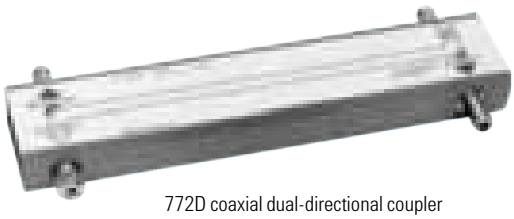
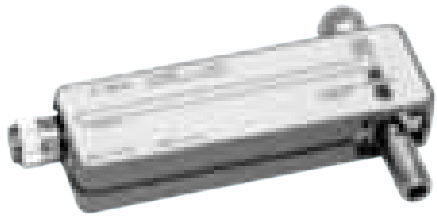
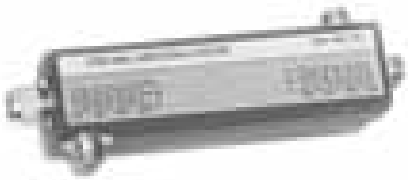


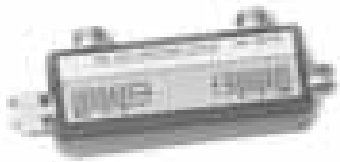
772D coaxial dual-directional coupler



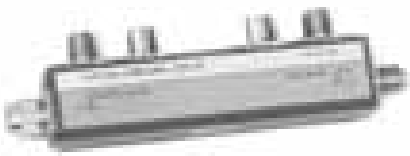
773D coaxial directional coupler



775D coaxial dual-directional coupler

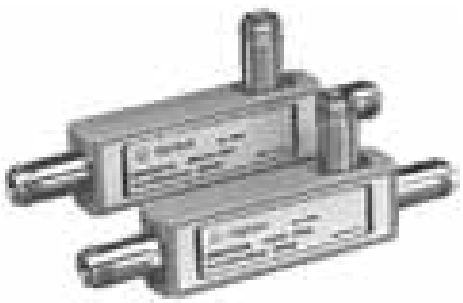


776D coaxial dual-directional coupler

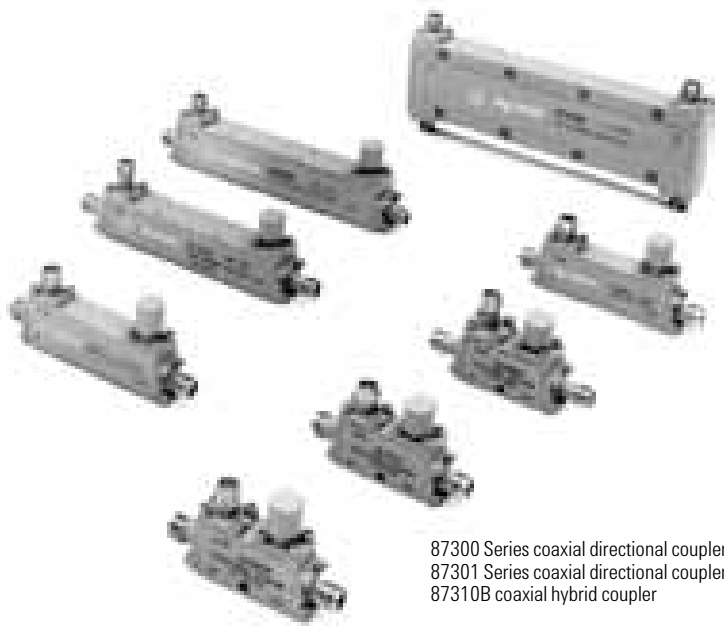


777D coaxial dual-directional coupler

778D coaxial dual-directional coupler



86205A RF bridge
86207A RF bridge



87300 Series coaxial directional coupler
87301 Series coaxial directional coupler
87310B coaxial hybrid coupler

Overview

Directional couplers are general purpose tools used in RF and microwave signal routing for isolating, separating or combining signals. They find use in a variety of measurement applications:

- Power monitoring
- Source leveling
- Isolation of signal sources
- Swept transmission and reflection measurements

Key Specifications

The key specifications for a directional coupler depend on its application. Each of them should be carefully evaluated to ensure that the coupler meets its intended use.

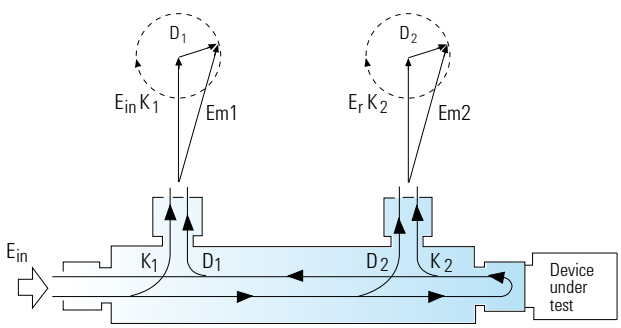
- Directivity
- SWR
- Coupling coefficient
- Transmission loss
- Input power

Directivity

Directivity is a measure of how well the coupler isolates two opposite-travelling (forward and reverse) signals. In the case of measuring reflection coefficient (return loss) of a device under test, directivity is a crucial parameter in the uncertainty of the result. Figure 1 shows how the reflection signal, E_r, is degraded by the undesired portion of the incident signal D_2. And since the undesired signal, D_2, combines with the reflected signal as a phasor, the error in the measured signal Em_2 can only be compensated or corrected on a broadband basis using vector analyzers.

Because the reverse-coupled signal is very small, it adds a negligible amount of uncertainty when measuring large reflections. But as the reflected signal becomes smaller, the reverse-coupled signal becomes more significant.

For example, when the return loss in dB equals the value of directivity, the measurement error can be between –6 to +8 dB. The higher the directivity specified in dB, the higher the measurement accuracy. The effect of the directivity error on the forward-coupler output, Em1, is less important because the desired signal is usually a large value. When Agilent couplers are used for power monitoring and leveling, directivity is less important than coupling coefficient flatness.



K_1 and K_2 : Coupling coefficients (dB)
D_1 and D_2 : Directivities (dB)
E_{in} = Input signal
E_r = Reflected signal from DUT
E_m = Measured signal (includes directivity error)

Figure 1. Effect of directivity on reflection measurement

SWR

For many applications, coupler SWR is important to minimize low mismatch errors and to improve measurement accuracy. For example, when making swept reflection measurements, it is customary to set a full reflection (0 dB return loss) reference by connecting a short at the test port of the coupler. Some of the reflected signal re-reflects due to the output port (test port) SWR. This re-reflected signal goes through a wide phase variation because of the width of the frequency sweep, adding to and subtracting from the reflected signal. This phase variation creates a ripple in the full reflection (0 dB return loss) reference. The magnitude of the re-reflected signal, and thus the measurement uncertainty, can be minimized by selecting couplers with the lowest SWR.

Coupling Coefficient

In power monitoring and leveling, the most desired specification is a highly accurate and flat coupling value, because the coupling factor directly affects the measurement data. For wideband leveling, the coupling factor directly influences the flatness of the output power. Coupling values of 10 and 20 dB are most common but for high power and pulsed systems, there can be a need for 40 dB coupling.

In reflection measurements, coupling factor is less important than directivity and SWR, since both the forward and reverse coupling elements are usually identical, and so the variation of coupling factors match versus frequency.

Transmission Loss

Transmission loss is the total loss in the main line of a directional coupler, and includes both insertion loss and coupling loss. For example, for a 10 dB coupler, 10% of the forward signal is coupled off, which represents approximately 0.4 dB of signal loss added to the inherent losses in the main transmission line.

Transmission loss is usually not important at low frequencies where most swept sources have sufficient available power. However, in the millimeter ranges, power sources are limited and lower loss devices become significant. In general, broadband couplers have transmission losses on the order of 1 dB. On the other hand, directional bridges, which are sometimes used in place of couplers for reflection/transmission measurements, have insertion losses of at least 6 dB. This loss directly subtracts from the dynamic range of the measurement.

Input Power

High power handling characteristics of directional couplers are critical when used for monitoring pulsed power systems. Most couplers designed for test and measurement applications are not ideal for system powers in the kilowatt range. One reason is that the coupler's secondary transmission line often has an internal termination that limits the coupler's mainline power handling capability. A second reason is the maximum power rating of the connectors. Such models have a power rating from 20 to 50 W average.

87300/301 Series Directional Couplers

This line of compact, broadband directional couplers is ideal for signal monitoring, or, when combined with a coaxial detector, for signal leveling. The 8474 series coaxial detectors are recommended if output detection is desired. A broad offering of products is available with frequencies up to 50 GHz.

87310B Hybrid Coupler

The 87310B is a 3 dB hybrid coupler, intended for applications requiring a 90 degree phase difference between output ports. In that sense, it is different from typical power dividers and power splitters, which have matched signal phase at their output ports.

773D Directional Coupler
772D Dual-Directional Coupler

These high-performance couplers are designed for broadband swept measurements in the 2 to 18 GHz range. The 773D is ideal for leveling broadband sources when used with an 8474B detector. (Also, see the Agilent 83036C directional detector). For reflectometer applications, the 772D dual coupler is the best coupler to use with Agilent power sensors and power meters (such as the 438A dual power meter). Forward and reverse power measurements on transmitters, components, or other broadband systems are made simpler by using the 772D. The broadband design allows the use of a single test setup and calibration for tests spanning the entire 2 to 18 GHz frequency range.

775/6/7/8D Dual-Directional Couplers

These couplers cover a frequency spread of more than 2:1, each centered on one of the important VHF/UHF bands. Agilent 778D covers a multi-octave band from 100 to 2000 MHz. With their high directivity and mean coupling accuracy of ±0.5 dB, these are ideal couplers for reflectometer applications. Power ratings are 50 W average, 500 W peak.

RF Bridges

These high directivity RF bridges are ideal for accurate reflection measurements and signal-leveling applications. They combine the directivity and broadband frequency range of directional bridges and the low insertion loss and flat coupling factor of directional couplers. These bridges can be used with the Agilent 8711A RF scalar network analyzer, the Agilent 8753 family of RF vector analyzers as well as Agilent spectrum analyzers.

86205A RF Bridge

This 50 Ω bridge offers high directivity and excellent port match from 300 kHz to 6 GHz. Directivity is 30 dB to 3 GHz. Coupling factor is 16 dB with a slope of +0.15 dB per GHz to 3 GHz. Insertion loss is 1.5 dB with a slope of +0.1 dB per GHz. Connectors are type-N (f).

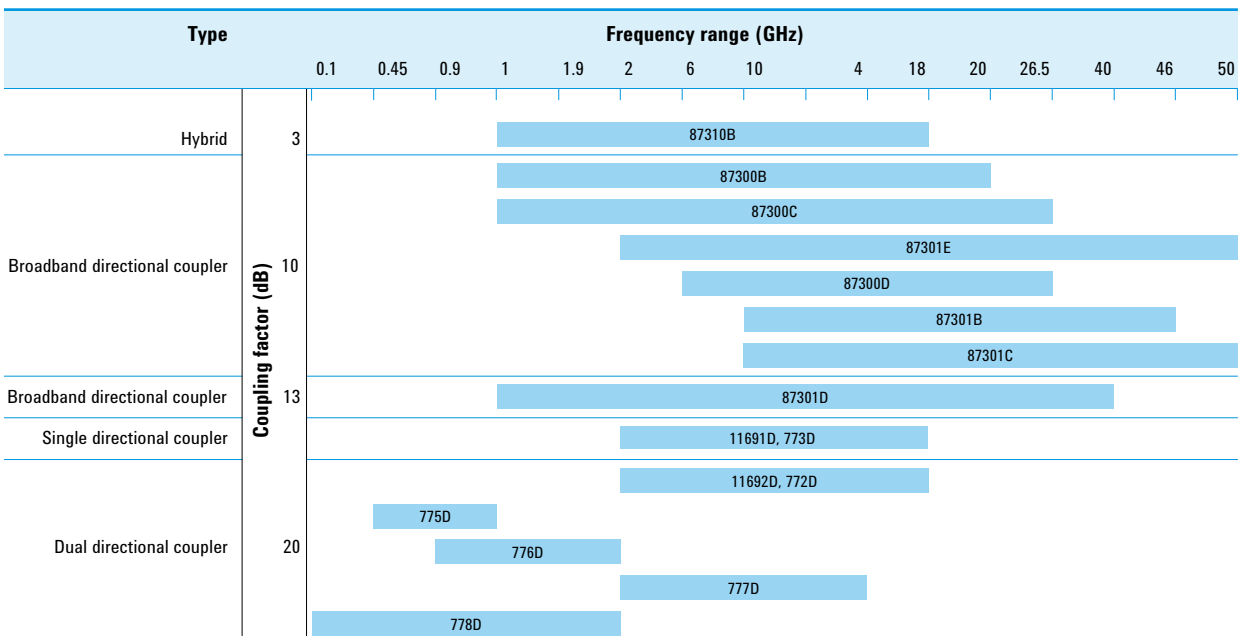
86205B RF Bridge

This 50 Ω bridge offers a high directivity and excellent port to port match from 300 kHz to 3 GHz. Directivity is 33 dB to 3 GHz. Coupling factor is 18 dB with a slope of +/– 3 dB. Insertion loss is 2.5 dB to 3 GHz and the connector type is 3.5 mm and APC-7

86207A RF Bridge

This 75 Ω type-N bridge has high directivity and excellent port match from 300 kHz to 3 GHz. It is used for external reflection measurements or coupling signal from main path. Directivity is 30 dB to 5 MHz, 40 dB to 1.3 GHz, 35 dB to 2 GHz, and 30 dB to 3 GHz. Coupling factor is 16 dB with a slope of +0.15 dB per GHz to 3 GHz. Insertion loss is 1.5 dB with a slope of +0.1 dB per GHz. Connectors are type-N (f).

Directional Coupler Selection Guide



Product Specifications

Model	Frequency range (GHz)	Coupling	Amplitude imbalance	Phase imbalance	Isolation	Maximum SWR (dB)	Insertion loss (dB)	Power rating average, peak	Connectors
Hybrid coupler									
87310B	1 to 18	3 dB	±0.5 dB at each port, centered at –3 dB	±10 Degrees	> 17 dB	1.35	< 2.0	20 W, 3 kW	SMA (f)

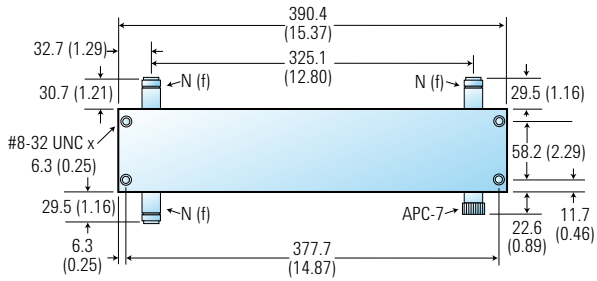
Model	Frequency range (GHz)	Nominal coupling & variation (dB)	Directivity (dB)	Maximum SWR (dB)	Insertion loss (dB)	Power rating average, peak
Broadband directional coupler						
87300B	1 to 20	10 ±0.5	> 16	1.35	< 1.5	20 W, 3 kW
87300C	1 to 26.5	10 ±1.0	> 14 to 12.4 GHz > 12 to 26.5 GHz	1.35 to 12.4 GHz 1.5 to 26.5 GHz	< 1.2 to 12.4 GHz < 1.7 to 26.5 GHz	20 W, 3 kW
87300D	6 to 26.5	10 ±0.5	> 13	1.4	< 1.3	20 W, 3 kW
87301B	10 to 46	10 ±0.7	> 10	1.8	< 1.9	20 W, 3 kW
87301C	10 to 50	10 ±0.7	> 10	1.8	< 1.9	20 W, 3 kW
87301D	1 to 40	13 ±1.0	> 14 to 20 GHz > 10 to 40 GHz	1.5 to 20 GHz 1.7 to 40 GHz	< 1.2 to 20 GHz < 1.9 to 40 GHz	20 W, 3 kW
87301E	2 to 50	10 ±1.0	> 13 to 26.5 GHz > 10 to 50 GHz	1.5 to 26.5 GHz 1.8 to 50 GHz	< 2.0	20 W, 3 kW
Single directional coupler						
773D [1]	2 to 18	20 ±0.9	> 30 to 12.4 GHz > 27 to 18 GHz	1.2	< 0.9	50 W, 250 W
Dual directional coupler						
772D [1]	2 to 18	20 ±0.9	> 30 to 12.4 GHz > 27 to 18 GHz	1.28 to 12.4 GHz 1.4 to 18 GHz	< 1.5	50 W, 250 W
775D [2]	0.45 to 0.94	20 ±1	> 40	1.15	< 0.40	50 W, 500 W
776D [2]	0.94 to 1.9	20 ±1	> 40	1.15	< 0.35	50 W, 500 W
777D [2]	1.9 to 4	20 ±0.4	> 30	1.2	< 0.75	50 W, 500 W
778D	0.1 to 2	20 ±1.5	> 36 to 1 GHz 3 > 32 to 2 GHz [3]	1.1	< 0.60	50 W, 500 W

[1] See data sheet for typical out of band data from 0.1 to 2 GHz and 18 to 20 GHz
[2] Maximum auxiliary arm tracking: 0.3 dB for Agilent 776D; 0.5 dB for Agilent 777D
[3] 30 dB to 2.0 GHz, input port

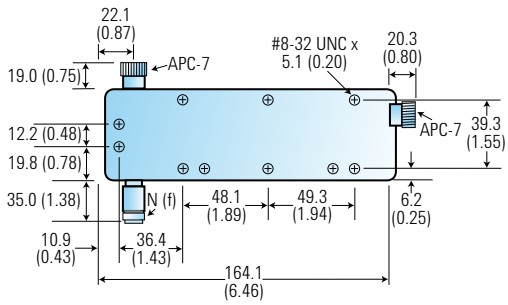
87310B Hybrid Coupler Specifications

Frequency range	1 to 18 GHz
Coupling	3 dB
Amplitude imbalance	±0.5 dB at each port, centered at –3 dB
Phase imbalance	±10 Degrees
Isolation	> 17 dB
Maximum SWR	1.35
Insertion loss	< 2.0 dB
Power rating	
Average	20 W
Peak	3 kW
Connectors	SMA (f)
Weight in grams (oz)	148 (5.2)

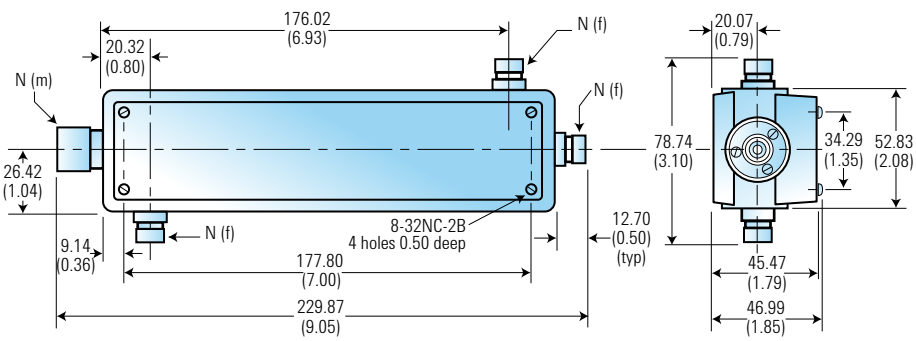
772D Coaxial Dual-Directional Coupler



773D Coaxial Directional Coupler

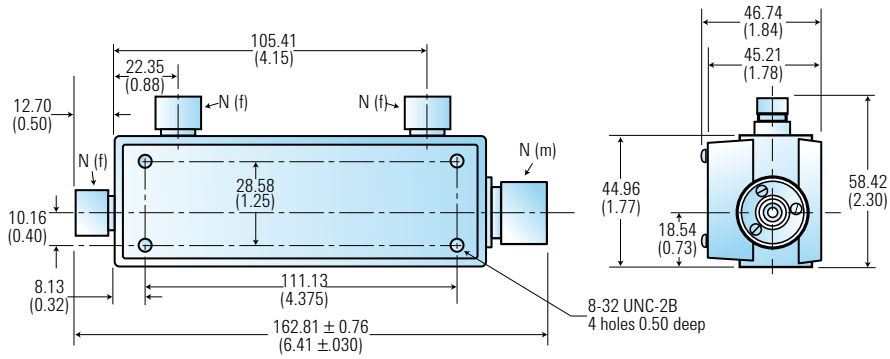


775D Coaxial Dual-Directional Coupler

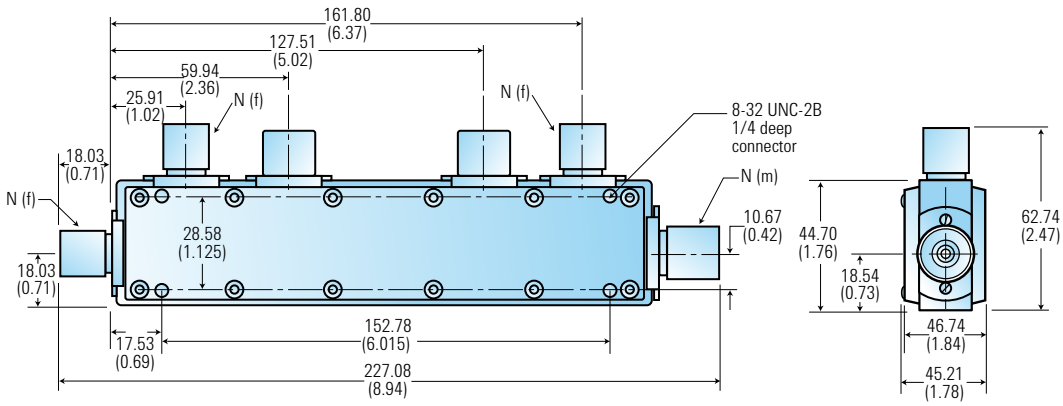


Dimensions are in mm (inches) nominal, unless otherwise specified.

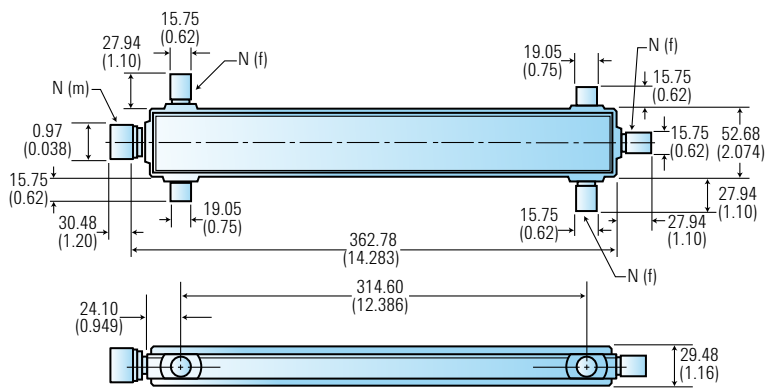
776D Coaxial Dual-Directional Coupler



777D Coaxial Dual-Directional Coupler

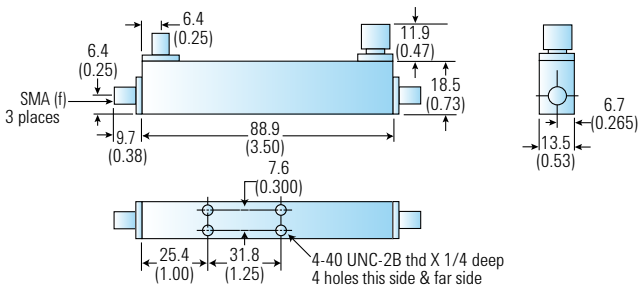


778D Coaxial Dual-Directional Coupler

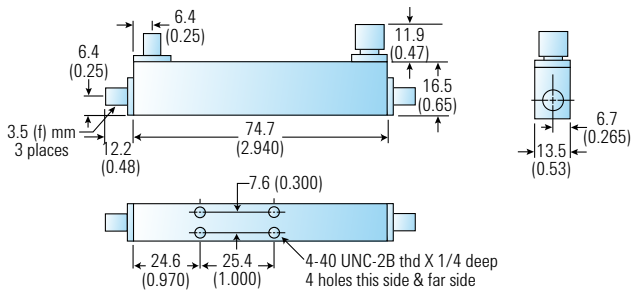


Dimensions are in mm (inches) nominal, unless otherwise specified.

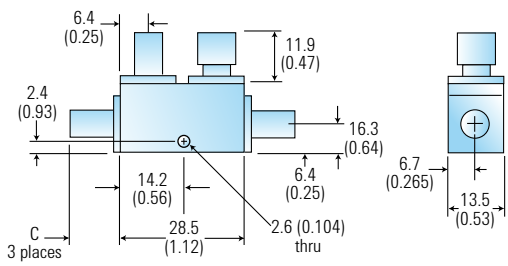
87300B Coaxial Directional Coupler



87300C Coaxial Directional Coupler



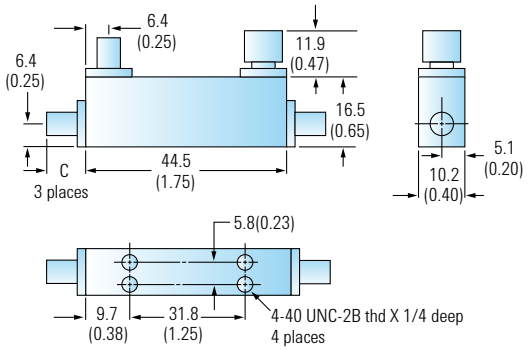
87300D, 87301B, 87301C Coaxial Directional Coupler



Model	Connector type	Connector dimension
87300D	3.5 mm (f)	12.2 (0.48)
87301B	2.9 mm (f)	9.7 (0.38)
87301C	2.4 mm (f)	28.4 (1.0)

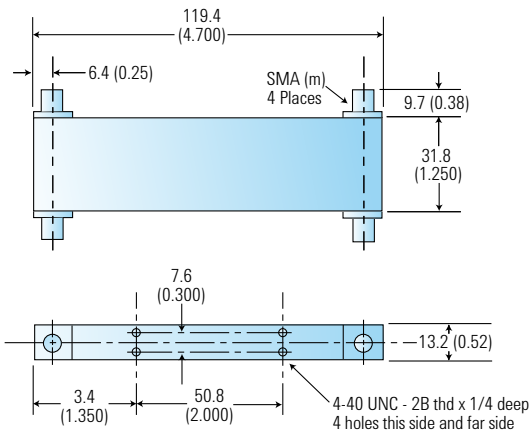
Dimensions are in mm (inches) nominal, unless otherwise specified.

87301D, 87301E Coaxial Directional Coupler

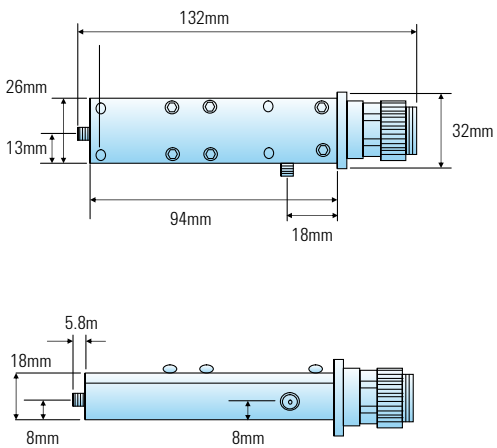


Model	Connector type	Connector dimension
87301D	2.4 mm (f)	9.7 (0.38)
87301E	2.92 mm (f)	9.7 (0.38)

87310B Coaxial Hybrid Coupler



86205B RF Bridge



Dimensions are in mm (inches) nominal, unless otherwise specified.

Model	86205A	86205B	86207A
Frequency range	300 kHz to 6 GHz	300 kHz to 3 GHz	300 kHz to 3 GHz
Impedance	50 Ω	50 Ω	75 Ω
Directivity (min)	30 dB, 0.3 MHz to 5 MHz 40 dB, 5 MHz to 2 GHz 30 dB, 2 GHz to 3 GHz 20 dB, 3 GHz to 5 GHz (typical) 16 dB, 5 GHz to 6 GHz (typical)	38 dB, 0.3 MHz to 1.3 MHz 33 dB, 1.3 MHz to 3 GHz	30 dB, 0.3 MHz to 5 MHz 40 dB, 5 MHz to 1.3 GHz 35 dB, 1.3 GHz to 2 GHz 30 dB, 2 GHz to 3 GHz (typical)
Return loss (min)	23 dB, 0.3 MHz to 2 GHz 20 dB, 2 GHz to 3 GHz 18 dB, 3 GHz to 5 GHz (typical) 16 dB, 5 GHz to 6 GHz (typical)	14 dB, 0.3 MHz to 3 GHz	20 dB, 0.3 MHz to 1.3 GHz 18 dB, 1.3 GHz to 2 GHz 18 dB, 2 GHz to 3 GHz (typical)
Insertion loss (max)	1.5 dB, +0.1 dB/GHz	2.0 dB, 0.3 MHz to 1 GHz 2.5 dB, 1 GHz to 3 GHz	1.5 dB, +0.1 dB/GHz
Coupling factor (nom)	(< 3 GHz) 16.0 dB, +0.15 dB/GHz (> 3 GHz) 16.5 dB, –0.20 dB/GHz	–21 dB to –15 dB, 0.3 MHz to 3 GHz	(< 3 GHz) 16.0 dB, +0.15 dB/GHz

Ordering Information

	Standard connector	
Model	**Primary line**	**Auxiliary arm**
772D		
772D-STD	APC-7, APC-7	N(f)
772D-001	N(f), N(f)	N(f)
773D		
773D-STD/101	APC-7, APC-7	N(f)
773D-001	N(f), N(f)	N(f)
773D-010	N(m), N(f)	N(f)
773D-002	N(f), N(m)	N(f)
775D/777D		
775D/777D-STD	N(m), N(f)	N(f)
778D		
778D-STD	N(f), N(m)	N(f), N(f)
778D-011	APC-7, N(f)	N(f), N(f)
778D-012	N(m), N(f)	N(f)
87301D		
87301D-240	2.4 mm(f), 2.4 mm(f)	2.4 mm(f)
87301D-292	2.92 mm(f), 2.92 mm(f)	2.92 mm(f)
87300B	SMA (f), SMA (f)	SMA (f)
87300C	3.5 mm(f), 3.5 mm(f)	3.5 mm(f)
87300D	3.5 mm(f), 3.5 mm(f)	3.5 mm(f)
87301B	2.92 mm(f), 2.92 mm(f)	2.92 mm(f)
87301C	2.4 mm(f), 2.4 mm(f)	2.4 mm(f)
87301E	2.4 mm(f), 2.4 mm(f)	2.4 mm(f)
87310B	SMA (m), SMA (m)	SMA (m)

Related Literature

772D, 773D directional couplers 2 to 18 GHz technical overview, part number 5959-8753
775D dual Directional couplers operating and service manual, part number 00774-90009
778D dual Directional coupler 100 to 2000 MHz datasheet, part number 5952-8133
86205A & 86207A 50 Ω & 75 Ω RF bridges technical data, part number 5091-3117E
87300/301 Series directional couplers & 87310B hybrid coupler product overview, part number 5091-6188E
Couplers quick fact sheet, part number 5990-5353EN
RF and microwave test accessories selection guide, part number 5990-5499EN

Web Link

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