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HASCO Cage Code:
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WAVEGUIDE CATALOG

- **Waveguide Adapters**
- **Broadband Amplifiers**
- **Waveguide Attenuators**
- **Waveguide Isolators**
- **Gain Horn Antennas**
- **Waveguide Mixers and Frequency Multipliers**
- **Waveguide Terminations**
- **Waveguide Detectors**
- **Waveguide Sections (Bends, Twists, Straights)**

HASCO, Inc. is a global distributor of quality on-demand RF and Microwave components based in Southern California. As an AS9120:B and ISO 9001:2015 certified supplier, the HASCO team takes pride in offering quality and personalized customer service and a large selection of high-performance adapters, amplifiers, attenuators, connectors, cable assemblies, launch accessories, millimeter wave and waveguide components, and more.

Since 1986, HASCO's forward-thinking leadership team has been successful in year-over-year product growth, customer reach, and manufacturer partnerships. From a robust line of quality test and measurement components to a growing selection of millimeter wave active and passive components that are in stock and ready to ship daily, HASCO is an industry leader for "just in time" components designed for systems with higher frequencies, performance and flexibility.

In addition to providing easy and convenient access to highly sought-after RF and Microwave components, HASCO supports its customers through every aspect of the buying experience with an easy-to-use, highly optimized web store and technical sales support, both online and through area sales representatives. From product selection and education to an easy and seamless reordering process, HASCO is committed to its mission of being a convenient and quality source for RF and Microwave engineers.

HASCO offers these value propositions:

- AS9120:B and ISO 9001:2015 certified
- Same-Day Shipping
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WAVEGUIDE ADAPTERS

HASCO offers Coax to Waveguide Adapters interface to WR-10 through WR-430 waveguides, operating from 1.7 GHz to 110 GHz in both right angle and end launch designs.

HASCO's offerings of Waveguide to Coax adpters are known for their superior performance as well as low-loss and low VSWR characteristics.

WAVEGUIDE TO COAX ADAPTERS

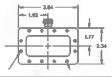
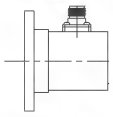
PHOTO	CONFIG.	PART #/TYPE	SPECIFICATIONS
	WR-10 to 1.0mm (F) Straight End-Launch	**HWCA-101F-EL**	**Freq:** 75-110 GHz **VSWR**: √1.7:1 (17dB RL) Typ. **Flange:** UG387/UM **Temp:** -20° to +50°C
	WR-10 to 1.0mm (F) Right Angle	**HWCA-101F-RA**	**Freq:** 75-110 GHz **VSWR**: 1.4:1 Max **Flange:** UG387/UM **Max Power:** 10W (CW)
	WR-10 to 1.0mm (F) Right Angle	**HWCA-101F-RAR**	**Freq:** 75-110 GHz **VSWR**: 1.4:1 Max **Flange:** UG387/UM **Max Power:** 10W (CW)
	WR-112 to SMA (F) Right Angle	**HWCA-112SF-RA**	**Freq:** 7.05-10.0 GHz **VSWR**: 1.25:1 Max **Flange:** UG138/U **IL:** 0.15 dB Typ.
	WR-12 to 1.0mm (F) Straight End-Launch	**HWCA-121F-EL**	**Freq:** 60-90 GHz **VSWR**: √1.7:1 (17dB RL) Typ **Flange:** UG387/U **Temp:** -20° to +50°C
	WR-12 to 1.0mm (F) Right Angle	**HWCA-121F-RA**	**Freq:** 60-90 GHz **VSWR**: 1.4:1 Max **Flange:** UG387/U **Max Power:** 10W (CW)
	WR-12 to 1.0mm (F) Right Angle	**HWCA-121F-RAR**	**Freq:** 60-90 GHz **VSWR**: 1.4:1 Max **Flange:** UG387/U **Max Power:** 10W (CW)
	WR-15 to 1.0mm (F) Straight End-Launch	**HWCA-151F-EL**	**Freq:** 50-75 GHz **VSWR**: √1.7:1 (17dB RL) Typ **Flange:** UG385/U **Temp:** -20° to +50°C
	WR-15 to 1.0mm (F) Right Angle	**HWCA-151F-RA**	**Freq:** 50-75 GHz **VSWR**: 1.4:1 Max **Flange:** UG385/U **Max Power:** 10W (CW)
	WR-15 to 1.0mm (F) Right Angle	**HWCA-151F-RAR**	**Freq:** 50-75 GHz **VSWR**: 1.4:1 Max **Flange:** UG385/U **Max Power:** 10W (CW)
	WR-15 to 1.85mm (F) Right Angle	**HWCA-1518F-RAR**	**Freq:** 50-67 GHz **VSWR**: 1.4:1 Max **Flange:** UG385/U **Max Power:** 30W (CW)
	WR-15 to 1.85mm (F) Straight End-Launch	**HWCA-15VF-EL**	**Freq:** 50-70 GHz **VSWR**: √1.7:1 (17dB RL) Typ **Flange:** UG385/U **Temp:** -20° to +50°C
	WR-159 to N (F) Right Angle	**HWCA-159NF-RA**	**Freq:** 4.90-7.05 GHz **VSWR**: 1.25:1 Max **Flange:** CPR159F
	WR-187 to N (F) Right Angle	**HWCA-187NF-RA**	**Freq:** 3.95-5.85 GHz **VSWR**: 1.25:1 Max **Flange:** CMR187
	WR-229 to N (F) Right Angle	**HWCA-229NF-RA**	**Freq:** 3.30-4.90 GHz **VSWR**: 1.25:1 Max **Flange:** CMR229
	WR-284 to N (F) Right Angle	**HWCA-284NF-RA**	**Freq:** 3.30-4.90 GHz **VSWR**: 1.25:1 Max **Flange:** UG1484/U
	WR-28 to 2.92mm (F) Right Angle	**HWCA-2829F-RA**	**Freq:** 2.6-3.95 GHz **VSWR**: 1.20:1 Max **Flange:** UG599/U **IL:** 0.010 dB Typ.

PHOTO	CONFIG.	PART #/TYPE	SPECIFICATIONS
	WR-34 to 2.92mm (F) Straight End-Launch	**ADP-W-27500-11000-34-2F-E**	**Freq:** 22-33 GHz **IL**: <0.4 dB Typ **Flange:** UG1530/U **Temp:** -25° to +65°C
	WR-34 to 2.92mm (F) Right Angle	**HWCA-3429F-RA**	**Freq:** 22-33 GHz **VSWR**: 1.25:1 Max **Flange:** UG1530/U **IL:** 0.30 dB Typ.
	WR-34 to N (F) Right Angle	**HWCA-340NF-RA**	**Freq:** 2.1 - 3.0 GHz **VSWR**: 1.25:1 Max **Flange:** UG554F/U **Temp:** -40° to +85°C
	WR-42 to SMA (F) Right Angle	**HWCA-42SF-RA**	**Freq:** 18-26.5 GHz **VSWR**: 1.30:1 Max **Flange:** UG595/U & UG597/U **Temp:** -55° to +120°C
	WR-430 to N (F) Right Angle	**HWCA-430NF-RA**	**Freq:** 1.7-2.6 GHz **VSWR**: 1.20:1 Max **Flange:** UG437F **IL:** 0.15 dB Typ.
	WR-51 to SMA (F) Right Angle	**HWCA-515SF-RA**	**Freq:** 15-22 GHz **VSWR**: 1.20:1 Max **Flange:** WR51 **IL:** 0.10 dB Typ.
	WR-62 to SMA (F) Right Angle	**HWCA-62SF-RA**	**Freq:** 12.4-18.0 GHz **VSWR**: 1.25:1 Max **Flange:** UG1665/U **IL:** 0.30 dB Typ.
	WR-75 to SMA (F) Right Angle	**ADP-W-12500-5000-75-E**	**Freq:** 10-15 GHz **IL**: 0.15 dB Typ **Flange:** UBR120 **Temp:** -50° to +85°C
	WR-75 to SMA (F) Right Angle	**HWCA-75SF-RA**	**Freq:** 10-15 GHz **VSWR**: 1.25:1 Max **Flange:** WR-75 Cover **IL:** 0.30 dB Typ.
	WR-75 to SMA (F) Right Angle	**HWCA-75SF-RA-01**	**Freq:** 10-15 GHz **VSWR**: 1.25:1 Max **Flange:** WR-75 Cover **IL:** 0.30 dB Typ.
	WR-90 to SMA (F) Right Angle	**HWCA-90SF-RA**	**Freq:** 8.2-12.4 GHz **VSWR**: 1.25:1 Max **Flange:** UG135/U **IL:** 0.30 dB Typ.
	WR-90 to N (F) Right Angle	**HWCA-90NF-RA**	**Freq:** 8.2-12.4 GHz **VSWR**: 1.25:1 Max **Flange:** UG135/U

Ask us about your specific requirement.

HASCO can provide engineering assistance to fulfill many specialized requirements.

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BROADBAND AMPLIFIERS

An amplifier boosts the loss experienced by a microwave signal.

A Low Noise Amplifier is placed near the input of a receiver. The noise figure measures how much the LNA degrades the signal-to-noise ratio of the received signal. The other important characterstics of the LNA is its linearity, survivable power and DC dissipation.

Power Amplifiers are used to boost a small signal to a large signal based on the frequency.

HASCO's line of amplifiers are high performance LNA (Low Noise Amplifiers) and power amplifier designs with extremely low noise and broadband performance in Waveguide Amplifier and MMIC Amplifier options.

Our amplifiers operate from 17 GHz up to 110 GHz with up to 32 dB of gain or a Psat of 27 dBm, depending on the design. The LNA designs can achieve a noise figure down to 3.5 dB in the mmWave bands.

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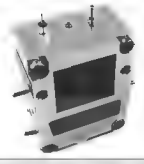
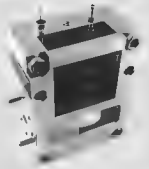
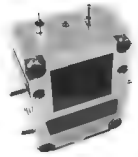
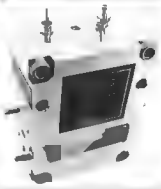
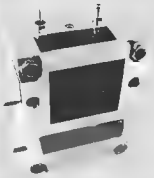
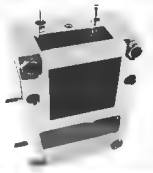
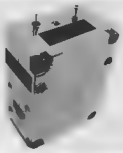
LOW NOISE AMPLIFIERS

PHOTO	TYPE/PART #	OUTPUT FREQUENCY	GAIN	NOISE FACTOR	DC	MATERIALS
	**W-Band, WR-10 HWLNA10-W10045**	75-110 GHz	• 75-105 GHz: 20 dB Typ • 106-110 GHz: Gain may drop slightly • 110- GHz: 10 dB Typ	4.5 dB Typ.	+8V @ 100 mA Typ. or +7V to +12V	• **Waveguide:** Gold Plated Aluminum • WR-10, UG-387/U-M
	**E-Band, WR-12 HWLNA12-E2304**	67-90 GHz	23 dB Typ.	4.5 dB Typ.	+7.5V to 12V @ 75 mA Typ.	• **Waveguide:** Gold Plated Aluminum • WR-12, UG-3387/U
	**V-Band, WR-15 HWLNA15-V2004**	53-65 GHz	-10° - +65°C	4 dB Typ.	+8V @ 100 mA Typ. or +7V to +12V	• **Waveguide:** Gold Plated Aluminum • WR-15, UG-385U

POWER AMPLIFIERS

PHOTO	TYPE/PART #	OUTPUT FREQUENCY	GAIN	PSAT	DC	MATERIALS
	**W-Band, WR-10 HWAMP10-W1712**	75-110 GHz	17 dB Typ	75-105 GHz: +12 dBm Typ. 110 GHz: +8 dBm Typ.	+8V @ 300 mA Typ. or +7V to +12V	• **Waveguide:** Gold Plated Aluminum • WR-10, UG-387/U-M
	**E-Band, WR-12 HWAMP12-E1011**	71-860 GHz	25 dB Typ.	+11 dBm to +13 dBm	+7.5V to 12V @ 150 mA Typ.	• **Waveguide:** Gold Plated Aluminum • WR-12, UG-3387/U
	**V-Band, WR-15 HWAMP15-V2012**	50-75 GHz	20 dB Typ.	12 dBm Typ.	+8V @ 300 mA Typ. or +7V to +12V	• **Waveguide:** Gold Plated Aluminum • WR-15, UG-385U
	**U-Band, WR-19 HWAMP19-U1820**	40-60 GHz	18 dB Typ.	20 dBm Typ.	+8V @ 300 mA Typ.	• **Waveguide:** Gold Plated Aluminum • WR-19, UG-383/U
	**Q-Band, WR-22 HWAMP22-Q1821**	33-48 GHz	18 dB Typ.	21 dBm Typ	+8V @ 450 mA Typ.	• **Waveguide:** Gold Plated Aluminum • WR-22, UG-383/U
	**Ka-Band, WR-28 HWAMP28-KA2222**	26.5-40 GHz	22 dB Typ.	22 dBm Typ	+8V @ 200 mA Typ.	• **Waveguide:** Gold Plated Aluminum • WR-28, UG-599/U

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WAVEGUIDE ATTENUATORS

A Millimeter Waveguide Attenuator is a passive RF device specifically designed to reduce the power of a signal without affecting or reducing the waveform of the signal. Millimeter Waveguide Fixed Attenuators have a fixed level of attenuation - any signal input in to the system will be attenuated by the waveguide.

HASCO stocks thousands of RF and Microwave attenuators and can support most requirements, such as Type N, SMA, 2.92mm, 2.4mm, and 1.85mm in addition to many other RF Coaxial and Waveguide Attenuators.

FIXED WAVEGUIDE ATTENUATORS

PHOTO	TYPE/PART #	FREQUENCY	POWER	TEMP RANGE	ATTENUATION ACCURACY	VSWR	MATERIALS
	**W Band HWFA10-03-1.0 (1 Inch)**	75 to 110 GHz	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 3 dB Typ.	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-387/U-M
	**W Band HWFA10-06-1.0 (1 Inch)**	75 to 110 GH	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 6 dB Typ.	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-387/U-M
	**W Band HWFA10-10-1.0 (1 Inch)**	75 to 110 GH	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 10 dB Typ.	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-387/U-M
	**E Band HWFA12-03-1.0 (1 Inch)**	60 to 90 GHz	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 3 dB Typ.	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-387/U
	**E Band HWFA12-06-1.0 (1 Inch)**	60 to 90 GHz	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 6 dB Typ	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-387/U
	**E Band HWFA12-10-1.0 (1 Inch)**	60 to 90 GHz	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 10 dB Typ.	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-387/U
	**V Band HWFA15-03-1.0 (1 Inch)**	50 to 75 GHz	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 3 dB Typ.	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-385/U
	**V Band HWFA15-06-1.0 (1 Inch)**	50 to 75 GHz	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 6 dB Typ	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-385/U
	**V Band HWFA15-10-1.0 (1 Inch)**	50 to 75 GHz	0.3 Watts	-0° - +100°C	Accuracy: (0.7 dB @ 4%) 10 dB Typ.	1:15:1	• **Waveguide:** 075-T6 Aluminum • **Finish:** Gold Over Electroless Nickel • **Flange** UG-385/U

LEVEL-SET WAVEGUIDE ATTENUATORS

PHOTO	TYPE/PART #	FREQUENCY	VARIABLE ATTENUATION	VSWR	MATERIALS
	**WR-06** **D Band** **HWLSA06-0330-ER**	110 to 170 GHz	0 to 30dB	1:30:1	• **Waveguide:** OFHC Copper • **Flange:** OFHC Copper • **Finish:** Gold Plate • **Flange** UG-387/M
	**WR-08** **F Band** **HWLSA08-0330-ER**	90 to 140 GHz	0 to 30dB	1:30:1	• **Waveguide:** OFHC Copper • **Flange:** OFHC Copper • **Finish:** Gold Plate • **Flange** UG-387/M
	**WR-10** **W Band** **HWLSA10-0330-ER**	75 to 110 GHz	0 to 30dB	1:30:1	• **Waveguide:** OFHC Copper • **Flange:** OFHC Copper • **Finish:** Gold Plate • **Flange** UG-387/M
	**WR-12** **E Band** **HWLSA12-0330-ER**	60 to 90 GHz	0 to 30dB	1:30:1	• **Waveguide:** OFHC Copper • **Flange:** OFHC Copper • **Finish:** Gold Plate • **Flange** UG-387
	**WR-15** **V Band** **HWLSA15-0330-ER**	50 to 75 GHz	0 to 30dB	1:30:1	• **Waveguide:** OFHC Copper • **Flange:** OFHC Copper • **Finish:** Gold Plate • **Flange** UG-385
	**WR-19** **U Band** **HWLSA19-0330-ER**	40 to 60 GHz	0 to 30dB	1:30:1	• **Waveguide:** OFHC Copper • **Flange:** OFHC Copper • **Finish:** Gold Plate • **Flange** UG-383/M
	**WR-22** **Q Band** **HWLSA22-0330-ER**	33 to 50 GHz	0 to 30dB	1:30:1	• **Waveguide:** OFHC Copper • **Flange:** OFHC Copper • **Finish:** Gold Plate • **Flange** UG-383/U-M
	**WR-28** **Ka Band** **HWLSA28-0330-ES**	26.5 to 40 GHz	0 to 30dB	1:25:1	• **Waveguide:** OFHC Copper • **Flange:** OFHC Copper • **Finish:** Gold Plate • **Flange** UG-599

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BIAS TEES
MAGIC TEES

A **Bias Tee** is a diplexer, which splits incoming signals from a common port into two paths (sometimes called “channels”), dependent on frequency. It is a three-port network used to supply DC currents or voltages to RF devices, and for setting the DC bias point, without disturbing other components. The DC port injects a bias onto the RF path by adding a DC bias level to a radio-frequency signal from the RF port onto the RF-DC port. The biased RF signal can be sent to a remote device to provide both an RF signal and a DC supply.

A **Waveguide Magic Tee** is a four-port hybrid coupler and/or power divider with two collinear arms, an E-plane (difference) arm and an H-plane (sum) arm. HASCO Magic Tees offer a nominal insertion loss and high isolation between the two collinear arms and between the sum and difference arms.

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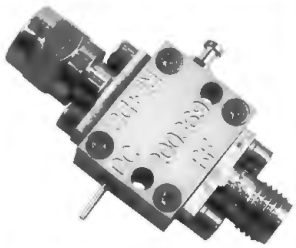
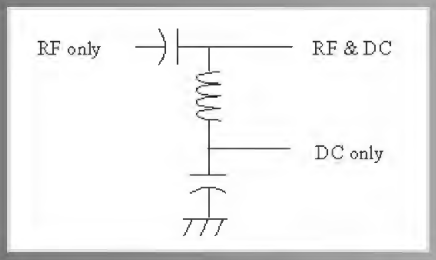
BIAS TEES

PHOTO	PART #	CONNECTOR	TYPE	SPECIFICATIONS
	**HBT4-20040-MF**	2.92mm Male to 2.92mm Female	Coaxial	**Freq:** 200 MHz - 40 GHz **VSWR**: 2.0:1 Max. **IL:** 1.5dB Typ. **RL:** -15dB Typ **Voltag**e: 225mA **Temp:** -55° to 125°C

In this figure, an RF signal is introduced to the RF & DC port and a DC bias is added from the DC Only port. A **Bias Tee** can also work in reverse order to remove a DC bias that is received from the RF & DC port, while allowing only the RF signal to pass to the RF port. In the reverse scenario, the DC Only port can be c onnected to a VDC port of an active device, such as an amplifier, to power it.



Properties that are important to a bias tee are RF bandwidth, insertion loss and mismatch at the two RF ports, the maximum DC current, and video bandwidth of the DC port.

WAVEGUIDE MAGIC TEES

PHOTO	PART #	WAGEGUIDE BAND	FLANGE	SPECIFICATIONS
	**HWMT10-9030T-ER**	W-Band	WR-10 UG-387/UM	**Freq:** 75 - 105 GHz **IL:** 1.0dB Typ. **RL:** 14dB MIN (H Port) 12.5 dB Min (E Port) **Isolation:** 30 dB Min E-H Ports 20 dB Min Colinear Points **Balance:** 0.5 dB Max
	**HWMT12-7330T-ER**	E-Band	WR-12 UG-387/U	**Freq:** 60 - 86 GHz **IL:** .35dB Typ. **RL:** 14dB MIN (H Port) 12.5 dB Min (E Port) **Isolation:** 30 dB Min E-H Ports 20 dB Min Colinear Points **Balance:** 0.5 dB Max
	**HWMT15-6130T-ER**	V-Band	WR-15 UG-385/U	**Freq:** 50 - 72 GHz **IL:** 1.0dB Typ. **RL:** 14dB MIN (H Port) 12.5 dB Min (E Port) **Isolation:** 30 dB Min E-H Ports 20 dB Min Colinear Points **Balance:** 0.5 dB Max

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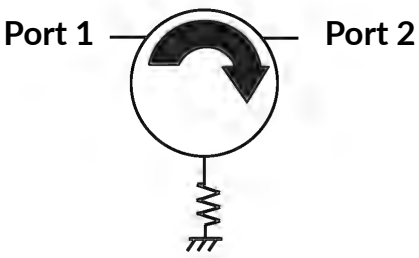
WAVEGUIDE ISOLATORS

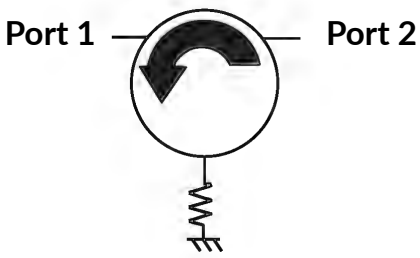
Waveguide isolators have by far the best electrical characteristics. You can specify insertion loss down to less than 0.2 dB in some cases!

By terminating one port, a circulator becomes an isolator, which has the property that energy flows on one direction only. They isolate components in a chain, so that bad VSWRs don't contribute to gain ripple, or lead to instabilities. An isolator is a non-reciprocal, passive network.

WAVEGUIDE FULL BAND ISOLATORS

PHOTO	TYPE PART #	FREQUENCY RANGE	ISOLATION (MIN.)	IL (MAX)	POWER (MAX)	FLANGE MATERIAL
	**WR-08 HWFBI08-ER**	90 to 140 GHz	20 dB	3..2 dB	0.75 WATTS	UG-387/U-M Round Gold Plated Brass
	**WR-10 HWFBI10-ER**	75 to 110 GHz	27 dB	2.5 dB	1.0 WATTS	UG-387/U-M Round Gold Plated Brass
	**WR-12 HWFBI12-ER**	60 to 90 GHz	27 dB	2.0 dB	1.0 WATTS	UG-387/U Round Gold Plated Brass
	**WR-15 HWFBI15-ER**	50 to 75 GHz	27 dB	1.8 dB	1.5 WATTS	UG-385/U Round Gold Plated Brass
	**WR-19 HWFBI19-ER**	40 to 60 GHz	27 dB	1.8 dB	1.5 WATTS	UG-383/U Round Gold Plated Brass
	**WR-22 HWFBI22-ER**	33 to 50 GHz	27 dB	1.8 dB	1.5 WATTS	UG-383/U Round Gold Plated Brass
	**WR-28 HWFBI28-ES**	26.5 to 40 GHz	25 dB	1.8 dB	1.5 WATTS	UG-599/U Square Gold Plated Brass





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WAVEGUIDE GAIN HORN ANTENNAS

HASCO's Stand Rectangular Gain Horns are used in a wide variety of applications, such as antenna testing and RF radiation pattern measurement. Our Gain Horns function as a calibration standard or as reference for antenna gain measurement. They are also used as feed horns for lens and reflector antennas or stand-alone antennas in subsystems.

The HASCO standard gain horn antenna is used for antenna range calibration and general-purpose system setups.

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WAVEGUIDE GAIN HORN ANTENNAS

PHOTO	PART #	INPUT WAVEGUIDE	GAIN	SPECIFICATIONS
	**HWSGH10-23-ER**	WR-10 Waveguide **Flange:** UG-387/UM W Band	23 dBi	**Frequency:** 75 - 110 GHz **VSWR**: 1.10:1 Max **Series:** Directional **Polarity**: Vertical **Temp:** -55° to 85°C
	**HWSGH12-23-ER**	WR-12 Waveguide **Flange:** UG-387/U E Band	23 dBi	**Frequency:** 60 - 90 GHz **VSWR**: 1.10:1 Max **Series:** Directional **Polarity**: Vertical **Temp:** -55° to 85°C
	**HWSGH15-23-ER**	WR-15 Waveguide **Flange:** UG-385/U V Band	23 dBi	**Frequency:** 50 - 75 GHz **VSWR**: 1.10:1 Max **Series:** Directional **Polarity**: Vertical **Temp:** -55° to 85°C
	**HWSGH19-23-ER**	WR-19 Waveguide **Flange:** UG-383/UM U Band	23 dBi	**Frequency:** 40 - 60 GHz **VSWR**: 1.10:1 Max **Series:** Directional **Polarity**: Vertical **Temp:** -55° to 85°C
	**HWSGH22-23-ER**	WR-22 Waveguide **Flange:** UG-383/UM Q Band	23 dBi	**Frequency:** 33 - 50 GHz **VSWR**: 1.10:1 Max **Series:** Directional **Polarity**: Vertical **Temp:** -55° to 85°C
	**HWPSD28-23-ES**	WR-28 Waveguide **Flange:** UG-599/U Ka Band	23 dBi	**Frequency:** 26.5 - 40 GHz **VSWR**: 1.10:1 Max **Series:** Directional **Polarity**: Vertical **Temp:** -55° to 85°C
	**HWPSD42-23-ES**	WR-42 Waveguide **Flange:** UG-599/U K Band	23 dBi	**Frequency:** 18 - 26.5 GHz **VSWR**: 1.10:1 Max **Series:** Directional **Polarity**: Vertical **Temp:** -55° to 85°C

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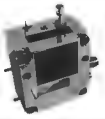
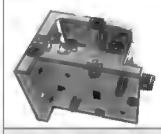
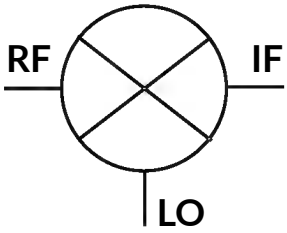
MIXERS and FREQUENCY MULTIPLIERS

HASCO offers a selection of microwave and millimeter-wave Mixers and Frequency Multipliers in packaged and MMIC designs. Connectorized Mixers and Multipliers operate as low as 2 GHz and up to 110 GHz. MMIC Mixers operate between the 57 through 170 GHz band, while MMIC Multipliers have an input frequency as low as 9.5 GHz, with an output up to 106 GHz. MMIc's are available in die form and come in gelpacks.

WAVEGUIDE MIXERS

PHOTO	TYPE/PART #	FREQUENCY	CONVERSION LOSS	LO INPUT POWER	ISOLATION	MATERIALS
	**W-Band, WR-10 Waveguide, Balanced HWMX10-SFW**	RF: 75-110 GHz LO: 75-110 GHz IF: 0.1-18 GHz	9.5 dB Typical	+10 to +13 dBm	LO/RF: +20dB Typ.	• **Waveguide:** Gold Plated Aluminum • WR-10, UG-387/UM • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**E-Band, WR-12 Waveguide, Balanced HWMX12-SFE**	RF: 60-90 GHz LO: 60-90 GHz IF: 0.1-18 GHz	9 dB Typical	+10 to +13 dBm Typ.	LO/RF: +20dB Typ.	• **Waveguide:** Gold Plated Aluminum • WR-12, UG-387/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**V-Band, WR-15 Waveguide, Balanced HWMX15-SFV**	RF: 50-75 GHz LO: 50-75 GHz IF: 1-18 GHz	8.5 dB Typical	+10 to +13 dBm Typ.	LO/RF: +20dB Typ.	• **Waveguide:** Gold Plated Aluminum • WR-15, UG-385/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**U-Band, WR-19 Waveguide, Balanced HWMX19-SFU**	RF: 40-60 GHz LO: 40-60 GHz IF: 0.1-18 GHz	7.5 dB Typical	+10 to +13 dBm Typ.	LO/RF: +20dB Typ.	• **Waveguide:** Gold Plated Aluminum • WR-19, UG-383/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**Q-Band, WR-22 Waveguide, Balanced HWMX22-SFQ**	RF: 33-50 GHz LO: 33-50 GHz IF: 0.1-18 GHz	7 dB Typical	+10 to +13 dBm Typ.	LO/RF: +20dB Typ.	• **Waveguide:** Gold Plated Aluminum • WR-22, UG-383/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**Ka-Band, WR-28 Waveguide, Balanced HWMX28-SFKA**	RF: 26.5-40 GHz LO: 26.5-40 GHz IF: 0.1-18 GHz	7 dB Typical	+10 to +13 dBm Typ.	LO/RF: +20dB Typ.	• **Waveguide:** Gold Plated Aluminum • WR-28, UG-599/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu



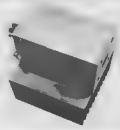
A mixer is a device that performs the task of frequency conversion, by multiplying two signals. Mixers are needed in most microwave systems because the RF signal is way too high to process its information.

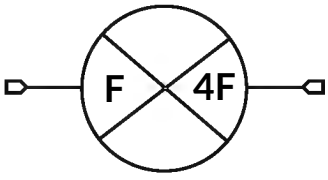
You can use a mixer to convert a signal down in frequency (as in a receiver) or up in frequency (as in an transmitter or exciter) because it is a reciprocal device.

A mixer can be as simple as one that uses a single diode, or it can get far more complicated for improved performance. Two broad categories of mixers commonly used in microwave applications are switching mixers and nonlinear mixers. Switching mixers include single-balanced and double-balanced mixers and are the most prevalent and have the most predictable performance, but nonlinear mixers allow you to go to much higher frequencies (well into the millimeterwave spectrum).

Even in switching mixers you still need a nonlinear device. The nonlinear device within a mixer is most often a Schottky diode, but can also be a FET or other transistor. PIN diodes are never used for mixers, they switch too slowly.

FREQUENCY MULTIPLIERS

PHOTO	TYPE/PART #	FREQUENCY	POWER	DC	SIGNAL PURITY	MULTIPLICATION POWER	MATERIALS
	**WR-10 Full Band Active Multiplier HWFM10-SF6X10**	Output 75-110 GHz Input 12.5-18.33 GHz	Output 10-12 dBm Input 6-15 dBm	+8V @ 600mA	-20 dBc	X6	• **Waveguide:** Gold Plated Aluminum • WR-10, UG-387/UM • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**WR-12 Full Band Active Multiplier HWFM12-SF4X13**	Output 60-90 GHz Input 15-22 GHz	Output 10-12 dBm Input 6-10 dBm	+8V @ 500mA	-20 dBc	X4	• **Waveguide:** Gold Plated Aluminum • WR-12, UG-387/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**WR-12 Full Band Active Multiplier HWFM12-SF6X12**	Output 71-86 GHz Input 11.83-14.33 GHz	Output 12-13 dBm Input 6-15 dBm	+8V @ 600mA	-20 dBc	X6	• **Waveguide:** Gold Plated Aluminum • WR-12, UG-387/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**WR-15 Full Band Active Multiplier HWFM15-SF4X13**	Output 50-75 GHz Input 12.5-18.75 GHz	Output 13-15 dBm Input 6-15 dBm	+8V @ 600mA	-20 dBc	X4	• **Waveguide:** Gold Plated Aluminum • WR-15, UG-385/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**WR-19 Full Band Active Multiplier HWFM19-SF4X15**	Output 40-60 GHz Input 10-15 GHz	Output 14-16 dBm Input 3-8 dBm	+8V @ 400mA	-20 dBc	X4	• **Waveguide:** Gold Plated Aluminum • WR-19, UG-383/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**WR-22 Full Band Active Multiplier HWFM22-SF4X15**	Output 33-50 GHz Input 8.25-12 GHz	Output 15-17 dBm Input 3-8 dBm	+8V @ 600mA	-20 dBc	X4	• **Waveguide:** Gold Plated Aluminum • WR-22, UG-383/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu
	**WR-28 Full Band Active Multiplier HWFM28-SF2X23**	Output 26-40 GHz Input 13-20 GHz	Output 0-3 dBm Input 23 dBm	+8V @ 400mA	-20 dBc	X2	• **Waveguide:** Gold Plated Aluminum • WR-28, UG-599/U • **SMA Housing:** Passivated SS • **Contact:** Gold Plated BeCu



Frequency Multipliers are nonlinear, two-port devices where an input signal is used to create an output signal that is at a higher harmonic.

Passive multipliers

Passive multipliers are usually an arrangement of diodes that rectify a signal. For a doubler, you can expect 8-10 dB loss.

Passive doublers are usually not reciprocal, meaning one port will be defined as the input and the other defined as the output. In some cases the ports will be obvious, as the input will be coax and the output will be waveguide.

Active multipliers

Active multipliers combine a multiplier with an amplifier on the output.

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WAVEGUIDE TERMINATIONS

RF Terminations or loads are components that are used to absorb energy and prevent RF signals from reflecting back from an open-ended or unused port. The ports are usually terminated with a load that has the same characteristic impedance as the transmission line.

Any multi-port RF system, whose ports are not all being used should be terminated so that any signal incident on these ports will be absorbed. If a port is left un-terminated, then the signals can reflect back into the system which can introduce distortions and other undesirable effects. These are used in couplers, hybrids, isolators, test equipment and in systems where a port needs to be terminated.

WAVEGUIDE TERMINATIONS

PHOTO	TYPE PART #	FREQUENCY RANGE	MAX. VSWR	POWER	FLANGE MATERIAL
	WR-08 (0.9" length) **HWLPT08-02-ER**	90 to 140 GHz	1.10:1	0..2 WATTS	• WG: Gold Plated Copper • Flange: UG-387/U-M Round Gold Plated Brass
	WR-10 (2.0" length) **HWLPT10-ER**	75 to 110 GHz	1.50:1	0.3 WATTS	• WG: Gold Plated Aluminum • Flange: UG-387/U-M Round Gold Plated Aluminum
	WR-10 (1.5" length) **HWLPT10-03-ER**	75 to 110 GHz	1.05:1	0.3 WATTS	• WG: Gold Plated Copper • Flange: UG-387/U-M Round Gold Plated Brass
	WR-12 (2.0" length) **HWLPT12-ER**	60 to 90 GHz	1.05:1	0.3 WATTS	• WG: Gold Plated Aluminum • Flange: UG-387/U Round Gold Plated Aluminum
	WR-12 (1.5" length) **HWLPT12-03-ER**	60 to 90 GHz	1.05:1	0.3 WATTS	• WG: Gold Plated Copper • Flange: UG-387/U Round Gold Plated Brass
	WR-15 (2.0" length) **HWLPT15-ER**	50 to 75 GHz	1.05:1	0.3 WATTS	• WG: Gold Plated Aluminum • Flange: UG-385/U Round Gold Plated Aluminum
	WR-15 (1.5" length) **HWFBI15-03-ER**	50 to 75 GHz	1.05:1	0.3 WATTS	• WG: Gold Plated Aluminum • Flange: UG-385/U Round Gold Plated Aluminum
	WR-19 (1.75" length) **HWLPT19-2-ER**	40 to 60 GHz	1.05:1	2.0 WATTS	• WG: Gold Plated Copper • Flange: UG-383/U-M Round Gold Plated Brass
	WR-22 (2.0" length) **HWLPT22-2-ER**	33 to 50 GHz	1.05:1	4.0 WATTS	• WG: Gold Plated Copper • Flange: UG-383/U Round Gold Plated Brass
	WR-28 (0.56" length) **HWLPT28-1-ES**	26.5 to 40 GHz	1.30:1	1.0 WATTS	• WG: Gold Plated Copper • Flange: UG-599/U Square
	WR-34 (0.69" length) **HWLPT34-2-ES**	22 to 33 GHz	1.25:1	1.0 WATTS	• WG: Gold Plated Copper • Flange: UG-1530/U Square
	WR-42 (1.0" length) **HWLPT42-2-ES**	18 to 26.5 GHz	1.25:1	1.0 WATTS	• WG: Gold Plated Copper • Flange: UG-1530/U Square
	WR-51 (1.0" length) **HWLPT51-1-ES** **HWLPT51-2-ES**	15 to 22 GHz	1.20:1	1.0 WATTS 2.0 WATTS	• WG: Gold Plated Copper • Flange: UBR180 Square
	WR-62 (1.0" length) **HWLPT62-2-ES**	12.4 to 18 GHz	1.20:1	2.0 WATTS	• WG: Gold Plated Copper • Flange: UG-1665/U Square
	WR-75 (1.0" length) **HWLPT75-2-ES**	10 to 15 GHz	1.20:1	2.0 WATTS	• WG: Gold Plated Copper • Flange: UG-138/U Square
	WR-90 (1.0" length) **HWLPT90-1-ES** **HWLPT90-2-ES**	8.2 to 12.4 GHz	1.20:1	1.0 WATTS 2.0 WATTS	• WG: Gold Plated Copper • Flange: UG-135/U Square
	WR-112 (1.13" length) **HWLPT112-2-ES**	7.05 to 10 GHz	1.20:1	2.0 WATTS	• WG: Gold Plated Copper • Flange: UG-138/U Square

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WAVEGUIDE DETECTORS

A detector is a two-terminal device that is used to rectify an RF signal (like a diode rectifies an alternating current signal in a power supply). Detectors are used as the receiving element in amplitude modulation schemes among other uses.

HASCO Waveguide Detectors offer full waveguide band operation with high sensitivity without tuning and high sensitivity stability over a broad temperature range.

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WAVEGUIDE DETECTORS

PHOTO	PART #	INPUT WAVEGUIDE	OUTPUT CONNECTOR	SPECIFICATIONS
	**HWPSD08-90140-S2**	WR-08 Waveguide **Flange:** UG-387/UM F Band	SMA Female	**Frequency:** 90 - 140 GHz **Sensitivity**: 700 mV/mW Typ. **Flatness:** +/- 1.7 dB Max **Polarity:** Positive **Tangential Sensitivity**: -40 dBm (BW 40 Hz, dBm) **CW Power**: +16 dBm **Absolute Max Input Power**: +20 dBm **Temp:** -55° to 85°C
	**HWPSD10-75110-S2**	WR-10 Waveguide **Flange:** UG-387/UM W Band	SMA Female	**Frequency:** 75 - 110 GHz **Sensitivity**: 800 mV/mW Typical **Flatness:** +/- 1.5 dB Max **Polarity:** Positive **Tangential Sensitivity**: -45 dBm (BW 40 Hz, dBm) **CW Power**: +16 dBm **Absolute Max Input Power**: +20 dBm **Temp:** -55° to 85°C
	**HWPSD12-6090-S2**	WR-12 Waveguide **Flange:** UG-387/U E Band	SMA Female	**Frequency:** 60 - 90 GHz **Sensitivity**: 1000 mV/mW Typical **Flatness:** +/- 1.5 dB Max **Polarity:** Positive **Tangential Sensitivity**: -45 dBm (BW 40 Hz, dBm) **CW Power**: +16 dBm **Absolute Max Input Power**: +20 dBm **Temp:** -55° to 85°C
	**HWPSD15-5075-S2**	WR-15 Waveguide **Flange:** UG-385/U V Band	SMA Female	**Frequency** 50 - 75 GHz **Sensitivity**: 1000 mV/mW Typical **Flatness:** +/- 1.5 dB Max **Polarity:** Positive **Tangential Sensitivity**: -45 dBm (BW 40 Hz, dBm) **CW Power**: +16 dBm **Absolute Max Input Power**: +20 dBm **Temp:** -55° to 85°C
	**HWPSD19-4060-S2**	WR-19 Waveguide **Flange:** UG-383/U U Band	SMA Female	**Frequency:** 40 - 60 GHz **Sensitivity**: 750 mV/mW Typ. **Flatness:** +/- 2 dB Max **Polarity:** Positive **Tangential Sensitivity**: -50 dBm (BW 40 Hz, dBm) **CW Power**: +16 dBm **Absolute Max Input Power**: +20 dBm **Temp:** -55° to 85°C
	**HWPSD22-3350-S2**	WR-22 Waveguide **Flange:** UG-383/U Q Band	SMA Female	**Frequency:** 33 - 50 GHz **Sensitivity**: 1500 mV/mW Typ. **Flatness:** +/- 1.5 dB Max **Polarity:** Positive **Tangential Sensitivity**: -55 dBm (BW 40 Hz, dBm) **CW Power**: +16 dBm **Absolute Max Input Power**: +20 dBm **Temp:** -55° to 85°C
	**HWPSD28-2640-S2**	WR-28 Waveguide **Flange:** UG-599/U Ka Band	SMA Female	**Frequency:** 26.5 - 40 GHz **Sensitivity**: 1300 mV/mW Typ. **Flatness:** +/- 2 dB Max **Polarity:** Positive **Tangential Sensitivity**: -55 dBm (BW 40 Hz, dBm) **CW Power**: +16 dBm **Absolute Max Input Power**: +20 dBm **Temp:** -55° to 85°C

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WAVEGUIDE SECTIONS

HASCO waveguide sections provide different configurations to route waveguide signals between devices using Straight Waveguides, Twist Waveguides, E-Bend Waveguides, H-Bend Waveguides in common 1 inch, 1.5 inch, 2 inch and 2.5 inch lengths.

HASCO's waveguides come in standard WR designs and operate across the full waveguide band from 18 GHz to 325 GHz. Whether it is WR-42, WR12, WR-03 or WR sizes in between, HASCO has them in stock.

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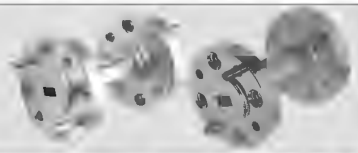
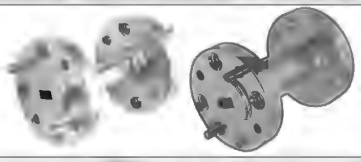
WAVEGUIDE STRAIGHT SECTIONS

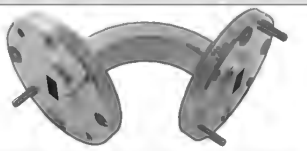
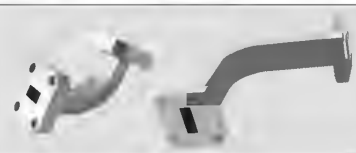
XX = LENGTH

PHOTO	TYPE/PART #	FREQUENCY	TEMP RANGE	VSWR	MATERIALS
	WR-3 **HWSS03-XX-ER** (Available in 1.0, 1.5 & 2.0 Inch)	220 to 325 GHz	+220°C Max	1:04:1 Typ.	• **Waveguide:** Silver • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	G-Band, WR-5 **HWSS05-XX-ER** (Available in 1.0, 1.5 & 2.0 Inch)	140 to 220 GHz	+220°C Max	1:04:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	D-Band, WR-6 **HWSS06-XX-ER** (Available in 1.0, 1.5 & 2.0 Inch)	110 to 175 GH	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	F Band, WR-8 **HWSS08-XX-ER** (Available in 1.0, 1.5 & 2.0 Inch)	90 to 1400 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	W Band, WR-10 **HWSS10-XX-ER** **HWSS10-XX-ER-1** (Available in 1.0 & 2.0 Inch)	75 to 110 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	E Band, WR-12 **HWSS12-XX-ER** **HWSS12-XX-ER-1** (Available in 1.0 & 2.0 Inch)	60 to 90 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U • **Finish**: Gold Plated
	V Band, WR-15 **HWSS15-XX-ER** **HWSS15-XX-ER-1** (Available in 1.0 & 2.0 Inch)	50 to 75 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-385/U • **Finish**: Gold Plated
	U Band, WR-19 **HWSS19-XX-ER** (Available in 1.0, 1.5 & 2.0 Inch)	40 to 60 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-383/U-M • **Finish**: Gold Plated
	Q Band, WR-22 **HWSS22-XX-ER** (Available in 1.0, 1.5 & 2.0 Inch)	33 to 50 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-383/U-M • **Finish**: Gold Plated
	Q Band, WR-28 **HWSS28-XX-ES** (Available in 1.0, 1.5 & 2.0 Inch)	26.5 to 40 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-599/U • **Finish**: Gold Plated
	WR-34 **HWSS34-XX-ES** (Available in 1.0, 1.5 & 2.0 Inch)	22 to 33 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-595/U-M • **Finish**: Gold Plated
	WR-42 **HWSS42-XX-ES** (Available in 1.0, 1.5 & 2.0 Inch)	18 to 26.5 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-595/U • **Finish**: Gold Plated

WAVEGUIDE 90° TWISTS

PHOTO	TYPE/PART #	FREQUENCY	TEMP RANGE	VSWR	MATERIALS
	WR-3 **HWTW03-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	220 to 325 GHz	+220°C Max	1:04:1 Typ.	• **Waveguide:** Silver • **Flange:** Brass , UG-387/U-M • **Finish:** Gold Plated
	G-Band, WR-5 **HWTW05-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	140 to 220 GHz	+220°C Max	1:04:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish:** Gold Plated
	D-Band, WR-6 **HWTW06-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	110 to 175 GH	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish:** Gold Plated
	F Band, WR-8 **HWTW08-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	90 to 1400 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish:** Gold Plated
	W Band, WR-10 **HWTW10-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	75 to 110 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish:** Gold Plated
	E Band, WR-12 **HWTW12-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	60 to 90 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U • **Finish:** Gold Plated
	V Band, WR-15 **HWTW15-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	50 to 75 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-385/U • **Finish:** Gold Plated
	U Band, WR-19 **HWTW19-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	40 to 60 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-383 /U-M • **Finish:** Gold Plated
	Q Band, WR-22 **HWTW22-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	33 to 50 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-383/U-M • **Finish:** Gold Plated
	Q Band, WR-28 **HWTW28-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	26.5 to 40 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-599/U • **Finish:** Gold Plated
	WR-34 **HWTW34-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	22 to 33 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-595/U-M • **Finish:** Gold Plated
	WR-42 **HWTW42-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	18 to 26.5 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-595/U • **Finish:** Gold Plated

WAVEGUIDE E BENDS

PHOTO	TYPE/PART #	FREQUENCY	TEMP RANGE	VSWR	MATERIALS
	WR-3 **HWEB03-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	220 to 325 GHz	+220°C Max	1:04:1 Typ.	• **Waveguide:** Silver • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	G-Band, WR-5 **HWEB05-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	140 to 220 GHz	+220°C Max	1:04:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	D-Band, WR-6 **HWEB06-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	110 to 175 GH	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	F Band, WR-8 **HWEB08-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	90 to 1400 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	W Band, WR-10 **HWEB10-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	75 to 110 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	E Band, WR-12 **HWEB12-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	60 to 90 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U • **Finish**: Gold Plated
	V Band, WR-15 **HWEB15-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	50 to 75 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-385/U • **Finish**: Gold Plated
	U Band, WR-19 **HWEB19-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	40 to 60 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-383/U-M • **Finish**: Gold Plated
	Q Band, WR-22 **HWEB22-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	33 to 50 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-383/U-M • **Finish**: Gold Plated
	Q Band, WR-28 **HWEB28-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	26.5 to 40 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-599/U • **Finish**: Gold Plated
	WR-34 **HWEB34-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	22 to 33 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-595/U-M • **Finish**: Gold Plated
	WR-42 **HWEB42-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	18 to 26.5 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-595/U • **Finish**: Gold Plated

WAVEGUIDE H BENDS

PHOTO	TYPE/PART #	FREQUENCY	TEMP RANGE	VSWR	MATERIALS
	WR-3 **HWHB03-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	220 to 325 GHz	+220°C Max	1:04:1 Typ.	• **Waveguide:** Silver • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	G-Band, WR-5 **HWHB05-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	140 to 220 GHz	+220°C Max	1:04:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	D-Band, WR-6 **HWHB06-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	110 to 175 GH	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	F Band, WR-8 **HWHB08-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	90 to 1400 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	W Band, WR-10 **HWHB10-XX-ER** (Available in 1.0, 2.05 & 2.5 Inch)	75 to 110 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U-M • **Finish**: Gold Plated
	E Band, WR-12 **HWHB12-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	60 to 90 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-387/U • **Finish**: Gold Plated
	V Band, WR-15 **HWHB15-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	50 to 75 GHz	+220°C Max	1:03:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-385/U • **Finish**: Gold Plated
	U Band, WR-19 **HWHB19-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	40 to 60 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-383/U-M • **Finish**: Gold Plated
	Q Band, WR-22 **HWHB22-XX-ER** (Available in 1.0, 2.0 & 2.5 Inch)	33 to 50 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-383/U-M • **Finish**: Gold Plated
	Q Band, WR-28 **HWHB28-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	26.5 to 40 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-599/U • **Finish**: Gold Plated
	WR-34 **HWHB34-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	22 to 33 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-595/U-M • **Finish**: Gold Plated
	WR-42 **HWHB42-XX-ES** (Available in 1.0, 2.0 & 2.5 Inch)	18 to 26.5 GHz	+220°C Max	1:02:1 Typ.	• **Waveguide:** OFHC Copper • **Flange:** Brass, UG-595/U • **Finish**: Gold Plated

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