $P_{in} = P_{out} + P_{coupled} + P_{reflected}$

❖ Coupler Nomenclature

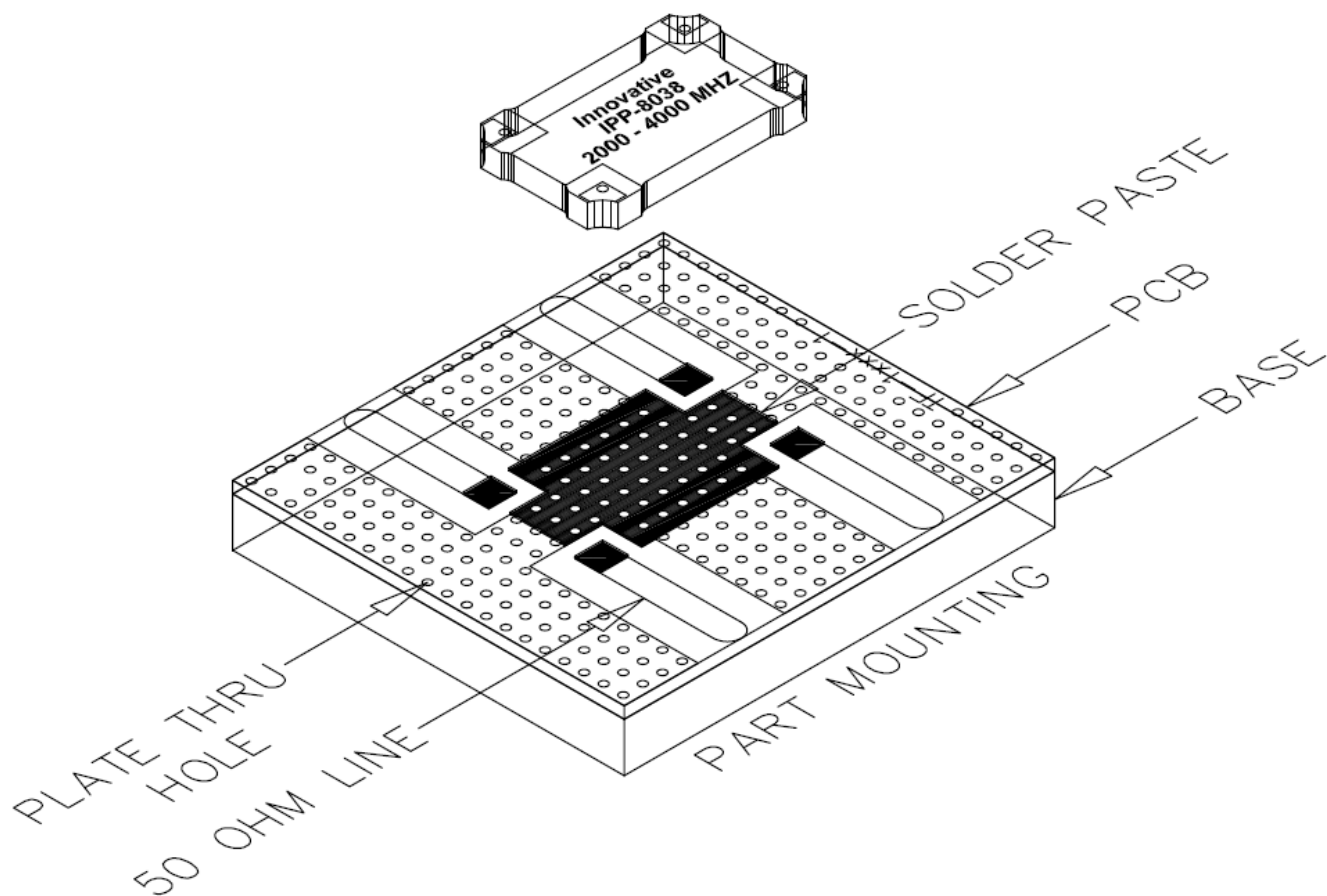
- Dual Directional Coupler (DDC) refers to a 4 port directional coupler (input, output, forward coupling, reverse coupling) which contains two distinct directional couplers. Isolations ports for each of the two couplers are normally terminated on board the part
- Single Directional Coupler (SDC) refers to 3 or 4 port directional coupler. For the 3 port version (input, output, coupled port) the isolation port is internally terminated. For the 4 port version (input, output, coupled port, termination port) the isolation port must be terminated with an external 50 Ohm load and is not available to the customer.
- Bi-Directional Coupler (BDC) refers to a 4 port directional coupler (input, output, forward coupled, reflected coupled) where both of the coupled lines ports are available to the customer.

SMD Coupler Mounting

❖ Mounting, General

- The couplers are designed to be surface mounted to standard types of RF pcbs using tin-lead or lead-free solder. The couplers are available in three finishes, Tin, Tin-Lead or Gold.
- For best performance the ground area of the coupler should be fully soldered to the pcb ground. The pcb should have sufficient plated thru holes to provide a good, low inductance ground for the coupler while also providing a low thermal resistance to the heat sink.
- 50 Ohm transmission lines are required to bring the RF signal to and from each ports solder pad. Do not allow the 50 Ohm lines to encroach into the air gap between the coupler RF port pads and the ground plane as this will reduce the breakdown voltage.
- Solder paste should be applied to the pcb using a stencil, screen or dispensing gun. The solder paste should cover the complete coupler ground plane area as well as the RF port pad area where the coupler interfaces with the pcb.
- Placement of the coupler into the solder paste can be done by hand or pick and place machine. Care should be taken to place the coupler as close to the final required alignment as possible. Misalignment of the coupler after solder reflow can result in RF shorts or reduced performance.
- After couplers are reflow soldered and cleaned, a dry out period is recommended to remove any cleaning solvents before RF signals are applied.
- The Couplers are tested to specification in IPP test fixtures. Use of pcbs other than what is used on the IPP test fixture is allowed however some minor matching of the 50 Ohm lines may be required to achieve the best performance. The extent of the matching is usually a narrowing or widening of the transmission line as it enters the port. The narrowing is directly related to the value of the parasitic capacitor created below the RF port pads to the ground plane. Thin pcb materials with high dielectric constants create larger capacitors which require the narrowing. Thicker pcb materials with lower Er may require widening of the line.

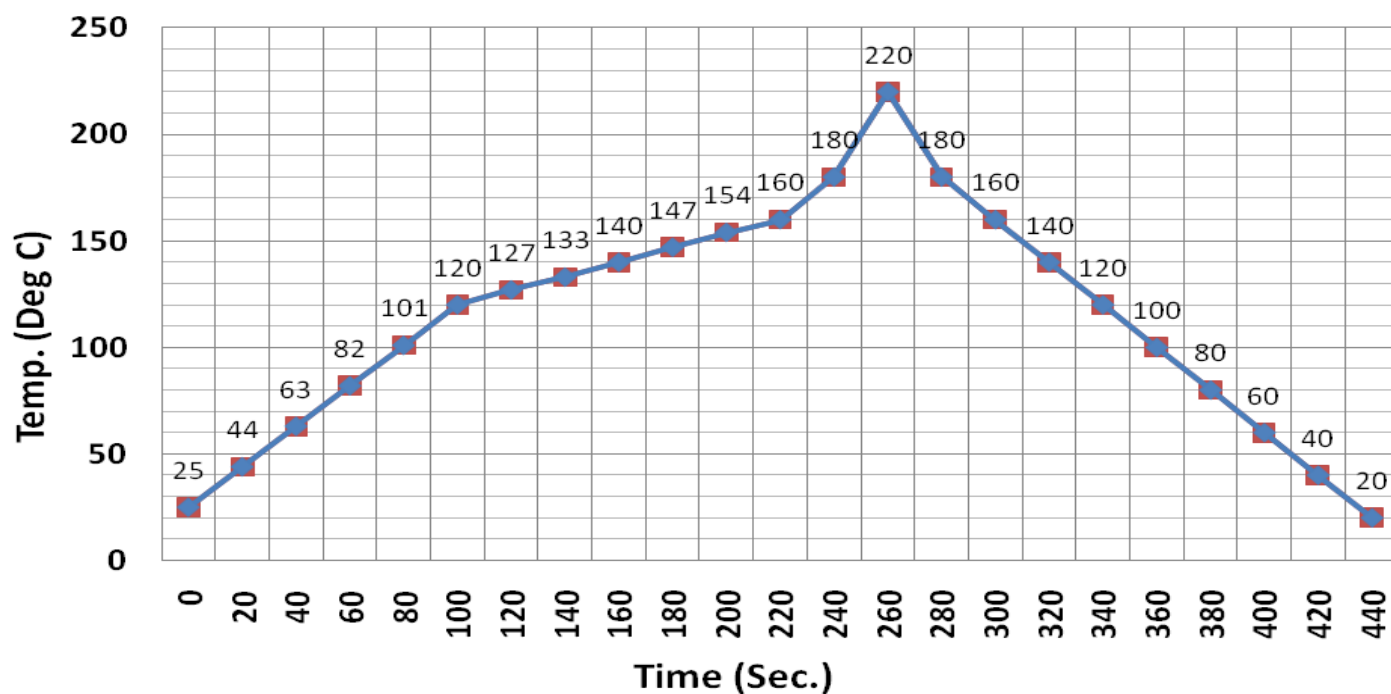
Typical Coupler Mounting



Solder Profiles

(Do Not Exceed Max Reflow Temperature Noted on Outline Drawing)

SN63/Pb37 Solder Reflow Profile



Lead Free Solder Reflow Profile

