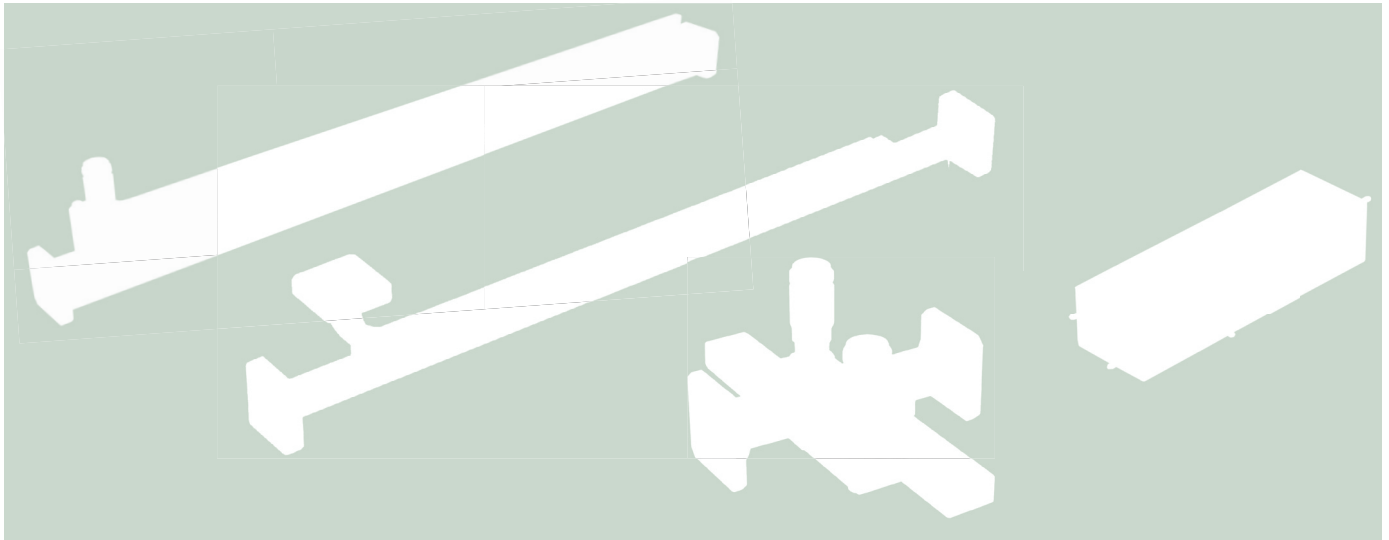


Couplers Selection Guide



OPTIONS AVAILABLE:

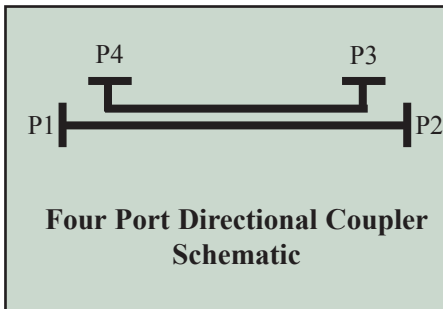
Series 130	Systems Grade	Page 27
Full band, 35 dB nominal directivity entry level multihole directional coupler. 2.6 GHz to 40.1 GHz.		
Series 131	High Directivity	Pages 28-29
Full band, 40 dB nominal directivity multihole directional coupler. 2.6 GHz to 40.1 GHz		
Series WRD131/WRD132	High Directivity	Page 30
Full band, 40 dB nominal directivity double ridged multihole directional coupler. 2.0 GHz to 40 GHz		
Series 132	Very High Directivity	Page 31-32
Full band, 46 dB nominal directivity multihole directional coupler. 2.6 GHz to 40.1 GHz		
Series 133	Ultra High Directivity	Page 33
Full band, 50 dB nominal directivity multihole directional coupler. 3.22 GHz to 40.1 GHz		
Series 136	High Directivity	Page 34
Full band, 40 dB nominal directivity multihole directional coupler. 33.0 GHz to 330 GHz		
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Full band, 44 dB nominal directivity multihole directional coupler. 33.0 GHz to 330 GHz		
Series 230	3 Way Splitter	Page 35
Full band, 40 dB nominal directivity multihole 3 way splitter. 2.6 GHz to 140 GHz		
Series 231	3 Way Splitter	Page 35
Full band, 40 dB nominal directivity multihole 3 way splitter. 140 GHz to 220 GHz		
Series 270	Crossguide (Relatively compact design)	Page 36
Full band, 20 dB nominal directivity crossguide coupler. 2.6 GHz to 330 GHz		
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Special and Customised Directional Couplers & Series 300/301 Dual Couplers		Page 38-39

Multihole Directional Couplers

General Information

Flann Directional Couplers have many applications: it is important that their capabilities and specifications are understood.

Consider the 4 port directional coupler illustrated schematically.



For the purpose of this analysis if P1 is the power incident at Port 1 then the output powers at Ports 2, 3 and 4 are P2, P3 and P4 respectively. If P2' is the power incident at Port 2 then P1', P3' and P4' are the output powers at Ports 1, 3 and 4 respectively.

The three most important parameters in the specification of directional coupler performance are Coupling, Directivity and Through Loss which can be defined as follows:-

$$\begin{aligned} \text{Coupling (dB)} &= 10 \log (P1/P3) \quad \dots(1) \\ \text{or} &= 10 \log (P2'/P4') \\ \text{Directivity (dB)} &= 10 \log (P3/P4) \\ \text{or} &= 10 \log (P4'/P3') \\ \text{Through Loss (dB)} &= 10 \log (P1/P2) \quad \dots(2) \\ \text{or} &= 10 \log (P2'/P1') \end{aligned}$$

In determining the above expressions, unused ports should be terminated with reflectionless loads.

A parameter referred to as Isolation is sometimes used when characterising directional couplers where:-

$$\begin{aligned} \text{Isolation (dB)} &= 10 \log (P1/P4) \\ \text{or} &= 10 \log (P2'/P3') \end{aligned}$$

It can be shown that:-

$$\text{Isolation (dB)} = \text{Coupling (dB)} + \text{Directivity (dB)}$$

This must be borne in mind whilst comparing the specifications from other manufacturers. For a matched coupler in low loss waveguide the main arm through power, P2, is equal to the input power minus the powers coupled to the secondary arm, i.e. $P2 = P1 - (P3 + P4)$ or $P1' = P2' - (P4' + P3')$

For a high directivity coupler P4 and P3' are negligible, hence:-

$$\begin{aligned} P2 &= P1 - P3 \\ \text{or} \quad P1' &= P2' - P4' \end{aligned}$$

also

$$\begin{aligned} \text{Through Loss (dB)} &= 10 \log (P1/(P1 - P3)) \\ \text{or} &= 10 \log (P2/(P2' - P4')) \end{aligned}$$



The table shows, for power incident at Port 1 only, the percentage powers at Ports 2 and 3 and Through Loss for a matched high-directivity coupler of negligible waveguide loss. At lower frequencies waveguide absorption losses are small. However at millimetric frequencies absorption losses are significant and affect the measured performance of couplers. If the power absorbed within the coupler is Pa then the through loss in dB can be defined as:-

$$\text{Through loss} = 10 \log (P1/(P1 - P3 - Pa)) \dots(3)$$

assuming $P4 \ll P3$ (ie high directivity).

Consider a 3 dB coupler with an absorption loss of 0.5 dB. If engineered to have a coupling of 3 dB, as in expression (1), 50.11% of the input power at Port 1 is coupled to Port 3. By using expression (3) it can be shown that an absorption loss of 0.5 dB represents 10.875% of the input power, thus effectively reducing the power at Port 2 to 39.01%. This represents a Through Loss of 4.09 dB.

The table also illustrates the effect of an absorption loss of 0.1 dB and 0.25 dB on the relative powers at Ports 2 and 3:- the coupling value of Flann directional couplers is the true value as defined in the expression (1) above. Millimetre band models must be used with the understanding that there is an additional main guide loss.

The Directivity of a coupler is essentially dependent on the following factors:-

- (i) The design of coupling structure and the accuracy to which it can be manufactured.
- (ii) The inherent VSWR of the coupler's internal termination (3 port devices).
- (iii) Discontinuities and perturbations in the waveguide.
- (iv) The dimensional accuracy of the waveguide at the measurement port.

In four port couplers the VSWR of the bends in the secondary arm are often the most significant factor limiting directivity performance. For example a 4 port coupler with a 1.05 VSWR bend in the secondary arm

will give, at best, a 32.2 dB directivity.

Flann directional couplers have specified directivities which include the interface at the measurement port when connected to an ideal termination. It is important when making comparisons that users should enquire whether alternative manufacturers have also followed similar test procedures when quoting performance. It is not uncommon that when measuring directivity, terminations are inserted into the measuring port's terminal flange. This is not a Flann recommended procedure.

The terms used in Flann Directional Coupler specifications are:-

Nominal Coupling Accuracy

This is the mean coupling value expressed as a percentage of the Nominal Coupling. For example a 10 dB coupler which has a specified Nominal Coupling Accuracy of 5% could have a mean coupling value within the limits 9.5 to 10.5 dB.

Coupling Sensitivity

This is the variation of actual coupling about the mean coupling value over the specified operating frequency band. For example the actual coupling value of a nominal 9.6 dB coupler could vary from 9.1 to 10.1 dB over the specified frequency range.

Directivity

The directivity of a directional coupler is the ratio, in dB, of the power in the forward direction of the secondary guide to that in the reverse direction of the secondary guide when the primary guide is fed only in the forward direction.

i.e. Directivity (dB) = $10 \log_{10} (P3/P4)$ when signal is input to P₁ only.

Coupling (dB)	% Power at Port 3	Waveguide Absorption Loss							
		0 dB @ 5 GHz		0.1 dB @ 25 GHz		0.25 dB @ 65 GHz		0.5 dB @ 140 GHz	
		% Power at Port 2	Through Loss (dB)	% Power at Port 2	Through Loss (dB)	% Power at Port 2	Through Loss (dB)	% Power at Port 2	Through Loss (dB)
3	50.1	49.0	3.02	47.60	3.22	44.29	3.54	39.01	4.09
6	25.1	74.9	1.26	72.60	1.39	69.29	1.59	64.01	1.94
10	10.0	90.0	0.46	87.72	0.57	84.41	0.74	79.13	1.02
20	1.09	9.0	0.044	96.72	0.14	93.41	0.30	88.13	0.55
30	0.1	99.9	0.044	97.62	0.10	94.31	0.255	89.03	0.505
40	0.01	99.99	0.0004	97.71	0.10	94.40	0.250	89.12	0.500