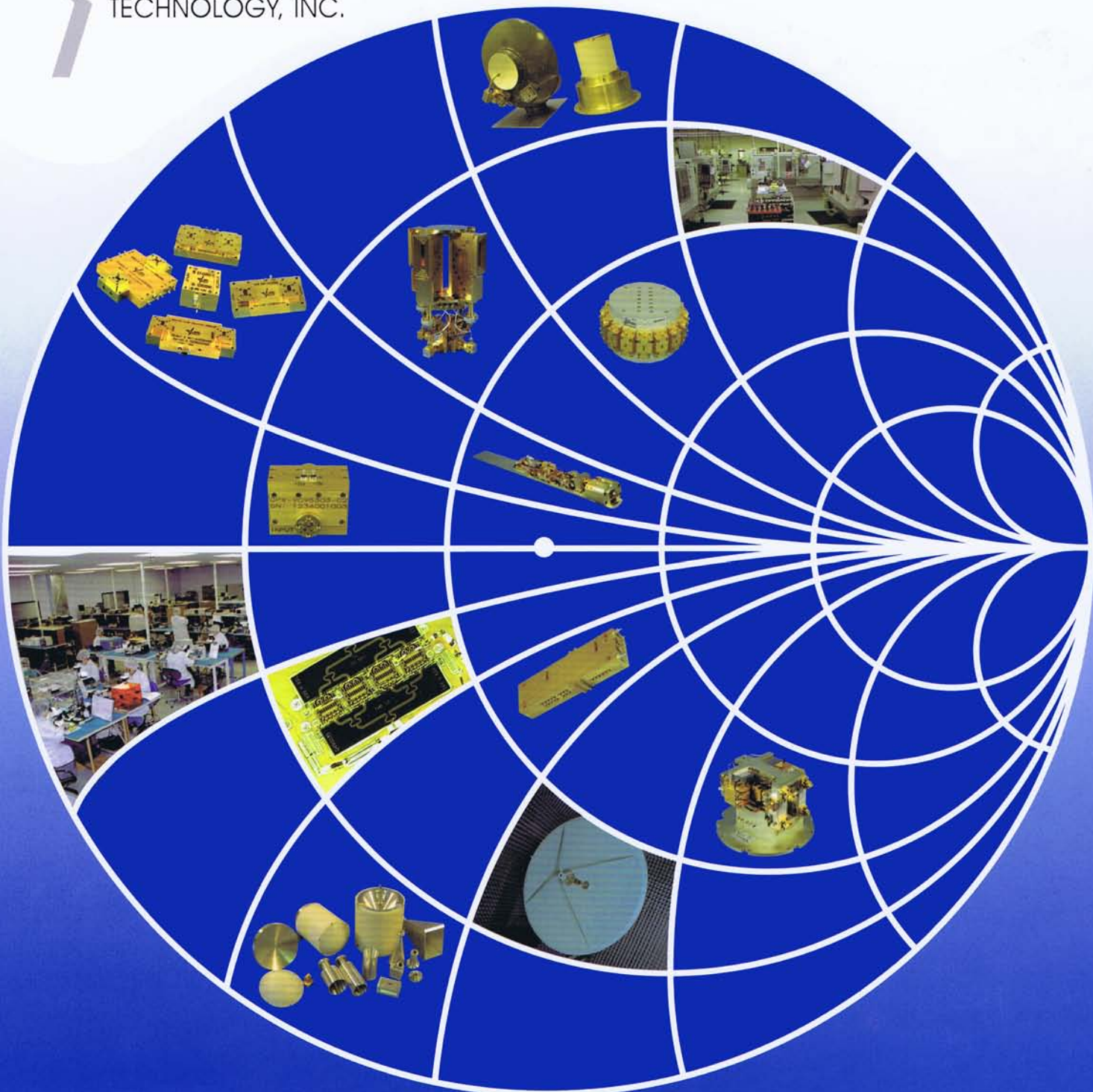


# QUINSTAR

TECHNOLOGY, INC.



## MILLIMETER WAVE PRODUCTS

- ❖ *Standard and Customized Components*
- ❖ *Subsystems and Integrated Modules*
- ❖ *Application-Specific Products and System Applications*



## About Our Company

**QuinStar Technology, Inc.** is a millimeter-wave technology company. Founded in March 1993 by seasoned managers from major aerospace companies, QuinStar is dedicated

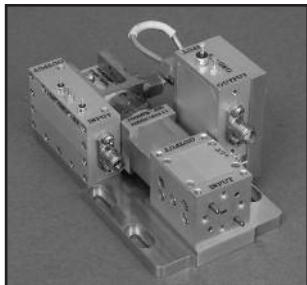


to the development, manufacture and marketing of millimeter-wave products serving established as well as emerging markets and system applications in the commercial, scientific and defense arenas. Our customers span the

world and our program experience includes Department of Defense research and development, high reliability space flight, and volume production of products fielded in leading edge broadband wireless communication networks.

QuinStar's products range from standard catalog components to specialized high-performance RF signal

generating, amplifying and conditioning components to fully integrated and customized assemblies and subsystems for digital and analog sensor, communications and test applications. QuinStar's primary goals are to deliver quality products and services to our customers while maintaining



a pleasant work environment for our employees. We are committing our full resources, experiences and talents to achieving these simple yet most important goals.

### About This Catalog

The products offered in this catalog are standard and performance is not necessarily limited to the specifications presented. In addition, this catalog only presents a portion of our total product capability and offerings. Therefore, we encourage you to contact QuinStar to discuss your specific millimeter-wave product needs. Our web site ([www.quinstar.com](http://www.quinstar.com)) has latest information on new products and updates to this catalog.

### Commitment to Quality

QuinStar Technology, Inc. is dedicated to providing the best service in the industry from initial inquiry all the way through



3 Axis Optical Measurement System

product delivery and after sales support. In addition, QuinStar strives to design and produce products that meet or exceed the performance specifications to which we have agreed upon and fully comply with all

applicable quality standards. We are **ISO 9001:2008** certified in 2004 and our certification number is A2176US. Our quality standards address commercial through military and NASA Hi-Rel Space Flight requirements. As always, we stand behind our commitment to quality and on-time delivery.



Class 10,000 Clean Room for MIC Amplifier Manufacturing



Near Field Antenna Test Range



Dual Microscope for Inspection and Training



## Vision and History

### Our Vision:

**To be the premier millimeter-wave technology company that provides innovative product solutions to the communications and sensor industries**

### Our Mission:

**To fulfill our customers' expectations of performance, delivery, value, quality, and service.**

**To employ superior technologies, responsive engineering, and efficient manufacturing.**

**To create highly rewarding careers for our employees in a stimulating and fun work environment.**

### QuinStar Strategy and Legacy:

Throughout the years, QuinStar Technology grew its business by servicing the needs of customers in the millimeter-wave and microwave sensors and communication field. As a key growth strategy, QuinStar Technology also developed business by acquiring synergistic businesses to further broaden our products and services to better serve our customers.

We acquired DCL Inc. a small local electronic engineering firm in 1996.

In 1997, we acquired the complete assets of CERNEX Inc, a microwave amplifiers company in Sunnyvale, CA. We continued to operate in Sunnyvale as QuinStar Technology, Sunnyvale Division. In 2000, the facility was moved to our Torrance location to effect greater efficiency and responsiveness to our customers.

QuinStar acquired the manufacturing rights and all equipment and inventory of Silicon IMPATT diode product line from Raytheon in 1998. The technology was developed for Satellite communications and missile seekers in the mid 70s to 80s by Hughes Aircraft Company and later acquired by Raytheon. This was the foundation of our IMPATT amplifier

and oscillator business. We are the only commercial Silicon IMPATT diodes supplier in America today.

In 2002, we purchased all assets and the name of MPI / Millimeter Products, Inc., ([www.milpi.com](http://www.milpi.com)) a millimeter-wave components company in New Hampshire. The company was moved to our Torrance facility in 2003. This purchase expanded our waveguide and test components products similar to the TRG product line.

We expanded into the cryogenic amplifier business in 2004, with the acquisition of Berkshire Technologies, Inc. ([www.berkshiretech.com](http://www.berkshiretech.com)). This acquisition enables us to further support the scientific research customers.

During the recent years, QuinStar has significantly upgraded its manufacturing and test facilities. In particular, the machining capability has been significantly upgraded. Other enhancements are in the antenna range and environmental test facility.

With each acquisition, we increased our capabilities and broadened our areas of expertise. QuinStar continues to grow as a company of diverse abilities to meet the many needs of our customers.



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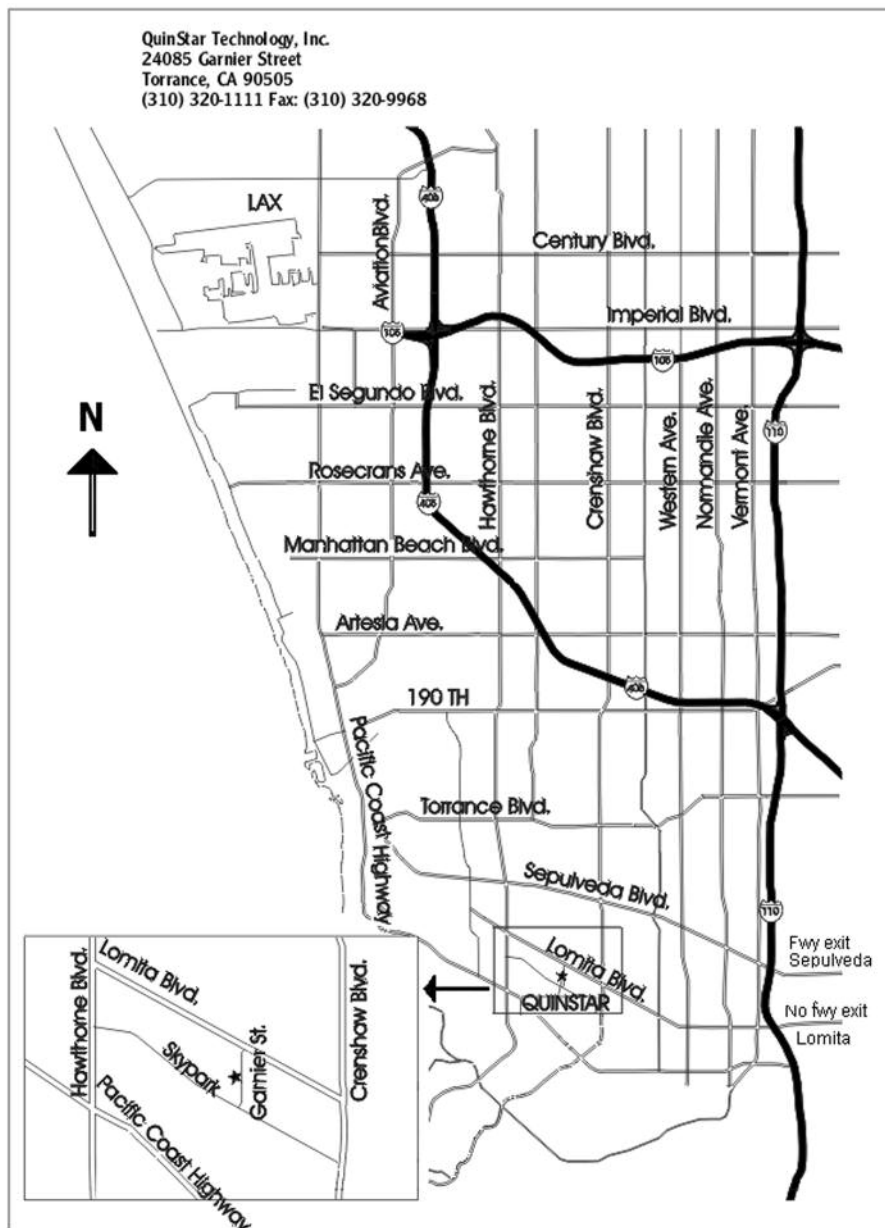
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## Directions to QuinStar Technology



Directions from Los Angeles Airport (LAX) and Points North: Take 405 South toward Long Beach. Exit on Hawthorne Blvd exit. Stay in the right lane and turn right onto Hawthorne Blvd (southbound). Go approx. 5.5 miles, turn left on Lomita Blvd., go 0.5 mile, turn right on Garnier Street. QuinStar is on your right 1/2 block down.

Directions from San Diego and Points South: Take 405 North toward Santa Monica. Exit on Crenshaw Blvd, and head south toward Torrance. Go 4.5 miles, and turn right on Lomita Blvd. Go 0.5 mile, and turn left on Garnier Street. QuinStar is on your right 1/2 block down.



## Section 1

# Amplifier Products

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# Glossary of Terminology for Amplifiers

**1 dB gain compression point (P1dB)** defines the output level at which the amplifier's gain is 1 dB less than the small signal gain, or is compressed by 1 dB.

**Conditionally stable** amplifier refers to an amplifier that may oscillate under particular load or source impedance (VSWR) conditions, an undesirable situation.

**Dynamic range** is the power range over which an amplifier provides useful linear operation, with the lower limit dependent on the noise figure and the upper level determined by the 1 dB compression point.

**Gain flatness** indicates the variation of an amplifier's gain characteristic over the full frequency response range at a given temperature expressed in dB.

**Gain (forward gain, G)** for RF amplifiers is the ratio of output power to input power, specified in the small signal, linear gain region, with a signal applied at the input. Gain in dB is defined as,  $G \text{ (dB)} = 10 \log_{10} G \text{ (numeric)}$ .

**Harmonic distortion** is produced by nonlinear amplifier operation and appears in the form of output signal frequencies at integral multiples of the input signal frequency. Since harmonic distortion is influenced by input power level it is generally specified in terms of the relative level for the harmonics to the fundamental signal power.

**Linearity** of an amplifier signifies its output power is a linear function of the input power. A linear amplifier produces at its output an amplified replica of the input signal with negligible compression and minimal or no harmonic generation.

**Maximum signal level** refers to the largest CW or pulse RF signal that can be safely applied to an amplifier's input. Exceeding the specified limit can result in noise figure degradation, increased distortion, gain reduction, and/or amplifier burnout.

**Noise factor** is the ratio of signal-to-noise power ratio at an amplifier's input to the signal-to-noise power ratio at the output. Noise figure NF in dB is related to noise factor F by

$$NF \text{ (in dB)} = 10 \log_{10} F$$

**Return loss (RL)** is the ratio of reflected power to incident power at the RF port of an amplifier, expressed in dB

$$RL = -20 \log |R|, \text{ where } R = \text{reflection coefficient.}$$

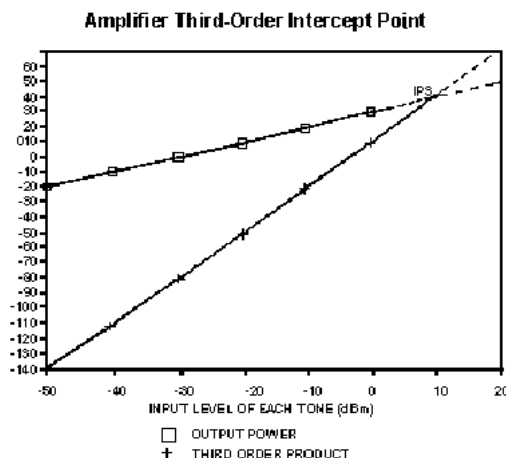
**Stability** of an amplifier is an indication of its tendency to oscillate or generate a signal at its output without an applied input.

**Two-Tone Third-order intercept point** Two-tone third-order intercept point is a measure of third-order products generated by a second signal arriving at the input of a device such as an amplifier. If F1 and F2 are the frequencies of the two signals arriving at the input, the amplifier generates intermod products at its output due to inherent nonlinearity, in the form  $\pm m \cdot F1 \pm n \cdot F2$  where m and n are positive integers which can assume any value from 1 to infinity. The order of the intermod is defined as  $m + n$ . Hence  $2 \cdot F1 - F2$ ,  $2 \cdot F2 - F1$ ,  $3 \cdot F1$  and  $3 \cdot F2$  are third-order products by definition. The first two products are called two-tone third-order products as they are generated when two tones are applied simultaneously at the input and the latter two are called single-tone third-order products.

For example, if 100 and 101 MHz are the frequencies of two applied signals, then 99 and 102 MHz are the two-tone third-order products and 300 and 303 MHz are single-tone third-order products. Two-tone third-order products are very close to the desired signals and are very difficult to filter out. Hence they are of great importance in system design. In the linear region, third-order products decrease/increase by 3 dB for every 1 dB decrease/increase of input power, and output signal power decreases/increases by a dB for every dB of input power. When drawn on a X-Y graph, with input power on X-axis and output power on the Y-axis, third-order products fall on a straight line with a slope of 3 and signal power on a straight line with a slope 1 as shown below. By extending the linear portions the two lines, they intercept at a point. The X co-ordinate and the Y co-ordinate of this point are called the input and output intercept point, and the two differ by an amount equal to the small-signal gain of the amplifier. Output intercept point, IP3(dBm) can also be calculated using a simple formula.

$$IP3(dBm)_{out} = P_{out}(dBm) + A/2$$

where  $P_{out}$  (dBm) is the output power of each tone in dBm and "A" is the difference of output power and intermod level in dB. Input intercept point is obtained by substituting  $P_{in}(dBm)$  for  $P_{out}(dBm)$  in the above formula. Single-tone and two-tone third-order intercept points differ by a fixed amount but have the same slope.



**Unconditionally stable** refers to an amplifier that will not oscillate regardless of load or source impedance.

**VSWR** (voltage standing wave ratio) is related to return loss (RL) by the following:

$$VSWR = \frac{1 + 10^{-RL/20}}{1 - 10^{-RL/20}}$$



# Microwave Broadband Low Noise Amplifiers QLJ

## Characteristics

- ◆ 0.5-18 GHz Coverage
- ◆ Broad Bandwidth Operation
- ◆ State-of-the-art Low Noise Performance
- ◆ Compact Package



## Product Description

QuinStar Technology's series QLJ low noise microwave amplifiers utilize advanced MMICs and discrete devices

for state-of-the-art low noise performance in the 0.5-18 GHz frequency range.

## Specifications

Model Number	Frequency Range (GHz)	Noise Figure (dB)	Gain (dB)	Gain Flatness (±dB)	Current (mA) at 12V	Outline Pages 40-45
QLJ-00021818	.5-2	1.8	18	1.5	100	H3, E, J
QLJ-00021832	.5-2	1.8	32	1.75	160	E,J
QLJ-00021845	.5-2	1.8	45	2	220	E,J
QLJ-02061514	2-6	1.5	14	1.75	100	J
QLJ-02061524	2-6	1.5	24	2	160	J
QLJ-02061535	2-6	1.5	35	2.25	220	J
QLJ-06183013	6-18	3	13	1.25	100	H3, E, J
QLJ-06183026	6-18	3	26	1.5	160	H3, E, J
QLJ-06183040	6-18	3	40	1.75	230	H4,J
QLJ-00183513	0.5-18	3.5	13	1.5	100	E,J
QLJ-00183526	0.5-18	3.5	26	2	170	E,J
QLJ-00183540	0.5-18	3.5	40	2.5	210	J

## Ordering Information

Model Number **QLJ - ABCD EF GH - IJ**

frequency range, minimum-maximum, in GHz (use 00 for minimum freq. below 1 GHz)

noise figure, in tenth of dB (EF = 40 for noise figure = 4.0 dB)

outline designation (see pages 40-45)

gain, in dB



# Microwave Broadband General Purpose Amplifiers

QGJ

## Characteristics

- ◆ 0.5-18 GHz Coverage
- ◆ Wide range of Gain Options
- ◆ Compact Package



## Product Description

QuinStar Technology's series QGJ broadband high gain general purpose amplifiers are ideally suited for a very wideband amplification. The amplifiers are offered with

nominal gains in 13-40 dB range, and nominal output 1 dB compression point power (P-1 dB) in 13-20 dBm range.

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Current (mA) at 12V, max.	Current (mA) at -12V	Outline Pages 40-45
QGJ-00181314	0.5-18	13	14	1.5	120	–	E, J
QGJ-00181326	0.5-18	13	26	1.75	180	–	E, J
QGJ-00181340	0.5-18	13	40	2	240	–	J
QGJ-00181713	0.5-18	17	13	1.5	200	–	E, J
QGJ-00181726	0.5-18	17	26	1.75	270	–	E, J
QGJ-00181740	0.5-18	17	40	2	330	–	J
QGJ-00182013	0.5-18	20	13	1.5	400	50	J
QGJ-00182026	0.5-18	20	26	1.75	470	50	J
QGJ-00182040	0.5-18	20	40	2	530	50	J

## Ordering Information

Model Number **QGJ - ABCD EF GH - IJ**

frequency range, minimum-maximum, in GHz (use 00 for minimum freq. below 1 GHz)

P1dB (power at 1dB gain compression point) in dBm

outline designation (see pages 40-45)

gain, in dB



# Microwave Broadband Power Amplifiers

## QPJ

### Characteristics

- ◆ 1-18 GHz Coverage
- ◆ Wide Range of Gain & Output Power Options
- ◆ Compact Package



### Product Description

QuinStar Technology's series QPJ power amplifiers utilize advanced MMICs and discrete devices for state-of-the-art power performance in the 2-18 GHz frequency range. A wide range of gain values is offered for significantly high

power output levels. These amplifiers offer gain in the 10-54 dB range, with output power from 23-44 dBm available. The baseline amplifier is provided with coaxial input/output ports.

### Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPJ-00182310	0.5-18	23	10	2	12	0.6	-	-	J
QPJ-00182324	0.5-18	23	24	2.25	12	0.7	-	-	J
QPJ-00182338	0.5-18	23	38	2.5	12	0.8	-	-	J
QPJ-02182714	2-18	27	14	2	15	1.4	-	-	J
QPJ-02182727	2-18	27	27	2.25	15	1.7	-	-	J
QPJ-02182741	2-18	27	41	2.5	15	1.8	-	-	J
QPJ-02083014	2-8	30	14	2	15	1.4	-	-	J
QPJ-02083027	2-8	30	27	2.5	15	1.7	-	-	J
QPJ-02083041	2-8	30	41	2.5	15	1.8	-	-	J
QPJ-02083314	2-8	33	14	2.5	12	3	-12	50	A
QPJ-02083325	2-8	33	25	2.5	12	3.3	-12	50	A
QPJ-02083340	2-8	33	40	2.5	12	3.4	-12	50	A
QPJ-02083354	2-8	33	54	2.5	12	3.5	-12	50	A
QPJ-02083611	2-8	36	11	2.5	12	4.5	-12	50	A
QPJ-02083625	2-8	36	25	2.5	12	4.8	-12	50	A
QPJ-02083640	2-8	36	40	2.5	12	4.9	-12	50	A
QPJ-02083654	2-8	36	54	2.5	12	5	-12	50	A
QPJ-02083810	2-8	38	10	2.5	12	9	-12	100	A
QPJ-02083825	2-8	38	25	2.5	12	9.5	-12	100	A
QPJ-02083840	2-8	38	40	2.5	12	9.7	-12	100	A
QPJ-02083854	2-8	38	54	2.5	12	10	-12	100	A
QPJ-02084025	2-8	40	25	2.5	12	19	-12	100	B
QPJ-02084040	2-8	40	40	2.5	12	19.5	-12	100	B
QPJ-02084054	2-8	40	54	2.5	12	20	-12	100	B
QPJ-02064225	2-6	42	25	2.5	12	9.5	-12	50	B
QPJ-02064240	2-6	42	40	2.5	12	9.7	-12	50	B
QPJ-02064254	2-6	42	54	2.5	12	9.8	-12	50	B



# Microwave Broadband Power Amplifiers

QPJ

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPJ-02064425	2-6	44	25	2.5	12	19	-12	100	B
QPJ-02064440	2-6	44	40	2.5	12	19.5	-12	100	B
QPJ-02064454	2-6	44	54	2.5	12	19.8	-12	100	B
QPJ-06183020	6-18	30	20	3	12	1.5t	-	-	J, A
QPJ-06183034	6-18	30	34	3.25	12	1.55	-	-	J, A
QPJ-06183048	6-18	30	48	3.5	12	1.6	-	-	J, A
QPJ-06183320	6-18	33	20	3	12	3.5	-	-	A
QPJ-06183334	6-18	33	34	3.25	12	3.9	-	-	A
QPJ-06183348	6-18	33	48	3.5	12	4	-	-	A
QPJ-06183619	6-18	36	19	3	12	7	-	-	A
QPJ-06183633	6-18	36	33	3.25	12	7.5	-	-	A
QPJ-06183647	6-18	36	47	3.5	12	8	-	-	A
QPJ-06183818	6-18	38	18	3.5	12	14	-	-	B
QPJ-06183832	6-18	38	32	3.5	12	15	-	-	B
QPJ-06183846	6-18	38	46	3.5	12	16	-	-	B
QPJ-06184016	6-18	40	16	3.5	12	17	-	-	B
QPJ-06184030	6-18	40	30	3.5	12	17.5	-	-	B
QPJ-06184045	6-18	40	45	3.5	12	18	-	-	B

## Ordering Information

Model Number **QPJ - ABCD EF GH - IJ**

frequency range, minimum-maximum, in GHz (use 00 for minimum freq. below 1 GHz)

P1dB (power at 1dB gain compression point) in dBm

outline designation (see pages 40-45)

gain, in dB

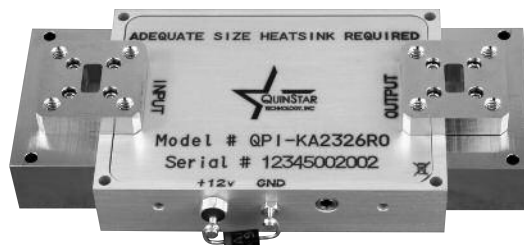


# ..... Millimeter-Wave Full Waveguide Band Power Amplifiers

**QPI**

## Characteristics

- ◆ Power Output to 38 dBm
- ◆ Gain Options from 10 to 50 dB
- ◆ Frequency 18-75 GHz



## Product Description

QuinStar Technology's series QPI power amplifiers provide state-of-the-art high power performance in the 18-75 GHz frequency range. The standard amplifier products are offered with either a coaxial connector or waveguide ports.

However, any combination of these interfaces is available as an option. A wide range of optional features is available for these amplifiers. Please see page 39 for details of these options.

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPI-K02310	K (18-26.5)	23	10	1.5	12	0.5	-	-	J,G,L,S
QPI-K02325	K (18-26.5)	23	25	1.75	12	0.6	-	-	J,G,L,S
QPI-K02340	K (18-26.5)	23	40	2	12	0.7	-	-	J,G,L,S
QPI-K02710	K (18-26.5)	27	10	1.5	12	0.8	-	-	J,G,L,S
QPI-K02725	K (18-26.5)	27	25	1.75	12	1.1	-	-	J,G,L,S
QPI-K02740	K (18-26.5)	27	40	2	12	1.2	-	-	J,G,L,S
QPI-K03010	K (18-26.5)	30	10	1.75	12	1.5	-	-	A,R,M,T
QPI-K03025	K (18-26.5)	30	25	2	12	1.8	-	-	A,R,M,T
QPI-K03040	K (18-26.5)	30	40	2.25	12	1.9	-	-	A,R,M,T
QPI-K03310	K (18-26.5)	33	10	1.75	12	3	-	-	A,R,M,T
QPI-K03325	K (18-26.5)	33	25	2	12	3.6	-	-	A,R,M,T
QPI-K03340	K (18-26.5)	33	40	2.25	12	3.7	-	-	A,R,M,T
QPI-K03625	K (18-26.5)	36	25	2	12	6.8	-	-	B,K,N,Q
QPI-K03640	K (18-26.5)	36	40	2.25	12	7	-	-	B,K,N,Q
QPI-K03825	K (18-26.5)	38	25	2.3	9	13.5	-	-	*
QPI-K03840	K (18-26.5)	38	40	2.5	9	14	-	-	*
QPI-KA2320	Ka (26.5-40)	23	20	2.5	12	0.8	-	-	J,G,L,S
QPI-KA2330	Ka (26.5-40)	23	30	2.5	12	0.95	-	-	J,G,L,S
QPI-KA2340	Ka (26.5-40)	23	40	2.5	12	1.1	-	-	J,G,L,S
QPI-KA2350	Ka (26.5-40)	23	50	2.5	12	1.2	-	-	J,G,L,S
QPI-KA2720	Ka (26.5-40)	27	20	2.5	12	1.6	-	-	J,G,L,S
QPI-KA2730	Ka (26.5-40)	27	30	2.5	12	1.9	-	-	J,G,L,S
QPI-KA2740	Ka (26.5-40)	27	40	2.5	12	2	-	-	J,G,L,S
QPI-KA2750	Ka (26.5-40)	27	50	2.5	12	2.1	-	-	J,G,L,S
QPI-KA3015	Ka (26.5-40)	30	15	3.5	12	6.5	-12	100	B,K,N,Q
QPI-KA3025	Ka (26.5-40)	30	25	3.5	12	6.7	-12	100	B,K,N,Q
QPI-KA3035	Ka (26.5-40)	30	35	3.5	12	6.9	-12	100	B,K,N,Q



# Millimeter-Wave Full Waveguide Band Power Amplifiers

**QPI**

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPI-KA3045	Ka (26.5-40)	30	45	3.5	12	7.1	-12	100	B,K,N,Q
QPI-Q02018	Q (33-50)	20s	18	3.5	12	0.9	-	-	A,R,M,T
QPI-Q02030	Q (33-50)	20s	30	3.5	12	0.95	-	-	A,R,M,T
QPI-Q02040	Q (33-50)	20s	40	3.5	12	1.2	-	-	A,R,M,T
QPI-U01816	U (40-60)	18s	16	3.5	12	0.5	-	-	J,G,L,S
QPI-U01825	U (40-60)	18s	25	3.5	12	0.6	-	-	J,G,L,S
QPI-V01616	V (50-75)	16s	16	3.5	12	0.3	-	-	P2
QPI-V01628	V (50-75)	16s	28	3.5	12	0.4	-	-	P2

\*Contact QuinStar for outline information

s = saturated power

## Ordering Information

Model Number **QPI -**

**AB CD EF GH I**

waveguide band designator

K0 = K-band      KA = Ka-band  
Q0 = Q-band      U0 = U-band  
V0 = V-band

options (see page 39)

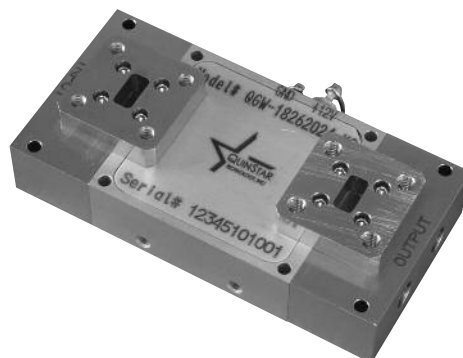
outline designation (see pages 40-45)

P1dB (power at 1dB gain compression point), in dBm

gain, in dB

## Characteristics

- ◆ Offered Over 2-110 GHz
- ◆ Broadband Performance
- ◆ Wide range of power and Gain options
- ◆ Choices of packages and interfaces



## Product Description

QuinStar Technology's series QGW broadband general purpose, high gain-amplifiers are ideally suited for power amplification over a wide bandwidth with gain and output power to suit virtually any application in the 2 to 110 GHz region. The amplifiers are offered with gains ranging from 10 to 50 dB, and nominal output power of 13 to 20 dBm, across the entire operating frequency band.

The standard amplifier housing offers a wide range and combinations of input and output coaxial connectors or

waveguide ports. For 18 to 40 GHz amplifiers, we offer 2.9 mm coaxial connectors, and 2.4 mm for 40-50 GHz and 1.9 mm connector for frequencies beyond. Appropriate coaxial or waveguide input and/or output ports are offered for the entire range from 2 to 110 GHz. Any valid combination of coaxial and waveguide input and output ports can be supplied, if desired. A wide range of optional features is available for these amplifiers. Please see page 39 for details of these options.

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QGW-02301312	2-30	13	12	2	12	200	-12	50	J
QGW-02301324	2-30	13	24	2	12	250	-12	50	J
QGW-02301336	2-30	13	36	2	12	300	-12	50	J
QGW-02301348	2-30	13	48	2	12	350	-12	50	J
QGW-02301712	2-30	17	12	2	12	250	-12	50	J
QGW-02301724	2-30	17	24	2	12	300	-12	50	J
QGW-02301736	2-30	17	36	2	12	350	-12	50	J
QGW-02301748	2-30	17	48	2	12	400	-12	50	J
QGW-02302012	2-30	20	12	2	12	300	-12	50	J
QGW-02302024	2-30	20	24	2	12	350	-12	50	J
QGW-02302036	2-30	20	36	2	12	400	-12	50	J
QGW-02302048	2-30	20	48	2	12	450	-12	50	J
QGW-18401415	18-40	14	15	2.7	12	180	-12	50	E,J
QGW-18401423	18-40	14	23	2.8	12	230	-12	50	E,J
QGW-18401431	18-40	14	31	2.9	12	280	-12	50	J
QGW-18401439	18-40	14	39	3	12	330	-12	50	J
QGW-18401715	18-40	17	15	2.7	12	400	-	-	E,J
QGW-18401723	18-40	17	23	2.8	12	460	-	-	E,J
QGW-18401731	18-40	17	31	2.9	12	530	-	-	J
QGW-18401739	18-40	17	39	3	12	600	-	-	J
QGW-18402015	18-40	20	15	2.7	12	800	-	-	J
QGW-18402023	18-40	20	23	2.8	12	850	-	-	J



# Millimeter-Wave Broadband Amplifiers

QGW

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QGW-18402031	18-40	20	31	2.9	12	900	-	-	J
QGW-18402039	18-40	20	39	3	12	950	-	-	J
QGW-33491312	33-49	13	12	2	12	500	-12	50	J,G,L,S
QGW-33491323	33-49	13	23	2	12	550	-12	50	J,G,L,S
QGW-33491334	33-49	13	34	2.1	12	600	-12	50	J,G,L,S
QGW-33491345	33-49	13	45	2.2	12	650	-12	50	J,G,L,S
QGW-33491712	33-49	17	12	2	12	500	-12	50	J,G,L,S
QGW-33491723	33-49	17	23	2	12	550	-12	50	J,G,L,S
QGW-33491734	33-49	17	34	2.1	12	600	-12	50	J,G,L,S
QGW-33491745	33-49	17	45	2.2	12	650	-12	50	J,G,L,S
QGW-15501312	15-50	13	12	2.5t	12	180	-	-	J
QGW-15501324	15-50	13	24	2.6t	12	230	-	-	J
QGW-15501336	15-50	13	36	2.7t	12	280	-	-	J
QGW-15501348	15-50	13	48	2.8t	12	320	-	-	J
QGW-33501710	33-50	17s	10	2.5t	12	360	-	-	J,G,L,S
QGW-33501722	33-50	17s	22	2.6t	12	410	-	-	J,G,L,S
QGW-33501736	33-50	17s	36	2.7t	12	460	-	-	J,G,L,S
QGW-33501748	33-50	17s	48	2.8t	12	510	-	-	J,G,L,S
QGW-45571315	45-57	13t	15	2.5	12	180	-	-	J,G,L,S
QGW-45571325	45-57	13t	25	2.6	12	240	-	-	J,G,L,S
QGW-45571335	45-57	13t	35	2.7	12	300	-	-	J,G,L,S
QGW-45571345	45-57	13t	45	2.8	12	350	-	-	J,G,L,S
QGW-45571615	45-57	16t	15	2.5	12	310	-	-	J,G,L,S
QGW-45571625	45-57	16t	25	2.6	12	370	-	-	J,G,L,S
QGW-45571635	45-57	16t	35	2.7	12	430	-	-	J,G,L,S
QGW-45571645	45-57	16t	45	2.8	12	480	-	-	J,G,L,S
QGW-45571915	45-57	19s	15	2.5	12	360	-	-	A,R,M,T
QGW-45571925	45-57	19s	25	2.6	12	480	-	-	A,R,M,T
QGW-45571935	45-57	19s	35	2.7	12	600	-	-	A,R,M,T
QGW-45571945	45-57	19s	45	2.8	12	700	-	-	A,R,M,T
QGW-50751315	50-75	13s	15t	3.5t	8	200	-	-	P1
QGW-50751330	50-75	13s	30t	3.5t	8	270	-	-	P1
QGW-50751515	50-75	15s	15t	3.5t	8	400	-	-	C1
QGW-50751530	50-75	15s	30t	3.5t	8	470	-	-	C1
QGW-50751715	50-75	17s	15t	3.5t	8	800	-	-	C2
QGW-50751730	50-75	17s	30t	3.5t	8	950	-	-	C2
QGW-50662015	50-66	20	15	3.5t	8	1100	-	-	C1
QGW-50662030	50-66	20	30	3.6	8	1200	-	-	C1
QGW-70781715	70-78	17	15	2.5t	8	500	-	-	P1
QGW-70781725	70-78	17	25	3t	8	800	-	-	P1
QGW-70782015	70-78	20s	15	2.5t	8	1000	-	-	C1
QGW-70782025	70-78	20s	25	3t	8	1600	-	-	C1
QGW-81911715	81-91	17	15	2.5t	5	300	-	-	P1
QGW-81911730	81-91	17	30	3t	5	500	-	-	P1
QGW-81912014	81-91	20s	14	2.5t	5	300	-	-	C1



# Millimeter-Wave Broadband Amplifiers

## QGW

### Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness ( $\pm$ dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QGW-81912030	81-91	20s	30	3t	5	500	-	-	C1

s = saturated power

t = typical value

### Ordering Information

Model Number **QGW - ABCD EF GH IJ - K**

frequency range, minimum-maximum, in GHz

P1dB (power at 1dB gain compression point) in dBm

options (see page 39)

outline designation (see pages 40-45)

gain, in dB

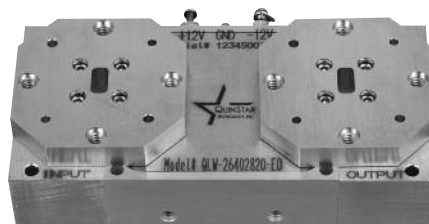


# Millimeter-Wave Broadband Low Noise Amplifiers

## QLW

### Characteristics

- ◆ Offered over 2-110 GHz
- ◆ State-of-the-art Low Noise Performance
- ◆ Low Power Consumption



### Product Description

QuinStar Technology's series QLW low noise amplifiers utilize advanced MMICs and discrete devices for state-of-the-art noise performance in the 2-110 GHz frequency range. The majority of these amplifiers offer greater than a standard waveguide bandwidth, and use appropriate coaxial or waveguide interfaces. The standard amplifier housing offers a wide range and combinations of input and output coaxial connectors or waveguide ports. For 18 to 40 GHz amplifiers, we offer 2.9 mm coaxial connectors, and

2.4 mm for 40-50 GHz and 1.9 mm connector for frequencies beyond. Any valid combination of coaxial and waveguide input and output ports can be supplied, if desired. These low noise amplifiers are useful in EW systems, test equipment, and instrumentation systems where low system noise figure is very important. A wide range of optional features is available for these amplifiers. Please see page 39 for details of these options.

### Specifications

Model Number	Frequency Range (GHz)	Noise Figure (dB)	Gain (dB)	Gain Flatness (±dB)	Current (mA) max. at 12V	Outline (pages 40-45)
QLW-00504521	2-50	4.5*	21	2*	150	J
QLW-00504533	2-50	4.5*	33	2.5*	200	J
QLW-14273516	14-27	3.5	16	2	150	J
QLW-14273528	14-27	3.5	28	2.1	200	J
QLW-14273540	14-27	3.5	40	2.2	250	J
QLW-15262820	15-26	2.8	20	2.75	100	J,E
QLW-15262840	15-26	2.8	40	3	180	J,E
QLW-15262855	15-26	2.8	55	3.25	300	J
QLW-18262520	18-26.5	2.5	20	2.5	100	J,E,G,L,S
QLW-18262530	18-26.5	2.5	30	2.5	170	J,E,G,L,S
QLW-18262540	18-26.5	2.5	40	2.5	230	J,G,L,S
QLW-10333510	10-33	3.5	10	2	100	J, E
QLW-10333522	10-33	3.5	22	2.1	150	J
QLW-10333535	10-33	3.5	35	2.2	200	J
QLW-18404510	18-40	4.5*	10	2	100	J, E
QLW-18404520	18-40	4.5*	20	2.1	150	J
QLW-18404530	18-40	4.5*	30	2.2	200	J
QLW-18404540	18-40	4.5*	40	2.3	260	J
QLW-24403328	24-40	3.3	28	3.5	180	J,E
QLW-24403336	24-40	3.3	36	3.5	250	J



# Millimeter-Wave Broadband Low Noise Amplifiers

QLW

## Specifications

Model Number	Frequency Range (GHz)	Noise Figure (dB)	Gain (dB)	Gain Flatness (±dB)	Current (mA) max. at 12V	Outline (pages 40-45)
QLW-36464815	36-46	4.8	15	2.25	100	J,E,G,L,S
QLW-36464826	36-46	4.8	26	2.5	180	J,E,G,L,S
QLW-36464835	36-46	4.8	35	2.5	250	J,G,L,S
QLW-33505510	33-50	5.5*	10	2.5*	100	J,G,L,S
QLW-33505520	33-50	5.5*	20	2.6	150	J,G,L,S
QLW-33505530	33-50	5.5*	30	2.7	200	J,G,L,S
QLW-33505540	33-50	5.5*	40	2.8	260	J,G,L,S
QLW-48605016	48-60	5*	16	3	200	J,G,L,S
QLW-48605025	48-60	5*	25	3.25	300	J,G,L,S
QLW-48605035	48-60	5*	35	3.5	400	J,G,L,S
QLW-50754515	50-75	4.5*	15	3	100	P1,I1
QLW-50754530	50-75	4.5*	30	3.5	200	P1,I2
QLW-60905518	60-90	5.5*	18	3.5	80	P1, I1
QLW-60905530	60-90	5.5*	30	3.5	120	P1, I2
QLW-75B05512	75-110	5.5*	12	3.5*	80	P1, I1
QLW-75B05522	75-110	5.5*	22	5*	120	P1,I2

\* = typical value

## Ordering Information

Model Number **QLW - ABCD EF GH IJ - K**

frequency range, minimum-  
maximum frequencies, in GHz

noise figure, in tenths of dB  
(example: EF = 45 for  
noise figure = 4.5 dB)

options (see page 39)

outline designation (see pages 40-45)

gain, in dB

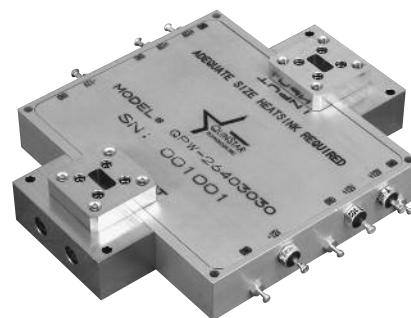


# Millimeter-Wave Broadband Power Amplifiers

## QPW

### Characteristics

- ◆ Broad Bandwidth of Operation
- ◆ High Power Performance
- ◆ Available from 15 to 95 GHz



### Product Description

QuinStar Technology's series QPW power amplifiers utilize advanced MMICs and discrete devices for state-of-the-art power performance in the 15-95 GHz frequency range. The standard amplifier housing offers a wide range and combinations of input and output coaxial connectors or waveguide ports. For 15 to 40 GHz amplifiers, we offer 2.9 mm coaxial connectors, and 2.4 mm for 40-50 GHz and 1.9 mm connectors for frequencies beyond. Appropriate

waveguide input and/or output ports are offered for the entire range from 15 to 95 GHz. Any valid combination of coaxial and waveguide input and output ports can be supplied, if desired. In addition to the standard products, QuinStar can produce customized amplifiers to specific requirements. A wide range of optional features is available for these amplifiers. Please see page 39 for details of these options.

### Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPW-15272313	15-27	23	13	2	12	1	-	-	J
QPW-15272328	15-27	23	28	2	12	1.1	-	-	J
QPW-15272344	15-27	23	44	2	12	1.2	-	-	J
QPW-15272713	15-27	27	13	2	12	1.6	-	-	J
QPW-15272728	15-27	27	28	2	12	1.7	-	-	J
QPW-15272744	15-27	27	44	2	12	1.8	-	-	J
QPW-15273012	15-27	30	12	2	12	3.3	-	-	A
QPW-15273022	15-27	30	22	2	12	3.4	-	-	A
QPW-15273032	15-27	30	32	2	12	3.6	-	-	A
QPW-15273042	15-27	30	42	2	12	3.7	-	-	A
QPW-15273211	15-27	32	11	2	12	6	-	-	A
QPW-15273221	15-27	32	21	2	12	6.3	-	-	A
QPW-15273231	15-27	32	31	2	12	6.4	-	-	A
QPW-15273241	15-27	32	41	2	12	6.5	-	-	A
QPW-18282311	18-28	23	11	2	12	0.7	-	-	J,G,L,S
QPW-18282327	18-28	23	27	2	12	0.8	-	-	J,G,L,S
QPW-18282343	18-28	23	43	2	12	0.9	-	-	J,G,L,S
QPW-18282710	18-28	27	10	2	12	0.8	-	-	J,G,L,S
QPW-18282716	18-28	27	16	2	12	1.1	-	-	J,G,L,S
QPW-18282742	18-28	27	42	2	12	1.2	-	-	J,G,L,S
QPW-18283025	18-28	30	25	2.2	12	1.8	-	-	A
QPW-18283036	18-28	30	36	2.3	12	1.9	-	-	A
QPW-18283046	18-28	30	46	2.3	12	2	-	-	A
QPW-18283320	18-28	33	20	2.0	12	3.3	-	-	A
QPW-18283330	18-28	33	30	2.2	12	3.4	-	-	A



# Millimeter-Wave Broadband Power Amplifiers

QPW

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPW-18283340	18-28	33	40	2.3	12	3.5	-	-	A
QPW-18283620	18-28	36	20	2.2	12	7	-	-	B
QPW-18283630	18-28	36	30	2.3	12	7.5	-	-	B
QPW-18283640	18-28	36	40	2.4	12	7.7	-	-	B
QPW-18283820	18-28	38	20	2.5	12	14	-	-	*
QPW-18283830	18-28	38	30	2.6	12	15	-	-	*
QPW-18283840	18-28	38	40	2.7	12	15.5	-	-	*
QPW-26352315	26.5-34.5	23	15	1.8	12	0.4	-	-	J,G,L,S
QPW-26352326	26.5-34.5	23	26	2	12	0.45	-	-	J,G,L,S
QPW-26352337	26.5-34.5	23	37	2.3	12	0.5	-	-	J,G,L,S
QPW-26352348	26.5-34.5	23	48	2.5	12	0.55	-	-	J,G,L,S
QPW-26352815	26.5-34.5	28	15	2	12	1.5	-	-	A,R,M,T
QPW-26352826	26.5-34.5	28	26	2.3	12	1.6	-	-	A,R,M,T
QPW-26352837	26.5-34.5	28	37	2.5	12	1.7	-	-	A,R,M,T
QPW-26352848	26.5-34.5	28	48	2.8	12	1.8	-	-	A,R,M,T
QPW-26353013	26.5-34.5	30	13	3	12	3	-	-	B,K,N,Q
QPW-26353024	26.5-34.5	30	24	3	12	3.2	-	-	B,K,N,Q
QPW-26353035	26.5-34.5	30	35	3	12	3.4	-	-	B,K,N,Q
QPW-26353046	26.5-34.5	30	46	3	12	3.6	-	-	B,K,N,Q
QPW-20452320	20-45	23	20	2.5	12	0.8	-	-	J
QPW-20452330	20-45	23	30	2.5	12	0.95	-	-	J
QPW-20452340	20-45	23	40	2.5	12	1.1	-	-	J
QPW-20452350	20-45	23	50	2.5	12	1.2	-	-	J
QPW-20452720	20-45	27	20	2.5	12	1.6	-	-	J
QPW-20452730	20-45	27	30	2.5	12	1.9	-	-	J
QPW-20452740	20-45	27	40	2.5	12	2	-	-	J
QPW-20452750	20-45	27	50	2.5	12	2.1	-	-	J
QPW-20452918	20-45	29	18	3	12	3.2	-12	50	A
QPW-20452928	20-45	29	28	3	12	3.6	-12	50	A
QPW-20452940	20-45	29	40	3	12	3.8	-12	50	A
QPW-20452950	20-45	29	50	3	12	4	-12	50	A
QPW-24313020	24-31	30	20	2	10	2.5	-12	50	A,R,M,T
QPW-24313030	24-31	30	30	2	10	2.6	-12	50	A,R,M,T
QPW-24313040	24-31	30	40	2	10	2.7	-12	50	A,R,M,T
QPW-24313050	24-31	30	50	2	10	2.8	-12	50	A,R,M,T
QPW-24313320	24-31	33	20	2	10	3.5	-12	50	A,R,M,T
QPW-24313330	24-31	33	30	2	10	3.6	-12	50	A,R,M,T
QPW-24313340	24-31	33	40	2	10	3.7	-12	50	A,R,M,T
QPW-24313350	24-31	33	50	2	10	3.8	-12	50	A,R,M,T
QPW-24313618	24-31	36	18	2	10	7	-12	50	A,R,M,T
QPW-24313628	24-31	36	28	2	10	7.1	-12	50	A,R,M,T
QPW-24313638	24-31	36	38	2	10	7.2	-12	50	A,R,M,T
QPW-24313648	24-31	36	48	2	10	7.5	-12	50	A,R,M,T
QPW-24313817	24-31	38	17	2	10	14	-12	100	B,K,N,Q
QPW-24313827	24-31	38	27	2	10	14.2	-12	100	B,K,N,Q



# Millimeter-Wave Broadband Power Amplifiers

QPW

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPW-24313837	24-31	38	37	2	10	14.4	-12	100	B,K,N,Q
QPW-24313847	24-31	38	47	2	10	15	-12	100	B,K,N,Q
QPW-24314017	24-31	40s	17	2	10	28	-12	100	*
QPW-24314027	24-31	40s	27	2	10	28.4	-12	100	*
QPW-24314037	24-31	40s	37	2	10	28.8	-12	100	*
QPW-24314047	24-31	40s	47	2	10	30	-12	100	*
QPW-30403010	30-40	30	10	3	10	3	-12	50	A,R,M,T
QPW-30403020	30-40	30	20	3	10	3.5	-12	50	A,R,M,T
QPW-30403030	30-40	30	30	3	10	3.5	-12	50	A,R,M,T
QPW-30403040	30-40	30	40	3	10	3.6	-12	50	A,R,M,T
QPW-30403310	30-40	33	10	3	10	6	-12	50	A,R,M,T
QPW-30403320	30-40	33	20	3	10	6.5	-12	50	A,R,M,T
QPW-30403330	30-40	33	30	3	10	6.5	-12	50	A,R,M,T
QPW-30403340	30-40	33	40	3	10	6.6	-12	50	A,R,M,T
QPW-30403510	30-40	35	10	3	10	12	-12	50	B,K,N,Q
QPW-30403520	30-40	35	20	3	10	13	-12	50	B,K,N,Q
QPW-30403530	30-40	35	30	3	10	13	-12	50	B,K,N,Q
QPW-30403540	30-40	35	40	3	10	13.5	-12	50	B,K,N,Q
QPW-30403720	30-40	37s	20	3	10	17	-12	50	B,K,N,Q
QPW-30403730	30-40	37s	30	3	10	17	-12	50	B,K,N,Q
QPW-30403740	30-40	37s	40	3	10	17.3	-12	50	B,K,N,Q
QPW-30403750	30-40	37s	50	3	10	17.6	-12	50	B,K,N,Q
QPW-32482310	32-48	23	10	2	12	0.7	-12	30	J,G,L,S
QPW-32482322	32-48	23	22	2	12	0.8	-12	30	J,G,L,S
QPW-32482334	32-48	23	34	2	12	0.9	-12	30	J,G,L,S
QPW-32482346	32-48	23	46	2	12	1	-12	30	J,G,L,S
QPW-32472718	32-47	27	18	2	12	1.5	-12	50	J,G,L,S
QPW-32472730	32-47	27	30	2	12	1.6	-12	50	J,G,L,S
QPW-32472742	32-47	27	42	2	12	1.7	-12	50	J,G,L,S
QPW-32472923	32-47	29	23	2	12	1.5	-12	50	J,G,L,S
QPW-32472935	32-47	29	35	2	12	1.6	-12	50	J,G,L,S
QPW-32472947	32-47	29	47	2	12	1.7	-12	50	J,G,L,S
QPW-40473215	40-47	32	15	2.5	10	14	-12	100	A,R,M,T
QPW-40473235	40-47	32	35	2.5	10	14.5	-12	100	A,R,M,T
QPW-40473247	40-47	32	47	2.5	10	15	-12	100	A,R,M,T
QPW-45572215	45-57	22s	15	2.5	12	2	-12	50	A,R,M,T
QPW-45572225	45-57	22s	25	2.6	12	2.1	-12	50	A,R,M,T
QPW-45572235	45-57	22s	35	2.7	12	2.2	-12	50	A,R,M,T
QPW-45572245	45-57	22s	45	2.8	12	2.3	-12	50	A,R,M,T
QPW-50662315	50-66	23	15	3.5	8	2.2	-	-	C2
QPW-50662330	50-66	23	30	3.5	8	2.3	-	-	C2
QPW-71762128	71-76	21	28	2	6	0.7	-	-	P2
QPW-80912215	80-91	22s	15	3	8	2.2	-	-	C1
QPW-80912230	80-91	22s	30	3	8	2.3	-	-	C1



# Millimeter-Wave Broadband Power Amplifiers

QPW

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness ( $\pm$ dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPW-90952318	90-95	23	18	3	5	0.8	-	-	P2
QPW-90952328	90-95	23	28	3	5	1	-	-	P2
QPW-90952715	90-95	27	15	3	5	1.8	-	-	C1
QPW-90952728	90-95	27	28	3	5	2	-	-	C1
QPW-90953020	90-95	30	20	3.5	5	5	-	-	C2
QPW-90953030	90-95	30	30	3.5	5	5.2	-	-	C2

s = Saturated Power

\*Please contact QuinStar for outline information.

## Ordering Information

Model Number **QPW - ABCD EF GH IJ - K**

frequency range, minimum-  
maximum frequencies, in GHz

P1dB (power at 1dB gain  
compression point) in dBm  
(or saturated power where applicable)

options (see page 39)

outline designation (see pages 40-45)

gain, in dB

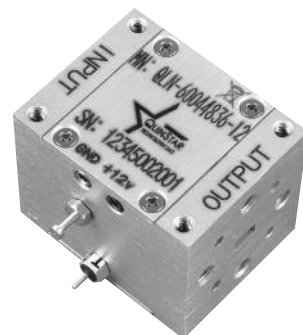


# Millimeter-Wave Low Noise Amplifiers

## QLN

### Characteristics

- ◆ Offered Over 18-104 GHz Range
- ◆ State-of-the-art Low Noise Performance
- ◆ Wide Selection of Gain and Noise Figures
- ◆ Low Power Consumption



### Product Description

QuinStar Technology's series QLN low noise amplifiers utilize advanced MMICs and discrete devices for state-of-the-art low noise performance in the 18-104 GHz frequency range. These amplifiers operate over up to 4 GHz bandwidth at most frequency ranges of commercial or military interest. Wide range of noise figures and gains are offered over each frequency interval.

The standard amplifier housing offers a wide range and combinations of input and output coaxial connectors or

waveguide ports. For 18 to 40 GHz amplifiers, we offer 2.9 mm coaxial connectors, and 2.4 mm for 40-50 GHz and 1.9 mm connector for frequencies beyond. Appropriate waveguide input and/or output ports are offered for the entire range from 18 to 104 GHz. Any valid combination of coaxial and waveguide input and output ports can be supplied, if desired. Integral waveguide isolators are also available for improved input and output matches. A wide range of optional features is available for these amplifiers. Please see page 39 for details of these options.

### Specifications

Model Number	Frequency Range (GHz)	Noise Figure (dB)	Gain (dB)	Gain Flatness (±dB)	Current (mA) max.	Outline (pages 40-45)
QLN-ABCD2520	18-22	2.5	20	1	100	J,E,G,L,S,D1
QLN-ABCD2540	18-22	2.5	40	1.25	180	J,E,G,L,S
QLN-ABCD2550	18-22	2.5	50	1.5	250	J,G,L,S
QLN-ABCD2520	22-26	2.5	20	1	100	J,E,G,L,S,D1
QLN-ABCD2540	22-26	2.5	40	1.25	180	J,E,G,L,S,D1
QLN-ABCD2550	22-26	2.5	50	1.5	250	J,G,L,S
QLN-ABCD2822	26-32	2.8	22	1.75	100	J,E,G,L,S,D1
QLN-ABCD2834	26-32	2.8	34	2	150	J,E,G,L,S,D1
QLN-ABCD2846	26-32	2.8	46	2.25	250	J,G,L,S
QLN-ABCD2822	32-36	2.8	22	1	100	J,E,G,L,S,D1
QLN-ABCD2834	32-36	2.8	34	1.25	150	J,E,G,L,S,D1
QLN-ABCD2846	32-36	2.8	46	1.5	250	J,G,L,S
QLN-ABCD2818	36-40	2.8	18	1.75	100	J,E,G,L,S,D1
QLN-ABCD2830	36-40	2.8	30	2	150	J,E,G,L,S,D1
QLN-ABCD2840	36-40	2.8	40	2.25	250	J,G,L,S
QLN-ABCD3522	38-42	3.5	22	2	150	J,E,G,L,S,D1
QLN-ABCD3534	38-42	3.5	34	2	200	J,E,G,L,S
QLN-ABCD3546	38-42	3.5	46	2	250	J,G,L,S
QLN-ABCD3522	40-45	3.5	22	2	150	J,E,G,L,S,D1
QLN-ABCD3534	40-45	3.5	34	2	200	J,E,G,L,S
QLN-ABCD3546	40-45	3.5	46	2	250	J,G,L,S
QLN-ABCD4518	42-46	4.5	18	1.5	150	J,E,G,L,S,D1



# Millimeter-Wave Low Noise Amplifiers

## QLN

### Specifications

Model Number	Frequency Range (GHz)	Noise Figure (dB)	Gain (dB)	Gain Flatness ( $\pm$ dB)	Current (mA) max.	Outline (pages 40-45)
QLN-ABCD4527	42-46	4.5	27	1.75	200	J,G,L,S
QLN-ABCD4537	42-46	4.5	37	2	250	J,G,L,S
QLN-ABCD4520	46-50	4.5	20	2	180	J,E,G,L,S
QLN-ABCD4530	46-50	4.5	30	2.1	250	J,G,L,S
QLN-ABCD4540	46-50	4.5	40	2.2	300	J,G,L,S
QLN-ABCD4520	50-54	4.5	20	2	180	P1,G
QLN-ABCD4530	50-54	4.5	30	2.1	250	P1,G
QLN-ABCD4540	50-54	4.5	40	2.2	300	P1,G
QLN-ABCD4518	54-58	4.5	18	1.5	100	P1,G
QLN-ABCD4536	54-58	4.5	36	2	180	P1,G,I2
QLN-ABCD4518	58-62	4.5	18	1.5	100	P1,I1
QLN-ABCD4536	58-62	4.5	36	2	180	P1,I2
QLN-ABCD4518	62-66	4.5	18	1.5	100	P1,I1
QLN-ABCD4536	62-66	4.5	36	2	180	P1,I2
QLN-ABCD4518	66-70	4.5	18	1.5	100	P1,I1
QLN-ABCD4536	66-70	4.5	36	2	180	P1,I2
QLN-ABCD4518	70-74	4.5	18	1.5	100	P1,I1
QLN-ABCD4536	70-74	4.5	36	2	180	P1,I2
QLN-ABCD5518	74-78	5.5t	18	2	100	P1,I2
QLN-ABCD5530	74-78	5.5t	30	2.2	130	P1
QLN-ABCD5518	78-82	5.5t	18	2	100	P1,I2
QLN-ABCD5530	78-82	5.5t	30	2.2	130	P1
QLN-ABCD5518	82-86	5.5t	18	2	100	P1,I2
QLN-ABCD5530	82-86	5.5t	30	2.2	130	P1
QLN-ABCD5518	86-92	5.5t	18	2	100	P1,I2
QLN-ABCD5530	86-92	5.5t	30	2.2	130	P1
QLN-ABCD6515	92-96	6.5	15	1.5	80	P1,I1
QLN-ABCD6528	92-96	6.5	28	2	150	P1,I2
QLN-ABCD5510	96-100	5.5	10	2	50	P1,I1
QLN-ABCD5524	96-100	5.5	24	2.5	150	P1,I2
QLN-ABCD5510	100-104	5.5	10	2t	50	P1,I1
QLN-ABCD5520	100-104	5.5	20	2.5t	100	P1,I2

t = typical

### Ordering Information

Model Number **QLN - AB CD EF GH IJ - K**

center frequency in GHz

(A0 = 100 GHz, A1 = 101 GHz,  
B1 = 111 GHz, etc.)

bandwidth in GHz up to 4 GHz

noise figure, in tenths of dB

(example: EF = 32 for noise figure = 3.2 dB)

options (see page 39)

outline designation (see pages 40-45)

gain, in dB



# Millimeter-Wave High Power Amplifiers

## QPN

### Characteristics

- ◆ 18-95 GHz Coverage
- ◆ State-Of-The-Art Power Performance
- ◆ Large Selection of Standard Models



### Product Description

QuinStar Technology's series QPN power amplifiers utilize advanced Millimeter wave Monolithic Integrated Circuits (MMICs) and discrete devices for state-of-the-art power performance up to 4 GHz bandwidth in the 18-95 GHz frequency range. The standard amplifier housing offers a wide range and combinations of input and output coaxial connectors or waveguide ports. For 18 to 40 GHz amplifiers, we offer 2.9 mm coaxial connectors, and 2.4 mm for 40-50 GHz and 1.9 mm connectors for frequencies

beyond. Appropriate waveguide input and/or output ports are offered for the entire range from 18 to 95 GHz. Any valid combination of coaxial and waveguide input and output ports can be supplied, if desired.

In addition to the standard products, QuinStar can produce customized amplifiers to specific requirements. A wide range of optional features is available for these amplifiers. Please see page 39 for details of these options.

### Specifications

Model Number	Frequency Range <sup>1</sup> (GHz)	Power P1dB (dBm)	Gain (dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPN-ABCD2310	18-22	23	10	12	0.5	-	-	J,G,L,S
QPN-ABCD2325	18-22	23	25	12	0.6	-	-	J,G,L,S
QPN-ABCD2340	18-22	23	40	12	0.7	-	-	J,G,L,S
QPN-ABCD2710	18-22	27	10	12	0.8	-	-	J,G,L,S
QPN-ABCD2725	18-22	27	25	12	1.1	-	-	J,G,L,S
QPN-ABCD2740	18-22	27	40	12	1.2	-	-	J,G,L,S
QPN-ABCD3010	18-22	30	10	12	1.5	-	-	A,R,M,T
QPN-ABCD3025	18-22	30	25	12	1.8	-	-	A,R,M,T
QPN-ABCD3040	18-22	30	40	12	1.9	-	-	A,R,M,T
QPN-ABCD3310	18-22	33	10	10	3	-	-	A,R,M,T
QPN-ABCD3325	18-22	33	25	10	3.4	-	-	A,R,M,T
QPN-ABCD3340	18-22	33	40	10	3.5	-	-	A,R,M,T
QPN-ABCD3620	18-22	36	20	10	6t	-12	150	B,K,N,Q
QPN-ABCD3640	18-22	36	40	10	6.5	-12	150	B,K,N,Q
QPN-ABCD3820	18-22	38	20	10	12	-12	150	B,K,N,Q
QPN-ABCD3840	18-22	38	40	10	13	-12	150	B,K,N,Q
QPN-ABCD2310	22-26	23	10	12	0.5	-	-	J,G,L,S
QPN-ABCD2325	22-26	23	25	12	0.6	-	-	J,G,L,S
QPN-ABCD2340	22-26	23	40	12	0.7	-	-	J,G,L,S
QPN-ABCD2710	22-26	27	10	12	0.8	-	-	J,G,L,S
QPN-ABCD2725	22-26	27	25	12	1.1	-	-	J,G,L,S
QPN-ABCD2740	22-26	27	40	12	1.2	-	-	J,G,L,S
QPN-ABCD3010	22-26	30	10	12	1.5	-	-	A,R,M,T
QPN-ABCD3025	22-26	30	25	12	1.8	-	-	A,R,M,T
QPN-ABCD3040	22-26	30	40	12	1.9	-	-	A,R,M,T



# Millimeter-Wave High Power Amplifiers

## QPN

### Specifications

Model Number	Frequency Range <sup>1</sup> (GHz)	Power P1dB (dBm)	Gain (dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPN-ABCD3310	22-26	33	10	10	3	-	-	A,R,M,T
QPN-ABCD3325	22-26	33	25	10	3.4	-	-	A,R,M,T
QPN-ABCD3340	22-26	33	40	10	3.5	-	-	A,R,M,T
QPN-ABCD3620	22-26	36	20	10	6	-12	150	B,K,N,Q
QPN-ABCD3640	22-26	36	40	10	6.5	-12	150	B,K,N,Q
QPN-ABCD3820	22-26	38	20	10	12	-12	150	B,K,N,Q
QPN-ABCD3840	22-26	38	40	10	13	-12	150	B,K,N,Q
QPN-ABCD2315	26-32	23	15	12	0.4	-	-	J,G,L,S
QPN-ABCD2326	26-32	23	26	12	0.45	-	-	J,G,L,S
QPN-ABCD2337	26-32	23	37	12	0.5	-	-	J,G,L,S
QPN-ABCD2348	26-32	23	48	12	0.55	-	-	J,G,L,S
QPN-ABCD2713	26-32	27	13	12	0.9	-	-	J,G,L,S
QPN-ABCD2728	26-32	27	28	12	1.1	-	-	J,G,L,S
QPN-ABCD2739	26-32	27	39	12	1.2	-	-	J,G,L,S
QPN-ABCD2750	26-32	27	50	12	1.3	-	-	J,G,L,S
QPN-ABCD3027	26-32	30	27	12	3.1	-	-	A,R,M,T
QPN-ABCD3038	26-32	30	38	12	3.2	-	-	A,R,M,T
QPN-ABCD3050	26-32	30	50	12	3.3	-	-	A,R,M,T
QPN-ABCD3327	26-32	33	27	12	4.4	-12	50	A,R,M,T
QPN-ABCD3338	26-32	33	38	12	4.5	-12	50	A,R,M,T
QPN-ABCD3350	26-32	33	50	12	4.6	-12	50	A,R,M,T
QPN-ABCD3627	26-32	36	27	8	8.8	-12	50	B,K,N,Q
QPN-ABCD3638	26-32	36	38	8	9	-12	50	B,K,N,Q
QPN-ABCD3650	26-32	36	50	8	9.6	-12	50	B,K,N,Q
QPN-ABCD3827	26-32	38	27	8	17	-12	50	*
QPN-ABCD3838	26-32	38	38	8	18	-12	50	*
QPN-ABCD3850	26-32	38	50	8	19	-12	50	*
QPN-ABCD2312	32-36	23	12	12	0.7	-	-	J,G,L,S
QPN-ABCD2325	32-36	23	25	12	0.8	-	-	J,G,L,S
QPN-ABCD2336	32-36	23	36	12	0.9	-	-	J,G,L,S
QPN-ABCD2347	32-36	23	47	12	0.95	-	-	J,G,L,S
QPN-ABCD2712	32-36	27	12	12	1.4	-	-	J,G,L,S
QPN-ABCD2725	32-36	27	25	12	1.6	-	-	J,G,L,S
QPN-ABCD2736	32-36	27	36	12	1.8	-	-	J,G,L,S
QPN-ABCD2747	32-36	27	47	12	2	-	-	J,G,L,S
QPN-ABCD3010	32-36	30	10	12	2.8	-12	50	A,R,M,T
QPN-ABCD3023	32-36	30	23	12	3	-12	50	A,R,M,T
QPN-ABCD3035	32-36	30	35	12	3.2	-12	50	A,R,M,T
QPN-ABCD3045	32-36	30	45	12	3.5	-12	50	A,R,M,T
QPN-ABCD3312	32-36	33	12	12	4.8	-12	100	A,R,M,T
QPN-ABCD3323	32-36	33	23	12	5	-12	100	A,R,M,T
QPN-ABCD3335	32-36	33	35	12	5.2	-12	100	A,R,M,T
QPN-ABCD3345	32-36	33	45	12	5.5	-12	100	A,R,M,T
QPN-ABCD3621	32-36	36	21	10	9	-12	100	B,K,N,Q
QPN-ABCD3630	32-36	36	30	10	9.5	-12	100	B,K,N,Q



# Millimeter-Wave High Power Amplifiers

QPN

## Specifications

Model Number	Frequency Range <sup>1</sup> (GHz)	Power P1dB (dBm)	Gain (dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPN-ABCD3640	32-36	36	40	10	10	-12	100	B,K,N,Q
QPN-ABCD3820	32-36	38	20	10	18	-12	100	*
QPN-ABCD3830	32-36	38	30	10	19	-12	100	*
QPN-ABCD3840	32-36	38	40	10	20	-12	100	*
QPN-ABCD2313	36-40	23	13	12	0.35	-	-	J,G,L,S
QPN-ABCD2324	36-40	23	24	12	0.4	-	-	J,G,L,S
QPN-ABCD2335	36-40	23	35	12	0.5	-	-	J,G,L,S
QPN-ABCD2345	36-40	23	45	12	0.55	-	-	J,G,L,S
QPN-ABCD2710	36-40	27	10	12	0.9	-	-	J,G,L,S
QPN-ABCD2723	36-40	27	23	12	1.2	-	-	J,G,L,S
QPN-ABCD2734	36-40	27	34	12	1.3	-	-	J,G,L,S
QPN-ABCD2745	36-40	27	45	12	1.4	-	-	J,G,L,S
QPN-ABCD3021	36-40	30	21	12	2.7	-	-	A,R,M,T
QPN-ABCD3032	36-40	30	32	12	2.8	-	-	A,R,M,T
QPN-ABCD3043	36-40	30	43	12	2.9	-	-	A,R,M,T
QPN-ABCD3321	36-40	33	21	12	4.5	-12	100	A,R,M,T
QPN-ABCD3332	36-40	33	32	12	4.7	-12	100	A,R,M,T
QPN-ABCD3343	36-40	33	43	12	4.8	-12	100	A,R,M,T
QPN-ABCD3621	36-40	36	21	10	9.4	-12	100	B,K,N,Q
QPN-ABCD3632	36-40	36	32	10	9.6	-12	100	B,K,N,Q
QPN-ABCD3643	36-40	36	43	10	10	-12	100	B,K,N,Q
QPN-ABCD3820	36-40	38	20	10	18	-12	100	*
QPN-ABCD3832	36-40	38	32	10	19	-12	100	*
QPN-ABCD3843	36-40	38	43	10	20	-12	100	*
QPN-ABCD2325	40-44	23	25	12	1.8	-12	50	A,R,M,T
QPN-ABCD2335	40-44	23	35	12	1.95	-12	50	A,R,M,T
QPN-ABCD2345	40-44	23	45	12	2.2	-12	50	A,R,M,T
QPN-ABCD2355	40-44	23	55	12	2.4	-12	50	A,R,M,T
QPN-ABCD2725	40-44	27	25	12	3.5	-12	50	A,R,M,T
QPN-ABCD2735	40-44	27	35	12	3.6	-12	50	A,R,M,T
QPN-ABCD2745	40-44	27	45	12	3.6	-12	50	A,R,M,T
QPN-ABCD2755	40-44	27	55	12	3.7	-12	50	A,R,M,T
QPN-ABCD3013	40-44	30	13	12	5.0	-12	50	A,R,M,T
QPN-ABCD3023	40-44	30	23	12	5.5	-12	50	A,R,M,T
QPN-ABCD3033	40-44	30	33	12	5.7	-12	50	A,R,M,T
QPN-ABCD3043	40-44	30	43	12	5.9	-12	50	A,R,M,T
QPN-ABCD3312	40-44	33	12	8	10	-12	100	B,K,N,Q
QPN-ABCD3323	40-44	33	23	8	11	-12	100	B,K,N,Q
QPN-ABCD3333	40-44	33	33	8	11.5	-12	100	B,K,N,Q
QPN-ABCD3343	40-44	33	43	8	11.8	-12	100	B,K,N,Q
QPN-ABCD3612	40-44	36	12	8	19	-12	100	B,K,N,Q
QPN-ABCD3623	40-44	36	23	8	20	-12	100	B,K,N,Q
QPN-ABCD3633	40-44	36	33	8	21	-12	100	B,K,N,Q
QPN-ABCD3643	40-44	36	43	8	22	-12	100	B,K,N,Q
QPN-ABCD2312	44-48	23	12	12	0.6	-12	50	J,G,L,S



# Millimeter-Wave High Power Amplifiers

QPN

## Specifications

Model Number	Frequency Range <sup>1</sup> (GHz)	Power P1dB (dBm)	Gain (dB)	Voltage (V)	Current (A) typ.	-Voltage (V)	-Current (mA), max.	Outline Pages 40-45
QPN-ABCD2322	44-48	23	22	12	0.9	-12	50	J,G,L,S
QPN-ABCD2332	44-48	23	32	12	1	-12	50	J,G,L,S
QPN-ABCD2342	44-48	23	42	12	1.2	-12	50	J,G,L,S
QPN-ABCD2610	44-48	26s	10	12	1.2	-12	50	J,G,L,S
QPN-ABCD2620	44-48	26s	20	12	1.5	-12	50	J,G,L,S
QPN-ABCD2630	44-48	26s	30	12	1.6	-12	50	J,G,L,S
QPN-ABCD2640	44-48	26s	40	12	1.8	-12	50	J,G,L,S
QPN-ABCD2318	50-54	23	18	8	2.2	-	-	C1
QPN-ABCD2330	50-54	23	30	8	2.5	-	-	C1
QPN-ABCD2618	50-54	26	18	8	5	-	-	C2
QPN-ABCD2630	50-54	26	30	8	5.5	-	-	C2
QPN-ABCD2818	50-54	28	18	8	10	-	-	*
QPN-ABCD2830	50-54	28	30	8	11	-	-	*
QPN-ABCD2318	54-58	23	18	8	2.2	-	-	C1
QPN-ABCD2330	54-58	23	30	8	2.5	-	-	C1
QPN-ABCD2618	54-58	26	18	8	5	-	-	C2
QPN-ABCD2630	54-58	26	30	8	5.5	-	-	C2
QPN-ABCD2816	54-58	28	16	8	10	-	-	*
QPN-ABCD2830	54-58	28	30	8	11	-	-	*
QPN-ABCD2318	58-62	23	18	8	2.2	-	-	C1
QPN-ABCD2330	58-62	23	30	8	2.5	-	-	C1
QPN-ABCD2618	58-62	26	18	8	5	-	-	C2
QPN-ABCD2630	58-62	26	30	8	5.5	-	-	C2
QPN-ABCD2816	58-62	28	16	8	10	-	-	*
QPN-ABCD2830	58-62	28	30	8	11	-	-	*
QPN-ABCD2318	62-66	23	18	8	12	-	-	C1
QPN-ABCD2330	62-66	23	30	8	13	-	-	C1
QPN-ABCD2618	62-66	26	18	8	14	-	-	C2
QPN-ABCD2630	62-66	26	30	8	15	-	-	C2
QPN-ABCD2816	62-66	28	16	8	16	-	-	*
QPN-ABCD2830	62-66	28	30	8	17	-	-	*
QPN-ABCD2128	71-76	21	28	6	0.7	-	-	P2
QPN-ABCD2420	90-95	24s	20	6	0.9	-	-	P1
QPN-ABCD2430	90-95	24s	30	6	1	-	-	P2
QPN-ABCD2718	90-95	27s	18t	6	1.8	-	-	C1
QPN-ABCD2730	90-95	27s	30	6	2	-	-	C1
QPN-ABCD3018	90-95	30s	18t	6	4.5	-	-	C2
QPN-ABCD3030	90-95	30s	30	6	5	-	-	C2

s = Saturated power output

<sup>1</sup> Standard product has 2 GHz of operating bandwidth within this frequency range

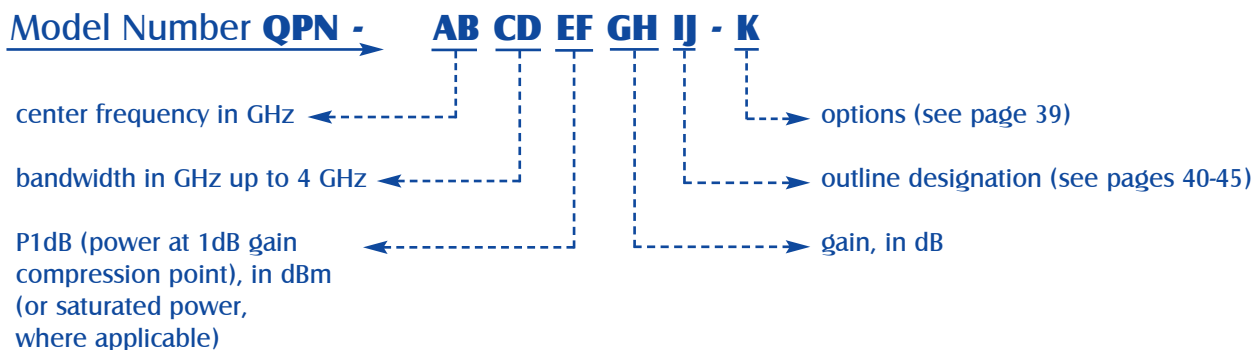
\* Please contact QuinStar for applicable package outline



# Millimeter-Wave High Power Amplifiers

## QPN

### Ordering Information



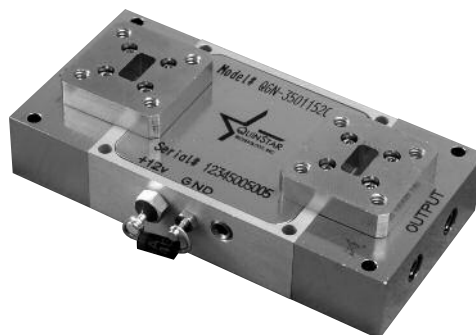


# Millimeter-Wave General Purpose Amplifiers

## QGN

### Characteristics

- ◆ 18-110 GHz Coverage
- ◆ Wide Range of Frequency and Gain Options
- ◆ Choice of Packages & Interfaces



### Product Description

QuinStar Technology's series QGN amplifiers are ideally suited for most common applications requiring high RF gain over a relatively narrow bandwidth. The amplifiers are offered with nominal gains of 20 to 50 dB typically, and nominal output power of 10-20 dBm, across their entire operating frequency range

The standard amplifier housing offers a wide range and combinations of input and output coaxial connectors or

waveguide ports. For 18 to 40 GHz amplifiers, we offer 2.9 mm coaxial connectors, and 2.4 mm for 40-50 GHz and 1.9 mm connector for frequencies beyond. Appropriate waveguide input and/or output ports are offered for the entire range from 18 to 110 GHz. Any valid combination of coaxial and waveguide input and output ports can be supplied, if desired. A wide range of optional features is available for these amplifiers. Please see page 39 for details of these options.

### Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (mA) max.	Outline (pages 40-45)
QGN-ABCD1720	18-22	17	20	1.5	12	350	J,G,E,L,S
QGN-ABCD1730	18-22	17	30	1.65	12	450	J,G,L,S
QGN-ABCD1740	18-22	17	40	1.8	12	500	J,G,L,S
QGN-ABCD1750	18-22	17	50	2	12	600	J,G,L,S
QGN-ABCD2020	18-22	20	20	1.5	12	350	J,G,E,L,S
QGN-ABCD2030	18-22	20	30	1.65	12	450	J,G,L,S
QGN-ABCD2040	18-22	20	40	1.8	12	500	J,G,L,S
QGN-ABCD2050	18-22	20	50	2	12	600	J,G,L,S
QGN-ABCD1718	22-26	17	18	1.5	12	350	J,G,L,S
QGN-ABCD1730	22-26	17	30	1.65	12	450	J,G,L,S
QGN-ABCD1740	22-26	17	40	1.8	12	500	J,G,L,S
QGN-ABCD1750	22-26	17	50	2	12	600	J,G,L,S
QGN-ABCD2020	22-26	20	20	1.5	12	600	J,G,L,S
QGN-ABCD2030	22-26	20	30	1.65	12	680	J,G,L,S
QGN-ABCD2040	22-26	20	40	1.8	12	750	J,G,L,S
QGN-ABCD2050	22-26	20	50	2	12	800	J,G,L,S
QGN-ABCD1716	26-32	17	16	1.5	12	350	J,G,L,S
QGN-ABCD1727	26-32	17	27	1.65	12	450	J,G,L,S
QGN-ABCD1737	26-32	17	37	1.8	12	550	J,G,L,S
QGN-ABCD1748	26-32	17	48	2	12	600	J,G,L,S
QGN-ABCD2020	26-32	20	20	1.5	12	600	J,G,L,S
QGN-ABCD2030	26-32	20	30	1.65	12	680	J,G,L,S
QGN-ABCD2040	26-32	20	40	1.8	12	750	J,G,L,S



# Millimeter-Wave General Purpose Amplifiers

QGN

## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (mA) max.	Outline (pages 40-45)
QGN-ABCD2050	26-32	20	50	2	12	800	J,G,L,S
QGN-ABCD1715	33-36	17	15	1.5	12	400	J,G,L,S
QGN-ABCD1726	33-36	17	26	1.65	12	480	J,G,L,S
QGN-ABCD1737	33-36	17	37	1.8	12	560	J,G,L,S
QGN-ABCD1748	33-36	17	48	2	12	630	J,G,L,S
QGN-ABCD2020	33-36	20	20	1.5	12	600	J,G,L,S
QGN-ABCD2030	33-36	20	30	1.65	12	680	J,G,L,S
QGN-ABCD2040	33-36	20	40	1.8	12	750	J,G,L,S
QGN-ABCD2050	33-36	20	50	2	12	800	J,G,L,S
QGN-ABCD1713	36-41	17	13	1.5	12	350	J,G,L,S
QGN-ABCD1724	36-41	17	24	1.65	12	450	J,G,L,S
QGN-ABCD1735	36-41	17	35	1.8	12	550	J,G,L,S
QGN-ABCD1745	36-41	17	45	2	12	600	J,G,L,S
QGN-ABCD2020	36-41	20	20	1.5	12	600	J,G,L,S
QGN-ABCD2030	36-41	20	30	1.65	12	680	J,G,L,S
QGN-ABCD2040	36-41	20	40	1.8	12	750	J,G,L,S
QGN-ABCD2050	36-41	20	50	2	12	800	J,G,L,S
QGN-ABCD1718	41-48	17	18	1.5	12	500	J,G,L,S
QGN-ABCD1728	41-48	17	28	1.65	12	600	J,G,L,S
QGN-ABCD1738	41-48	17	38	1.8	12	700	J,G,L,S
QGN-ABCD1748	41-48	17	48	2	12	750	J,G,L,S
QGN-ABCD2018	41-48	20	18	1.5	12	1100	J,G,L,S
QGN-ABCD2028	41-48	20	28	1.65	12	1600	J,G,L,S
QGN-ABCD2038	41-48	20	38	1.8	12	1700	J,G,L,S
QGN-ABCD2048	41-48	20	48	2	12	1800	J,G,L,S
QGN-ABCD1715	48-52	17*	15	2.5	8	700	J,G,L,S
QGN-ABCD1730	48-52	17*	30	2.5	8	800	J,G,L,S
QGN-ABCD1918	48-52	19*	18	2.5t	8	1200	J,G,L,S
QGN-ABCD1935	48-52	19*	35	2.7t	8	1300	J,G,L,S
QGN-ABCD1715	52-66	17	15	2	8	700	P1
QGN-ABCD1730	52-66	17	30	2	8	800	P2,P1
QGN-ABCD2015	52-66	20	15	2t	8	1400	P2
QGN-ABCD2030	52-66	20	30	2t	8	1600	P2
QGN-ABCD1718	66-70	17	18	2.5	5	250	P1,I1
QGN-ABCD1735	66-70	17	35	2.5	5	330	P1
QGN-ABCD1918	66-70	19*	18	2t	5	550	P2
QGN-ABCD1935	66-70	19*	35	2t	5	700	P2
QGN-ABCD1720	70-74	17	20	2	5	250	P1,I1
QGN-ABCD1735	70-74	17	35	2	5	330	P1,I2
QGN-ABCD1925	70-74	19*	25	2t	5	550	P1
QGN-ABCD1935	70-74	19*	35	2t	5	700	P1
QGN-ABCD1720	74-78	17	20	2	5	500	P1
QGN-ABCD1735	74-78	17	35	2	5	600	P1
QGN-ABCD2020	74-78	20*	20	2t	5	1000	P2
QGN-ABCD2035	74-78	20*	35	2t	5	1200	P2



# Millimeter-Wave General Purpose Amplifiers

QGN



## Specifications

Model Number	Frequency Range (GHz)	Power P1dB (dBm)	Gain (dB)	Gain Flatness (±dB)	Voltage (V)	Current (mA) max.	Outline (pages 40-45)
QGN-ABCD1715	78-84	17*	15	3	5	350	P1
QGN-ABCD1733	78-84	17*	33	3.5	5	350	P1
QGN-ABCD2015	78-84	20*	15	3t	5	700	P2
QGN-ABCD2033	78-84	20*	33	3.5t	5	800	P2
QGN-ABCD1715	84-90	17	15	2	5	200	P1,I1
QGN-ABCD1733	84-90	17	33	2	5	400	P1,I2
QGNABCD02015	84-90	20*	15	2	5	500	P1
QGN-ABCD2030	84-90	20*	30	2t	5	800	P1
QGN-ABCD1715	90-100	17	15	2	5	500	P1,I2
QGN-ABCD1730	90-100	17	30	2	5	750	P1
QGN-ABCD2020	90-100	20*	20	2	5	1000	P1
QGN-ABCD2030	90-100	20*	30	2t	5	1500	P1
QGN-ABCD1315	100-110	13*	15	2	5	700	P1

\* = Saturated power

t = typical value

## Ordering Information

Model Number **QGN - AB CD EF GH IJ - K**

center frequency in GHz

(A0 = 100 GHz, A1 = 101 GHz,  
B0 = 110 GHz, etc.)

bandwidth in GHz up to 4 GHz

power at 1dB gain compression  
point), in dBm

options (see page 39)

outline designation (see pages 40-45)

gain, in dB



# Instrumentation Amplifiers

QAI

## Characteristics

- ◆ Fully packaged in enclosure
- ◆ Operate on AC power
- ◆ Offered over 2-110 GHz range
- ◆ Custom Performance Available
- ◆ Wide Range of Options



## Product Description

QuinStar Technology's series QAI Instrumentation amplifiers are fully packaged high performance amplifiers for test and instrumentation applications. These amplifiers are packaged in rugged equipment enclosure with all power supplies and control circuits included to allow AC power operation. They employ QuinStar's wide range of amplifier products and incorporate optional features to enhance their user-friendliness. Standard products include power amplifiers, general-purpose amplifiers and broadband driver amplifiers for popular applications in frequency range covering 2 to 110 GHz. Custom products can be configured and readily produced to meet virtually any performance and operational requirements.

All products include appropriate displays, indicators, controls and cooling arrangements for ease of operation with high reliability. A wide range of optional features is also available for these amplifiers. See page 39 for details of these optional features. Enclosures may be standard rack-mountable or custom designs depending on application or customer requirements. If desired, models that operate on DC power supplies (12 or 24 V) can be supplied. These amplifiers are well suited for test and measurement, laboratory use, TWT replacement or for dedicated instrumentation sources.

## Specifications

Frequency Range	Performance Characteristics
2-8 GHz	10 Watts, 40 dB nominal gain, +/- 1.5 dB gain flatness
6-18 GHz	10 Watts, 35 dB min. gain, +/- 2 dB gain flatness
18-26.5 GHz	5 Watts, 40 dB gain
26.5-40 GHz	2 Watt, 30 dB min. gain, +/- 3 dB gain flatness
2-50 GHz	18 dBm typical power, 37 dB min. gain
33-50 GHz	17 dBm, 48 dB gain
50-75 GHz	16 dBm, 30 dB typical gain, +/- 3 dB gain flatness
75-110 GHz	13 dBm, 25 dB nominal gain



### Ordering Information

Model Number **QAI-**

**ABCD EF GH IJ - K**

frequency range, minimum-  
maximum frequencies, in GHz

power output in dBm

options (see page 39)

packaging options

gain, in dB



# Cryogenic Amplifiers and Systems

## QCA

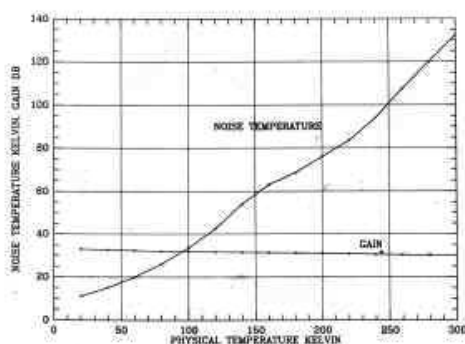
**QUINSTAR TECHNOLOGY** has acquired the product line and the capability of **Berkshire Technologies, inc.**, a small innovative company specializing in the manufacture of ultra low noise microwave amplifiers and systems. Berkshire Products incorporate many years of unique experience in designing GaAsFET and HEMT amplifiers tailored for ultra low noise at spot frequencies. QuinStar offers a standard line of coolable low-noise amplifiers (LNAs) that cover the most popularly used frequencies in the 1 to 18 GHz range. We can also custom-design and build special-purpose coolable amplifiers to customer specifications.

### APPLICATIONS

Cooled, low noise amplifiers are used in critical applications that require the ultimate in sensitivity. Cooled LNAs find important uses in radio astronomy, satellite earth stations, radiometers, and electron spin resonance measurements. They can also serve as IF amplifiers for SIS and Schottky diode-based millimeter and sub-millimeter mixers.

### COOLING HEMT BASED AMPLIFIERS

Cooling a HEMT-based amplifier to 20K decreases the noise temperature by a factor of ten (and increases gain by about 3dB) compared to room temperature values. A typical cooling curve showing amplifier noise temperature as a function of physical temperature is shown below. Note that the noise continues to decrease below 20K, and that amplifier performance continues to improve down to physical temperatures of 4K and lower.



An amplifier cooled to 20K physical produces the lowest noise temperature, which can be estimated by the relation 1.0K per 1 GHz of operating frequency plus 1K. That is, an amplifier operating at 8.5 GHz can be expected to have a typical noise temperature of 10K ( $1.0K \times 8.5 + 1K$ ).

### CRYOGENIC COOLING SYSTEMS

Cooling the amplifier to 20K or below requires a cryogenic refrigeration system. Components of this system are the

helium refrigerator, the dewar and its radiation heat shield, together with the amplifiers and associated waveguide and coaxial components. The amplifiers, which are attached to a 20K refrigerator cold head, are in a vacuum. They are surrounded by the radiation shield (temperature approximately 70K) which impedes the flow of heat from the dewar to the amplifiers. Microwave connections in and out of the dewar are designed to achieve low electrical loss and to provide a large thermal barrier. Input isolators are cooled to 20K to reduce the loss temperature of those components. Cool down time for such a system is several hours; the exact time depends upon the size of the refrigerator.

A 20K cryogenic system of the type described provides nearly the ultimate in noise performance for only moderate complexity and cost. Such systems can be custom built by QuinStar Technology. To exceed its performance, one would have to go to a liquid Helium cooling system, or employ a refrigerator capable of maintaining the amplifiers at temperatures of 4K.

Refrigerator-cooled HEMT systems have been found to be very reliable in field use on antennas. The MTBF for a 20K refrigerator is much greater than one year; amplifier life is extremely long based on the performance of hundreds of units operating in the field.

### POWER SUPPLIES FOR COOLABLE AMPLIFIERS

Power Supply Model PS-3D is recommended for use with our cooled amplifiers. This servo-controlled power supply is complete with metering and maintains the proper bias on the cooled FETs.

### AUTOMATED NOISE FIGURE TEST SYSTEMS

The Automated Test Bench measures the noise performance of low-noise microwave amplifiers as a function of frequency and displays the results as a graph and as a table of values. The frequency coverage is up to 18 GHz; measurement accuracy is better than 1 K. The Test Bench is computer controlled.

The system performs noise figure measurements by switching the input of the LNA between a terminated load at ambient temperature, and one at 77K (or other temperature). The Automated Test Bench consists of two units. The RF unit contains a precision test receiver; the D/A unit contains the analog-to-digital converter, relay drivers, and digital-to-analog converters. The Test Bench is controlled by an IBM-PC or compatible computer through the IEEE-488 bus.

### MANUFACTURING PRACTICES AND PROCEDURES

All our amplifiers are designed using computer aided techniques to optimize performance over the frequency range of interest. Computer design techniques have

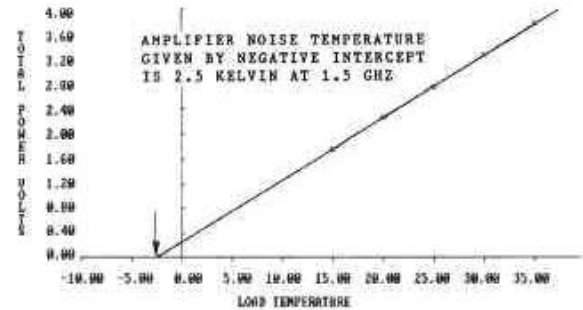


# Cryogenic Amplifiers and Systems

## QCA

enabled us to achieve much wider bandwidths than formerly possible. At 4 GHz, 30 percent bandwidth is available with only a small degradation of noise performance; we produce an octave band amplifier in the 2-4 GHz range. For cooled amplifiers, each stage is supplied with an external regulator circuit which stabilizes the operating point over the large range of temperature changes encountered during cool down. We test each amplifier several times at the appropriate temperatures in the process of manufacture, and adjust for optimum performance in the cold condition.

Noise temperature and gain of our cooled HEMT amplifiers are measured on an automated test system. The inherent accuracy of measurements is a few tenths of a degree Kelvin. With each amplifier shipped, we provide test data showing frequency range of the amplifier, noise figure, small signal gain, and optimum operating biases.



Additional test data over operating temperature and frequency ranges may be available at additional cost. Below is a sample list of some of our amplifier models. Most amplifiers we produce are custom-designed to meet the customer's specific requirements.

Noise Temperature Measured at 20 Kelvin Physical Temperature

MODEL NUMBER	FREQUENCY GHZ	NOISE TEMPERATURE	GAIN dB
QCA-L-1.5-30H	1.3 - 1.7	5 K	33
QCA-S-2.3-30H	2.1 - 2.4	6 K	33
QCA-C-4.0-30H	3.5 - 4.5	8 K	30
QCA-C-5.0-30H	4.8 - 5.1	9 K	28
QCA-X-8.5-30H	8.0 - 9.0	10 K	30
QCA-X-11-30H	9.0 - 10.0	12 K	30
QCA-K-15-25H	12.0 - 18.0	20 K	25

### General Specifications

Gain Flatness	± 1.5dB
Gain Slope	± 0.1dB/10MHz Max.
Power Out @ 1dB Compression	+3dBm
Third Order Intercept	+13dBm
Group Delay:	
Linear	± 0.1 nS/100MHz
Ripple	± 0.1 nS/10MHz
Input VSWR*	1.25:1 C, X and Ku band 2:1 L, S band (1.3:1 available as an option)
Output VSWR	2:1 max. (1.3:1 available as an option)
*L and S band amplifiers achieve VSWR below 2:1 without input isolators. Input isoaltors for these bands are available at additional cost. The C, X and Ku band amplifiers are supplied with input isolators. Output isolators, if desired, are available at additional cost.	
Connectors In/Out	SMA M/F

### Cooled Amplifier Systems

We supply complete cryogenically cooled systems containing our line of Ultra-Low-Noise cooled HEMT

amplifiers. These systems include the closed cycle helium refrigerator (CCR), vacuum dewar, cooled amplifiers, power supplies and remote control monitor unit. Standard models are available in the frequency ranges indicated below.

The amplifiers are cooled to 20 Kelvin in the dewar, where they are interfaced with low loss gapped waveguide. Low loss stainless steel coax lines are employed at the lower frequencies. Vacuum instrumentation and a cryogenic thermometer are included, and a remote helium compressor is supplied with a set of 10 feet of flexible helium lines. In addition a post amplifier of approximately 20 dB gain can be provided to overcome subsequent filter and mixer losses.

The standard system employs the Cryogenic Technology (CTI) model 22 refrigerator. For faster cool down and greater cooling capacity the CTI model 350 refrigerator may be supplied at additional cost.



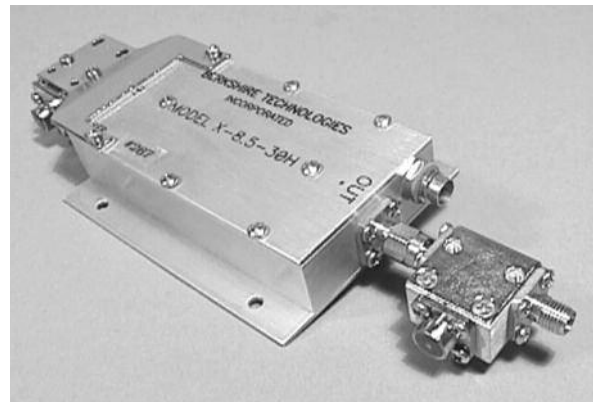
# Cryogenic Amplifiers and Systems

QCA

Model Number	Freq. GHz	Noise Temp.	Gain dB
QCA-L-22H	1.4-1.7	8K	30
QCA-C-4.0-30-350C	3.7-4.2	10K	30
QCA-C-22H	3.7-4.2	12K	30
QCA-XA-22H	8.18-8.98	15K	30
QCA-X-8.5-30-350C	8.2-8.5	12K	30
QCA-XB-22H	10.2-10.7	20K	28
QCA-K-15-30-350C	14.0-16.0	20K	25
QCA-K-22H	14.7-15.3	30K	28

## General Specifications:

Gain Flatness	+/-1.5dB
Gain Ripple	+/-0.2dB/50MHz
Group delay, Linear	0.01 nSec/MHz max.
1 dB Gain Compression	+3 dBm min.
3rd Order Intercept	+13 dBm
Input/output VSWR	1.25:1 max.
Input Connector	Waveguide/Type N
Output Connector	Type N or SMA
Phase linearity	5 deg. max. deviation from linear



Cryogenic LNA with input and output isolators

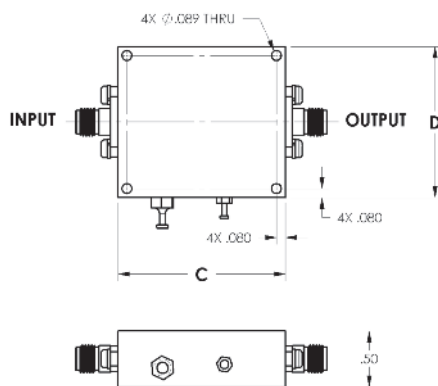


## ..... Custom Options and Configurations for Amplifier Products

In addition to the options for input and output interfaces and package style, QuinStar also offers a wide range of useful options, added features and practical configurations to suit customers' specific requirements. These optional features may be incorporated in most of the amplifier products offered by QuinStar Technology. If desired, more than one option may be selected for some amplifiers. Some of the most commonly supplied options are:

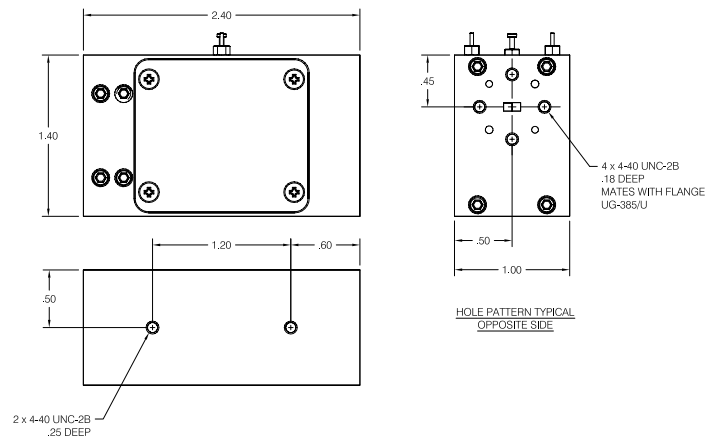
- **Gain Control (Option G):** A DC analog control signal may be applied to vary the gain of the amplifier over a wide range. This feature may be used with the power monitoring option to implement automatic gain control (AGC) or power output level control (ALC) functions.
- **Built-in detector output (Option D):** A built-in detector circuit detects sampled or coupled portion of output signal power. The detector's output voltage is made available for monitoring amplifier's output power. This detected signal may be used for automatic gain control, power monitoring or for built-in test.
- **Dual Output (Option M):** In addition to the main power output, a second output signal may also be provided. The second output may be derived by splitting the amplifier's output signal in any desired ratio or at any coupling level. Alternatively, a sample or coupled portion of an intermediate amplifier stage may be provided as the second output.
- **Pulse Modulation or TTL Switching (Option P):** The amplifier output may be pulsed or switched ON and OFF by an external signal. This option may be used to produce a narrow pulsed output from a CW input signal, or for switching the amplifier, thus reducing the DC power consumption and the heat dissipated in the amplifier. Typical turn-on and turn-off times are 10 and 20 ns, respectively. Minimum pulse width that may be generated is 100 ns.
- **Thermal Protection (Option T):** The amplifier's internal power supply is switched off automatically if the case temperature exceeds a predetermined maximum value thus protecting the amplifier from permanent damage
- **Temperature compensation (Option C):** Compensation or correction for changes in gain due to variation in temperature may be provided for certain amplifiers as an option.
- **Phase matched (Option F):** QuinStar can supply a set of amplifiers with their output phase characteristics matched to each other.
- **Active Cooling (Option A):** Heat sink with a fan is provided to cool the amplifier to temperatures within the safe limits.
- **Power Supplies (Option S):** Power supplies that allow the operation of the amplifier using AC voltage is integrated with the amplifier in a compact package.
- **Limiter (Option L):** A limiter that protects the amplifier from damage from excessive input power is incorporated in the amplifier circuit.
- **Phase Shifter (Option B):** Digital phase shifters are integrated within the amplifiers to provide the capability of shifting the output phase in suitable increments.
- **Integral or External Isolator (Option I):** Isolators are integrated with the amplifier's input and/or output to improve the match. Isolators may be incorporated within the amplifier housing (Integral Isolators) or externally connected (External Isolators) to achieve the desired match into the amplifier's input and/or output.

## Outline J,A,B

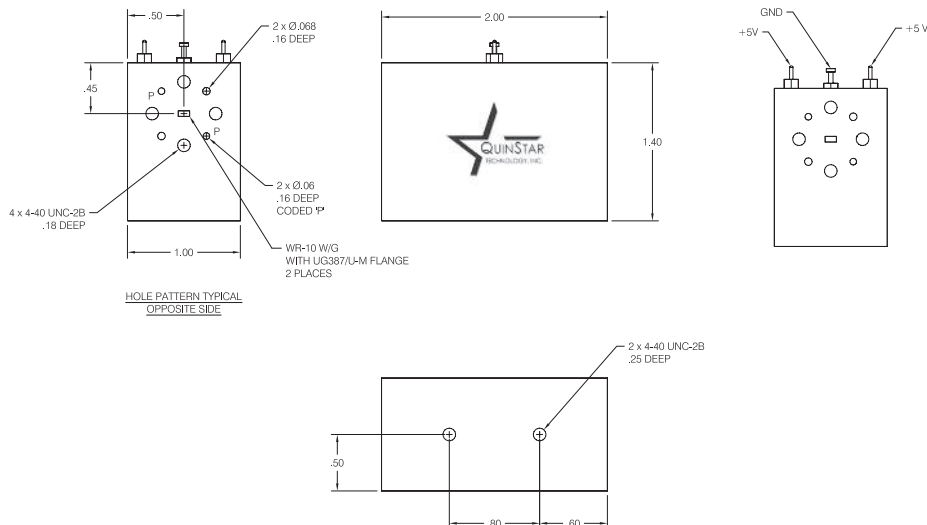


OUTLINE	C	D
J	1.50	1.35
A	2.50	1.75
B	2.50	3.00

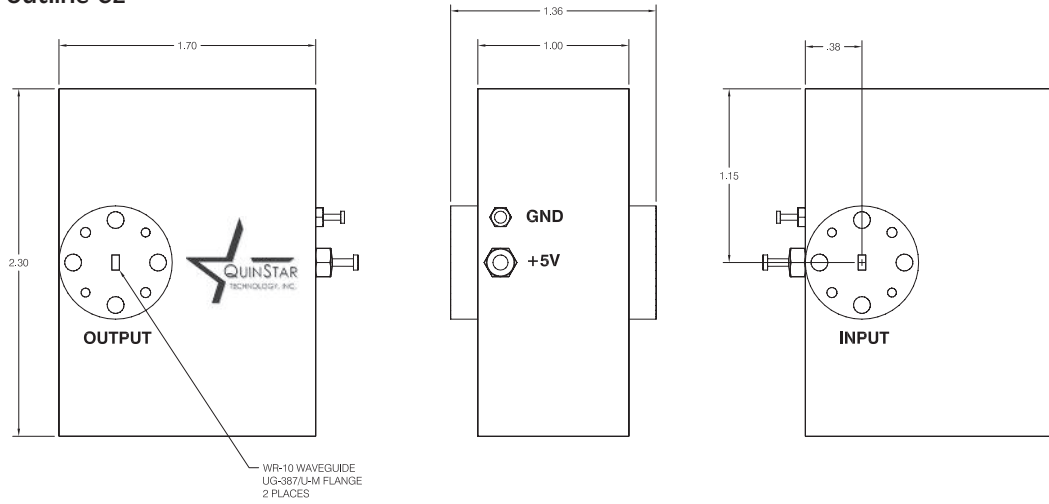
## Outline C1 (V-band)



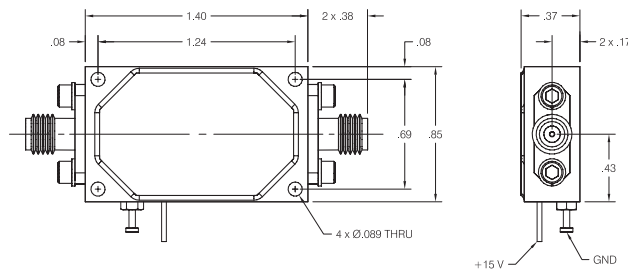
## Outline C1 (W-band)



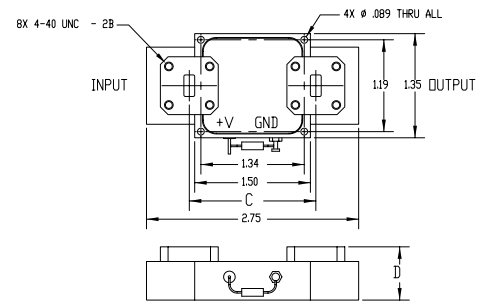
Outline C2



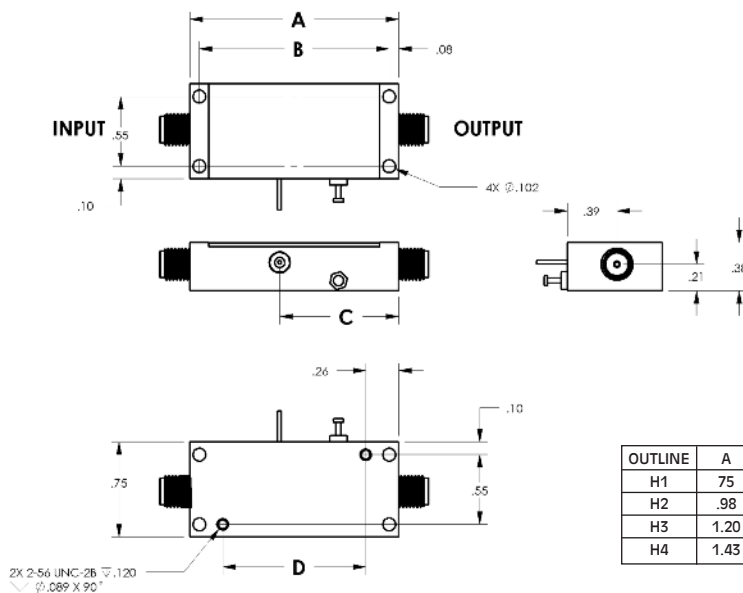
Outline D1



Outline G



Outline H

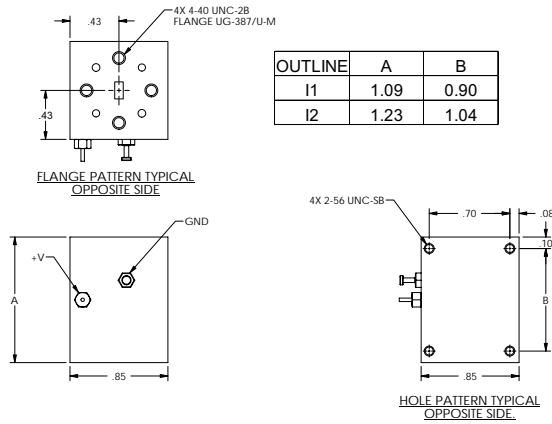


OUTLINE "G"

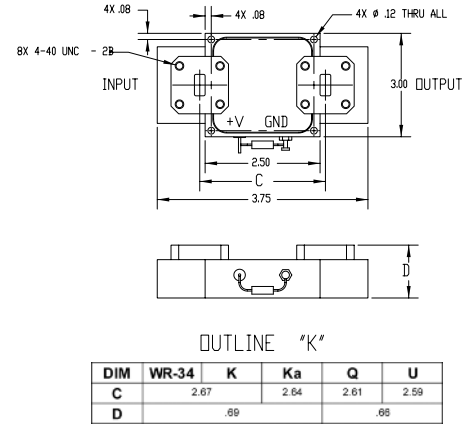
DIM	WR-34	K	Ka	Q	U
C	1.67	1.64	1.61	1.59	
D		.69		.66	

OUTLINE	A	B	C	D	REF STAGES
H1	.75	.60	.30	.25	1
H2	.98	.83	.49	.48	2
H3	1.20	1.05	.71	.70	3
H4	1.43	1.28	.71	.93	4

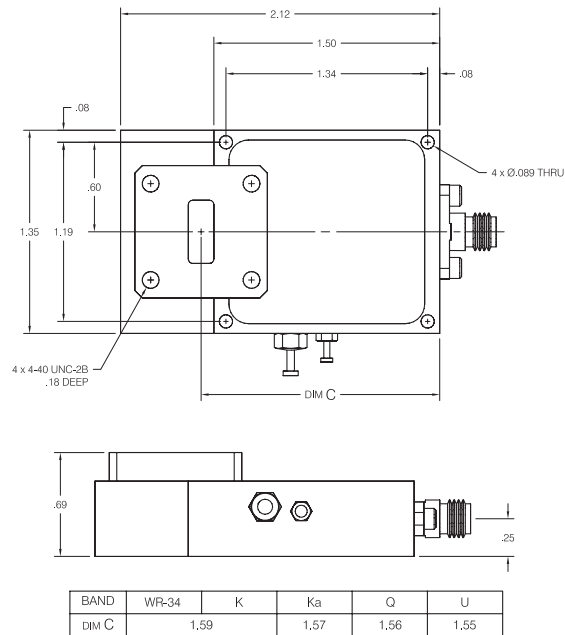
## Outline I1, I2



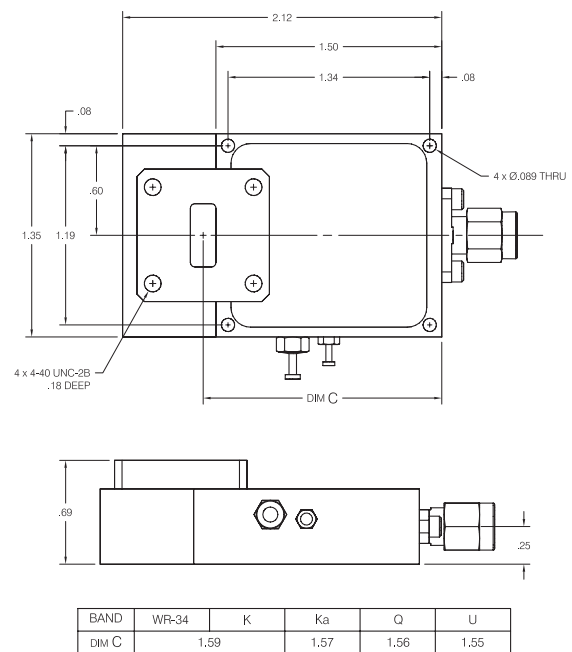
## Outline K



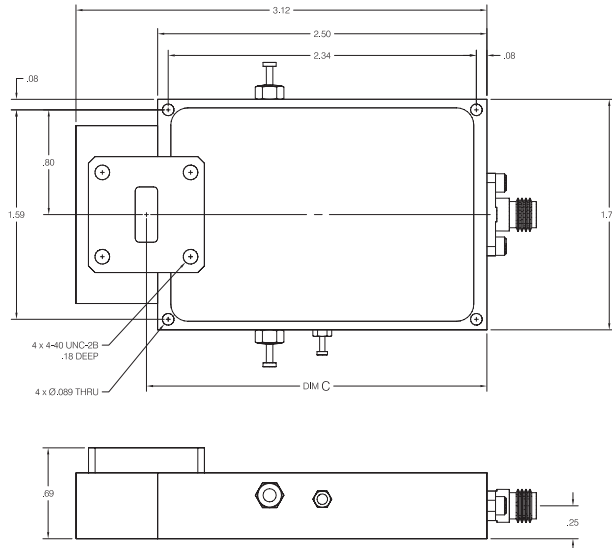
## Outline L (female)



## Outline L (male)

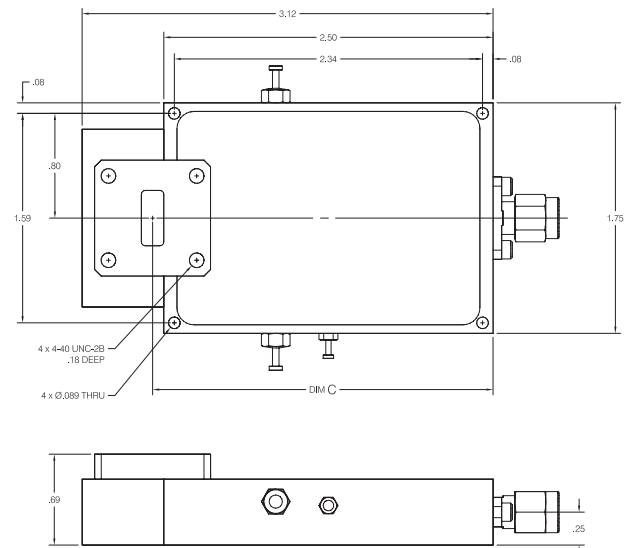


Outline M (female)



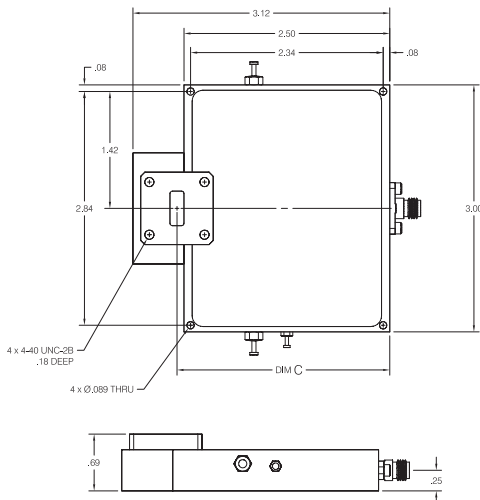
BAND	WR-34	K	Ka	Q	U
DIM C	2.59	2.57	2.56	2.55	

Outline M (male)



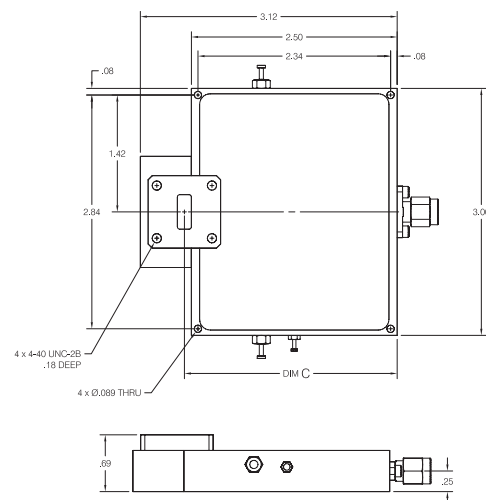
BAND	WR-34	K	Ka	Q	U
DIM C	2.59	2.57	2.56	2.55	

Outline N (female)



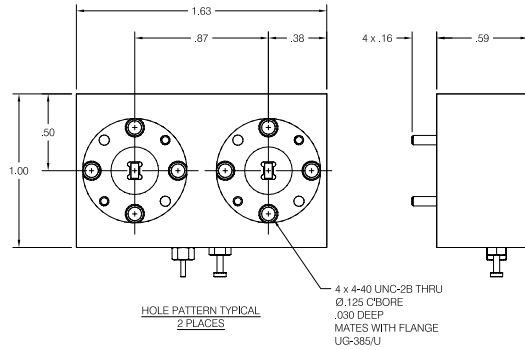
BAND	WR-34	K	Ka	Q	U
DIM C	2.59	2.57	2.56	2.55	

Outline N (male)

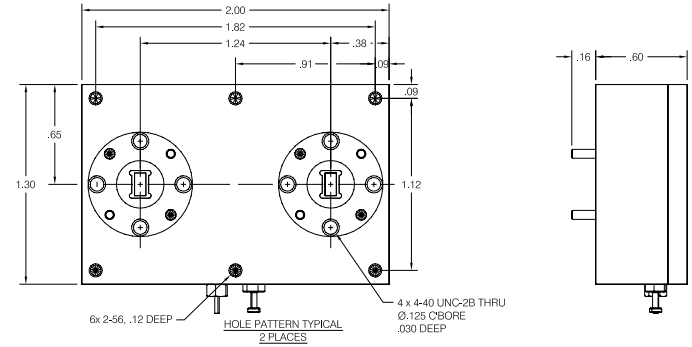


BAND	WR-34	K	Ka	Q	U
DIM C	2.59	2.57	2.56	2.55	

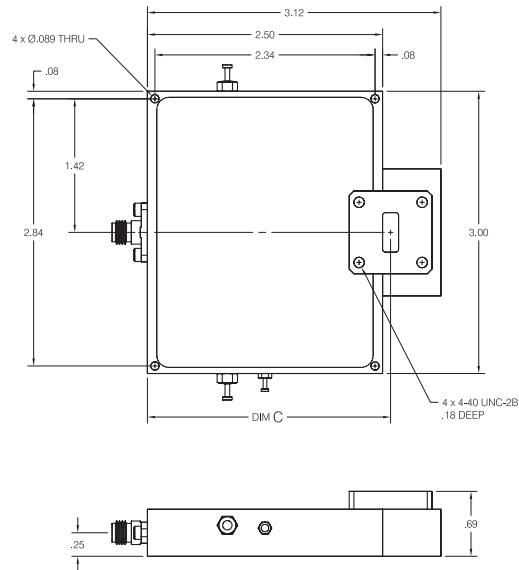
Outline P1



Outline P2

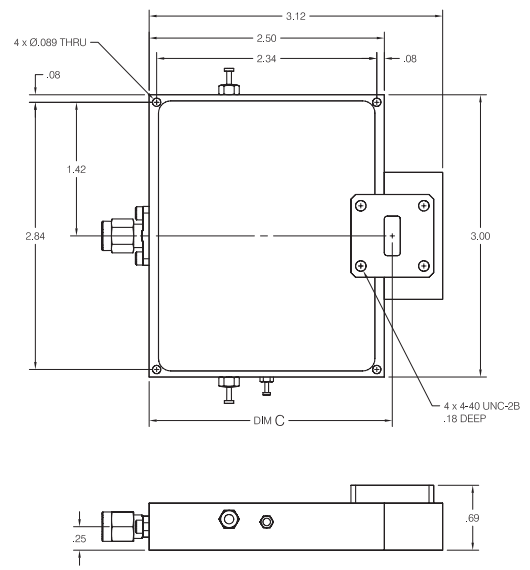


Outline Q (female)



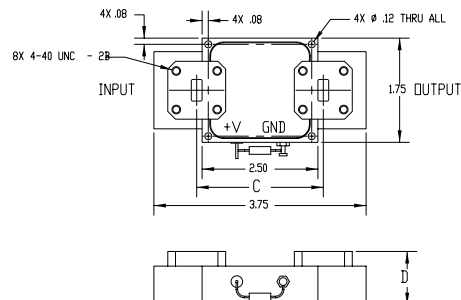
BAND	WR-34	K	Ka	Q	U
DIM C	2.59		2.57	2.56	2.55

Outline Q (male)



BAND	WR-34	K	Ka	Q	U
DIM C	2.59		2.57	2.56	2.55

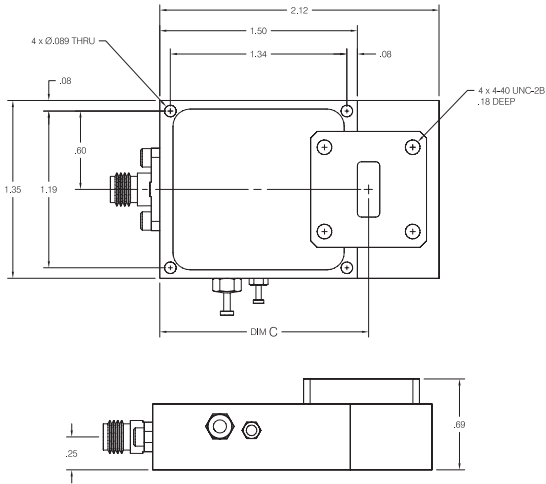
Outline R



OUTLINE "R"

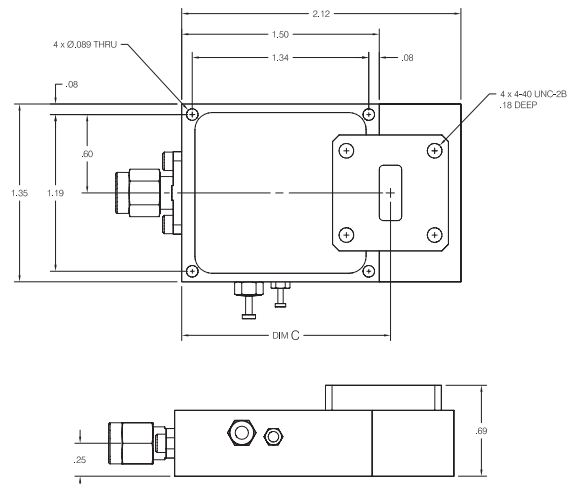
DIM	WR-34	K	Ka	Q	U
C	2.67		2.64	2.61	2.59
D		.69		.66	

Outline S (female)



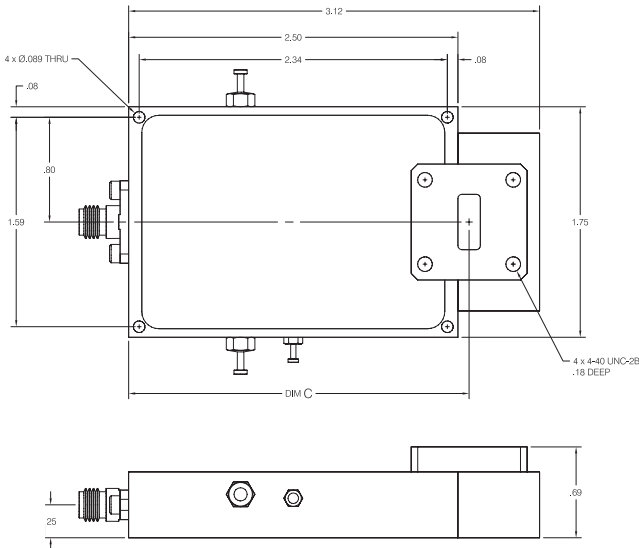
BAND	WR-34	K	Ka	Q	U
DIM C	1.59	1.57	1.56	1.55	

Outline S (male)



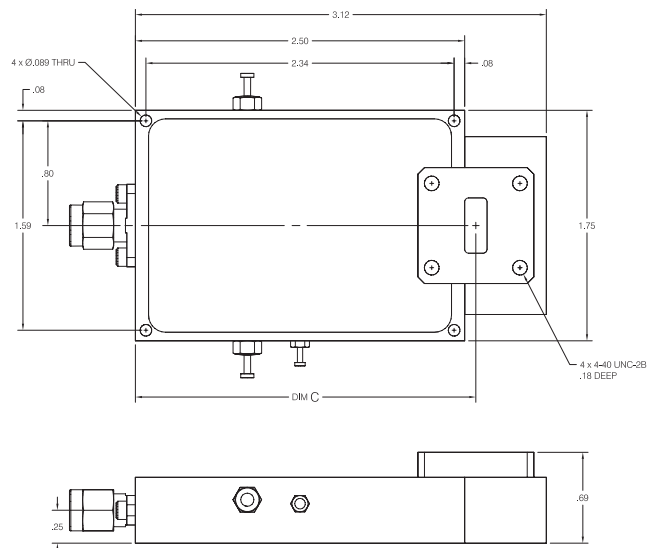
BAND	WR-34	K	Ka	Q	U
DIM C	1.59	1.57	1.56	1.55	

Outline T (female)



BAND	WR-34	K	Ka	Q	U
DIM C	2.59	2.57	2.56	2.55	

Outline T (male)



BAND	WR-34	K	Ka	Q	U
DIM C	2.59	2.57	2.56	2.55	





## Section 2

# Receiver Products

Product Title	Model No.	Page Number
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# Receiver Products

## Application Notes and Technical Information

**1 dB gain compression point.** – The dynamic range of a mixer is the range of input RF power levels (in dBm) for which the mixer produces useful IF output power. Dynamic range is limited at the low end by the noise performance of the mixer devices. When the input power is such as to produce a discernable IF output signal a constant power ratio (equal to the conversion loss) is established between input RF power and output IF power. As input power is increased, a point is reached where this constant power ratio is no longer maintained and conversion loss begins to increase. When conversion loss has increased by 1 dB, the upper limit of the mixers dynamic range is deemed to have been reached and this "1 dB compression point" generally delineates the upper level of input power for which the mixer should be used

**1 dB desensitization level** – The RF input level of an interfering signal that causes a mixer's small signal conversion loss to increase by 1 dB.

**Conversion loss (SSB)** – The ratio of RF input power to the IF output power of one sideband. If an IF amplifier is used, conversion gain may result.

**DC polarity** – The mixer IF voltage measured with only the LO operating and the RF port terminated.

**Harmonic intermodulation products** – Mixer output signals other than the desired  $f_{LO} +$  or  $-f_{RF}$ , which are harmonically related to either or both of the input signals. (Also termed NRF + or  $-MLO$ ,  $NxM$  or "spurs.")

**Isolation** – The amount an input signal is attenuated when measured at another mixer port.

### Noise Effective Power (NEP)

$$NEP = NV/R \sqrt{Hz}$$

Where NV is noise voltage in Volts/  $\sqrt{Hz}$ , and R = Responsivity in Volts/Watt

**Noise floor** =  $NEP \cdot (\text{modulation frequency})^{1/2}$  in Watts

**Noise figure (SSB)** – The ratio of the signal-to-noise ratio at the mixer input divided by the signal-to-noise ratio of one of the sidebands at the output.

**Responsivity** – The detector responsivity is the voltage produced at the output for a specific power input, usually expressed in millivolts per microwatt CW.

**Sensitivity** – The minimum input signal required to produce an output signal having a specified signal-to-noise ratio. Tangential sensitivity (TSS) typically assumes 8 dB signal-to-noise ratio.

**Spurious products** – Undesired or spurious products are generated in addition to the desired signal sidebands as a result of diode non-linearities. These products increase the amount of signal power lost, in addition to providing "false" outputs.

**Two-tone intermodulation products** – The generation of spurious output frequencies in a mixer is the result of using non-linear switching elements. Even for the single input frequency the number of such products that is generated as discernible power levels is quite large.

These products have even higher power when the input signal contains multitone components. A figure of merit indicative of the ability of a mixer to suppress such intermodulation products is the "two-tone third order

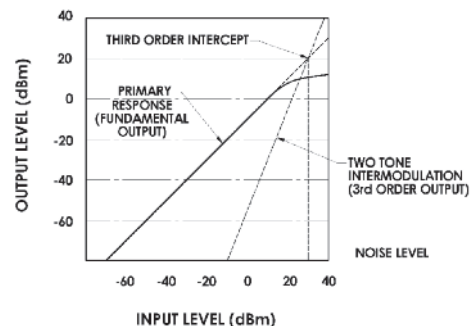
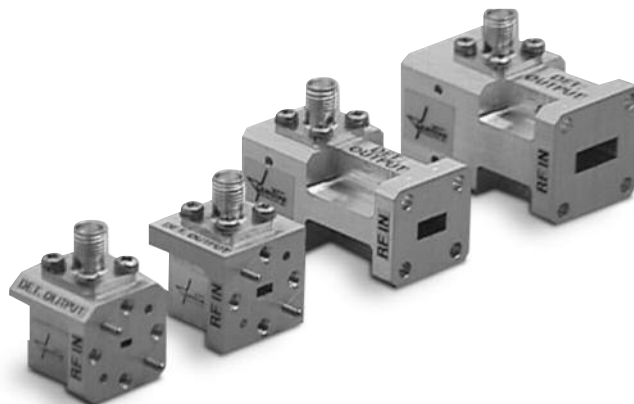


Figure 1. Two-Tone Third Order Intercept Point.

intercept point" (usually measured in dBm). See Figure 1 above. The hypothetical intercept point is arrived at by extrapolating measured data to suggest an input RF power level at which IF power and intermodulation products would be equal. Mixers with high intercept points generate low intermodulation distortion products.

### Characteristics

- ◆ Full Waveguide Bandwidths
- ◆ High Sensitivity
- ◆ No Bias Required
- ◆ Positive or Negative Output



### Product Description

QuinStar Technology's **QEA series broadband detectors** cover the frequency range of 18 to 170 GHz in nine waveguide bands. These detectors provide an output voltage which is directly proportional to the power level of an RF signal without needing any external DC bias. They are useful for power detection, monitoring, built-in-test and frequency measurement. The detectors can also be used in millimeter-wave test systems with a wide variety of

high-impedance oscilloscopes and scalar analyzers. They can be used for both CW and pulsed power measurements. They are constructed with a very rugged, reliable split-block mechanical design and are available with either positive or negative output voltage polarity. Detector adaptors for use with scalar network analyzers such as HP or Agilent 8756A are offered.

### Specifications

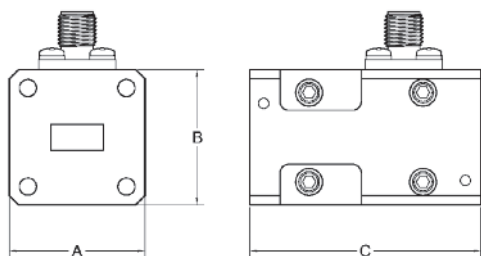
FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6
Sensitivity (mV/mW min) <sup>1,2</sup>	1000	1000	1000	800	800	500	500	250	250
Flatness (dB max) <sup>3</sup>	±1.5	±1.5	±1.5	±1.5	±1.5	±1.5	±2.0	±3.0	±3.0
Input Power (mW max)	100	100	100	100	100	100	100	50	50

<sup>1</sup> The sensitivity of QEA broadband detectors can be optimized over a narrow bandwidth if desired.

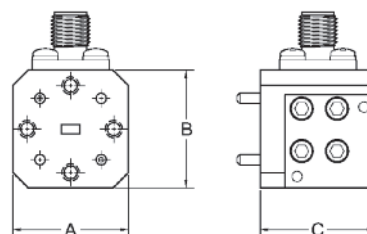
<sup>2</sup> Measured at - 10dBm input power level, into a 100 K ohm load.

<sup>3</sup> Better flatness can be achieved over reduced bandwidth

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN <sup>1</sup>	VIDEO OUTPUT	OUTLINE DIMENSIONS, inches/mm		
				A	B	C
K	WR-42	UG-595/U	SMA JACK	0.88/22.4	0.88/22.4	1.5/38.1
Ka	WR-28	UG-599/U	SMA JACK	0.75/19.1	0.75/19.1	1.5/38.1
Q	WR-22	UG-383/U <sup>1</sup>	SMA JACK	1.13/28.7	1.13/28.7	1.25/31.75
U	WR-19	UG-383/U <sup>1</sup>	SMA JACK	1.13/28.7	1.13/28.7	1.25/31.75
V	WR-15	UG-385/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1
E	WR-12	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1
W	WR-10	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1

<sup>1</sup> Square flanges available for Q and U band.

## Ordering Information

Model Number **QEA -**

**AB CD E F**

center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B0 = 110 GHz, B1 = 111 GHz, etc., FB = fullband)

bandwidth rounded to nearest GHz

(FB = fullband)

polarity \*

P = positive

N = negative

\* Detector output voltage with respect to case

waveguide band designator

K = K-band

A = Ka-band

Q = Q-band

U = U-band

V = V-band

E = E-band

W = W-band

## Characteristics

- ◆ Phase Comparison of 2 RF Signals
- ◆ High RF Isolation
- ◆ Balanced Configuration



## Product Description

QuinStar Technology's **QEP** series **balanced phase detectors** enable phase comparison of two RF signals. They utilize GaAs beam lead diodes which offer significant advantages over other detector types.

The diodes are carefully matched to achieve high isolation between RF ports, low DC offset, noise cancellation and

suppression of the adverse effect of amplitude modulation. The detected output is proportional to phase differences up to 180 degrees for two equal amplitude signals at the same frequency.

Balanced phase detectors are typically used in phase bridges and phase modulated receiver systems.

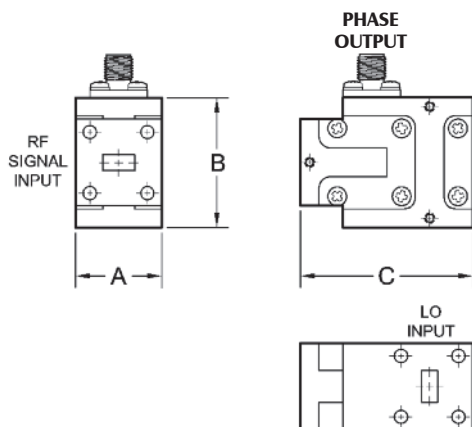
## Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Bandwidth (GHz typ)	4	4	4	4	4	4	4
Sensitivity (mV/degree, typ) <sup>1</sup>	5	5	5	5	4	3	3
RF Isolation (dB typ)	20	20	20	20	20	20	20
AM Suppression (dB typ)	20	20	20	20	20	20	20
Input Power (mW max)	100	100	100	100	100	100	100

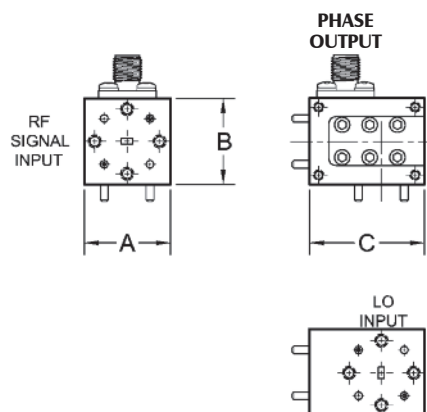
Other waveguide sizes are available.

<sup>1</sup> At 5 dBm input into each port with >100K ohm output load.

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	IF OUTPUT	OUTLINE DIMENSIONS, inches/mm		
				A	B	C
K	WR-42	UG-595/U	SMA JACK	0.88/22.4	1.13/28.7	1.89/48.0
Ka	WR-28	UG-599/U	SMA JACK	0.75/19.1	1.13/28.7	1.50/38.1
Q	WR-22	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.50/38.1
U	WR-19	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.50/38.1
V	WR-15	UG-385/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4
E	WR-12	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4
W	WR-10	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4

## Ordering Information

Model Number **QEP -**

**AB CD E 0**



Please specify exact RF frequency range when ordering.

center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B0 = 110 GHz, B1 = 111 GHz, etc., FB = fullband)

bandwidth rounded to nearest GHz

waveguide band designator

K = K-band V = V-band  
A = Ka-band E = E-band  
Q = Q-band W = W-band  
U = U-band

## Characteristics

- ◆ Optimized for Any Harmonic Number
- ◆ External Diplexer Option
- ◆ High Sensitivity
- ◆ Broad Bandwidth

## Product Description

QuinStar Technology's **QMH** series **harmonic mixers** enable downconversion of millimeter-wave signals using lower frequency (microwave) local oscillator in the 2 to 20 GHz frequency range. The downconverted intermediate frequency (IF) is in the 5 MHz to 3 GHz range. Harmonic mixing is achieved by mixing appropriate harmonic N of the local oscillator, generated by the mixer itself, with the RF signal to produce an IF typically in the 5 MHz to 3 GHz range, such that  $f_{IF} = |N \cdot f_{LO} - f_{RF}|$ . The separation of the LO and IF signals is done by an external diplexer. They cover the frequency range of 18 to 170 GHz in nine full waveguide bands. These harmonic mixers are useful for subsystem applications involving frequency sampling such as phase-locked oscillators and frequency linearizers.

They are also ideally suited for test and measurement equipment, such as spectrum analyzers, frequency counters and power meters.

Harmonic mixers can be optimized for either odd or even harmonics of the local oscillator (LO). They can also be produced to operate on all harmonics, even or odd. Series QMH harmonic mixers have a common SMA port for LO and IF signals, and hence require an external diplexer. Those mixers can be supplied with external diplexers to combine/separate LO and IF signals. Several choices of LO & IF ranges are offered as standard products. Typical LO ranges from 1.5 GHz to 20 GHz and IF from DC to 2.5 GHz.

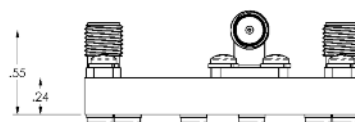
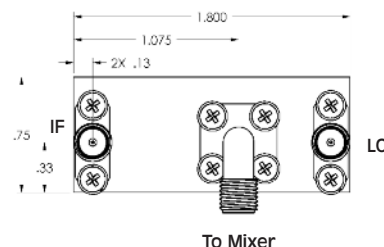
## Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6
Conversion Loss (dB typ) <sup>1</sup>	20	22	24	26	28	30	32	35	37
Minimum Detectable Signal in 1 kHz bandwidth (dBm, typ.) <sup>2</sup>	-110	-110	-105	-100	-95	-90	-85	-80	-75

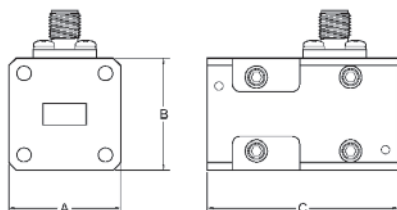
Other waveguide sizes are available.

<sup>1</sup> For 9th harmonic of LO, IF < 1 GHz. Typical LO power range is 7 to 14 dBm.

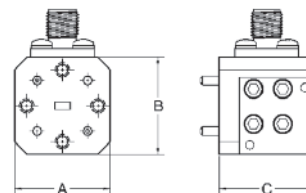
<sup>2</sup> For other harmonics, the minimum detectable signal may vary.



## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN <sup>1</sup>	LO and IF	OUTLINE DIMENSIONS, inches/mm		
				A	B	C
K	WR-42	UG-595/U	SMA JACK	0.88/22.4	0.88/22.4	1.5/38.1
Ka	WR-28	UG-599/U	SMA JACK	0.75/19.1	0.75/19.1	1.5/38.1
Q	WR-22	UG-383/U <sup>1</sup>	SMA JACK	1.13/28.7	1.13/28.7	1.25/31.75
U	WR-19	UG-383/U <sup>1</sup>	SMA JACK	1.13/28.7	1.13/28.7	1.25/31.75
V	WR-15	UG-385/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1
E	WR-12	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1
W	WR-10	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1

<sup>1</sup> Square flanges available for Q and U band.

## Ordering Information

Model Number **QMH -**

**AB CD E F GH**



Please specify exact RF and LO/IF frequency range when ordering.

RF center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B0 = 110 GHz, B1 = 111 GHz, etc., FB = fullband)

LO frequency rounded to nearest GHz

(If not fixed or defined, use XX)

harmonic number

O = odd  
E = even  
B = both

diplexer option

00 = no diplexer provided (customer to provide)  
D1 = diplexer provided IF = DC-1 GHz, LO = 1.8 to 7.5 GHz  
D2 = diplexer provided IF = DC-1 GHz, LO = 5 to 20 GHz  
D3 = diplexer provided IF = DC-2.5 GHz, LO = 5 to 20 GHz

waveguide band designator

K = K-band E = E-band  
A = Ka-band W = W-band  
Q = Q-band F = F-band  
U = U-band D = D-band  
V = V-band



# Spectrum Analyzer Mixers and Diplexers

**QMA**

## Characteristics

- ◆ Extends Spectrum Analyzer Frequency Range
- ◆ High Sensitivity
- ◆ Compatible with Many Popular Spectrum Analyzer Models



## Product Description

QuinStar Technology's **QMA** series of **spectrum analyzer mixers** facilitate the display and measurement of millimeter-wave signals using lower frequency (microwave) local oscillator signals. They cover the frequency range of 18 to 170 GHz in nine waveguide bands. These mixers are designed to operate with many popular spectrum analyzer models that have local oscillator outputs and IF inputs.

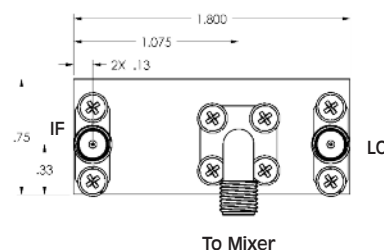
For spectrum analyzers with separate LO output and IF input ports, an optional diplexer that combines the LO and IF signals is available from QuinStar. Spectrum analyzers with built-in diplexers, such as the HP8555A, HP8565A, HP8569A, Tektronix 7L18 and Tektronix 492, do not require the diplexer option. However, the diplexer option is required for spectrum analyzers without built-in diplexers such as the HP8566A/B, HP8569B and Anritsu 710.

## Specifications

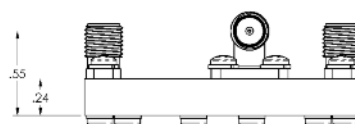
FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6
Minimum Detectable Signal in 1 kHz bandwidth (dBm, typ.) <sup>1</sup>	-110	-110	-105	-100	-95	-90	-85	-80	-75

Other waveguide sizes are available.

<sup>1</sup> For 9th harmonic of LO, IF < 1 GHz. Typical LO power range is 7 to 14 dBm. For other harmonics, the minimum detectable signal may vary



Diplexer Outline

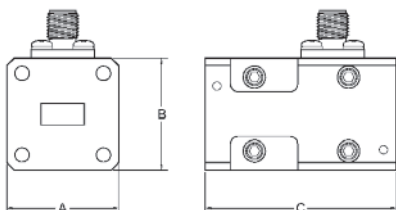




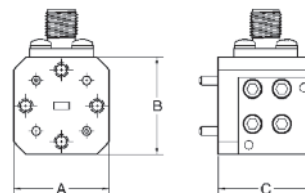
# Spectrum Analyzer Mixers and Diplexers

QMA

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	LO and IF	OUTLINE DIMENSIONS, inches/mm <sup>1</sup>		
				A	B	C
K	WR-42	UG-595/U	SMA JACK	0.88/22.4	0.88/22.4	1.5/38.1
Ka	WR-28	UG-599/U	SMA JACK	0.75/19.1	0.75/19.1	1.5/38.1
Q	WR-22	UG-383/U <sup>1</sup>	SMA JACK	1.13/28.7	1.13/28.7	1.25/31.75
U	WR-19	UG-383/U <sup>1</sup>	SMA JACK	1.13/28.7	1.13/28.7	1.25/31.75
V	WR-15	UG-385/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1
E	WR-12	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1
W	WR-10	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.1

<sup>1</sup> Dimensions do not include diplexer option.

## Ordering Information

Model Number **QMA - A B C 000**

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band

polarity \*

P = positive  
N = negative

\* Mixer bias voltage with respect to case.

diplexer option

0 = no diplexer provided by QuinStar  
D = with diplexer provided by QuinStar

### Characteristics

- ◆ Full Waveguide Band Coverage
- ◆ Low Conversion Loss
- ◆ High LO to RF Isolation
- ◆ Variety of IF Bands



### Product Description

QuinStar Technology's **QMB** series **balanced mixers** enable millimeter-wave signals to be down converted to broad IF bandwidths with a local oscillator. They are available for RF over 18-110 GHz in seven waveguide bands and operate over very broad RF, LO and IF bandwidths. For fixed LO frequency applications, a very wide IF range may

be provided if desired. The local oscillator waveguide port may be in either the same waveguide band as RF waveguide port, or in lower or higher waveguide bands (the two adjacent bands). For IF above 18 GHz, a K-connector is provided on the IF port.

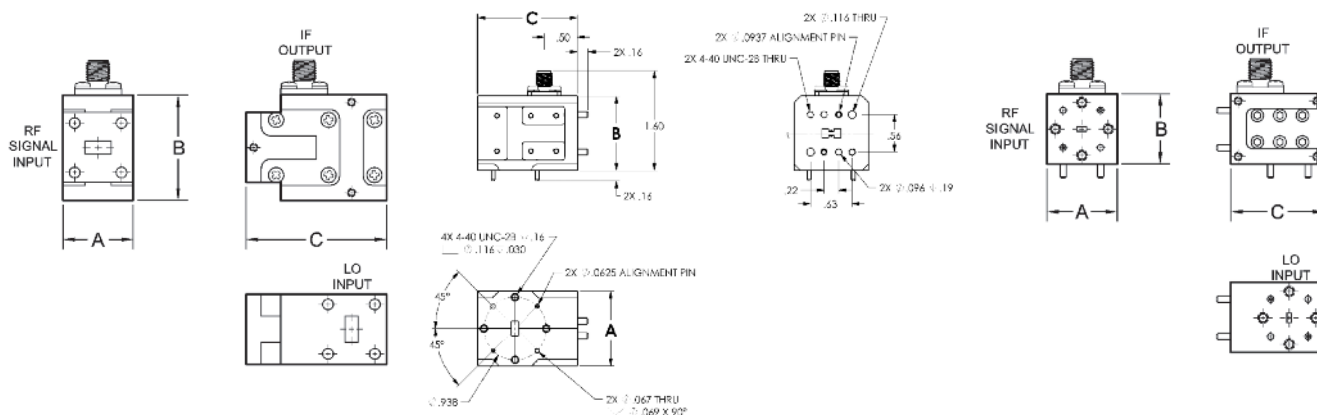
### Specifications

RF Waveguide Band		Multi-Octave	K	—	Ka	Q	U	V	E	W
RF Frequency Range (GHz)		18-40	18-26.5	22-33	26.5-40	23-50	40-60	50-75	60-90	75-110
RF Port Designation		WRD-180	WR-42	WR34	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
LO Port Options		WR-22	WR-42	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
		WR-28	SMA	WR-34	WR-22	WR-28	WR-22	WR-19	WR-15	WR-12
		K-Connector		K-Conn.	K-Conn.	WR-19	WR-15	WR-12	WR-10	WR-15
										WR-08
IF Range and Conversion Loss	IF Range (GHz)	0-5	0-5	0-5	0-5	0-5	0-5	0-5	0-5	0-5
	Conversion Loss (dB)	6.0	5.5	5.5	5.5	6.0	6.5	7.5	7.5	7.5
	IF Range (GHz)	5-17	5-12	5-12	5-14	5-17	5-20	5-25	5-30	5-35
	Conversion Loss (dB)	8.0	6.5	6.5	6.5	7.0	7.5	8.0	8.5	9.0

#### NOTES:

- 1 Local oscillators (LO) drive level required is 11.0 dBm minimum, 13 dBm typical (nominal) and 17 dBm max. for U-band and below; 15 dBm max. for V-band and above.
- 2 LO to RF isolation is typical 20 dB.
- 3 LO to IF isolation is 40 dB typical for LO above RF range and is 20 dB min. for LO below the RF range.
- 4 Conversion loss is tested at RF power level of -10 dBm

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28

WRD-180

WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	IF OUTPUT	OUTLINE DIMENSIONS, inches/mm		
				A	B	C
WRD-180	WRD-180	—	SMA JACK	1.12/28.5	1.12/28.5	1.50/29.2
K	WR-42	UG-595/U	SMA JACK	0.88/22.4	1.19/30.2	1.89/48.0
Ka	WR-28	UG-599/U	SMA JACK	0.75/19.1	1.13/28.7	1.50/38.1
Q	WR-22	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.50/38.1
U	WR-19	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.50/38.1
V	WR-15	UG-385/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4
E	WR-12	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4
W	WR-10	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4

## Ordering Information

Model Number **QMB -**

**AB CD E F**



Please specify RF, IF and LO frequencies when ordering.

RF center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc., FB = fullband)

LO frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc.)

local oscillator waveguide band

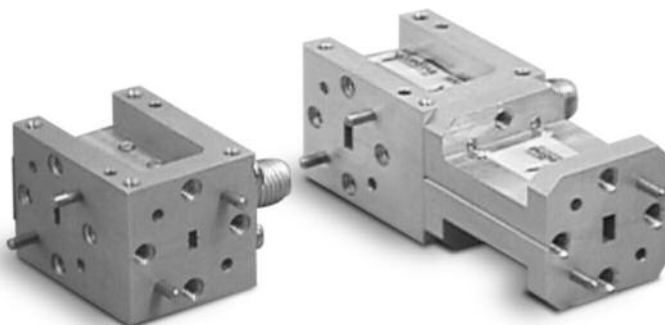
S = same waveguide band as RF  
L = lower waveguide band (next below RF)  
U = upper waveguide band (next above RF)  
C = coaxial LO input  
Z = custom

RF waveguide band designator

K = K-band      V = V-band  
A = Ka-band    E = E-band  
R = WRD-180   W = W-band  
Q = Q-band  
U = U-band

## Characteristics

- ◆ Customized RF Bandwidth
- ◆ Low Conversion Loss
- ◆ High Output Power
- ◆ Integral Filter for SSB



## Product Description

QuinStar Technology's **QMU** series **upconverters** cover the frequency range of 18 to 110 GHz in seven waveguide bands. These upconverters have a balanced mixer configuration for high LO to RF isolation. They are constructed with a rugged, split-block mechanical design that utilizes GaAs beam-lead Schottky barrier diodes.

The upconverter combines LO and IF signals and produces RF output signals at frequencies of their sum and difference, i.e.,  $LO \pm IF$ . An optional integral waveguide filter is available to produce a single-sideband output signal. Typical IF bandwidth is a few GHz, but wider bandwidth upconverters are available. The LO and IF drive power levels determine the RF output power level. Typically, a high LO power level (near 17 dBm/50 mw) is needed to produce fully saturated RF output power of

approximately 3 dBm. Conversion loss of the upconverter (defined as the difference between IF and RF output power) varies with LO drive level and IF input power. Generally, the RF output power varies linearly with IF signal below -10 dBm level, and hence conversion loss is nearly constant.

Local oscillator waveguide port may be in either the same waveguide band as RF waveguide port, or in a lower or higher waveguide band (the two adjacent bands), depending on LO frequency. The upconverter can supply several milliwatts of single-sideband output power with the proper input power levels. Upconverters are essential components in radars, communication systems and measurement instruments.

## Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Conversion Loss (dB typ) <sup>1</sup>	6-8	6-8	6-8	6-8	7-9	8-10	8-10
RF Output Power (dBm Sat. SSB)	4	4	4	4	4	3	3
Bandwidth (GHz typ) <sup>2</sup>	0.5-8.0	0.5-8.0	0.5-8.0	0.5-8.0	0.5-10.0	0.5-10.0	0.5-10.0
IF for SSB (GHz typ)	1-4	1-4	1-4	1-4	1-5	1-5	1-5
LO Input Power (dBm typ/min)	17/13	17/13	17/13	17/13	17/13	15/11	15/11
Maximum IF input Power (dBm) <sup>3</sup>	17	17	17	17	15	13	13
LO plus IF Power (dBm max)	20	20	20	20	18	16	16
LO to RF Isolation (dB typ)	30	30	0	30	30	30	30
LO to IF Isolation (dB typ)	35	35	35	35	35	35	35

Other waveguide sizes are available.

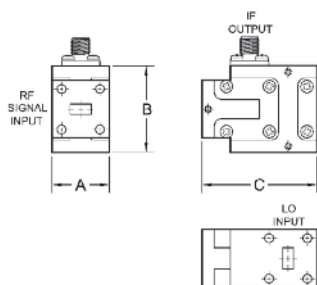
As specifications are dependent on application-specific configurations, typical ranges are tabulated.

<sup>1</sup> Conversion loss is measured at IF input power of -10 dBm.

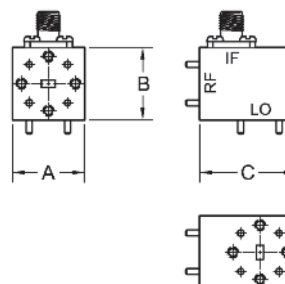
<sup>2</sup> Standard product RF/IF bandwidth is typically 2 GHz. Single sideband (SSB) upconverters must have IF band selection consistent with sideband filtering requirements. Contact QuinStar with your exact requirements to obtain an optimal solution.

<sup>3</sup> IF input power range is determined by application requirements, intermod and linearity considerations. Compression and saturation occur at high IF power levels.

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

### Double sideband version (without SSB filter)

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	BIAS INPUT	OUTLINE DIMENSIONS, inches/mm		
				A	B	C
K	WR-42	UG-595/U	SMA JACK	0.88/22.4	1.19/30.2	1.89/48.0
Ka	WR-28	UG-599/U	SMA JACK	0.75/19.1	1.13/28.7	1.50/38.1
Q	WR-22	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.50/38.1
U	WR-19	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.50/38.1
V	WR-15	UG-385/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4
E	WR-12	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4
W	WR-10	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4

Note: Filter dimensions for single sideband upconverters available upon request. Please see series QFB for approximate size.

## Ordering Information

### Model Number QMU -

**AB CD E F**



Please specify exact RF, IF and LO frequencies when ordering.

RF center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc., FB = fullband)

LO frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc.)

options

D = double sideband  
S = single sideband (filter included please specify exact sideband and LO filtering requirements)  
Z = custom

waveguide band designator

K = K-band      V = V-band  
A = Ka-band      E = E-band  
Q = Q-band      W = W-band  
U = U-band



### Characteristics

- ◆ Second and Third Harmonic of LO
- ◆ Low Conversion Loss

### Product Description

QuinStar Series QHS mixers operate at second or third harmonic of the Local Oscillator frequency with a low conversion loss. Hence, the LO frequency is either one half or one third of the RF signal in the applicable waveguide band. These mixers offer the advantage of a relatively low frequency Local Oscillator (compared to a fundamental mixer) while providing a reasonably low conversion loss and/or noise figure, typically between 9 and 15 dB. They generally operate over full waveguide RF band, and over a considerable broad LO frequency range and wide IF range. These mixers are particularly suited for applications that employ a millimeter wave low-noise amplifier (LNA) at the front end of the receiver, thus establishing a low noise figure, which is not significantly influenced by the conversion loss of the mixer that follows. Subharmonic Local Oscillators are significantly lower in cost, and can be

more readily implemented using lower frequency sources. Typical subharmonic LO power is 10-15 dBm.

QuinStar provides an external diplexer as an integral part of the Series QHS mixers. However, QuinStar can provide customized configuration to suit specific needs. These mixers may be optimized over a narrow RF range and fixed LO to achieve better conversion loss. QuinStar can also produce mixers at higher frequencies (beyond 110 GHz) for high frequency subharmonic LO receivers.

QuinStar series QHS mixers find numerous applications in frequency extenders, broadband receivers, test equipment and instrumentation, EW receivers, and MMW communication links.

### Specifications

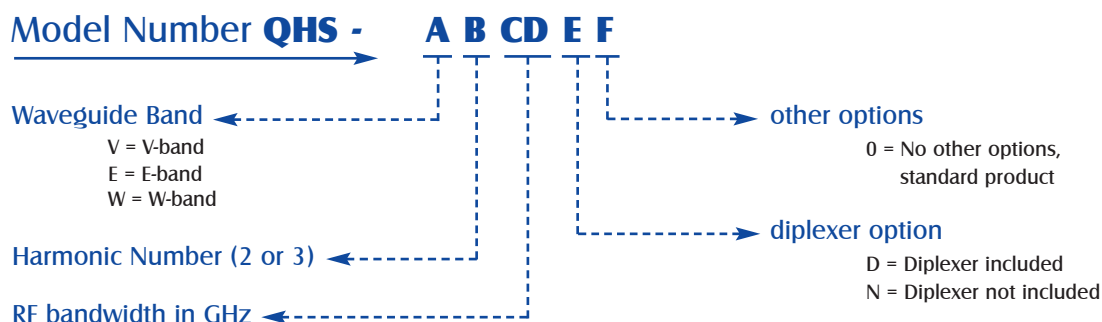
Model Number	QHS-V2	QHS-V3	QHS-E2	QHS-E3	QHS-W2	QHS-W3
Waveguide Band	WR-15	WR-15	WR-12	WR-12	WR-10	WR-10
RF Frequency Range <sup>1</sup> , GHz	50-75	50-75	60-90	60-90	75-110	75-110
LO Frequency Range <sup>2</sup> , GHz	25-37.5	16.7-25	30-45	20-30	37.5-55	25-36.7
Harmonic Number <sup>1</sup>	2	3	2	3	2	3
Conversion Loss, dB	9-15	10-17	9-15	10-17	9-16	10-18
IF Range <sup>3</sup> , GHz	0.1 to 4 GHz					

<sup>1</sup> Other harmonic numbers and RF ranges are possible. Please contact QuinStar with your exact requirements.

<sup>2</sup> Typical LO power required is between 10 and 15 dBm. Conversion loss has some dependence on LO power level.

<sup>3</sup> Higher IF frequency offered as an option.

### Ordering Information



### Characteristics

- ◆ Compact outline
- ◆ Excellent Amplitude and Phase Balance
- ◆ No DC bias required
- ◆ Usable as Image Reject Mixer or Single Sideband Upconverter

### Product Description

QuinStar Technology supplies series QMI mixer with I (in phase) and Q (quadrature phase) outputs. They are offered over the RF range of 18 to 110 GHz. These mixers utilize two balanced mixers, a 90 degree RF hybrid and an LO power splitter integrated to achieve excellent amplitude and phase balanced I-Q outputs. Using an external IF quadrature hybrid combiner, these mixers can be configured as image-reject mixers or as single-sideband upconverters. Good LO to RF isolation is achieved over a relatively broad RF and LO frequency ranges. Typical IF range is from DC to 3 GHz. Models with subharmonic LO

(local oscillator at one-half the RF frequency) can also be provided as custom products. The mechanical design of these mixers is very compact and can be customized to suit any specific application and outline requirement. Both waveguide and coaxial interfaces are offered as options for RF and LO ports.

These IQ mixers find applications in communication equipment, radar sensors, EW/ECM subsystems and instrumentation receivers.

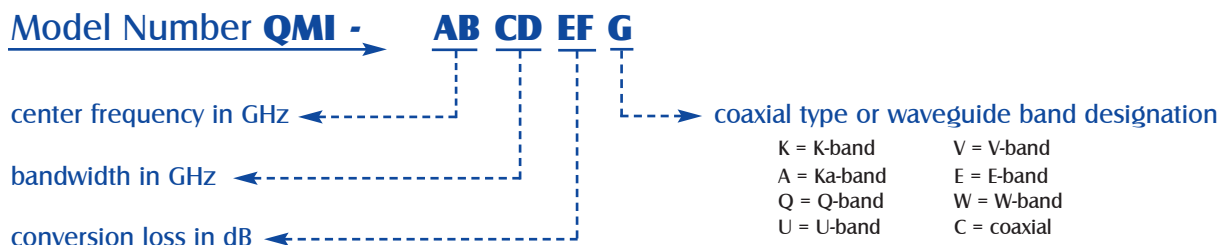
### Specifications

RF Frequency Range, GHz	Conversion Loss <sup>1</sup> , dB typ.	Amplitude imbalance, ± dB typ.	Phase Balance <sup>2</sup> degree typ.	LO to RF isolation, dB typ.
18-40	9	1	3	23
40-70	10	1	4	20
70-100	12	1.5	5	20
100-110	15	1.5	5	20

<sup>1</sup> As single-sideband mixer or upconverter.

<sup>2</sup> Error in I and Q phase difference

### Ordering Information



## Section 3

# Sources and Frequency Multipliers

Product Title	Model No.	Page Number
<b>Sources and Frequency Multipliers</b>		63
Application Notes		64
Mechanically-Tunable Gunn Oscillators	<b>QTM</b>	66
Varactor-Tunable Gunn Oscillators	<b>QTV</b>	68
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## Application Notes

**AFC (Automatic Frequency Control)** -Voltage tunability allows the user to provide an analog voltage input to the oscillator to provide "correction" tuning. This input may also be used with an external phase-locked circuit with digital inputs.

**Fixed tuning** – This type of oscillator provides a single output frequency to agreed-upon specifications. In some models, a fine tune adjustment is provided for long-term readjustment due to aging characteristics and frequency drift. The fixed tuned oscillator gives the best performance with respect to temperature stability, microphonic induced FM noise, and overall efficiency.

**Frequency stability with temperature** – The frequency drift of an oscillator with change in temperature (MHz/\_C) is a measure of its frequency stability. Various frequency stabilization techniques are provided and relate to the absolute frequency required and tuning options selected. The frequency stability of a free-running oscillator is determined by the Q of the cavity and the temperature characteristics of the materials used in the design.

**FM noise** – A.) Residual FM Noise, B.) SSB Phase Noise or C.) Phase Jitter. FM noise requirement is expressed in terms of either a total signal-to-noise ratio measured in a given bandwidth centered at some offset from the signal frequency of a signal sideband or the phase-noise-to-signal ratio per Hz bandwidth specified over a wide range of offset frequencies. Typical free-running and phase-locked noise characteristics are shown in oscillator and amplifier product capability section.

**Harmonic suppression** – The measured rejection of unwanted signals which are harmonically related to the output frequency. Measured in dBc (dB below carrier level). Harmonic band pass or low pass output filters may be added as options, if required.

**Load pulling** – Frequency pulling is the amount of frequency change as a result of change in load VSWR or phase angle associated with the VSWR. It is a measure of stability of the oscillator with external load, and is determined by the Q of the oscillator. An isolator in front of the oscillator significantly reduces load pulling, and hence, enhances the stability with load variation. Generally, all oscillators are designed to work into a load VSWR of up to 1.5:1 max., any phase. If load VSWR is greater, a load isolator should be specified.

**Mechanical tuning** – Most of the oscillator types are available with some type of mechanical tuning. Tuning types available are: (1) micrometer tuning, (2) recessed screwdriver-tuning shaft, accessible from outside of unit. All mechanical tuning methods may degrade the frequency stability, noise and microphonic performance used in the tuning mechanism. The amount of degradation depends upon the type of tuner used, the precision of tolerance, and the level of mechanical vibration and/or shock.

**Modulation rate** – The rate at which the output frequency can be modulated with an input modulation signal. The frequency tuning mechanism (voltage tuned oscillator, bias-tunable versus varactor-tunable) has a major impact on maximum modulation rate achievable.

**Phase-locked oscillator** - The output signal stability is directly related to the stability of the reference signal. The

reference signal may be external to the oscillator, or an internal crystal oscillator reference may be provided.

**Power stability vs. temperature** – The output RF power of an oscillator can vary relative to input voltage, load VSWR, temperature changes, and as a result of tuning. The change in output power only due to temperature is generally expressed in dB/deg.C, and ranges between 0.01 to 0.05 dB/deg C.

**Pushing** – Frequency pushing is the amount of frequency change proportional to change in input voltage, usually expressed in (MHz/Volt).

**Spurious responses** – Spurious frequencies are unwanted signals present at the oscillator output as a result of harmonics bias supply, phase-locked circuits, or undesirable internally generated frequencies. Spurious response is usually specified in terms of dBc (dB below output carrier).

**Tuning resolution** – The absolute instantaneous frequency to which an oscillator may be tuned or set.

**Tuning range** – Oscillators can be tuned in a number of ways: (1) fixed, (2) mechanical, (3) analog voltage (AFC), (4) digital (phaselocked types). See definitions on this page for individual tuning types.

**Voltage tuning** – Several models of oscillators are provided with a voltage tuning option. The maximum amount of voltage tuning available depends on center frequency and output power. Tuning can be achieved either through a varactor or by varying the diode bias voltage. For AFC (Automatic Frequency Control) applications, the voltage tuning provided must be wider than the free-running temperature stability of the oscillator. The effect of varactor tuning on noise or the temperature stability varies proportionally to the frequency tuning range specified.

### Glossary of Multiplier Terminology

**Bandwidth** – Frequency range over which the specifications of minimum output power will be met for a given input power level. In some cases a 3 dB bandwidth is specified, denoting the minimum frequency range over which power drops by half (3 dB) of a given fixed input power level.

**Cascading** – Arranging one multiplier to power a second multiplier for an overall frequency multiplication of the product of the two multipliers. To maintain the bandwidth of both multipliers, an isolator of the same bandwidth must be included between the two cascaded multipliers. For narrow band cascades, however, an isolator may not be necessary.

**Efficiency** – The efficiency of the conversion from the input frequency to the desired harmonic frequency. The ratio of output power to input power under specified conditions. Note that efficiency changes with input power level. Generally expressed as a percentage. Also expressed in dB as conversion loss.

**External bias** – The DC voltage and current necessary for efficient frequency multiplication is provided by a manually adjustable separate biasing box. The ability to change the biasing level of a multiplier extends the input power level range which may be used to efficiently drive the multiplier. Care must be taken whenever an external

bias connection is broken or reconnected to avoid electrostatic discharge (ESD).

**internal bias** – The DC voltage and current necessary for efficient frequency multiplication is provided internally. The voltage which is set for a particular multiplier is set for a particular input power level to that multiplier.

**Integral feedhorn** – The means by which the output power from the multiplier is launched into free space. Integral refers to the feedhorn and transition from a waveguide to feedhorn aperture being machined into the multiplier body, rather than being a separate unit. This reduces the losses associated with waveguide flanges, which can be very high for submillimeter wave connections.

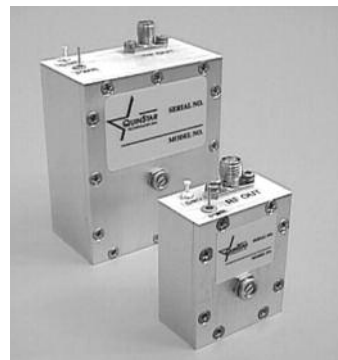
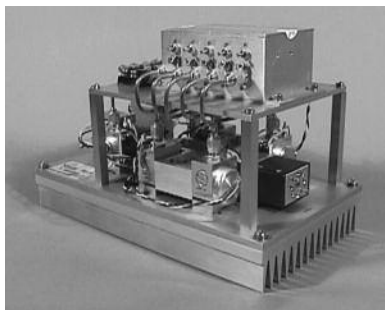
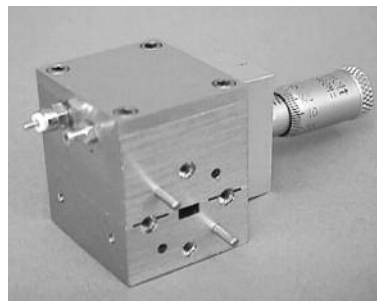
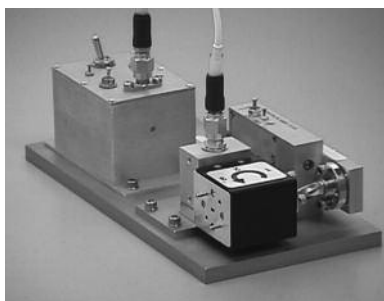
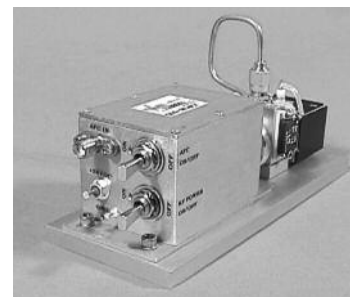
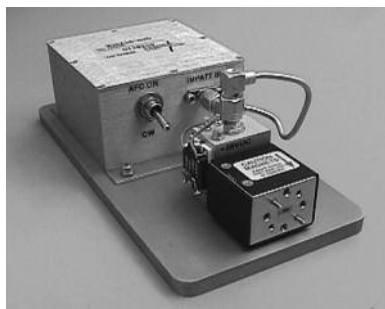
**Resistive multiplier** – A frequency multiplier which predominantly uses the resistance modulation of a diode

for harmonic generation. Resistive multipliers have wider bandwidth, but lower efficiency than varactor multipliers.

**Spurious harmonic content** – The power level at frequencies harmonic to the input, other than the desired harmonic, at the output port of a multiplier. This power level is usually expressed in dB relative to the power level of the desired harmonic frequency, as  $-X$  dBc, i.e., as  $X$  dB below the level of the carrier.

**Varactor multiplier** – A frequency multiplier which predominantly uses the capacitance modulation of a diode for harmonic generation. Varactor multipliers are higher efficiency, but narrower bandwidth than resistive multipliers.

## Millimeter Wave Sources and Subsystems





# Mechanically-Tunable Gunn Oscillators

## QTM

### Characteristics

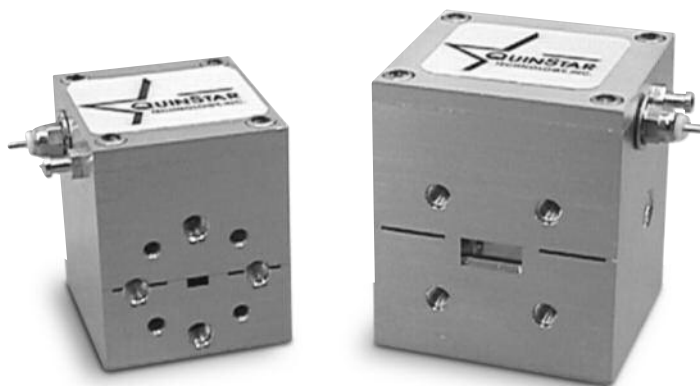
- ◆ High Output Power
- ◆ Excellent Frequency Stability
- ◆ Low AM and FM Noise

### Product Description

QuinStar Technology's **QTM** series of **mechanically-tunable Gunn oscillators** cover the frequency range of 18 to 150 GHz in nine waveguide bands. They combine a high-Q resonant circuit with either a GaAs or InP Gunn diode. Typically, InP diodes are used for high-power applications at the higher frequencies. Each oscillator has an internal low-frequency bias circuit with an oscillation suppression network and over-voltage protection. Standard units are rated over 0 to +50° C operating temperature and incorporate a screw tuner with a reliable self-locking feature. Gunn oscillators can be provided with broader

tuning ranges, higher power levels, micrometer tuners, temperature controlled heaters, integral isolators, voltage regulators, modulators and injection-locking capability. If higher power is required, QuinStar can provide an amplified version of the oscillators using power amplifiers.

Series QTM oscillators provide a small bias tuning of operating frequency. Often, bias tuning can be used in place of varactor-tuning (series QTV). Phase-locked oscillators (Series QPL) are also available.



### Specifications

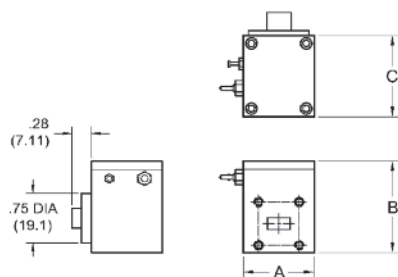
FREQUENCY BAND		K	Ka	Q	U	V	E	W	F	D
Frequency Range (GHz)		18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	100-140	130-150
Waveguide Size		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6
Output Power Range <sup>1</sup>	(mW)	10-500	10-300	10-250	10-200	10-100	10-80	10-50	1-30	1-20
	(dBm)	10-27	10-25	10-24	10-23	10-20	10-19	10-17	0-15	0-13
DC Bias Voltage Range (typ)	GaAs (volts)	5-8	5-7	5-6	5-6	3-6	3-6	3-6	—	—
	InP (volts)	—	—	6-11	6-10	6-10	8-10	8-10	8-10	8-10
DC Bias Current Range (typ)	GaAs (Amp)	0.6-2.0	0.6-2.6	0.6-2.0	0.6-2.0	0.6-1.5	0.6-1.5	0.6-1.5	—	—
	InP (Amp)	—	—	0.3	0.3	0.3	0.25	0.25	0.25	0.25
Mechanical Tuning Range (GHz) <sup>2</sup>		0.1-4	0.1-5	0.1-5	0.1-5	0.1-5	0.1-8	0.1-10	0.1-2	0.1-2
Frequency Stability (MHz/°C typ)		-1.5	-2.0	-2.5	-3.0	-4.0	-4.0	-5.0	-6.0	-6.0
Power Stability (dB/°C typ)		-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Operating Temperature		0 to 50°C								

Other waveguide sizes are available.

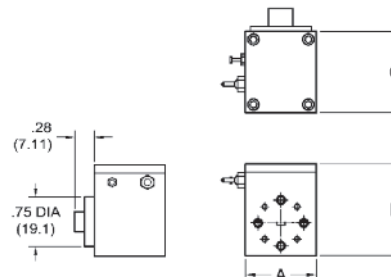
<sup>1</sup> Higher power outputs are available at selected frequencies. Amplified versions offered with significantly higher power output.

<sup>2</sup> Standard units have a minimum tuning range of  $\pm 250$  MHz. Broader mechanical tuning ranges are available.

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28

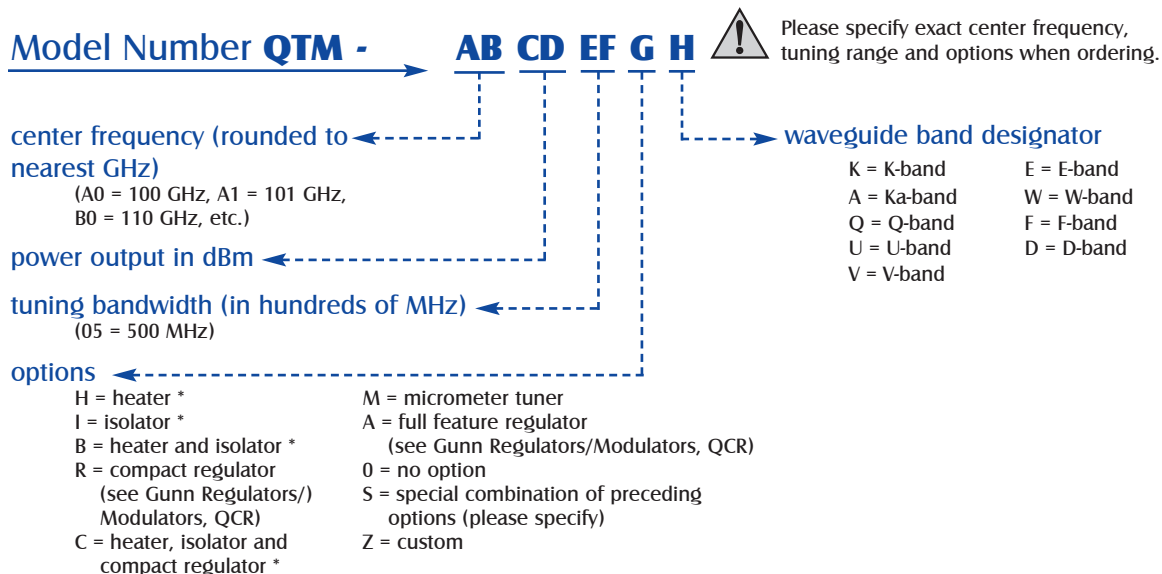


WR-22 through WR-6

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm <sup>1</sup>		
			A	B	C
K	WR-42	UG-595/U	1.13/28.7	1.38/35.1	1.00/25.4
Ka	WR-28	UG-599/U	1.13/28.7	1.38/35.1	1.00/25.4
Q	WR-22	UG-383/U	1.13/28.7	1.38/35.1	1.00/25.4
U	WR-19	UG-383/U	1.13/28.7	1.38/35.1	1.00/25.4
V	WR-15	UG-385/U	0.88/22.4	1.13/28.7	1.00/25.4
E	WR-12	UG-387/U	0.88/22.4	1.13/28.7	1.00/25.4
W	WR-10	UG-387/U	0.88/22.4	1.13/28.7	1.00/25.4
F	WR-8	UG-387/U	0.88/22.4	1.13/28.7	1.00/25.4
D	WR-6	UG-387/U	0.88/22.4	1.13/28.7	1.00/25.4

<sup>1</sup> Consult factory for exact outline dimensions if options are specified.

## Ordering Information



\* Addition of heater and isolator options reduce output power.



# Varactor-Tunable Gunn Oscillators

QTV

## Characteristics

- ◆ High Output Power
- ◆ Wide Tuning Bandwidth
- ◆ Low Phase Noise
- ◆ Optional Mechanical Tuning Capability



## Product Description

QuinStar Technology's series **QTV varactor-tunable Gunn oscillators** cover the frequency range of 18 to 110 GHz in seven waveguide bands. These oscillators combine proprietary cavity design, abrupt or hyperabrupt tuning varactor diodes and high performance Gunn diodes to produce power in the millimeter wave frequency range. Tuning voltages range from 0 to +20 VDC. The electrical tuning rate may be as high as 50 MHz (20ns per sweep).

Each oscillator has an internal low frequency suppression circuit to ensure stable RF oscillation and over-voltage protection. Mechanical tuning in addition to voltage tuning can be offered as an option. Gunn oscillators can be provided with broader tuning ranges, higher power

levels, temperature controlled heaters, integral isolators and voltage regulators.

These varactor-tunable Gunn oscillators exhibit low AM and FM noise, moderately high output power and wide tuning bandwidth, as well as monotonic tuning characteristics. These characteristics make the oscillator a unique low cost solution for most FM transmitter, local oscillator, AFC loops and phase locked subsystem applications.

For many applications, a bias tuned Gunn oscillator is adequate. Please see mechanically-tunable Gunn oscillators (series QTM) and contact QuinStar for more information.

## Specifications

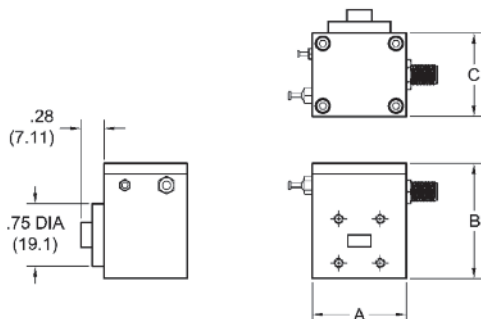
FREQUENCY BAND		K	Ka	Q	U	V	E	W
Frequency Range (GHz)		18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Output Power Range <sup>1</sup>	(mW)	10-250	10-200	10-200	10-100	10-100	10-60	10-50
	(dBm)	10-24	10-23	10-23	10-20	10-20	10-18	10-17
DC Bias Voltage Range (typ)	GaAs (volts)	5-8	5-7	5-6	5-6	3-6	3-6	3-6
	InP (volts)	---	---	6-11	6-10	6-10	8-10	8-10
DC Bias Current Range (typ)	GaAs (Amp)	0.6-2.0	0.6-2.0	0.6-2.0	0.6-2.0	0.6-1.5	0.6-1.5	0.6-1.5
	InP (Amp)	---	---	0.3	0.3	0.3	0.25	0.25
Mechanical Tuning Range (GHz) <sup>2</sup>		50-300	50-300	50-500	50-500	50-500	50-500	50-500
Frequency Stability (MHz/°C typ)		-2.0	-3.0	-4.0	-4.0	-5.0	-5.0	-6.0
Power Stability (dB/°C typ)		-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04
Operating Temperature		0 to 50°C						

Other waveguide sizes are available.

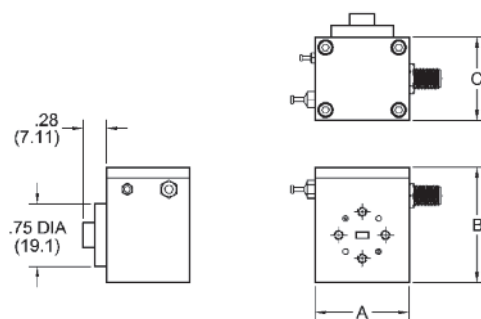
<sup>1</sup> This is the range for standard products within the band. Higher power outputs are available at selected frequencies.

<sup>2</sup> Standard units have a minimum tuning range of  $\pm 150$  MHz. Broader varactor tuning ranges are available.

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm <sup>1</sup>		
			A	B	C
K	WR-42	UG-595/U	1.13/28.7	1.38/35.1	1.00/25.4
Ka	WR-28	UG-599/U	1.13/28.7	1.38/35.1	1.00/25.4
Q	WR-22	UG-383/U	1.13/28.7	1.38/35.1	1.00/25.4
U	WR-19	UG-383/U	1.13/28.7	1.38/35.1	1.00/25.4
V	WR-15	UG-385/U	0.88/22.4	1.13/28.7	1.00/25.4
E	WR-12	UG-387/U	0.88/22.4	1.13/28.7	1.00/25.4
W	WR-10	UG-387/U	0.88/22.4	1.13/28.7	1.00/25.4

<sup>1</sup> Consult factory for exact outline dimensions if options are specified.

## Ordering Information

**Model Number QTV -**

**AB CD EF G H**



Please specify exact center frequency, tuning range and options when ordering.

center frequency (rounded to nearest GHz)

(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc.)

power output in dBm

tuning bandwidth (in hundreds of MHz)  
(03 = 300 MHz)

options

H = heater \*

I = isolator \*

B = heater and isolator \*

R = compact regulator  
(see page 70)

C = heater, isolator and compact regulator \*

M = micrometer tuner

A = full feature regulator  
(see page 70)

0 = no option

S = special combination of preceding options (please specify)

Z = custom

waveguide band designator

K = K-band

A = Ka-band

Q = Q-band

U = U-band

V = V-band

E = E-band

W = W-band

\* Addition of heater and isolator options reduce output power.



# Gunn Regulators/Modulators

## QCR

### Characteristics

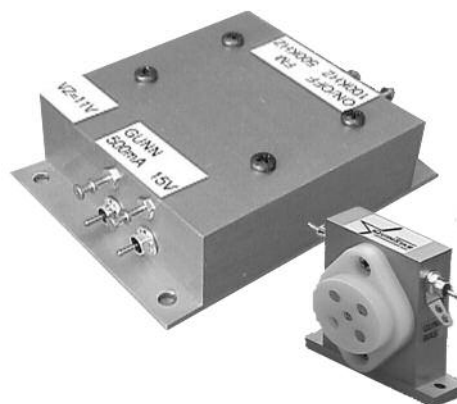
- ◆ Low Noise/Low Ripple
- ◆ Modulation Capability
- ◆ Adjustable Output Voltage

### Product Description

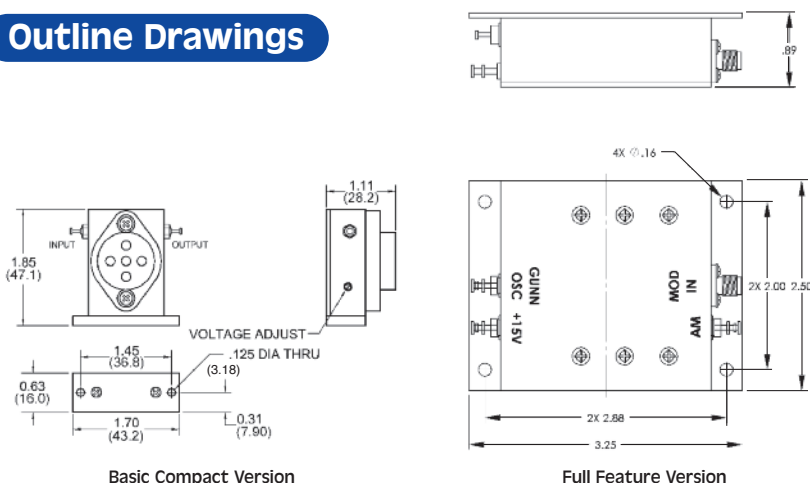
QuinStar Technology offers QCR series Gunn Bias Regulator and Modulators for providing bias voltage to Gunn oscillators in a safe and reliable manner. These are available in two configurations: the basic Compact Regulator and the Full Feature Regulator/Modulator version. The Compact Regulator provides a fixed regulated bias voltage, which may be adjusted by a screw adjustment. The Full Feature version has AM (amplitude modulation; ON/OFF) and FM (frequency modulation) capability. AM feature is used to turn the bias voltage on and off by supplying an external TTL control signal at speeds up to 10 kHz (or higher as a custom product). The FM feature allows the output Gunn bias voltage to be

continuously varied over a prescribed range by applying a signal between + 5 and - 5 volts. This may be used to change the operating frequency of the Gunn oscillator (FM) or its power level, depending on the oscillator type or application. The FM feature can also be used to phase-lock a Gunn oscillator using an external phase-lock loop or source-locking frequency counter.

Both versions provide a low-noise, low-ripple constant voltage output with capability of providing current up to a maximum of 2 amperes. They provide a significant degree of protection from power supply over-voltage and transients.



### Outline Drawings



### Ordering Information

Model Number **QCR -** **AB C D 00**

output voltage (rounded to nearest Volt) ←

version ←

C = compact (basic)  
F = full feature

options →

0 = none  
A = AM modulation  
F = FM modulation  
M = AM/FM modulation  
L = source locking capability  
Z = custom

### Characteristics

- ◆ High Power
- ◆ CW and Pulsed
- ◆ Low Parasitic Package
- ◆ Low Thermal Resistance( $R_{TH}$ )  
Diamond Heatsink



### Product Description

QuinStar Technology's **QID** series **IMPATT diodes** are high power silicon double drift diodes packaged in a low parasitic, hermetically sealed package. The diodes are mounted on a metallized diamond heatsink and copper base for efficient heat removal.

CW, long and short pulse diodes are offered and power output levels are tested over specific frequency windows.

### Specifications

CW and Long Pulse <sup>1</sup> Diodes					
Test Circuit Waveguide Band	<b>Ka</b> 26.5-40	<b>Q</b> 33-50	<b>V</b> 50-75	<b>W</b> 75-110	<b>D</b> 110-170
Test Frequency Range (GHz)	33-37	42-46	58-62	92-96	135-145
Power Outputs Available (mW typ) <sup>2</sup>	1000	800	800	400	20
Operating Voltage Range (V)	35-50	30-42	24-34	16-22	7-12
Total Capacitance at V=0 (pF)	1.0-3.0	1.0-3.0	1.2-2.5	0.7-1.5	0.7-1.0

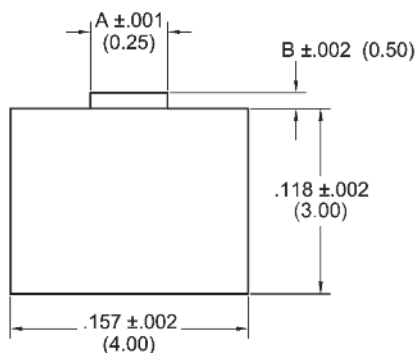
Short Pulse Diodes	
Test Circuit Waveguide Band	<b>W</b> 75-110
Test Frequency Range (GHz)	92-96
Peak Power Outputs Available (W typ) <sup>2</sup>	20
Total Capacitance at V=0 (pF)	6.0-9.0
Pulse Width (ns typ)	100

<sup>1</sup> Long Pulse: >1  $\mu$ Sec, up to 100% duty factor

<sup>2</sup> Diodes are tested to provide specified minimum power output at an unspecified single frequency in the test frequency range with estimated junction temperature not exceeding 250°C with the test fixture cavity at 50°C.



### Outline Drawing/Mechanical Specifications



FREQUENCY BAND	OUTLINE DIMENSIONS, inches/mm		
	A (CW, Long Pulse, Short Pulse)	A (Hi Power Dual Diode, (Short Pulse)	B
Ka	0.035/0.89	—	0.013/0.33
Q	0.035/0.89	—	0.013/0.33
V	0.035/0.89	—	0.013/0.33
W	0.035/0.89	0.030/0.76	0.013/0.33
D	0.018/0.45	—	0.010/0.25

### Ordering Information

Model Number **QID -** **AB CD E 0**

center frequency rounded to  
nearest GHz

(A0 = 100 GHz, A1 = 101 GHz,  
B0 = 110 GHz, etc.)

power output in dBm

diode type

C = CW and Long Pulse  
P = Short Pulse

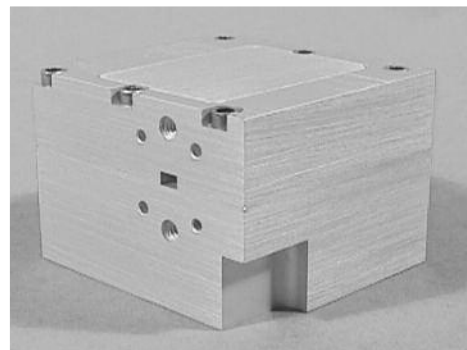


# Stable Millimeter Wave Sources

QSO

## Characteristics

- ◆ Compact Design
- ◆ Extremely Low Spurious and Harmonic Contents
- ◆ High Frequency Stability
- ◆ Excellent DC to RF Power Efficiency



## Product Description

QuinStar series QSO Stable Millimeter Wave Sources are compact, low thermal drift sources operating at customer-specified fixed frequencies in the most popular millimeter wave bands. They are ideally suited for use as local oscillators in millimeter wave receivers, and as master source or exciters in transmitters for communication and radar systems. In general, these sources are optimal solutions for applications where a phase-locked oscillator is not necessary, but relatively low drift is essential for operation or compliance. They typically demonstrate a temperature stability of operating frequency (drift) of better than 50 kHz per degree C. The other noteworthy

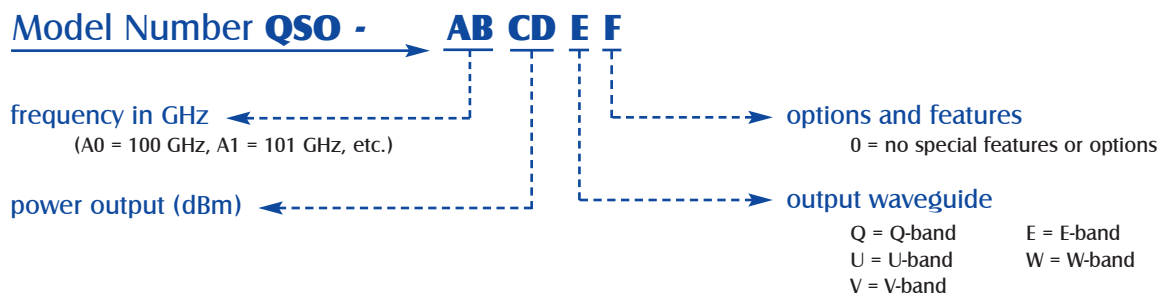
feature of these sources is the extremely low spurious signal content achieved by incorporating high performance filters in the architecture of the sources. These sources are designed to operate on a single voltage supply anywhere between 8-12 volts.

In addition to the standard products offered here, QuinStar Technology can design and build a custom stable oscillator for your specific application and requirement anywhere in the frequency range of 20-110 GHz.

## Specifications

PERFORMANCE CHARACTERISTICS	Q-BAND	V-BAND	W-BAND
Frequency Range, GHz	33-50	50-75	75-110
Power Output Range, dBm	10-17	10-16	10-12
Frequency Drift, kHz/deg. C, typical	50	50	70
Phase Noise, typical dBc/Hz at 10 kHz offset	-83	-80	-77
dBc/Hz at 100 kHz offset	-106	-103	-101
dBc/Hz at 1 MHz offset	-130	-127	-126
DC Power Consumption	8-12 V, 400 mA	8-12 V, 400 mA	8-12 V, 400 mA
Operating Temperature Range, degree C	-40 to +55	-40 to +55	-40 to +55
Size, typical, inches	1.75 x 1.75 x 2.0	1.25 x 1.25 x 1.5	1.25 x 1.25 x 1.1

## Ordering Information





# Phase Locked Sources

## QPL

### Characteristics

- ◆ Low Phase Noise
- ◆ Internal or External Reference
- ◆ High output power capability
- ◆ Compact Outline

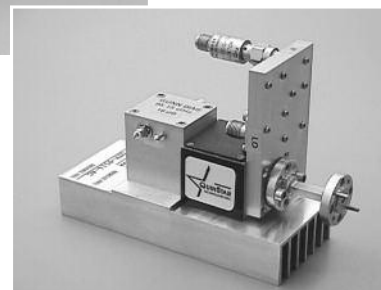
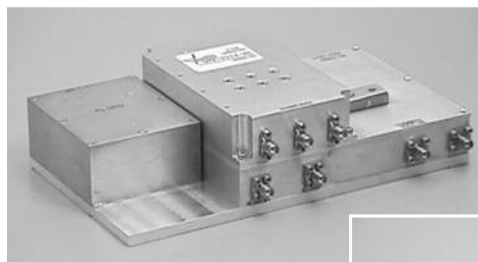
### Product Description

QuinStar Technology's QPL series Phase-Locked Sources are available over the frequency range of 6 to 150 GHz. They offer excellent performance in terms of phase noise, stability and power output. Sources with either internal crystal reference or with provision for external reference signal may be supplied. Internal references are typically between 5 MHz to 150 MHz. External reference frequency may be determined by the frequency of the phase-locked oscillator and phase noise specifications, or may be a customer-specified reference frequency depending on the application. The phase noise of these phase-locked sources at various offset values is established by a combination of reference oscillator phase noise, loop bandwidth and basic oscillator noise characteristics. Within the loop bandwidth, the phase noise is largely determined by the reference oscillator noise content. Outside the loop bandwidth, the phase noise is established by the oscillator's free-running noise characteristics. Hence, the noise characteristics of series QPL may be tailored to meet specified requirements.

The architecture and implementation scheme of these phase-locked sources depend on their operating

frequency, output power, phase noise requirements and other technical considerations. Sources could involve Dielectric Resonator Oscillators (DRO), Microwave Voltage Controlled Oscillators or Gunn Diode Oscillators and frequency multipliers, and power amplifiers as appropriate. Phase-locking technique that results in optimal performance is selected from among many available options for realizing the phase-lock loop. Lock status indicator or lock alarm is provided to indicate the locked condition of the oscillator. Frequency synthesizers and model with some frequency tuning capability are offered as custom products.

The degree of packaging of series QPL sources is determined by customer requirements. QuinStar can supply these sources with minimal packaging or mounted on a simple base plate to permit easy integration with a subsystem. Alternatively, products can be fully packaged in rugged enclosure for stand-alone use or instrumentation. A choice of power supplies is also offered to suit the application.



### Ordering Information

Model Number **QPL -**

**AB CD E F**

center frequency (GHz)

(A0 = 100 GHz, A1 = 101 GHz,  
B1 = 111 GHz, etc.)

power output (dBm)

options

S = Standard Version  
Z = Non Standard Version

reference signal

I = Internal  
E = External

## Characteristics

- ◆ Offered Over 8-110 GHz Output Frequency
- ◆ Active Amplification with Integral Filter
- ◆ Low Power Consumption



## Product Description

QuinStar Technology's series **QMM active multipliers** utilize state-of-the-art active multiplier devices for frequency multiplication and amplification over the 8-110 GHz frequency range. These frequency multipliers provide a broad bandwidth with multiplying factors between 2 and 12. The standard multiplier housing enables I/O ports of SMA (DC-26.5 GHz), 2.9 mm (DC-40 GHz) and 2.4 mm (DC-50 GHz) coaxial connectors and WR-42 through WR-10 waveguide sizes.

These multipliers are useful as part of the LO chain of communication, radar and instrumentation systems. They provide a simple and economical solution for adding signal multiplication and gain in a variety of system applications.

## Specifications

Output Frequency, Band, GHz	Multiplier Factor	Input Frequency, GHz	Output Power Range Offered, dBm <sup>1</sup>	Input Power Required dBm	Input Connector or Waveguide	Output Connector or Waveguide	Outline
8-20	2	4-10	13-27	3-6	SMA (F)	SMA (F)	J
18-26.5	2	9-13.25	13-27	5-10	SMA (F)	K (F), WR-42	J,S
26.5-40	2	13.25-20	10-20	5-10	SMA (F)	K (F), WR-28	J,S
26.5-40	3	8.83-13.33	10-20	4-6	SMA (F)	K (F), WR-28	J,S
26.5-40	4	6.62-10	10-20	3-6	SMA (F)	K (F), WR-28	J,S
33-50	2	16.5-25	10-17	0-5	K (F)	WR-22	S
33-50	3	11-16.67	10-17	5-10	SMA (F)	WR-22	S
33-50	4	8.25-12.5	10-15	5-10	SMA (F)	WR-22	S
40-60	2	20-30	10-13	5-10	K (F)	WR-19	*
40-60	3	13.3-20	10-13	5-10	SMA (F)	WR-19	*
40-60	4	10-15	10-13	5-10	SMA (F)	WR-19	*
50-75	2	25-37.5	7-16	5-8	K (F), WR-28	WR-15	*
50-75	3	16.7-25	7-16	7-10	K (F)	WR-15	*
50-75	4	12.5-18.75	7-16	5-8	SMA (F)	WR-15	*
50-75	6	8.33-12.5	7-16	4-6	SMA (F)	WR-15	*
50-75	8	6.25-9.38	7-16	4-6	SMA (F)	WR-15	*
60-90	2	30-45	0-5	5-8	K (F), WR-22	WR-12	*
60-90	3	20-30	0-5	5-8	K (F)	WR-12	*
60-90	4	15-22.5	0-5	5-8	SMA (F)	WR-12	*
60-90	6	10-15	0-5	5-8	SMA (F)	WR-12	*
60-90	8	7.5-11.25	0-5	5-8	SMA (F)	WR-12	*
70-86	2	35-39	12-17	5-8	K (F)	WR-12	W
70-86	3	23.33-26	12-17	5-8	K (F)	WR-12	W
70-86	4	17.5-19.5	12-17	5-8	SMA (F)	WR-12	W
92-96	2	46-48	7-20	-2-0	K (F), 2.4 mm	WR-10	W
92-96	3	30.67-32	7-20	5-8	K (F)	WR-10	W
92-96	4	23-24	7-20	5-8	SMA (F)	WR-10	W
92-96	6	15.33-16	7-20	5-8	SMA (F)	WR-10	W
92-96	8	11.5-12	7-20	0-5	SMA (F)	WR-10	W
92-96	12	7.67-8	7-20	0-5	SMA (F)	WR-10	W



# Active Frequency Multipliers

## QMM

### Specifications

Output Frequency, Band, GHz	Multiplier Factor	Input Frequency, GHz	Output Power Range Offered, dBm <sup>1</sup>	Input Power Required dBm	Input Connector or Waveguide	Output Connector or Waveguide	Outline
75-110	2	37.5-55	7-10	5-10	1.85 mm, WR-19	WR-10	*
75-110	3	25-36.67	7-10	5-10	K (F), WR-28	WR-10	*
75-110	4	18.75-27.5	7-10	5-10	K (F), WR-42	WR-10	*
75-110	6	12.5-18.33	7-10	5-10	SMA (F)	WR-10	*
75-110	8	9.38-13.75	7-10	5-10	SMA (F)	WR-10	*
75-110	12	6.25-9.17	7-10	5-10	SMA (F)	WR-10	*

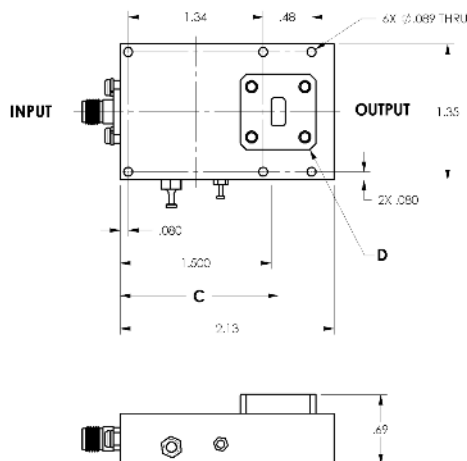
\* Please contact Quinstar for outline information.

<sup>1</sup> Range of power levels available over the full frequency band. Higher power levels available over narrower band input.

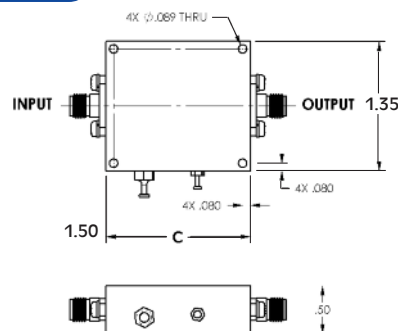
### Outline Drawings/Mechanical Specifications

Outline S

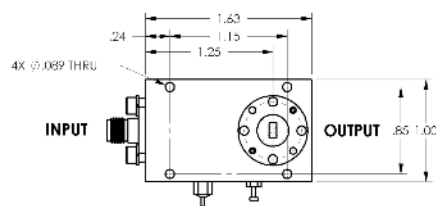
BAND	C	D
K	1.59	UG-595/U
Ka	1.57	UG-599/U
Q	1.56	UG-383/U
U	1.55	UG-383/U MOD



Outline J



Outline W



### Ordering Information

Model Number **QMM -**

**AB CD EF GH I**



Please specify exact output frequency range when ordering.

output center frequency (rounded to nearest GHz)

bandwidth, in GHz

power output in dBm

outline drawing (see above)

Z = non-standard

multiplying factor

02 = x2, 03 = x3, 04 = x4  
12 = 12



# Passive Frequency Multipliers

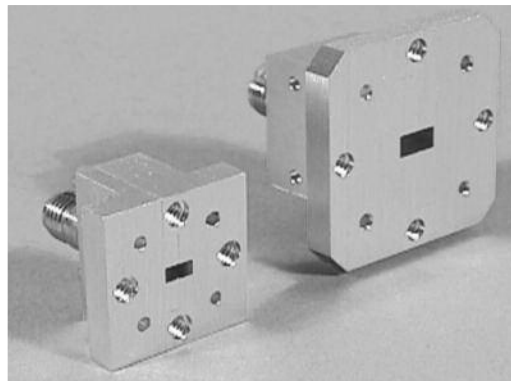
## QPM

### Characteristics

- ◆ No External Bias Required
- ◆ Full Waveguide Bandwidth
- ◆ Low Conversion Loss

### Product Description

QuinStar Technology's **QPM** series of **passive multipliers** cover the output frequency range of 18 to 110 GHz. The design enhances either even or odd harmonics while suppressing unwanted odd or even harmonics. No external bias is required providing flexibility for system implementation. Standard units are rated over the 0 to +50°C operating temperature range with a maximum



input power of +22 dBm. Standard RF interfaces are SMA or K female coaxial for the input and waveguide for the output. Other RF interface configurations are available.

QuinStar can provide higher output power over narrower bandwidth. QuinStar also produces series QMM Active Multipliers over 18-110 GHz.

### Specifications

Output Waveguide Band	Output Frequency Range, GHz	Multiplication Factor	Input Frequency Range, GHz	Input Power Level <sup>1</sup> , dBm	Output Power Level <sup>1</sup> , dBm min	Output Waveguide	Input Connector or Waveguide <sup>2</sup>
K	18-26.5	2	9.0-13.25	20	8	WR-42	SMA
Ka	26.5-40	2	13.25-20.0	20	8	WR-28	SMA
Ka	26.5-40	3	8.67-13.33	20	5	WR-28	SMA
Q	33-50	2	16.5-25	20	8	WR-22	SMA
Q	33-50	3	11-16.67	20	3	WR-22	SMA
U	40-60	2	20-30	20	7	WR-19	K (F)
U	40-60	3	13.33-20	20	3	WR-19	SMA
V	50-75	2	25-37.5	20	5	WR-15	K (F), WR-28
V	50-75	3	16.67-25	20	3	WR-15	K (F)
E	60-90	2	30-45	20	3	WR-12	K (F), WR-22
E	60-90	3	20-30	20	3	WR-12	K (F)
W	75-110	2	37.5-55	18	2	WR-10	V (F), WR-19
W	75-110	3	25-36.67	20	0	WR-10	K (F), WR-28

<sup>1</sup> Typical optimum input power level. Output power saturates at around this level. Lower input power produces lower output power in non-linear fashion. Maximum safe power level is typically 2 dB higher. Higher output power available over narrower range.

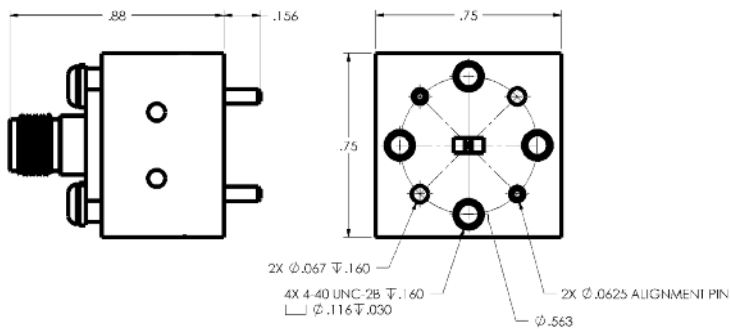
<sup>2</sup> Other Waveguide or connectors available as custom products. Please contact QuinStar.

<sup>3</sup> Outline Drawings available upon request.

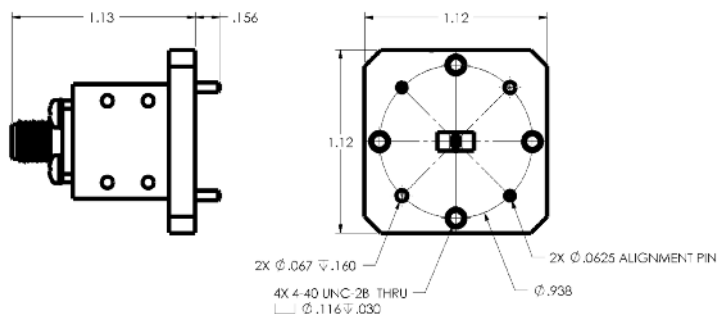


# Passive Frequency Multipliers

## QPM



V-Band Doubler



Q-Band Doubler

## Ordering Information

Model Number **QPM** -

output center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc.)

power output in dBm

**AB CD E F**

output waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band

V = V-band  
E = E-band  
W = W-band

multiplying factor

2 = x2

3 = x3

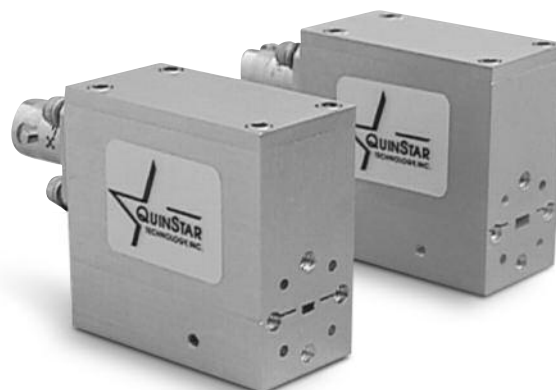
## Characteristics

- ◆ Broadband Coverage
- ◆ High Noise Power Output
- ◆ Compatible with Most Noise Figure Meters
- ◆ Fast Rise/Fall Time

## Product Description

QuinStar Technology's **QNS** series of **millimeter-wave noise sources** cover the frequency range of 18 to 110 GHz in seven waveguide bands with up to full standard waveguide band coverage. They feature stable noise power output, high switching speed and relatively flat high output power. Careful device selection, special cavity design and matching circuits have all contributed to a reliable design that is highly stable with time and over temperature.

The noise output power of these noise sources is specified in terms of **excess noise power ratio** (ENR) as a function of frequency. QuinStar Technology offers three versions of these noise sources to suit virtually any application. Full waveguide band noise sources are offered for use with Noise Figure Meters. These models provide very flat ENR (nominally 15 dB) over complete standard waveguide bands in the 18 to 110 GHz region. Higher power noise



sources offer amplified output power (ranging from 20 to 30 dB ENR) over the 18 to 110 GHz frequency range. Narrowband versions with high output power are offered for subsystem applications and special test equipment. These nominally offer 1 to 2 GHz bandwidth with excellent flatness and stable characteristics. An integral isolator is offered as an option for improved VSWR. QuinStar can readily provide a custom-designed noise source to suit unique applications or subsystem requirements.

Series QNS noise sources are ideally suited for measuring noise figure of amplifiers and receivers using the most currently available noise figure meters and eliminate the need for gas tubes. They are also well suited for calibration and built-in test functions in many sensitive receiver subsystems, radiometers and measurement instruments.

## Specifications

Frequency Range (GHz)		18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Output Waveguide Size		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Excess Noise Ratio (ENR) (dB typ)	Instrumentation Sources (Fullband Version) <sup>1</sup>	15	15	15	15	15	15	12
	Amplified Noise Power Sources (Broadband Version) <sup>2</sup>	20-30	20-30	20-30	20-30	20-30	20-30	20-30
	High Power Sources (Narrowband Version) <sup>3</sup>	25	23	21	20	20	17	15
Output Power Flatness (dB typ)	Instrumentation Sources (Fullband Version) <sup>1</sup>	±1	±1	±1	±1	±2	±3	±3
	Amplified Noise Power Sources (Broadband Version) <sup>2</sup>	±1.5	±2.0	±2.5	±2.5	±2.5	±2.5	±2.5
	High Power Sources (Narrowband Version) <sup>3</sup>	±0.5	±0.5	±1	±1	±1	±1	±1
Stability of Noise Power Output for All Models (typ)	Temperature Stability, dB/°C typ.	0.01	0.01	0.01	0.01	0.015	0.015	0.015
	Stability With Bias Voltage, dB/1% Bias Voltage Change <sup>4</sup>	0.1	0.1	0.1	0.1	0.15	0.15	0.15

<sup>1</sup> Fullband coverage. Other waveguide bands are available.

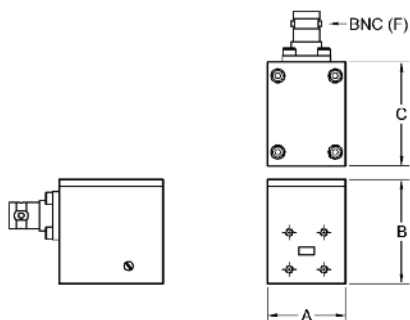
<sup>2</sup> Fullband up to 40 GHz, any 10 GHz band within the 40-110 GHz range.

<sup>3</sup> 2 GHz bandwidth anywhere in waveguide band.

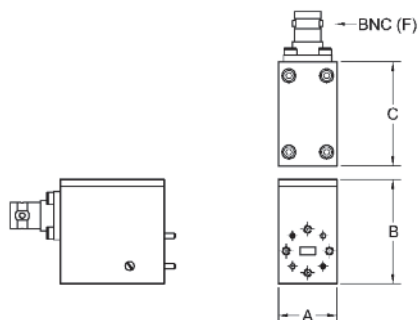
<sup>4</sup> Operating voltage 28 VDC (optional 15 VDC).



### Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm		
			A	B	C
K	WR-42	UG-595/U	0.88/22.4	1.72/43.7	1.44/36.6
Ka	WR-28	UG599/U	0.75/19.0	1.55/39.4	1.30/33.0
Q	WR-22	UG383/U	1.13/28.7	1.50/38.1	1.31/33.3
U	WR-19	UG383/U-M	1.13/28.7	1.50/38.1	1.31/33.3
V	WR-15	UG385/U	0.76/19.3	1.50/38.1	1.50/38.1
E	WR-12	UG387/U	0.76/19.3	1.50/38.1	1.50/38.1
W	WR-10	UG387/U-M	0.76/19.3	1.50/38.1	1.50/38.1

### Ordering Information

Model Number **QNS -**

**AB CD E F**



Please specify exact frequency range when ordering.

frequency

Fullband: FB

Narrowband: center frequency rounded to nearest GHz (A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc.)

waveguide band designator

K = K-band

A = Ka-band

Q = Q-band

U = U-band

V = V-band

E = E-band

W = W-band

excess noise ratio (ENR) in dB

version

T = instrumentation version (fullband) without isolator

E = amplified power version without isolator

M = narrowband, high power version without isolator

L = instrumentation version (fullband) with isolator

P = amplified power version with isolator

N = narrowband, high power version with isolator

Z = custom

## Characteristics

- ◆ Output frequencies up to 110 GHz
- ◆ Broadband and Sweepable
- ◆ Excellent Power flatness

## Product Description

QuinStar Technology's series QBE Frequency Extenders utilize a chain of passive or active frequency multipliers, amplifiers and filters to extend microwave signal generators to cover frequency ranges of 18 to 110 GHz. These extenders also extend the operation of microwave network analyzers, sweepers and synthesizers operating in the 2-20 GHz range to millimeter wave frequencies in the 18 to 110 GHz range. Frequency multiplication factors of 2 to 12 are available, and use of waveguide filters guarantees low spurious levels and very low harmonics of the microwave signal. Models covering full waveguide bands with input power of 10 dBm are offered as standard products. Also, models with higher output power levels up to 20 dBm are available over full or partial bands.



Series QBE Frequency Extenders are packaged in a rugged enclosure typically with a coaxial SMA-F or K connector input and a waveguide output. However, these can be provided with the entire assembly mounted on a baseplate.

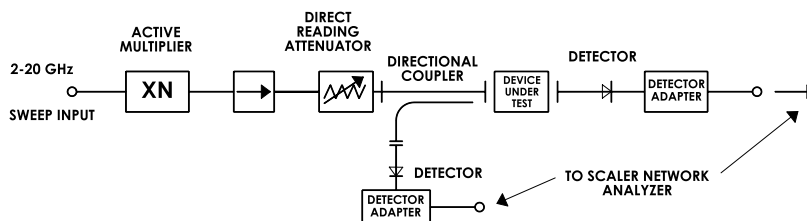
Frequency Extenders can be readily combined with QuinStar's full-band isolators, direct reading attenuators, directional couplers and broadband detectors to economically extend the operating frequency range of microwave scalar network analyzers to millimeter waves in the 18 to 110 GHz region.

## Specifications

OUTPUT FREQUENCY BAND	K	Ka	Q	U	V	E	W
<b>Multiplying Factor</b>	2	2-4	2-6	2-8	2-8	2-12	2-12
<b>Input Power Range (dBm)</b>	10-20	10-20	10-20	10-20	10-20	10-20	10-20
<b>Output Frequency Range (GHz)</b>	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
<b>Fullband Output Power (dBm min)</b>	20	20	17	13	16	2	10
<b>Narrowband Output Power (dBm min) <sup>1</sup></b>	27	23	20	17	18	17	20
<b>Input Connector</b>	SMA	SMA	SMA	SMA	SMA or K	SMA or K	SMA or K
<b>Output Waveguide Size</b>	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10

Other frequency bands and input and output interfaces are available.

<sup>1</sup> Typical bandwidth 2 GHz. Larger bandwidth available. Please contact QuinStar for power output level for moderate bandwidth versions.



**SCALAR NETWORK ANALYZER EXTENDER**



# Frequency Extenders

## QBE

### Ordering Information

Model Number **QBE -**

**AB CD E FG H**



Please specify exact frequency range when ordering.

frequency

Fullband: FB

Narrowband: center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz,

B1 = 111 GHz, etc.

power output in dBm

custom options

multiplying factor (between 2 and 12)

waveguide band designator

K = K-band

A = Ka-band

Q = Q-band

U = U-band

V = V-band

E = E-band

W = W-band



## Section 4

# Control Components and Ferrite Products

Product Title	Model No.	Page Number
<b>Control Components and Ferrite Products</b>		83
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Precision Junction Circulators and Isolators	<b>QJY/QJI</b>	85
Fullband Junction Circulators and Isolators	<b>QJE/QJF</b>	87
Fullband Isolators	<b>QIF</b>	89
Cryogenic Circulators & Isolators	<b>QCY/QCI</b>	91
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## Glossary of Control Component Terminology

**1 dB gain compression point** – As RF signal input level to a phase modulator is increased, output should follow in a linear manner. However, after a certain point, output signal level increases at a lower rate until the modulator output level becomes fairly constant. The RF input level for which the output level deviates from linearity by 1 dB is the “1 dB compression point.”

**Amplitude imbalance** – Amplitude unbalance is a measure of the worst-case variation in insertion loss between the states in a modulator. For a demodulator, amplitude imbalance is the difference of the I and Q power. Amplitude Imbalance =  $PI(dBm) - PQ(dBm)$ .

**Attenuation** – This is the amount by which the input signal is decreased when the PIN diodes are fully biased (in other words, when maximum current is drawn). It is also often termed “isolation” of a PIN switch.

**Carrier rejection** – The amount of carrier measured in dB below the desired output signal when a coherent signal of equal amplitude and 90 degrees phase difference is applied to the I&Q ports. This is shown in **Figure 1** below.  $f_c$  &  $f_i$  are the carrier and IF (I-port/Q-port) frequencies, respectively. This also applies to biphase modulators

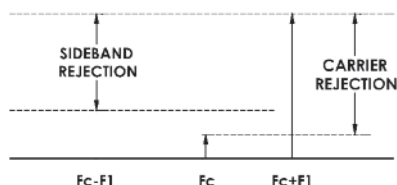


Figure 1. Carrier Rejection.

**Conversion loss** – For a modulator, conversion loss (C.L.), in dB, is defined as below:

**C.L.(dB) = Input(I+Q) Power – Output RF Power of the dominant sideband.**

For a demodulator, it is defined as:

**C.L.(dB) = RF Input Power – (I+Q) Output Power.**

**Harmonic suppression** – In a modulator, besides the undesired sideband and carrier, harmonic products of the IF combine with the carrier to produce undesired signals at RF as below:

$$f_c \pm n f_i$$

The most important products are the third and fifth,  $f_c \pm 3f_i$  and  $f_c \pm 5f_i$  since they are very close to the desired sideband and almost impossible to filter. For a demodulator, the harmonic products of interest are  $n f_i$ . The products of most interest are  $n = 3$  and  $n = 5$ .

**I & Q.** In-phase and quadrature-phase components of output.

**Insertion loss** – This loss figure is the minimum amount of attenuation when the bias current is zero and the PIN diodes are off. The loss is made up of any device losses and the individual insertion losses of the circuit. The insertion loss of a phase modulator is measured statically in one of the possible states and represents the worst-case loss for any state. For QPSK modulators, the insertion loss is 6 dB typically.

**Phase imbalance** – Phase imbalance is a measure of the offset from the desired carrier phase relative to the actual phase shift in any of the possible phase states. This is measured with respect to a reference or 0 degree phase state. The deviation from 90 degrees of the phase angle difference of the I&Q port output signals.

**Quadrature phase shift keying modulator** – Quadrature phase shift keying (QPSK) modulators are four-port devices with RF-in, RF-out, and two data input ports. A bipolar signal is applied at data ports to produce an RF output signal phase-modulated by 0 (reference), 90, 180, or 270 degrees, depending on the state of the modulating signal.

**Sideband rejections** – The amount of undesired sideband measured in dB below the desired sideband under the same conditions as the carrier rejection measurement.

**Switching Speed** – Please see Figure 2 below for explanation of Switching Speed.

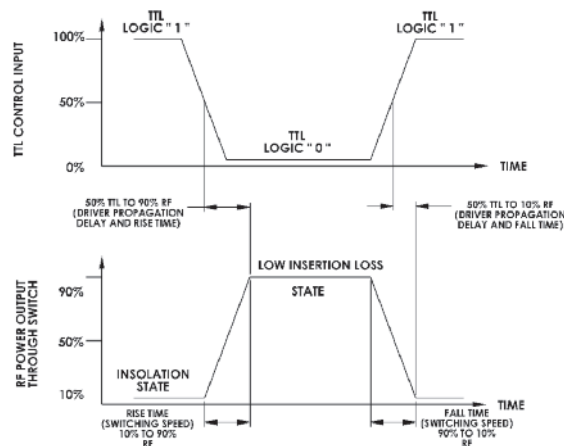


Figure 2. Switching Speed and Driver Propagation Delay Measurement.

**VSWR** – VSWR is a measure of impedance match at input and output ports of the modulator. This parameter represents imperfect input and output impedances.



# Precision Junction Circulators and Isolators

## QJY/QJI

### Characteristics

- ◆ Compact
- ◆ High Isolation
- ◆ Low Insertion Loss
- ◆ Broadband



### Product Description

QuinStar Technology's **QJY** series **precision junction circulators** and **QJI** series **precision junction isolators** are available in seven waveguide bands covering the frequency range of 18 to 110 GHz. Single-junction isolators and single- and three- junction circulator versions are offered. These three-port Y-junction ferrite devices feature high isolation, low insertion loss, and broad bandwidth. The three-junction circulators effectively combine a standard circulator with input and output isolators in a compact package.

Junction circulators and isolators are used to provide load isolation in a wide variety of components including Gunn and IMPATT oscillators and amplifiers, upconverters and downconverters, power combiners, and also as duplexers at the antenna ports of millimeter-wave transceiver systems.

### Specifications

FREQUENCY BAND		K	Ka	Q	U	V	E	W
Frequency Range (GHz)		18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Bandwidth (GHz min)		2	2	2	2	2	2	2
Isolation (dB min)	Single-Junction	20	20	20	20	20	18	18
	Three-Junction (Circulator Only)	35	35	35	35	35	35	35
Insertion Loss (dB max)	Single-Junction	0.3	0.5	0.5	0.6	0.7	0.8	1.0
	Three-Junction (Circulator Only)	1.0	1.0	1.1	1.2	1.3	1.5	1.6
VSWR (max)		1.2:1	1.2:1	1.2:1	1.2:1	1.3:1	1.3:1	1.3:1
Power Rating (Watts max), QJY Junction Circulator		10	8	8	6	5	5	4
Power Rating (Watts max), QJI Junction Isolator		3	3	2	2	1.5	1	1

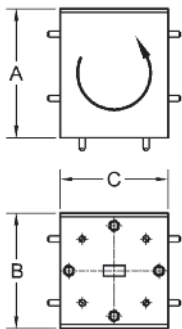
Other waveguide sizes are available.



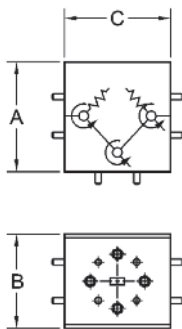
# Precision Junction Circulators and Isolators

## QJY/QJI

### Outline Drawings/Mechanical Specifications



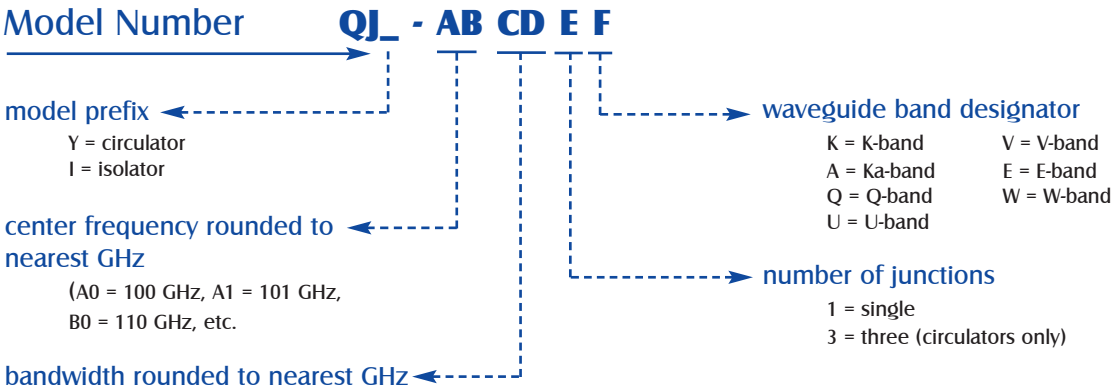
Single-Junction Circulators and Isolators  
(round flange pattern shown)



Three-Junction Circulators  
(round flange pattern shown)

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	SINGLE JUNCTION OUTLINE DIMENSIONS, inches/mm			THREE-JUNCTION OUTLINE DIMENSIONS, inches/mm		
			A	B	C	A	B	C
K	WR-42	UG-595/U	1.20/30.5	0.88/22.4	1.00/25.4	1.50/38.1	1.20/30.5	2.00/50.8
Ka	WR-28	UG599/U	0.90/22.9	0.80/20.3	0.90/22.9	1.25/31.8	1.20/30.5	1.50/38.1
Q	WR-22	UG-383/U	1.45/36.8	1.20/30.5	1.13/28.7	1.25/31.8	1.20/30.5	1.50/38.1
U	WR-19	UG-383/U	1.45/36.8	1.20/30.5	1.13/28.7	1.25/31.8	1.20/30.5	1.50/38.1
V	WR-15	UG-385/U	1.05/26.7	0.85/21.6	1.00/25.4	1.14/29.0	0.98/24.9	1.10/27.9
E	WR-12	UG-387/U	1.05/26.7	0.85/21.6	1.00/25.4	1.14/29.0	0.98/24.9	1.10/27.9
W	WR-10	UG-387/U	1.05/26.7	0.85/21.6	1.00/25.4	1.14/29.0	0.98/24.9	1.10/27.9

### Ordering Information





# Fullband Junction Circulators and Isolators

## QJE/QJF

### Characteristics

- ◆ Full Waveguide Band
- ◆ Compact
- ◆ High Isolation
- ◆ Low Insertion Loss

### Product Description

QuinStar Technology's **QJE** series **fullband junction circulators** and **QJF** series **fullband junction isolators** are available in two waveguide bands covering the frequency range of 18 to 40 GHz. These H-plane three-port Y-junction ferrite devices feature high isolation, low insertion loss and full waveguide bandwidth.

Junction circulators and isolators are used to provide load isolation in a wide variety of components including Gunn oscillators and amplifiers, upconverters and downconverters, power combiners, and also as duplexers at the antenna ports of millimeter-wave transceiver systems. They are also ideally suited for broadband or swept frequency applications.

### Specifications

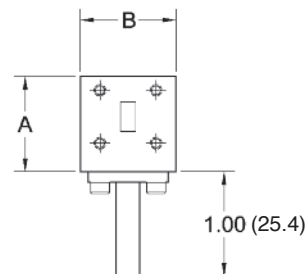
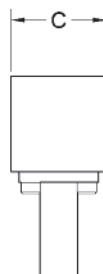
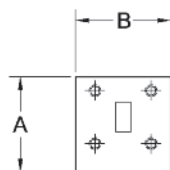
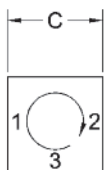
FREQUENCY BAND	K	Ka
Frequency (GHz)	18-26.5	26.5-40
Waveguide Size	WR-42	WR-28
Bandwidth (GHz min)	Full	Full
Isolation	20	18
Insertion Loss (dB max)	0.4	0.6
VSWR	1.25:1	1.3:1
Power Rating (W max)	5	4



# Fullband Junction Circulators and Isolators

## QJE/QJF

### Outline Drawings/Mechanical Specifications



Circulators

Isolators

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm		
			A	B	C
K	WR-42	UG-595/U	1.15/29.2	0.88/22.4	1.00/25.4
Ka	WR-28	UG-599/U	0.90/22.9	0.90/22.9	0.90/22.9

### Ordering Information

Model Number **QJ - A 00000**

model prefix

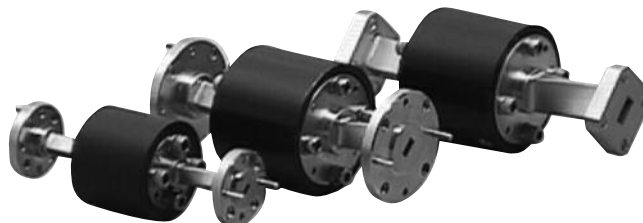
E = circulator  
F = isolator

waveguide band designator

K = K-band  
A = Ka-band

### Characteristics

- ◆ Full Waveguide Bandwidths
- ◆ Low Insertion Loss and VSWR
- ◆ High Wideband Isolation



### Product Description

QuinStar Technology's **QIF** series **fullband isolators** are available in six waveguide bands covering the frequency range of 26.5 to 110 GHz. These isolators are Faraday-rotation type ferrite devices with bandwidths covering a full waveguide band.

Series QIF isolators provide a minimum of 25 dB of isolation and typically more than 30 dB across most of the

waveguide bands. The isolators can handle power levels from one Watt at W-band to two Watts at Ka-band. They provide isolation over wider bandwidths than single-junction waveguide isolators. The wide bandwidth of these isolators makes them ideally suited for broadband or swept frequency applications and wideband measurement systems.

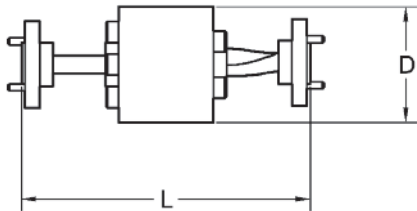
### Specifications

FREQUENCY BAND	Ka	Q	U	V	E	W
Frequency Range (GHz)	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
FULLBAND ISOLATORS						
Insertion Loss (dB max)	1.3	1.4	1.6	1.7	2.0	2.2
Isolation (dB min)	25	27	27	27	27	27
VSWR (max)	1.45:1	1.4:1	1.4:1	1.4:1	1.4:1	1.4:1
Power Rating (W max)	2.0	1.5	1.5	1.0	1.0	1.0

Other waveguide sizes are available.



Outline Drawing/Mechanical Specifications



(round flange pattern shown)

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm	
			L	D
Ka	WR-28	UG-599/U	2.95/74.9	1.31/33.3
Q	WR-22	UG-383/U	2.69/68.3	1.31/33.3
U	WR-19	UG-383/U	2.69/68.3	1.31/33.3
V	WR-15	UG-385/U	2.50/63.5	1.00/25.4
E	WR-12	UG-387/U	2.50/63.5	1.00/25.4
W	WR-10	UG-387/U	2.50/63.5	1.00/25.4

Other waveguide sizes are available.

Ordering Information

Model Number **QIF** - **A 00000**

→ waveguide band designator

- A = Ka-band
- Q = Q-band
- U = U-band
- V = V-band
- E = E-band
- W = W-band

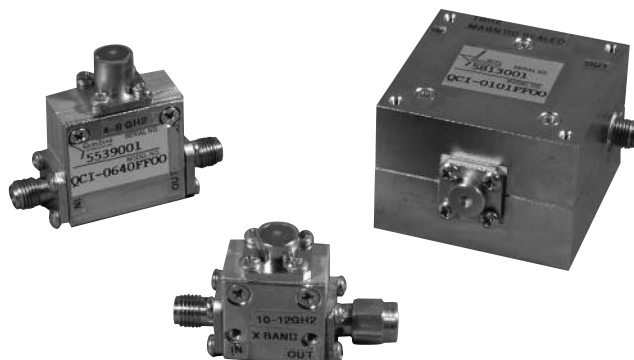


# Cryogenic Circulators and Isolators

## QCY/QCI

### Characteristics

- ◆ Broad Bandwidth
- ◆ High Isolation, Low Insertion Loss
- ◆ Low VSWR
- ◆ Magnetically Shielded



### Product Description

QuinStar Technology's **QCY** series **Cryogenic Circulators** and **QCI** series **Cryogenic Isolators** are custom-designed field-displacement devices with exceptional broadband performance. These are often used in conjunction with QuinStar's series QCA Cryogenic Amplifiers and Systems. These products have internal magnetic shielding. However, an external magnetic shield is optionally available to augment the standard internal shielding to preserve the electrical characteristics while operating in a

stronger magnetic field. When connected with cryogenic amplifiers, the DC bias to the amplifier may be provided using the termination of the isolator. Consult QuinStar if planning to use this option.

Typical applications for these devices include radio astronomy, satellite earth stations, radiometers and electron spin resonance measurement systems.

### Specifications

Characteristics <sup>1</sup>	4-8 GHz	4-10.5 GHz	8-12 GHz	10.5-12 GHz	12-18 GHz	18-26.5 GHz	26.5-40 GHz
Isolation, dB min.	18	18	18	14	18	18	18
Insertion Loss, dB max.	0.4	0.8	0.4	1.2	0.5	0.4	0.5
VSWR, max.	1.28	1.28	1.28	1.38	1.28	1.28	1.28
Input/Output Connector	Coax (SMA)	Coax (SMA)	Coax (SMA)	Coax (SMA)	Coax (SMA)	Waveguide (WR-42)	Waveguide (WR-28)

Note 1: Tested at 77 degree K. Other bandwidths available. Performance may be improved over narrower bandwidth.

### Ordering Information

Model Number **QC - AB.C D.EF G H 00**

model prefix

Y = circulator  
I = isolator

center frequency in GHz

(example: 10.5 GHz = 10.5)

bandwidth in GHz

(example: 750 MHz = 0.75)

magnetic shielding

M = Optional external soft iron shielding  
0 = Standard unit

microwave frequency band



## Variable PIN Attenuators

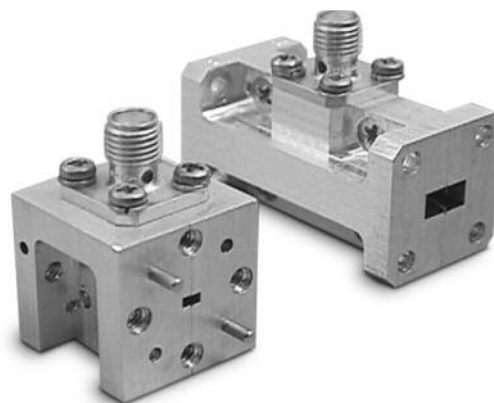
### QSA

### Characteristics

- ◆ Broad RF Bandwidth
- ◆ Low Insertion Loss
- ◆ Current Controlled

### Product Description

QuinStar Technology's **QSA** series **millimeter-wave variable PIN attenuators** cover the frequency range of 18 to 110 GHz in seven waveguide bands. They are constructed with a rugged, split block mechanical design that utilizes PIN diodes, and are capable of handling RF power levels up to 0.5 Watt. Standard units feature broad bandwidth. However, they can be optimized over a



narrower frequency range for greater attenuation range or lower insertion loss. They are ideal for signal level control and amplitude modulation.

A coaxial version covering DC to 50 GHz frequency range is also offered. See model QVA for details.

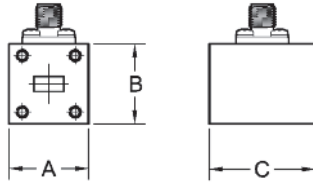
### Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Insertion Loss (dB typ.)	1.0	1.0	1.0	1.2	1.5	2.0	2.0
Bandwidth (GHz min)	Full	Full	Full	Full	10	10	10
Attenuation Range (dB min)	0-23	0-23	0-23	0-23	0-20	0-20	0-20

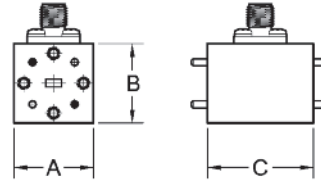
Attenuators require a control voltage varying between 0 and 10 V for varying the attenuation.

Power Rating: 0.5 Watt (max).

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	BIAS INPUT	OUTLINE DIMENSIONS, inches/mm		
				A	B	C
K	WR-42	UG-595/U	SMA JACK	0.88/22.4	0.88/22.4	1.50/38.1
Ka	WR-28	UG-599/U	SMA JACK	0.75/19.1	0.75/19.1	1.50/38.1
Q	WR-22	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.00/25.4
U	WR-19	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.00/25.4
V	WR-15	UG-385/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4
E	WR-12	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4
W	WR-10	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	1.00/25.4

## Ordering Information

Model Number **QSA -** **AB CD E F**

center frequency rounded to  
nearest GHz

(A0 = 100GHz, A1 = 101 GHz,  
B0 = 110 GHz, etc.)

maximum attenuation  
required, in dB

waveguide band designator

K = K-band      V = V-band  
A = Ka-band    E = E-band  
Q = Q-band      W = W-band  
U = U-band

options

0 = none  
Z = custom



# Coaxial PIN Attenuator

## QVA

### Characteristics

- ◆ Ultra Wide RF Bandwidth
- ◆ Low Insertion Loss
- ◆ Compact Package

### Product Description

QuinStar Technology's series **QVA** coaxial variable **PIN attenuators** cover the frequency range from DC to 50 GHz. They offer a low insertion loss and a large attenuation range, typically up to 40 dB. These attenuators are housed in a compact package with 2.9 mm or 2.4 mm coaxial connector interfaces. The

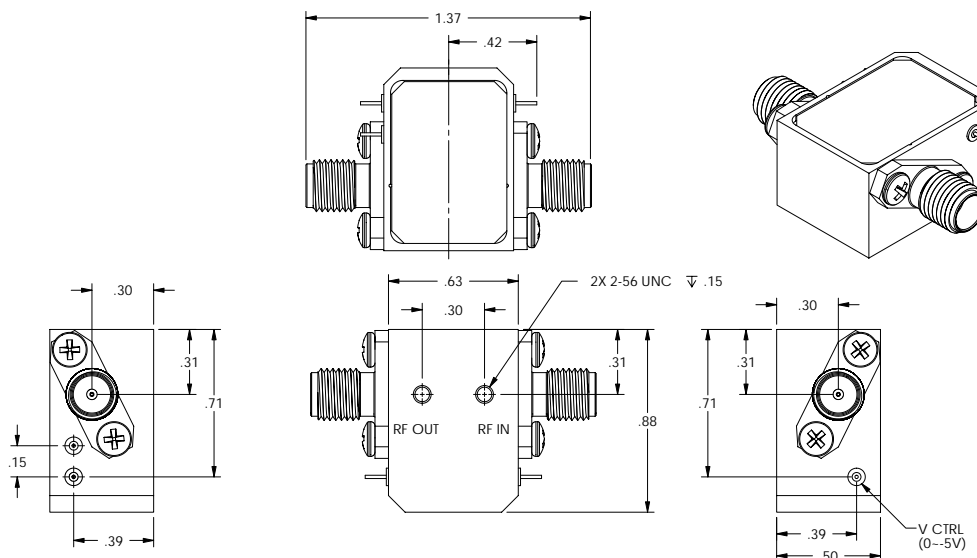
control voltage required for varying the attenuation is from 0 to -5 volts. Series QVA attenuators are well suited for signal level control, amplitude modulation and test and measurement applications.



### Specifications

<b>Frequency Range</b>	DC to 50 GHz
<b>Insertion Loss</b>	2 dB for 20 dB attenuation range 4 dB for 40 dB attenuation range
<b>Power Handling</b>	1 W (30 dBm)
<b>Control Voltage</b>	0 to -5 V DC

### Outline Drawings/Mechanical Specifications

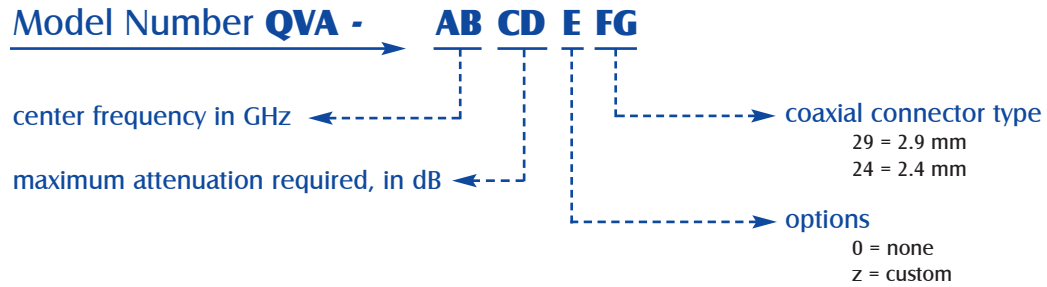




# Coaxial PIN Attenuator

## QVA

### Ordering Information





# Waveguide PIN Switches

## QSS/QSD

### Characteristics

- ◆ Single, Double and Multi-Throw Versions
- ◆ Broad RF Bandwidth
- ◆ Low Insertion Loss
- ◆ High Speed Switching Option



### Product Description

QuinStar Technology's **QSS and QSD** series millimeter-wave broadband **PIN switches** cover the frequency range of 18 to 110 GHz in seven waveguide bands. These waveguide switches are constructed with a rugged, splitblock mechanical design that utilizes PIN diodes. Most standard switches operate over a full waveguide band, and all can be optimized over a specific narrower frequency range for better isolation or lower insertion loss. They are ideal for signal attenuation, on/off switching such as

receiver protection, and variable pulse width control. The switches can handle RF power levels of up to 27 dBm (0.5 Watt) and optional integral drivers that accept a TTL input as the control signal are available.

Series QSS/QSD switches are useful for signal switching, receiver protection, pulse modulation and test equipment applications.

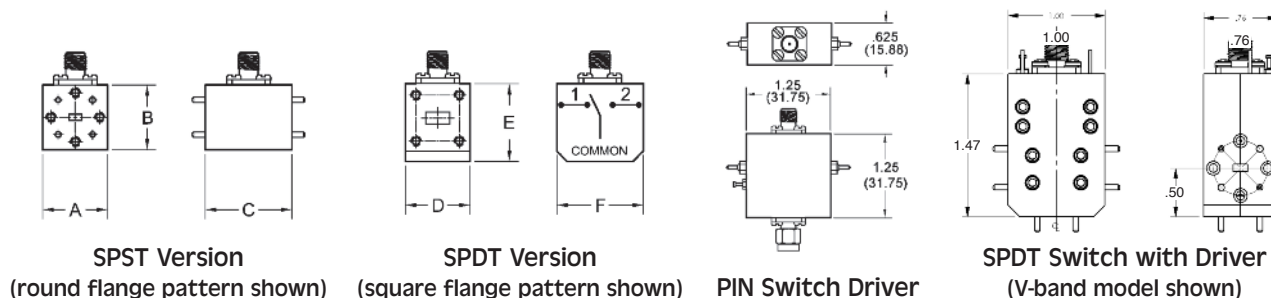
### Specifications

FREQUENCY BAND		K	Ka	Q	U	V	E	W
Frequency Range (GHz)		18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Bandwidth (GHz min)		Full	Full	Full	Full	10	10	10
Insertion Loss (dB max)	QSS	1.5	1.5	1.5	1.8	2.0	2.5	2.5
	QSD	2.0	2.0	2.0	2.3	2.5	2.8	2.8
Isolation (dB min)	QSS	30	30	26	26	25	20	20
	QSD	23	23	23	23	20	20	20
DC Bias Input <sup>1</sup>	Low Loss (Reverse)	+5V, -5V						
	Isolation (Forward)	35mA typ.						
Switching Speed (ns typ) <sup>2</sup>		250	250	250	250	250	250	250
VSWR (typ)		2:1	2:1	2:1	2:1	2:1	2:1	2:1

<sup>1</sup> For ON-state (low insertion loss), the switch requires a reverse voltage of 10 Volts; for OFF-state (isolation), a forward bias current of up to 25 mA is needed. For integral driver option, bias voltage supplies of +5 V and -5 V are required. The switch is controlled by TTL signals.

<sup>2</sup> Standard PIN switches require a total switching time of 350 ns max. Faster switching speed options (< 10 ns) are available.

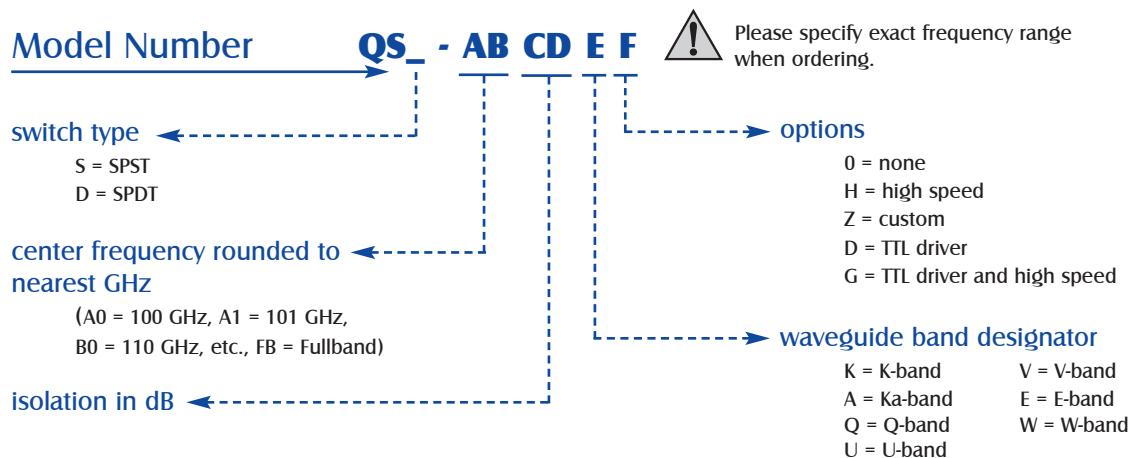
### Outline Drawings/Mechanical Specifications



FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	BIAS INPUT	OUTLINE DIMENSIONS, inches/mm					
				A	B	C	D	E	F
K	WR-42	UG-595/U	SMA JACK	0.88/22.4	0.88/22.4	1.50/38.1	0.88/2.4	0.94/23.9	1.50/38.1
Ka	WR-28	UG-599/U	SMA JACK	0.75/19.1	0.75/19.1	1.50/38.1	0.75/19.1	0.88/22.4	1.00/25.4
Q	WR-22	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.00/25.4	1.13/28.7	1.31/33.3	1.50/38.1
U	WR-19	UG-383/U	SMA JACK	1.13/28.7	1.13/28.7	1.00/25.4	1.13/28.7	1.31/33.3	1.50/38.1
V	WR-15	UG-385/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.0	0.75/19.1	0.88/22.4	1.00/25.4
E	WR-12	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.0	0.75/19.1	0.88/22.4	1.00/25.4
W	WR-10	UG-387/U	SMA JACK	0.75/19.1	0.75/19.1	0.75/19.0	0.75/19.1	0.88/22.4	1.00/25.4

Consult factory for dimensions on switches with greater than 2 throws.

### Ordering Information



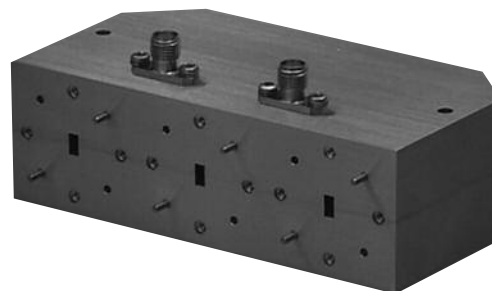


# Multi-throw PIN Switches

QSN

## Characteristics

- ◆ From Two Throw to 8 Throw
- ◆ Low Insertion Loss
- ◆ Wide Band Operation
- ◆ High Isolation Versions Offered
- ◆ Compact and Reliable
- ◆ Coaxial and Waveguide Versions



## Product Description

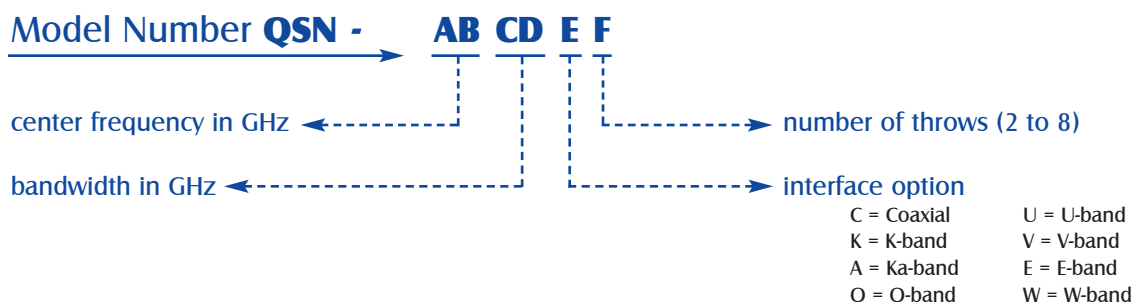
QuinStar Technology offers series **QSN** multi-throw **PIN switches** for a variety of applications that require multiple throws and/or custom switch configuration. These switches offer low insertion loss and a wide bandwidth of operation for a high isolation level. Waveguide and coaxial versions are available depending on the operating frequency. These switches are ideally suited for signal attenuation and switching for receiver protection, antenna switching, test and measurement sets and transceivers.

Switch drivers that accept TTL signals may be incorporated in these switches as an optional feature. QuinStar can combine switches to create custom configurations or outlines for application-specific switches.

## Specifications

Performance Characteristics	Available Range
Configurations	From SPDT to SP8T and custom configurations
Insertion Loss	From 1 dB to 6 dB depending on configuration and frequency
Frequency range	1 to 100 GHz
Isolation	20 dB to 40 dB
Switching Speed	10 ns to 200 ns depending on driver and frequency

## Ordering Information



## Characteristics

- ◆ Wideband Operation
- ◆ Fast Switching Speed
- ◆ High isolation

## Product Description

QuinStar Technology's series **QSC** coaxial **PIN** switches provide fast switching with high isolation and low insertion loss over the full K and Ka frequency bands. Standard models are available in SPST and SPDT configurations and feature a compact package that incorporates the driver circuitry. Switches with multiple throws (up to SP8T) are offered as custom products. Several versions of these switches are offered to suit a wide range of applications. SPST switches are offered in reflective and non-reflective versions. All switches are offered with a choice of either low insertion loss



version or high isolation version. Control signal required to operate these switches is TTL.

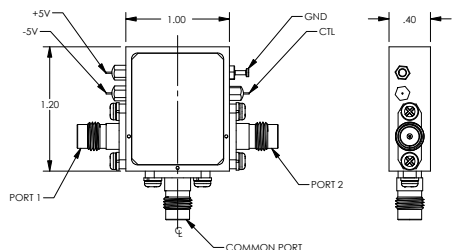
Standard input/output RF ports are K-female connectors, and DC bias/control signal is via feedthrough pins. For high speed versions, SMA connector is provided for control signal. These switches are ideally suited for pulse modulation and receiver protection in broadband systems that utilize coaxial components.

## Specifications

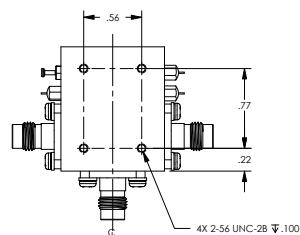
FREQUENCY BAND		K	Ka	K-Ka
Frequency Range (GHz)		18-26.5	26.5-40	18-40
Connectors		K-F	K-F	K-F
Insertion Loss (dB typ.)	SPST, SPDT (Low insertion loss version)	1.5	2.5	2.5
	SPST, SPDT(High isolation version)	5	5	5
Isolation (dB)	SPST, SPDT (Low insertion loss version)	28	28	28
	SPST, SPDT(High isolation version)	50	50	50
Switching speed (ns typ.)		5	5	5
Control signal		TTL		
DC Bias	SPST, SPDT (Low insertion loss version)	-5V, +5V; 60 mA		
	SPST, SPDT(High isolation version)	-5V, +5V; 110 mA		



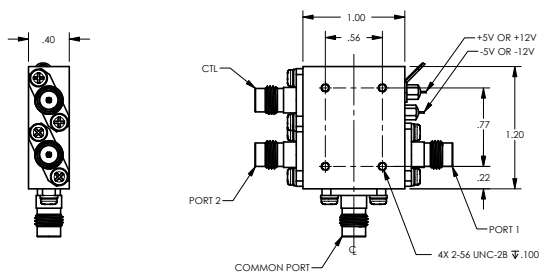
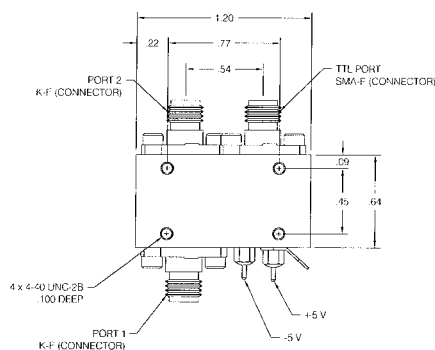
## Outline Drawings/Mechanical Specifications



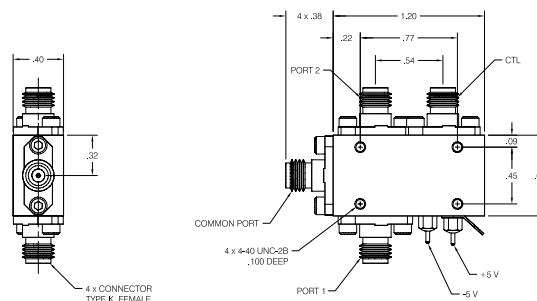
**SPDT High Speed Low Insertion Loss Version**



**SPDT High Isolation, Low-Speed Version**



**SPDT High Isolation, High-Speed Version**



**SPDT Low Insertion Loss, High Speed Version**

## Ordering Information

Model Number **QSC - A BC 0000**

frequency band designator ← version

K = K-band  
A = Ka-band  
T = K-Ka band (18-40 GHz)  
B = 2-40 GHz

SR = SPST reflective, low insertion loss version  
SH = SPST reflective version, high isolation version  
SN = SPST non-reflective, low insertion loss version  
ST = SPST non-reflective, high isolation version  
DH = SPDT high isolation version  
DL = SPDT low insertion loss version

## Section 5

# Waveguide Products and Filters

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# Glossary of Waveguide Products and Filters

**Center frequency** – The nominal frequency at which bandpass filters are geometrically centered. For example, if  $f_1$  and  $f_2$  represent the 3 dB frequency points of a bandpass filter, then the center frequency  $f_0$  is calculated as follows:

$$f_0 = \sqrt{f_1 \times f_2}$$

When the bandwidth,  $f_2 - f_1$ , is a small percentage of the value of  $f_0$ , then  $f_0$ , the geometric mean between  $f_2$  and  $f_1$  will approximately equal the arithmetic mean between  $f_2$  and  $f_1$ , i.e., the average  $(f_2 + f_1)/2$ .

**Cut-off frequency (corner frequency)** – This frequency is generally 3 dB below the insertion loss of the filter; it denotes the point at which the filter is considered to be rejecting unwanted signals. Above (or below) this frequency the filter is said to be in its passband and exhibits a low loss. This is the frequency that marks the edge of the passband of a filter and the beginning of the transition to the stopband. In waveguide, this figure is the lowest frequency at which the waveguide propagates energy in some particular mode without attenuation.

**Group delay** – The amount of time it takes for a signal having a finite time duration, such as a pulse, to pass through the filter. Ideally, all frequencies present in the signal should have the same time delay, so that the signal will not be distorted. In most types of filters, this is not the case, and group delay defined as  $d\phi/d\omega$  varies with frequency. For linear phase filters the group delay is constant. It is observed that the linear phase filters have a much lower and flatter value of group delay.

**Insertion loss** – Insertion loss is equal to the difference in its power measured at the component input and output. The power measured at the input is equal to the measured power when the component is replaced by a properly matched power meter or network analyzer. The input impedance of the measuring instrument should be equal to the characteristic impedance of the system. Similarly, the power measured at the output is equal to the measured power when the component is terminated by the same measuring instrument. The insertion loss will be equal to the sum of three loss factors. One is the loss due to the impedance mismatch at the input, the second is due to the mismatch at the output, and the third is due to the dissipative loss associated with each reactive element within the component.

**Linear phase or flat time delay** – Filters have the characteristic of enabling the signal at the filter output to have a constant phase difference for each fixed increment of frequency difference of the signal. Thus,

$$\Delta\phi = K \Delta f$$

where K is a constant. This enables the transmission of various frequency components contained in a pulse waveform to be delayed by the same amount while traveling through the filter thus preserving the pulse wave shape.

**Passband** – Passband is the desired band of frequencies in which the only loss is the insertion loss of the filter. It is the actual band of frequencies, which the filter is required to pass through with very little effect on system performance. Most of the QuinStar's low pass filter models are specified to have a maximum insertion loss value of 1.5 dB within the passband.

**Rejection band (stopband)** – The frequency range(s) which are undesired and must be strongly attenuated from the stopband or rejection band. The term "rejection" indicates the amount of attenuation of specific frequencies within this undesired frequency range.

**VSWR** – VSWR is a measure of the impedance looking into one port of the filter while the other filter port is terminated in its characteristic impedance. Many times, the impedance match is expressed in terms of return loss. The conversion between return loss and VSWR can be carried out using the chart given in the reference materials section.

**Average power handling capacity** – The CW average power handling capability with one-way transmission through the main line of the component under matched load conditions

**Bandwidth** – The range of frequencies over which performance falls within specific limits.

**Bidirectional coupler** – Another name for a 4-port coupler; that is, a single coupler having no internal termination. It is intended to allow forward and reflected signals to be sampled simultaneously.

**Coupling coefficient of a coupler** – The ratio in dB of the incident power fed into the main port to the coupled port power when all ports are terminated by reflectionless terminations. See figure below.

Coupling value =  $-10 \log_{10} (P_3/P_1)$ .

**Coupling flatness** – The maximum peak-to-peak variation in coupling coefficient that may be expected over a specified frequency range.

**Coupling tolerance** – The allowable unit-to unit variation in nominal coupling.

**Directivity** – The difference in dB of the power output at a coupled port, when power is transmitted in the desired direction, to the power output at the same coupled port when the same amount of power is transmitted in the opposite direction. In the case of a bidirectional coupler, an alternative definition is the difference in dB of the power output of the two coupled ports, when power is transmitted in a constant direction on the main line. Reflectionless terminations are assumed to be connected to all ports. See figure below.

Directivity =  $10 \log_{10} (P_3/P_3')$ .

**Main-line loss** – The change in load power, due to the insertion of the coupler in a transmission system, with reflectionless terminations connected to the ports of the coupler. The main-line loss includes the effect of power transferred to the coupled line. See figure below.

Main line loss =  $10 \log_{10} [(P_2 + P_3)/P_1]$ .



## Characteristics

- ◆ Fullband Coverage
- ◆ Excellent Coupling Flatness and Accuracy
- ◆ Low VSWR
- ◆ Very High Directivity



## Product Description

QuinStar Technology's **QJR series precision high directivity couplers** cover the frequency range of 18 to 170 GHz in nine waveguide bands. They are available in 3 port configuration with coupling values of 3, 6, 10, 20, 30 and 40 dB. They are constructed with a rugged splitblock mechanical design for long-lasting durability to maintain their coupling value.

Precision high directivity directional couplers are ideal devices for sampling or inserting RF energy in a waveguide transmission line without affecting the transmitting signal.

They prove especially useful in applications such as RF power and signal reflection measurements in test systems. The superior directivity, insertion loss, coupling flatness and accuracy also make these directional couplers useful for a wide range of laboratory requirements and subsystem applications. In addition to the standard three-port directional couplers, QuinStar offers custom four-port directional couplers. See series QJB couplers.

## Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6
Coupling Values (dB at center frequency)	3, 6, 10, 20, 30 and 40 ( $\pm 1$ )								
Coupling Flatness ( $\pm$ dB typ)	0.7	0.7	0.7	0.7	0.7	0.8	0.8	1.0	1.0
Directivity (dB typ) <sup>1, 3</sup>	37	37	37	37	35	35	35	30	28
Insertion Loss (dB max) <sup>2</sup>	0.7	0.7	0.7	0.7	0.8	1.0	1.2	2.0	2.5
VSWR, Main Line (typ)	1.1:1	1.1:1	1.1:1	1.1:1	1.1:1	1.1:1	1.1:1	1.15:1	1.15:1
VSWR, Secondary Line (typ)	1.1:1	1.1:1	1.1:1	1.1:1	1.1:1	1.15:1	1.15:1	1.2:1	1.2:1

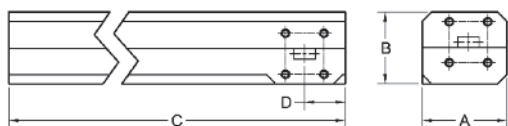
Other waveguide sizes are available.

<sup>1</sup> Directivity is the difference between power levels at the coupled port when input and output ports are interchanged.

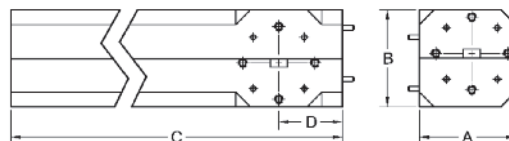
<sup>2</sup> Insertion loss is defined as the power loss in excess of the loss due to coupling.

<sup>3</sup> For 30 dB and 40 dB couplers: directivity = 25 dB typ.

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-6

FREQ. BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm			
			A	B	C	D
K	WR-42	UG-595/U	1.40/35.6	1.06/26.9	9.25/234.9	0.60/15.2
Ka	WR-28	UG-599/U	1.10/27.9	0.90/22.8	6.25/158.7	0.60/15.2
Q	WR-22	UG-383/U	1.36/34.5	1.248/31.7	5.50/139.7	0.80/20.3
U	WR-19	UG-383/U	1.36/34.5	1.248/31.7	5.50/139.7	0.80/20.3
V	WR-15	UG-385/U	1.10/27.9	0.83/21.0	4.0/101.6	0.60/15.2
E	WR-12	UG-387/U	1.10/27.9	0.817/20.7	3.5/88.9	0.60/15.2
W	WR-10	UG-387/U	1.10/27.9	0.81/20.6	3.25/82.6	0.60/15.2
F	WR-8	UG-387/U	1.10/27.9	0.80/20.3	3.0/76.2	0.60/15.2
D	WR-6	UG-387/U	1.10/27.9	0.80/20.3	3.0/76.2	0.60/15.2

## Ordering Information

Model Number **QJR - A BC D 00**

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band  
F = F-band  
D = D-band

flange type

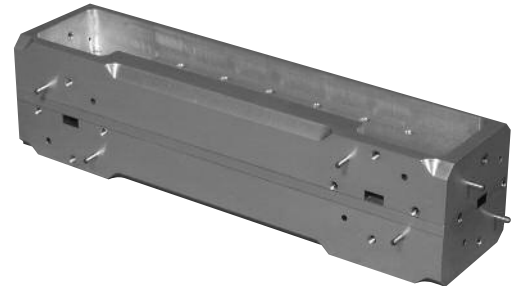
R = round flange  
S = square flange

coupling value in dB

03, 06, 10, 20, 30 or 40

### Characteristics

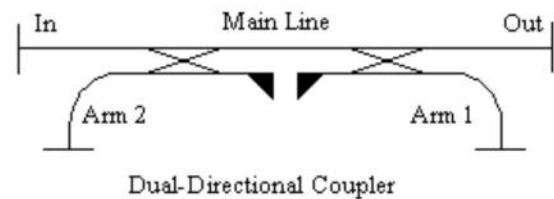
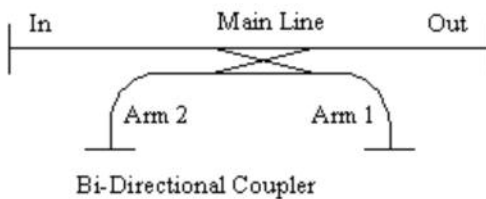
- ◆ Fullband Coverage
- ◆ High Directivity
- ◆ Excellent Coupling Flatness
- ◆ Low Return Loss



### Product Description

QuinStar Technology offers **QJB** and **QJD** series **precision bi-directional and dual-directional high directivity couplers**, which cover a frequency range of 18 to 220 GHz in twelve waveguide bands. Coupling values of 10, 20, 30 and 40 dB are available. In a dual directional coupler, the forward and reverse coupling values can be made different. The units are designed with a rugged split-block mechanical structure for long-lasting durability to maintain

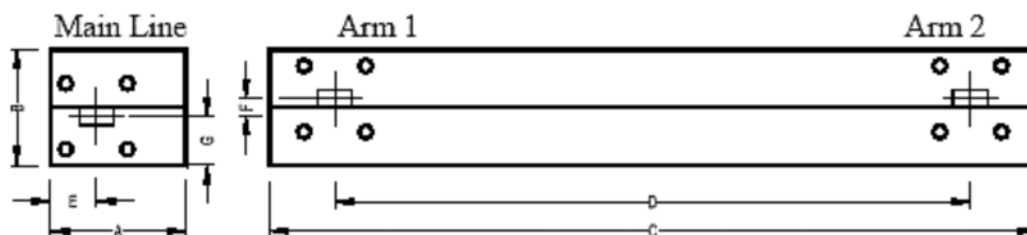
the precision coupling values. The bi- and dual-directional precision high directivity couplers are ideal devices in the applications of simultaneously testing, sampling or monitoring signals in both directions of the main arm of the coupler. Examples include instrumentation for incident and return signal measurement such as radar transmitted/reflected signal monitoring, etc.



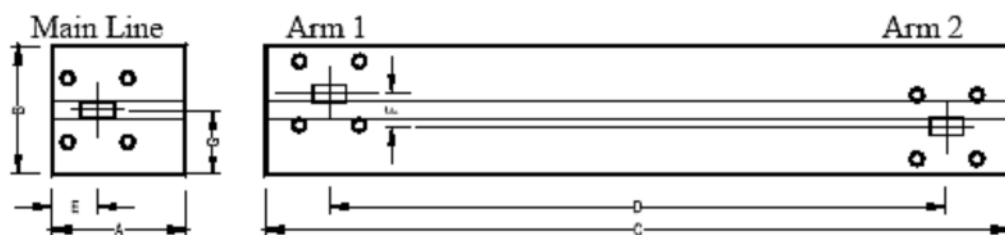
### Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D	G
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170	140-220
Coupling Level (dB)	20, 30, 40 (+/- 1)									
Coupling Variation (dB)	+/- 0.7	+/- 0.7	+/- 0.7	+/- 0.7	+/- 0.7	+/- 0.8	+/- 0.8	+/- 1.0	+/- 1.0	+/- 1.2
Insertion Loss, (dB typ.)	1.0	1.0	1.0	1.0	1.2	1.3	1.5	2.0	2.5	3.0
Directivity (dB typ.)	37	37	37	37	35	35	35	30	28	25
Main Line VSWR (max.)	1.10:1	1.10:1	1.10:1	1.10:1	1.10:1	1.10:1	1.10:1	1.15:1	1.15:1	1.20:1
Coupled Arm VSWR (max.)	1.10:1	1.10:1	1.10:1	1.10:1	1.10:1	1.15:1	1.15:1	1.20:1	1.21:1	1.25:1

## Outline Drawings/Mechanical Specifications



Bidirectional Coupler



Dual-directional Coupler

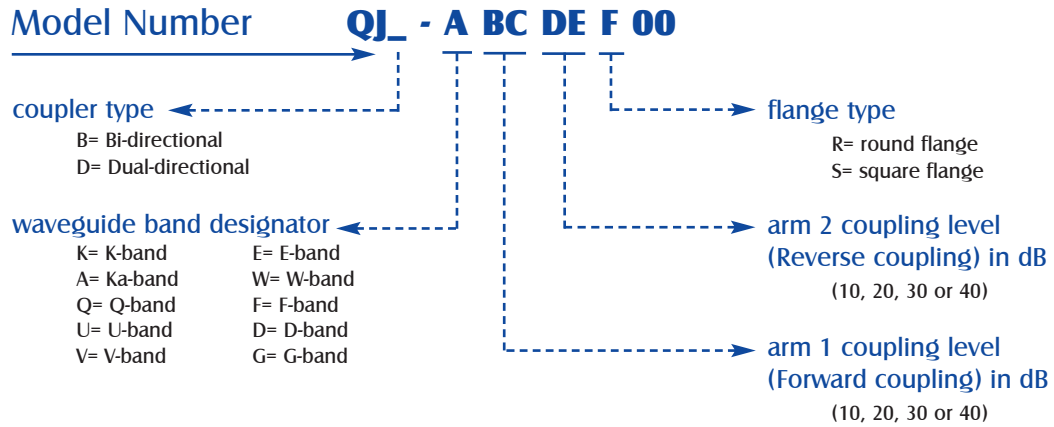
WAVEGUIDE BAND	WAVEGUIDE SIZE AND PATTERN	DIMENSIONS (INCHES/MM)							
		A	B		C	D	E	F	G
		Bi & Dual	Bi	Dual	Bi & Dual	Bi & Dual	Bi & Dual	Bi & Dual	Bi & Dual
K	WR-42 UG-595/U	1.40/35.6	1.10/27.9	1.24/31.4	7.75/196.9	6.87/174.5	0.44/11.1	0.350/8.9	0.475/12.1
Ka	WR-28 UG-599-U	1.10/27.9	0.93/23.6	1.05/26.7	6.21/157.7	5.15/130.8	0.38/9.7	0.29/7.4	0.405/10.3
Q	WR-22 UG-383/U	1.36/34.5	1.25/31.8	1.37/34.8	5.50/139.7	3.90/99.1	0.56/14.2	0.234/5.9	0.579/14.7
U	WR-19 UG-383/UM	1.36/34.5	1.23/31.2	1.34/34.0	5.50/139.7	3.90/99.1	0.56/14.2	0.198/5.0	0.578/14.7
V	WR-15 UG-385/U	1.20/30.5	0.83/21.1	0.91/23.1	3.84/97.5	2.64/67.1	0.38/9.7	0.153/3.9	0.383/9.7
E	WR-12 UG-387/U	1.20/30.5	0.82/20.7	0.88/22.4	3.40/86.40	2.20/55.9	0.38/9.7	0.127/3.2	0.384/9.8
W	WR-10 UG-387/UM	1.20/30.5	0.81/20.4	0.86/21.8	3.24/82.3	2.04/51.8	0.38/9.7	0.105/2.7	0.385/9.8
F	WR-8 UG-387/UM	1.20/30.5	0.80/20.3	0.84/21.3	2.42/61.5	1.22/31.0	0.38/9.7	0.085/2.2	0.385/9.8
D	WR-6 UG-387/UM	1.20/30.5	0.80/20.3	0.83/21.0	2.42/61.5	1.22/31.0	0.38/9.7	0.070/1.8	0.389/9.9
G	WR-5 UG-383/UM	1.20/30.5	0.80/20.3	0.81/20.6	2.42/61.5	1.22/31.0	0.38/9.7	0.056/1.4	0.392/10.0



# Precision Bi- and Dual-Directional Couplers

## QJB/QJD

### Ordering Information





# General Purpose Waveguide Directional Couplers

QDC

## Characteristics

- ◆ Broadband
- ◆ Low VSWR
- ◆ High Directivity
- ◆ Minimum Coupling Variation with Frequency



## Product Description

QuinStar products QDC series broadband directional couplers are multi-hole waveguide couplers. The QDC series couplers are offered in 7 waveguide sizes from 18.0 to 110 GHz. Nominal coupling of 10 dB, 20 dB, 30 dB, and 40 dB are offered as standard products. Two different mechanical configurations or outlines are offered for these

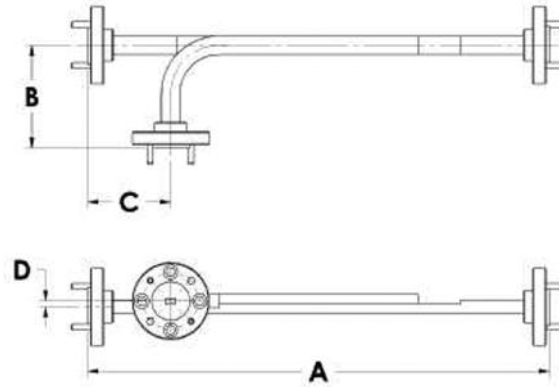
waveguide couplers- one with E-plane bend and the other with H-plane bend in the coupled port to suit the physical layout of all applications or test set requirements.

QuinStar also offers Series QJG and QJR Precision Directional Couplers in rectangular block geometry.

## Specifications

WAVEGUIDE BAND	K	Ka	Q	U	V	E	W
Frequency Range (GHz)	18.0-26.5	26.5-40.0	33.0-50.0	40.0-60.0	50.0-75.0	60.0-90.0	75.0-110.0
Coupling (dB)	10, 20, 30, 40						
Coupling Variation (dB)	+/- 0.6	+/- 0.6	+/- 0.6	+/- 0.8	+/- 1.0	+/- 1.0	+/- 1.0
Coupling Accuracy (dB)	+/- 1.0	+/- 1.0	+/- 1.0	+/- 1.2	+/- 1.5	+/- 1.5	+/- 1.5
Directivity (dB) Typical	35	35	35	35	35	35	30
Main Line VSWR (Typical)	1.05	1.05	1.05	1.10	1.10	1.10	1.10
Coupled Line VSWR (Typical)	1.12	1.12	1.12	1.15	1.15	1.15	1.17

## Outline Drawings/Mechanical Specifications



FREQUENCY BAND AND COUPLING LEVEL (dB)	OUTLINE DIMENSIONS, inches/mm			
	A	B	C	D
<b>K 10, 20, 30, 40</b>	11.50/292.0	2.00/50.8	1.50/38.1	.25/6.35
<b>Ka 10, 20, 30, 40</b>	9.62/244.0	1.75/44.5	1.38/35.1	.16/4.06
<b>Q 10, 20, 30, 40</b>	8.40/213.0	1.64/41.7	1.30/33.0	.13/3.30
<b>U 10, 20, 30, 40</b>	7.38/187.4	1.38/35.1	1.12/28.5	.11/2.80
<b>V 10, 20, 30, 40</b>	6.25/159.0	1.13/28.7	0.88/22.4	.08/2.03
<b>E 10, 20, 30, 40</b>	5.50/140.0	1.13/28.7	0.88/22.4	.07/1.78
<b>W 10, 20, 30, 40</b>	4.50/114.0	1.00/25.4	0.81/20.6	.06/1.52

## Ordering Information

Model Number **QDC -** **A B CD 00**

Coupled Port Configuration

E = E-plane bend on coupled port  
H = H-plane bend on coupled port

Coupling Level in dB

Waveguide Band

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band

## Characteristics

- ◆ Compact Size
- ◆ Low Insertion Loss
- ◆ Excellent Coupling Accuracy and Good Directivity



## Product Description

QuinStar Technology's **QJC** series of compact **precision crossguide directional couplers** cover the frequency range of 18 to 170 GHz in nine waveguide bands. Three- and four-port configurations are available for standard models with midband nominal coupling values of 20, 30 and 40 dB. Other coupling values are available as custom products. Crossguide couplers are ideal devices for sampling or inserting RF energy in a waveguide

transmission line without affecting the transmitting signal. Typical applications include frequency monitoring, power sampling and built-in testing. The crossguide type of directional coupler has the advantage of lower insertion loss, smaller size and lower cost when compared to broadwall directional couplers. QuinStar can provide custom configurations and application-specific interfaces to suit unique needs.

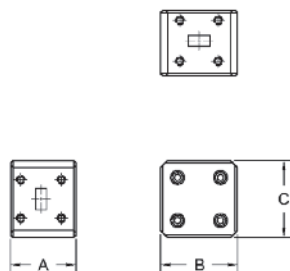
## Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6
Coupling Values (dB at center frequency)	Standard (20, 30 and 40 ± 1); Custom (17 to 40)								
Bandwidth (min)	20% of waveguide band								
Insertion Loss (dB max) <sup>1</sup>	0.4	0.4	0.5	0.6	0.6	0.8	1.0	1.2	1.3
Directivity (dB typ) <sup>2</sup>	20	20	20	20	20	20	20	15	15
Main Line VSWR (max)	1.15:1	1.15:1	1.15:1	1.15:1	1.2:1	1.2:1	1.2:1	1.2:1	1.25:1
Secondary Line VSWR (max)	1.2:1	1.2:1	1.2:1	1.2:1	1.25:1	1.25:1	1.25:1	1.25:1	1.25:1
Coupling Flatness (± dB typ)	1.5	1.5	1.5	1.5	1.8	1.8	1.8	2.0	2.0

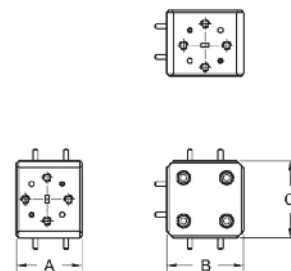
<sup>1</sup> Insertion loss is defined as the power loss in excess of the loss due to coupling.

<sup>2</sup> Directivity is the difference between power levels at the coupled port when input and output ports are interchanged.

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-6

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm	
			A	B, C
K	WR-42	UG-595/U	1.25/31.8	1.25/31.8
Ka	WR-28	UG-599/U	0.90/22.9	1.00/25.4
Q	WR-22	UG-383/U	1.38/35.1	1.38/35.1
U	WR-19	UG-383/U	1.38/35.1	1.38/35.1
V	WR-15	UG-385/U	0.84/21.3	1.00/25.4
E	WR-12	UG-387/U	0.84/21.3	1.00/25.4
W	WR-10	UG-387/U	0.84/21.3	1.00/25.4
F	WR-8	UG-387/U	0.84/21.3	1.00/25.4
D	WR-6	UG-387/U	0.84/21.3	1.00/25.4

## Ordering Information

Model Number **QJC -**

**AB CD E F**



Please specify exact center frequency when ordering.

center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc.)

coupling value in dB (20, 30, 40 for standard products)

waveguide band designator

K = K-band      E = E-band  
A = Ka-band    W = W-band  
Q = Q-band      F = F-band  
U = U-band      D = D-band  
V = V-band

number of ports

3 = 3 ports  
4 = 4 ports



# General Purpose Crossguide Couplers

## QJX

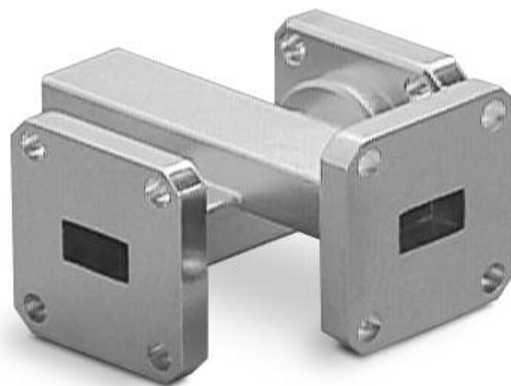
### Characteristics

- ◆ Compact Size
- ◆ Low Insertion Loss
- ◆ Low Cost/Moderate Performance

### Product Description

QuinStar Technology's **QJX** series of compact **general purpose** 3-port **crossguide directional couplers** cover the frequency range of 18 to 60 GHz in four waveguide bands with midband nominal coupling values of 20 and 30 dB. These crossguide couplers are ideal devices for sampling or inserting RF energy in a waveguide transmission line

without affecting the transmitting signal. Typical applications include frequency monitoring, power sampling and built-in testing. The crossguide type of directional coupler has the advantage of lower insertion loss, smaller size and lower cost when compared to broadwall directional couplers.



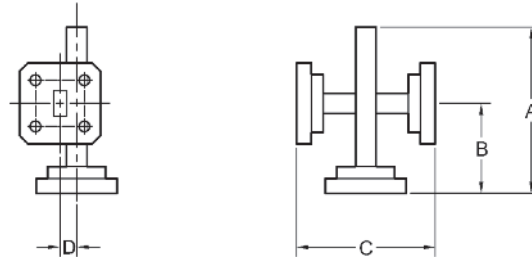
### Specifications

FREQUENCY BAND	K	Ka	Q	U
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60
Waveguide Size	WR-42	WR-28	WR-22	WR-19
Coupling Values, (dB at center frequency)	20 and 30 $\pm$ 2 dB			
Bandwidth (min)	20% of waveguide band			
Insertion Loss (dB max) <sup>1</sup>	0.5	0.5	0.6	0.7
Directivity (dB typ) <sup>2</sup>	15			
Main Line VSWR (max)	1.15:1			
Secondary Line VSWR (max)	1.2:1			
Coupling Flatness (dB max)	$\pm$ 1.5			

<sup>1</sup> Insertion loss is defined as the power loss in excess of the loss due to coupling.

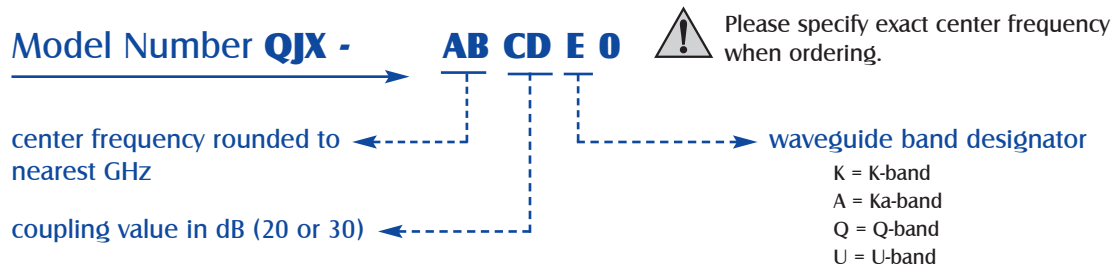
<sup>2</sup> Directivity is the difference between power levels at the coupled port when input and output ports are interchanged.

## Outline Drawing/Mechanical Specifications



FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm		
			A, C	B	D
K	WR-42	UG-595/U	2.00/50.8	1.00/25.4	0.19/4.7
Ka	WR-28	UG-599/U	1.50/38.1	0.75/19.1	0.16/4.1
Q	WR-22	UG-383/U	1.50/38.1	0.75/19.1	0.13/3.2
U	WR-19	UG-383/U	1.50/38.1	0.75/19.1	0.11/2.8

## Ordering Information



### Characteristics

- ◆ Broadband Operation
- ◆ High Isolation
- ◆ Low Insertion Loss
- ◆ Low VSWR



### Product Description

QuinStar Technology's **QJH** series of **matched hybrid tees (magic tees)** cover the frequency range of 18 to 170 GHz in nine waveguide bands. These four-port devices are used for balanced power-combining and/or dividing RF signals over a broad bandwidth. Matched hybrid Tee contains four ports: an H-plane port, an E-plane port and two co-linear ports, as shown in outline drawing. A signal entering the H-plane port will be equally to the two co-linear ports, but not to the E-plane port. The output signals coupled to the two co-linear ports are in phase. Similarly, a signal applied to the E-plane port will divide equally into the two co-linear ports. However, the output signal will be 180 degrees out of phase with each other. If two signals of equal amplitude are applied to the co-linear ports, the signals will be coupled to the E and H-plane ports. The amount of power combined at the E and H-plane ports depends on the relative phase relationship between the two input signals as follows:

$P_H / P_E = [\cos(\phi/2) / \sin(\phi/2)]^2$ , where  $\phi$  is the relative phase difference between the two input signals.

Hence, if the two signals are in phase, the total power will be combined at H-plane port. If the two signals are 180 degrees out of phase, the total power will appear at E-plane port. The isolation between the co-linear ports is greater than 20 dB, and between the E-plane and H-plane ports is greater than 30 dB.

Typical applications for these tees include power dividers/combiners, bridge circuits, balanced mixers, amplifiers, and instrumentation setups. QuinStar can provide custom 4- or 8-way power dividers by combining several hybrid tees (power dividers) into a single housing. It is also possible to configure the hybrid junctions to achieve unequal power split in 3, 5, 6 or 7 ports.

QuinStar Technology can also supply custom configurations ("folded tees") with output ports in different locations than in the standard product. Other power dividers (short slot hybrids and "rat-race" hybrids) are also available as special orders. If your application requires a unique power division scheme, please contact QuinStar with your requirements.

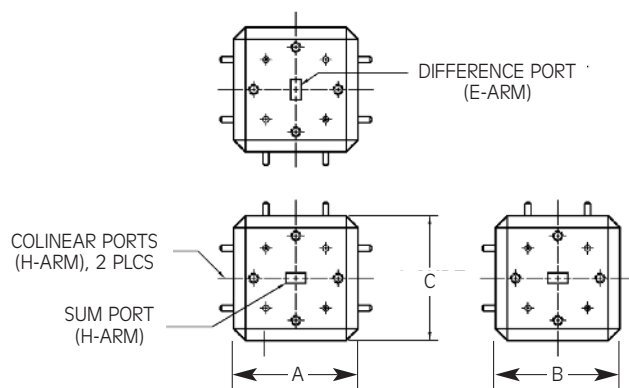
### Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D
Frequency Range (GHz) <sup>1</sup>	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6
Insertion Loss (dB max)	0.5	0.5	0.7	0.8	1.0	1.0	1.0	1.2	1.2
VSWR, H-Plane (max)	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1	1.5:1
VSWR, E-Plane (max)	1.6:1	1.6:1	1.6:1	1.6:1	1.6:1	1.6:1	1.6:1	1.6:1	1.6:1
Balance (+/- dB typ)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Other waveguide sizes are available.

<sup>1</sup> Standard products meet full performance specifications over 80% of the waveguide band, with slightly degraded performance over the balance of the band. Narrow bandwidth versions (25% of waveguide band) with superior isolation and lower insertion loss are available.

## Outline Drawing/Mechanical Specifications



(round flange pattern shown)

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	DIMENSIONS (inches/mm)		
			A	B	C
K	WR-42	UG-595/U	1.25/31.8	1.25/31.8	0.89/22.6
Ka	WR-28	UG-599/U	1.00/25.4	1.00/25.4	1.00/25.4
Q	WR-22	UG-383/U	1.38/35.1	1.38/35.1	1.38/35.1
U	WR-19	UG-383/U	1.38/35.1	1.38/35.1	1.38/35.1
V	WR-15	UG-385/U	1.00/25.4	1.00/25.4	0.80/20.3
E	WR-12	UG-387/U	1.00/25.4	1.00/25.4	0.80/20.3
W	WR-10	UG-387/U	1.00/25.4	1.00/25.4	0.80/20.3
F	WR-8	UG-387/U	1.00/25.4	1.00/25.4	0.80/20.3
D	WR-6	UG-387/U	1.00/25.4	1.00/25.4	0.80/20.3

## Ordering Information

Model Number **QJH** -

**A B CD 00**



Please specify exact center frequency when ordering narrowband version.

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band  
F = F-band  
D = D-band

frequency

Fullband: FB  
Narrowband: center frequency rounded to nearest GHz  
(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc.)

version

U = upper 80% of waveguide band  
L = lower 80% of waveguide band  
N = narrowband  
Z = custom



## Short Slot Hybrid Power Dividers

QSP

### Characteristics

- ◆ Small
- ◆ Compact
- ◆ Negligible Coupling Variation

### Product Description

QuinStar Technology's short slot hybrid is a narrow wall 3 dB coupler, available in standard waveguide sizes from 18 to 110 GHz. This compact, four-port device is inherently matched and well-suited for balanced mixers and power splitting circuits. There is a 90 degree phase difference between the two output signals, while the fourth port is isolated from the input.

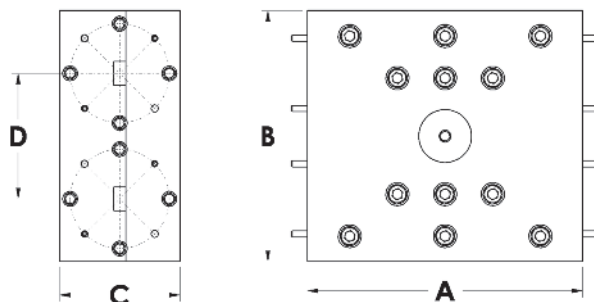


The QSP series short slot hybrids are power dividers (3 dB couplers) that can be used in waveguide bridge circuits, image-reject and single sideband mixers, phase shifters, and power splitters where 90 degree phase shift between output power ports is required.

### Specifications

FREQUENCY BAND	Ku	K	Ka	Q	U	V	E	W
Insertion Loss (dB) Max.	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.9
VSWR Max.	1.35	1.35	1.35	1.35	1.5	1.5	1.5	1.5
Isolation (dB) Min.	20	20	20	20	20	20	20	18
Bandwidth (GHz)	2	2	3	3	4	4	5	7

## Outline Drawings/Mechanical Specifications



FREQUENCY BAND	OUTLINE DIMENSIONS, inches/mm			
	C	A	B	D
<b>K</b>	3.75/95.3	2.47/62.7	1.12/28.5	1.38/35.1
<b>Ka</b>	3.75/95.3	2.47/62.7	1.12/28.5	1.38/35.1
<b>Q</b>	2.60/66.0	2.37/60.2	1.14/29.0	1.18/30.2
<b>U</b>	2.60/66.0	2.37/60.2	1.14/29.0	1.18/30.2
<b>V</b>	2.45/62.2	1.75/44.5	1.0/25.4	0.90/22.86
<b>E</b>	2.45/62.2	1.75/44.5	1.0/25.4	0.90/22.86
<b>W</b>	2.45/62.2	1.75/44.5	1.0/25.4	0.90/22.86

\*Contact QuinStar for Ku band dimensions

## Ordering Information

Model Number **QSP -**

**A B CD EF**

waveguide band designator

Y = Ku-band      V = V-band  
K = K-band      E = E-band  
A = Ka-band      W = W-band  
Q = Q-band      U = U-band

bandwidth (rounded to nearest GHz)

center frequency (rounded to nearest GHz)

options

0 = standard product  
C = custom product



# Multi-Output Power Dividers

## QMD

### Characteristics

- ◆ Low Insertion Loss over Broad Bandwidth
- ◆ Compact, Miniature
- ◆ Between 3 and 16 Output Ports
- ◆ Customized Configuration and Outline



### Product Description

QuinStar Technology offers compact multi-output power dividers for frequencies in the 18 to 140 GHz range as standard and customized products to suit specific application and assembly needs. Typical configuration has one input waveguide port and multiple (between 3 and 16) equal output power waveguide ports with minimal additional loss. These output ports may be located either in line, or at customer specified locations. Wide range of options is offered for port orientation, power divider type (short-slot hybrid, hybrid tee, rat-race or ring hybrid, etc.) and port separation/location. Also, several different applicable choices of phase relationship between the output ports and input port can be offered. Standard Products have four output ports in-line with the input port.

Output ports are designed to have isolation between them with minimal additional insertion loss. These power dividers offer considerable savings in space, cost and insertion loss over a conventional assembly of individual 2-way power dividers.

Custom Multi-Output Power Divider Arrays find numerous applications in subsystems and antenna assemblies as well as multi-channel receivers and transmitter products. QuinStar has a large selection of standard compact power dividers for 4 output ports, and miniaturized power dividers. In addition, custom configurations and geometries can be readily created to suit specific mechanical and performance requirements.

### Specifications

Performance Parameter	Typical Value
Number of Output Ports	Between 3 and 16 (typically 2N output ports)
Additional Insertion Loss	0.5 x N dB (in addition to the power division loss) for 2N output ports - K, Ka, Q, U bands. 0.7 x N dB (in addition to the power division loss) for 2N output ports - V, E, W bands. 1.0 x N dB (in addition to the power division loss) for 2N output ports - F, D bands.
Isolation	From 15 dB minimum to greater than 60 dB depending on the output port number

### Ordering Information

Model Number **QMD -**

**A B CD EF**

waveguide band designator

K = K-band      E = E-band  
A = Ka-band     W = W-band  
Q = Q-band      F = F-band  
U = U-band      D = D-band  
V = V-band

Options and Special Features:

00 = Standard Product  
Or, a unique number assigned by  
QuinStar to Custom Multi-Output  
Power Divider

version

U = Upper 80% of waveguide band  
L = Lower 80% of waveguide band  
N = Narrow band  
Z = custom

Number of Output ports (03 to 16)

### Characteristics

- ◆ Low Pass-Band Insertion Loss
- ◆ High Out-of-Band Rejection
- ◆ Wide Range of Bandwidth Options



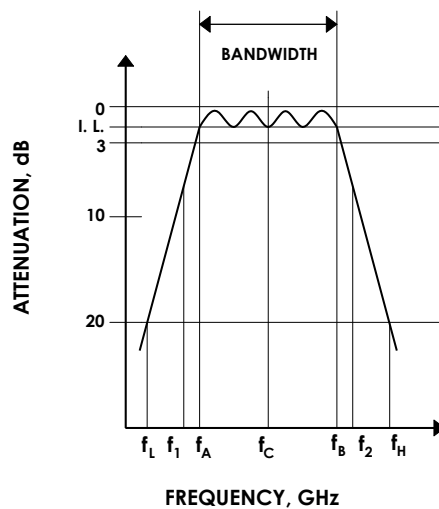
### Product Description

QuinStar Technology's **QFB** series **waveguide bandpass filters** are available in ten waveguide bands covering the frequency range of 18 to 220 GHz. Bandwidths may be specified from 2% to 20% of center frequency. The filters can handle up to one Watt (CW) of RF power. Standard versions are for 2%, 5% and 10% passband bandwidth.

The design ripple is typically 0.1 dB with a Chebychev response. High out-of-band rejection is offered with customer-specific attenuation characteristics. Since filter requirements vary widely, QuinStar Technology is set up to design and supply custom products in a short turnaround time.

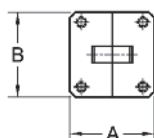
### Specifications

PERFORMANCE PARAMETER	TYPICAL CHARACTERISTICS
Range of Passband Bandwidth	2% to 20% of center frequency; standard versions 2%, 5%, 10%
Passband Attenuation (typ)	Less than 1 dB (Bandwidth & rejection dependent)
Rejection (typ)	20-40 dB at center frequency $\pm$ bandwidth
Ripple in Passband	0.1 dB to 0.5 dB depending on percent bandwidth and rejection requirements

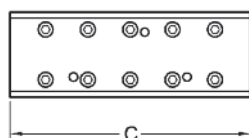


$f_A, f_B$ : Band edges  
 $f_L, f_H$ : 20 dB rejection points

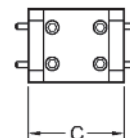
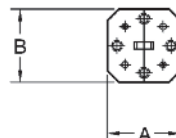
### Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-5



FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm		
			A	B	C <sup>1</sup>
K	WR-42	UG-595/U	0.88/22.4	0.88/22.4	2.00/51.0
Ka	WR-28	UG-599/U	0.75/19.1	0.75/19.1	2.00/51.0
Q	WR-22	UG-383/U	1.12/28.4	1.12/28.4	1.50/38.1
U	WR-19	UG-383/U	1.12/28.4	1.12/28.4	1.50/38.1
V	WR-15	UG-385/U	0.75/19.1	0.75/19.1	1.50/38.1
E	WR-12	UG-387/U	0.75/19.1	0.75/19.1	1.00/25.4
W	WR-10	UG-387/U-M	0.75/19.1	0.75/19.1	1.00/25.4
F	WR-8	UG-387/U-M	0.75/19.1	0.75/19.1	1.00/25.4
D	WR-6	UG-387/U-M	0.75/19.1	0.75/19.1	1.00/25.4
G	WR-5	UG-387/U-M	0.75/19.1	0.75/19.1	1.00/25.4

<sup>1</sup> Standard versions only. Length may vary depending on specifications. Contact QuinStar for exact length.

### Ordering Information

Model Number **QFB -**

**AB CD E 0**



Please specify exact center frequency and complete rejection requirements when ordering.

center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B0 = 110 GHz, etc.)

passband bandwidth rounded to nearest GHz

waveguide band designator

K = K-band	E = E-band
A = Ka-band	W = W-band
Q = Q-band	F = F-band
U = U-band	D = D-band
V = V-band	G = G-band

### Characteristics

- ◆ Low Insertion Loss
- ◆ High rejection Level
- ◆ Frequencies Up to 110 GHz

### Product Description

QuinStar Technology series **QFL Low Pass filters** provide high rejection level and steep skirt selectivity for frequencies above the band edge or corner frequency. Their pass band has low insertion loss over full standard waveguide bands. The lower band edge is established by the cut-off frequency of the waveguide for all standard models. These filters have a very wide rejection band that covers up to three times the highest pass band frequency. Series QFL filters are well suited as harmonic filters and as preselectors for receivers. They can be employed to remove undesirable sideband or spurious signals from

converters for receivers and transmitters. These filters also find applications in test equipment such as network analyzers and signal generators to eliminate or minimize sub-harmonics, harmonics and spurious signals.

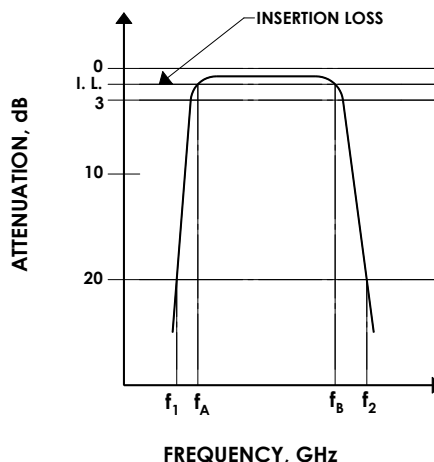
Standard products are offered in seven waveguide bands covering 18 to 110 GHz. Figure below shows the characteristics of this type of filters. Series QFL and QFH filters can be combined to create a very broad band-pass filter with distinct advantages

### Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Typical 3 dB Upper Cutoff Frequency (GHz)	28.5	41.5	52.2	62.3	77.0	93.0	114.0
Rejection Band (GHz)	30-100	48-120	60-145	72-185	90-220	108-270	132-330
Lower Cutoff Frequency (GHz) <sup>1</sup>	14.1	21.1	26.3	31.4	39.9	48.4	59.1
Insertion Loss (dB max)	1.0	1.0	1.0	1.0	1.2	1.5	1.8
Rejection Band for Attenuation >40 dB (GHz)	35-66	50-95	62-120	75-145	92-180	110-215	140-265

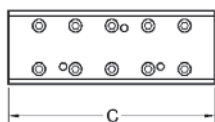
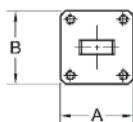
Other waveguide sizes are available.

<sup>1</sup> The lower cutoff frequency can be modified to meet special application requirements.

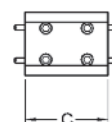
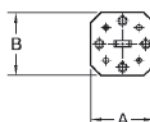


f<sub>B</sub>: High Cut-off frequency  
 f<sub>A</sub>: Low Cut-off frequency  
 (waveguide cut off)  
 f<sub>1</sub>, f<sub>2</sub>: 20 dB rejection points

## Outline Drawings/Mechanical Specifications



WR-42 and WR-28



WR-22 through WR-10

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm <sup>1</sup>	
			A, B	C
K	WR-42	UG-595/U	0.88/22.4	2.5/63.5
Ka	WR-28	UG-599/U	0.75/19.1	1.65/41.9
Q	WR-22	UG-383/U	1.13/28.7	1.5/38.1
U	WR-19	UG-383/U	1.13/28.7	1.5/38.1
V	WR-15	UG-385/U	0.75/19.1	1.0/25.4
E	WR-12	UG-387/U	0.75/19.1	1.0/25.4
W	WR-10	UG-387/U	0.75/19.1	1.0/25.4

<sup>1</sup> Standard versions.

## Ordering Information

Model Number **QFL -** **AB C D 00**

upper cutoff frequency rounded  
to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, etc.)

configuration

S = Standard  
Z = Custom

waveguide band designator

K = K-band      V = V-band  
A = Ka-band    E = E-band  
Q = Q-band    W = W-band  
U = U-band

### Characteristics

- ◆ Low Insertion Loss
- ◆ Custom Versions Available
- ◆ High rejection Level

### Product Description

Series QFH High-Pass Filters provide sharp skirt selectivity and high rejection levels for frequencies below their cutoff frequency and have minimum insertion loss in the pass band. Figure 1 shows the characteristics of this type of filters. These filters are offered in seven waveguide bands covering 18 to 110 GHz. Their rejection characteristics can be custom-designed to meet specified subsystem requirements.

These filters are ideally suited for rejecting lower sideband or image band in receivers, and for eliminating high power

signals at lower frequencies below the applicable signal band. They are also suitable for eliminating local oscillator leakage or spurious signals by limiting the band. Series QFH filters may be combined with series QFL Low Pass Filters to produce a band pass filter with very broad pass band.

The length of these filters depends on the rejection level and skirt selectivity. Please contact QuinStar for mechanical outline dimensions.



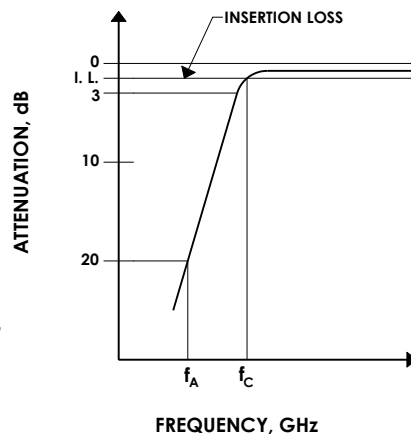
### Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Cutoff Frequency Range (GHz)	14-23	21-35	26-44	31-53	40-65	48-80	59-95
Pass Band Insertion Loss (dB max)	0.8	0.9	1.0	1.0	1.0	1.2	1.2
Pass Band VSWR (max)	1.15:1						
Rejection at 90% of Cutoff Frequency (dB min) <sup>1</sup>	45	45	40	40	40	35	35
Skirt Selectivity (dB/GHz typ) <sup>2</sup>	20	15	10	10	8	6	5

Other waveguide sizes are available.

<sup>1</sup> High pass filters are typically custom designed to meet your specific requirements. Typical performance presented here.

<sup>2</sup> Please contact QuinStar for mechanical specifications and/or outline drawing.



$f_c$ : Cut-off frequency  
 $f_A$ : Low side rejection frequency

Figure 1: High Pass Filter



## High Pass Filters QFH

### Ordering Information

Model Number **QFH -**

**AB C D 00**

lower cutoff frequency rounded  
to nearest GHz

waveguide band designator

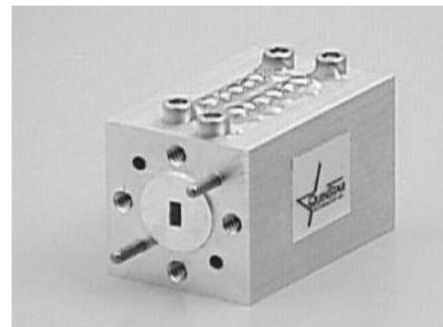
configuration

S = Standard  
Z = Custom

K = K-band	V = V-band
A = Ka-band	E = E-band
Q = Q-band	W = W-band
U = U-band	

### Characteristics

- ◆ Offered over 18-185 GHz
- ◆ High Rejection
- ◆ Low Insertion Loss over Pass Band
- ◆ Custom Designs Offered



### Product Description

QuinStar Technology offers Series QNF band-reject and notch filters at any rejection frequency in the 18-185 GHz range. The performance of these filters is custom-tailored to suit the specific attenuation need of the application. The insertion loss depends on the separation between the rejection frequency and the pass band, and the amount of rejection required. Very large rejection (attenuation) can be achieved over a relatively narrow frequency range to allow a high power signal (or interference signals) to be virtually eliminated from the band. These filters are

particularly well suited for eliminating harmonics and known interference frequencies from a system input or output in communication and plasma diagnostic receivers and radars.

The mechanical dimensions and performance characteristics are largely determined by the rejection requirements. QuinStar can also design and produce harmonic-reject filters for specific systems or equipment to meet compliance with regulations.

### Specifications

Performance Parameter	Notch Filter	Band-Reject Filter
Frequency Range (Pass Band)	Up to Full Waveguide Band	
Rejection Frequency (center)	Anywhere From Waveguide Cutoff to 2.5 X Waveguide Cutoff Frequency	
Rejection Bandwidth (at 10 dB insertion loss points in rejection band)	From 1% to 5% of Notch Center Frequency	
Insertion Loss	1-2.5 dB depending on required rejection characteristics	
Rejection Level (at center of rejection frequency band)	20 dB to 65 dB	

### Ordering Information

Model Number **QNF -**

**ABC DE F GH**

rejection band center frequency  
(or notch frequency), in GHz

rejection bandwidth (full width  
at 10 dB rejection points)

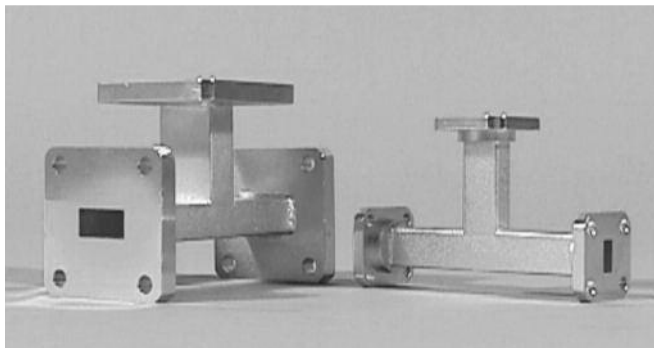
rejection (min.) at rejection band  
center (notch frequency)

waveguide band

K = K-band      E = E-band  
A = Ka-band    W = W-band  
Q = Q-band      F = F-band  
U = U-band      D = D-band  
V = V-band

## Characteristics

- ◆ Unmatched Ports
- ◆ Geometrical Symmetry
- ◆ Available from 12.4 to 220 GHz
- ◆ Equal Power Division Between the Two Outputs



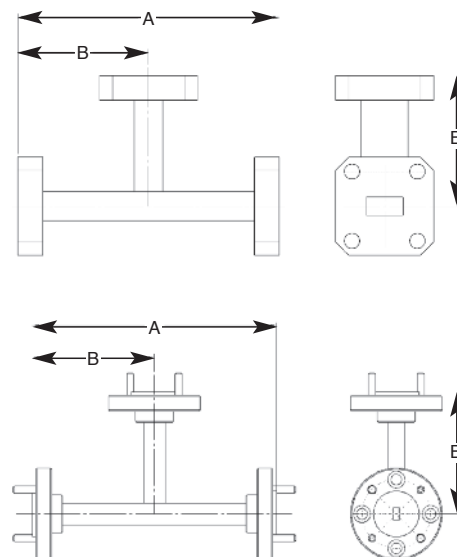
## Product Description

QuinStar Technology's E-plane tees consist of a length of standard flanged waveguide with a perpendicular E-plane coupling arm symmetrically located on the broad waveguide wall. Input power is divided equally and in opposite phase between the two outputs.

Similarly, the H-plane tees feature an H-plane coupling arm located on the narrow waveguide wall. Power at the coupling arm input is divided into equal signals in phase at the main outputs. These devices are available in standard waveguide sizes from 12.4 to 220 GHz. Neither of the tees has matched junctions and therefore they are not recommended for low VSWR applications.

## Outline Drawings/Mechanical Specifications

FREQUENCY BAND	OUTLINE DIMENSIONS, inches/mm	
	A	B
<b>Ku</b>	2.5/63.5	1.25/31.75
<b>K</b>	2.00/50.80	1.00/25.40
<b>Ka</b>	2.40/60.96	1.20/30.48
<b>Q</b>	2.40/60.96	1.20/30.48
<b>U</b>	2.40/60.96	1.20/30.48
<b>V</b>	2.00/50.80	1.00/25.40
<b>E</b>	2.00/50.80	1.00/25.40
<b>W</b>	2.00/50.80	1.00/25.40
<b>F</b>	1.5/38.10	0.75/19.05
<b>D</b>	1.5/38.10	0.75/19.05
<b>G</b>	1.5/38.10	0.75/19.05



## Ordering Information

Model Number **QUH - A B 000**

waveguide band designator

Y = Ku-band  
K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band

E = E-band  
W = W-band  
F = F-band  
D = D-band  
G = G-band

waveguide plane

E = E-plane tee  
H = H-plane tee



# Waveguide Straight Sections and Tapered Transitions

## QWS/QWR/QWP

### Characteristics

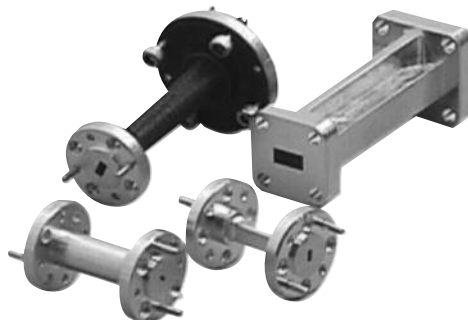
- ◆ Low VSWR
- ◆ Minimum Insertion Loss
- ◆ Precise Construction

### Product Description

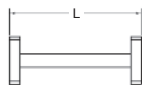
QuinStar Technology's **QWS**, **QWR** and **QWP** series **waveguide straight sections**, **raw waveguide** and **tapered transitions** cover the frequency range of 18 to 220 GHz in ten waveguide bands. Straight waveguide sections are available in standard lengths as well as customer-specific lengths.

The tapered transitions allow very efficient propagation of RF energy from one waveguide size to another.

The straight sections are built with precision and plated for low insertion loss and high corrosion resistance. Typical VSWR for straight sections is 1.05:1 over the entire frequency band.



### Outline Drawings/Mechanical Specifications



Straight Section



Tapered Transition

TAPERED TRANSITION LENGTHS, inches/mm										
FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D	G
Freq. Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170	140-220
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6	WR-5
K-band to		2.20/56.0	2.20/56.0	2.50/64.0	2.70/69.0	3.30/84.0	3.30/84.0	3.20/81.0	3.50/89.0	3.60/92.0
Ka-band to			2.00/51.0	2.00/51.0	2.00/51.0	2.40/61.0	1.80/46.0	2.20/56.0	2.30/58.0	2.40/61.0
Q-band to				1.80/46.0	1.80/46.0	1.80/46.0	1.80/46.0	1.80/46.0	1.80/46.0	1.90/48.3
U-band to					1.60/40.6	1.50/38.0	1.50/38.0	1.50/38.0	1.50/38.0	1.60/40.6
V-band to						1.40/36.0	1.40/36.0	1.40/36.0	1.40/36.0	1.40/36.0
E-band to							1.30/33.0	1.30/33.0	1.30/33.0	1.30/33.0
W-band to								1.20/31.0	1.20/31.0	1.20/31.0
F-band to									1.10/27.0	1.10/27.0
D-band to										1.00/26.0



# Waveguide Straight Sections and Tapered Transitions

## QWS/QWR/QWP

### Ordering Information

**Model Number** **QW - A BCD E 0**

model prefix

S = straight section  
R = raw waveguide (no flanges)

waveguide band designator

K = K-band      E = E-band  
A = Ka-band    W = W-band  
Q = Q-band      F = F-band  
U = U-band      D = D-band  
V = V-band      G = G-band

options

0 = none  
Z = special features

length rounded to nearest tenth of  
an inch

010 = 1.0 inch

**Model Number** **QWP - A B 0000**

larger waveguide band designator

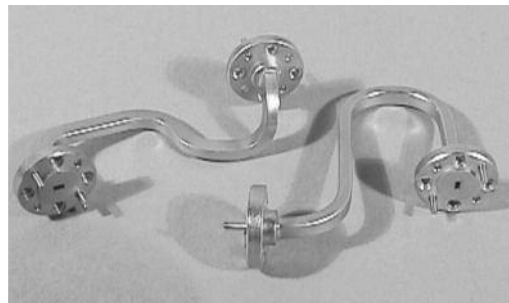
K = K-band      E = E-band  
A = Ka-band    W = W-band  
Q = Q-band      F = F-band  
U = U-band      D = D-band  
V = V-band      G = G-band

smaller waveguide band designator  
(see list at left)



## Characteristics

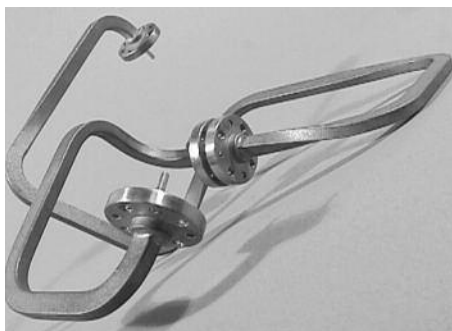
- ◆ Accurate Mechanical Dimensions for Complex Geometries
- ◆ Low Insertion Loss and VSWR
- ◆ Built Precisely to Customer's Specifications and Drawings
- ◆ Options in material, finish and features



## Product Description

QuinStar Technology specializes in producing custom waveguide assemblies for use in virtually any product assembly and for interconnects in millimeter wave subsystems. These waveguide assemblies can involve complex bend, twists, and other mechanical features required for low loss interconnections within subsystem

assemblies. Each waveguide assembly is manufactured to customer's precise mechanical drawing and specifications using the most suitable material, waveguide flanges and finish. Examples of some of the previously delivered assemblies are shown.



## Ordering Information

Model Number **QAC -**

**A BCDEF**

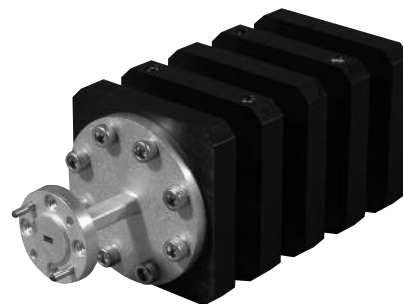
waveguide band designator

K = K-band	E = E-band
A = Ka-band	W = W-band
Q = Q-band	F = F-band
U = U-band	D = D-band
V = V-band	G = G-band

unique number assigned by QuinStar to custom assembly.

### Characteristics

- ◆ Low VSWR
- ◆ Compact Size
- ◆ Full Waveguide Bandwidths
- ◆ Available for High Power up to 300 watts CW Applications



### Product Description

QuinStar Technology offers a broad line of waveguide terminations in a variety of shapes and style, wide range of power handling capacities and cooling methods to suit both typical and special applications. The QWN series Standard Waveguide Terminations consist of an RF-absorbing matched load mounted in a short length of flanged waveguide. These standard terminations, offered in the K through G waveguide bands can dissipate 1 to 5 Watts of power depending on the specific band. They also present a low VSWR over the full waveguide band.

The QTW series High Power Terminations are produced with standard waveguide flange interface from 12.4 to 220 GHz in Ku through G bands. The termination consists of a short length of waveguide and an integral matched terminal load. Individual resistive dielectric loads are

tapered to precise wedge configurations for maximum effective power absorption. The gradual taper ensures a low VSWR over the full waveguide band. These loads have the capacity to absorb from 100 Watts to 300 Watts of power depending on the frequency band.

Series QTZ Custom High Power Terminations are available with custom form factors and features for radar and other high power transmitter applications. These terminations are specially designed and manufactured to meet the customer's mechanical and electrical requirements, and may incorporate convection cooling, active forced-air cooling or liquid cooling to dissipate the heat generated from power absorption. They are available within the C to Ku-bands, with power handling capacities up to 4 kW CW.

### Specifications

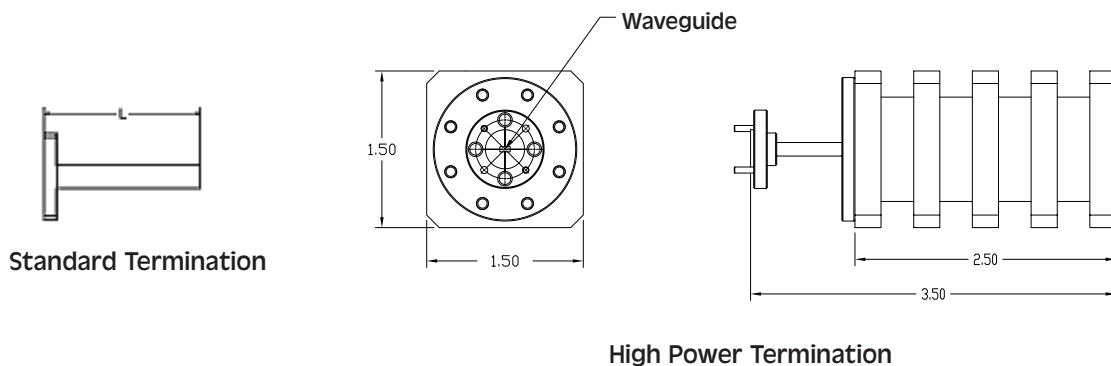
SERIES QWN STANDARD TERMINATIONS											
WAVEGUIDE BAND	K	Ka	Q	U	V	E	W	F	D	G	
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170	140-220	
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6	WR-5	
VSWR (max.)	1.03:1	1.03:1	1.04:1	1.05:1	1.05:1	1.06:1	1.06:1	1.08:1	1.1:1	1.12:1	
Power Handling (W)	5	5	4	4	3	3	3	3	1	1	
Length (in/mm)	3.31/84.0	2.81/71.3	2.56/65.0	2.56/65.0	1.56/39.6	1.56/39.6	1.56/39.6	0.9/22.8	0.90/22.8	0.9/22.8	
SERIES QTW HIGH POWER TERMINATIONS											
WAVEGUIDE BAND	Ku	K	Ka	Q	U	V	E	W	F	D	G
Frequency Band (GHz)	12.4-18	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170	140-220
VSWR Max.	1.10:1	1.10:1	1.10:1	1.10:1	1.10:1	1.10:1	1.10:1	1.10:1	1.15:1	1.15:1	1.15:1
Average Power (Watts)	300	250	250	250	250	200	200	200	200	100	100



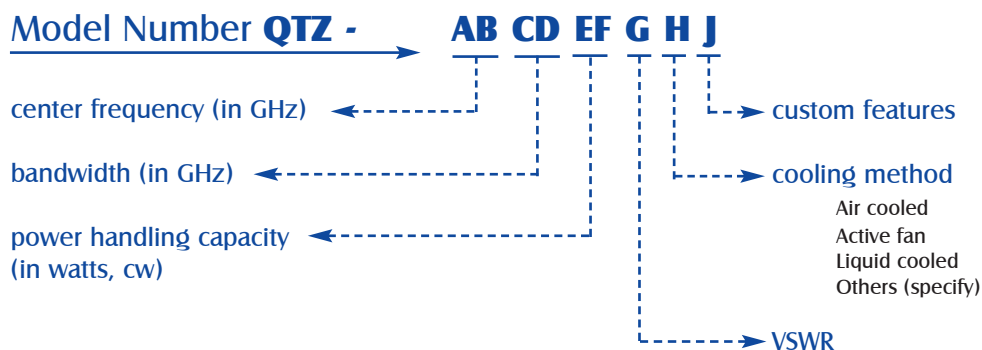
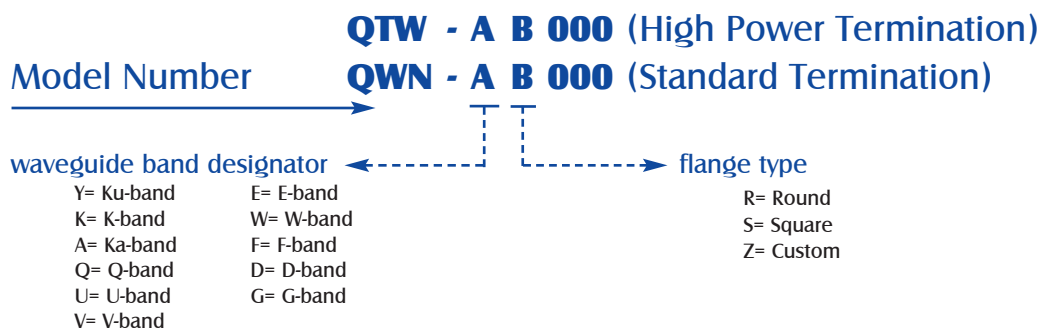
# Waveguide Terminations

## QWN/QTW/QTZ

### Outline Drawings/Mechanical Specifications



### Ordering Information





# Waveguide Bends and Twists

## QWB/QWT

### Characteristics

- ◆ 30°, 45°, 60° and 90° Bends
- ◆ 45° and 90° Twists
- ◆ Minimum Insertion Loss

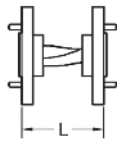


### Product Description

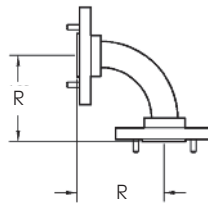
QuinStar Technology's **QWB** and **QWT** series **waveguide bends and twists** cover the frequency range of 18 to 220 GHz in ten waveguide bands. E-Plane and H-Plane formed bends are available with angles of 30°, 45°, 60°, and 90°. The twists allow changing the orientation in a waveguide

assembly. They are available with angles of 45° in either a left- or right-hand twist or a standard 90°. The bends and twists are built with high precision and then gold plated for low insertion loss and high corrosion resistance. Typical VSWR is 1.10:1 over entire frequency band.

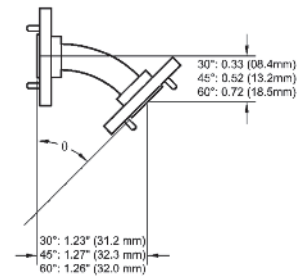
### Outline Drawings/Mechanical Specifications



Waveguide Twist  
(round flange pattern shown)



Right Angle



Waveguide Bends  
(round flange pattern shown)

FREQUENCY BAND	K	Ka	Q, U	V, E, W, F, D, G
Waveguide Size	WR-42	WR-28	WR-22, -19	WR-15, -12, -10, -8, -6, -5
Twist Length, inches/mm	2.5/63.5	1.75/44.5	1.25/31.8	1.00/25.4
Right Angle (90°) Bend Radius, inch/mm	1.5/38.1	1.5/38.1	1.5/38.1	1.0/25.4

### Ordering Information

#### Model Number

**QW - A B C D E**

model prefix

B = bend  
T = twist

flange type

R = round  
S = square  
Z = custom

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band  
F = F-band  
D = D-band  
G = G-band

type of twist or bend

L = left-handed twist  
R = right-handed twist  
0 = 90° twist  
E = E-plane bend  
H = H-plane bend

angle of twist or bend

30 = 30° / 60 = 60° / 45 = 45° / 90 = 90°



# Tunable Loads, Tunable Shorts, and E-H Tuners

## QWG/QAT/QWU

### Characteristics

- ◆ Full Waveguide Bandwidth
- ◆ Frequency 26.5-220 GHz
- ◆ Precision Micrometer Adjustment



### Product Description

QuinStar Technology's series **QWG, QAT and QWU tunable loads, tunable shorts** and **E-H tuners** are available in nine waveguide bands. They provide full waveguide band coverage and are ideally suited for precision measurements, experimental testing and developmental tuning.

**Tunable Loads:** Consist of a precision tapered waveguide load coupled to a micrometer drive. Repositioning of the sliding load permits determination of a minimum/maximum VSWR due to the phasing between the VSWR of the load and the VSWR of the unit under test.

**Tunable Shorts:** Consist of a movable non-contacting choke type short circuit designed to operate with high

electrical stability over the entire waveguide band. A micrometer drive provides smooth accurate positional tuning of one-half wavelength at the lowest operating frequency and a positive locking feature is included.

**E-H Tuners:** Consist of a hybrid tee section with micrometer drive tunable shorts (described above) in both the E-plane and H-plane arms. These tuners introduce discontinuities into the waveguide transmission line for simultaneous control of both phase and amplitude of the RF reflection coefficient. They can be used as matching devices to cancel reflections in transmission lines or to match detectors, terminations or similar components.

### Ordering Information

Model Number **Q - A 00000**

model prefix

WG = tunable load  
AT = tunable short  
WU = E-H tuner

waveguide band designator

A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band  
F = F-band  
D = D-band  
G = G-band



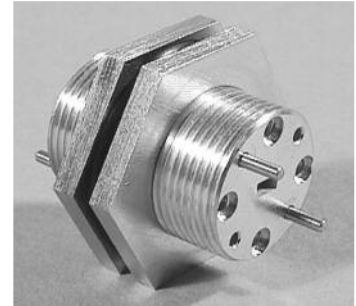
# Waveguide Flanges, Adapters and Associated Hardware

## Bulkhead Waveguide Adapter

QBA

### Product Description

QuinStar Technology's series QBA waveguide bulkhead adapter was developed for use as panel feed-through in assemblies and equipment packaging. These adapters operate over the full waveguide bandwidth in waveguide bands from 18.0 to 140 GHz. O-rings are provided on the panel mount for moisture resistance and a wide variety of flange types and configurations are offered. Standard lengths are 1.00 inches with custom lengths available upon request.



### Ordering Information

Model Number **QBA -** **A BCD 0**

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band  
F = F-band

flange type number

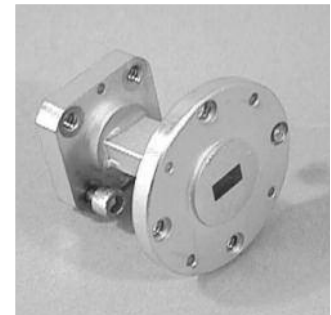
595 = UG 595 (K-band)  
599 = UG-599 (Ka-band)  
383 = UG-383 (Q- and U-band)  
385 = UG-385 (V-band)  
387 = UG-387 (E-, W- and F-band)

## Flange Adapters

QFA

### Product Description

QuinStar series QFA Flange Adapters are used to facilitate connection between different types or formats of flanges used for the same waveguide size. These are produced in various waveguide bands in the 12.4 to 220 GHz range with various combinations of commonly used flange styles attached to the two ends of a short low-loss waveguide. Custom combinations are also available upon request. Standard length is 1.0"



### Ordering Information

Model Number **QFA -** **A BCD EFG**

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band  
F = F-band

first flange type number  
(see QBA above)

second flange type number  
(see QBA above)



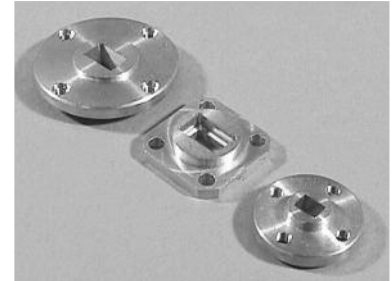
# Waveguide Flanges, Adapters and Associated Hardware

## Waveguide Flanges

QFF

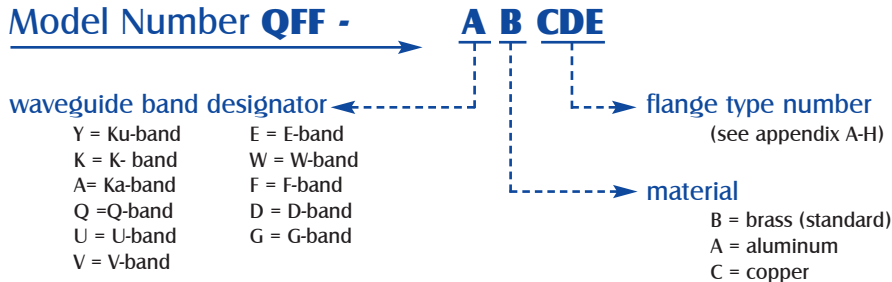
### Product Description

QuinStar series QFF precision machined waveguide flanges are offered for virtually any waveguide size and flange style in 12.4 to 220 GHz range covering waveguide bands WR-62 (KU) to WR-5 (G-band). Flanges with choke and O-ring groove are also available. All flanges are available in brass, aluminum or copper as material. Special flanges can be designed and manufactured as custom products.



### Ordering Information

Model Number **QFF -**

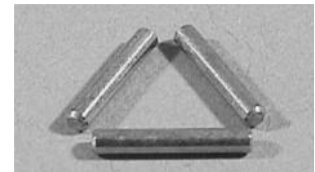


## Stainless Steel Dowel Pins

QFP

### Product Description

Available in 0.062-inch diameter (standard size) in units of 50 pins per bag



## Captivated Waveguide Flange Screws

QFS

### Product Description

Captivated waveguide flange screws are stainless steel 3/8" diameter head with 3/32" socket, 5/16" shaft length, standard 4-40 thread size. They are offered in bags of 50 screws each.





## Precision Drill Jigs & Waveguide Stands

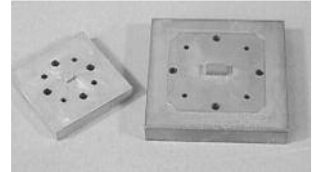
### Precision Drill Jigs

#### Product Description

Available in standard Ka to G waveguide bands (WR-28 to WR-06)

QuinStar Technology's Drill Jigs consists of a solid steel block with accurately positioned drill holes and a tapered locating tab that will locate the drill holes in precise relation to the internal waveguide surfaces. Hardened steel minimizes wear to ensure drilling accuracy. These precision drill jigs are designed to facilitate accurate fabrication of flanged waveguide sections for standard waveguide sizes from 26.5 to 220 GHz. They are used to locate alignment pins, mating pin holes, and connecting screw holes in the waveguide flanges.

QDJ



#### Ordering Information

Model Number **QDJ** -

**A BCD 00**

← waveguide band designator

→ flange type number

(see appendix A-B)

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band

V = V-band  
E = E-band  
W = W-band  
F = F-band

### Waveguide Stands

#### Product Description

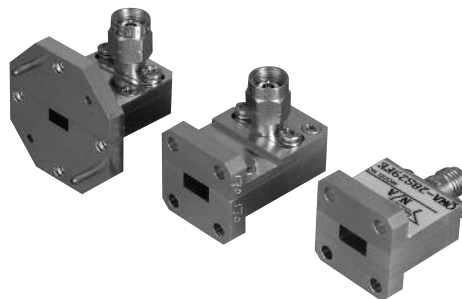
QuinStar Technology's waveguide stand consists of an adjustable clamp mounted on an adjustable height base stand. The waveguide clamp may be readily adjusted to fit all waveguide sizes and orientations. The stand has a large base area to prevent moving or tipping under normal test bench conditions. For further stability, the base may be secured to the bench with mounting bolts.

QVS



## Characteristics

- ◆ Low Insertion Loss
- ◆ Full Waveguide Band Operation
- ◆ Frequency Ranges 12.4 to 67 GHz



## Product Description

QuinStar Technology's **QWA** series **waveguide to coax adapters** allow an efficient method of transition from rectangular waveguide to a coaxial connector. Full waveguide band adapters are available from 18 to 67 GHz in K through V bands. Coaxial connectors include N, SMA, K, 2.4 mm and V connectors as appropriate for the applicable frequency range, with both male and female types. Exceptionally low insertion loss and low VSWR are the key features of this series of adapters.

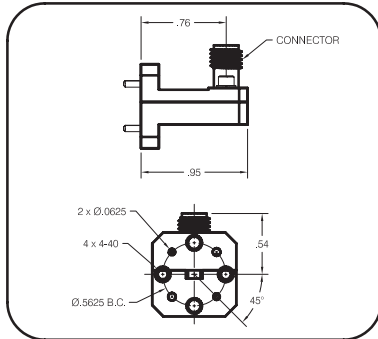
Two mechanical configurations for the interfaces of these adapters are offered: Right Angle and End-Launch. End launch or in-line version of the adapters are constructed such that the waveguide port and the coaxial connector are in line with each other. These adapters are very compact and useful where right angle adapters are mechanically not suitable.

## Specifications

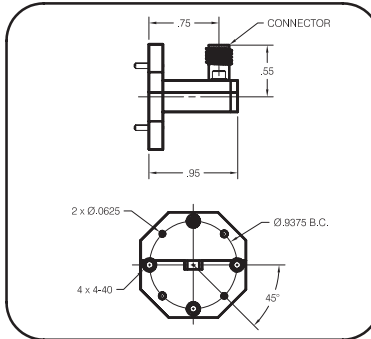
Model No. Range, (GHz)	Frequency	Waveguide	Flange	Standard Connectors Available	Insertion Loss (dB) max.		VSWR (typ.)	
					Right Angle	End Launch	Right Angle	End Launch
<b>QWA-62</b>	12.4-18	WR-62	UG-419/U	N, SMA	0.3	0.4	1.25:1	1.5:1
<b>QWA-51</b>	15-22	WR-51	UG-419/U	SMA, K	0.3	0.4	1.25:1	1.5:1
<b>QWA-42</b>	18-26.5	WR-42	UG-595/U	SMA, K	0.3	0.4	1.25:1	1.5:1
<b>QWA-34</b>	22-33	WR-34	UG-595/UM	K, 2.4 mm	0.35	0.45	1.25:1	1.5:1
<b>QWA-28</b>	26.5-40	WR-28	UG-599/U	K, 2.4 mm	0.4	0.5	1.25:1	1.5:1
<b>QWA-180</b>	18-40	WRD-180	UG-1587	K	N/A	0.6	N/A	1.5:1
<b>QWA-22</b>	33-50	WR-22	UG-383/UM	K*, 2.4 mm	0.6	0.7	1.35:1	1.5:1
<b>QWA-19</b>	40-60	WR-19	UG-383/UM	2.4 mm*, V	0.8	0.9	1.5:1	1.6:1
<b>QWA-15</b>	50-67	WR-15	UG-385/U	V	1.2	1.3	1.5:1	1.6:1

\* K connector up to 40 GHz only. Also, 2.4 mm connector up to 50 GHz only.

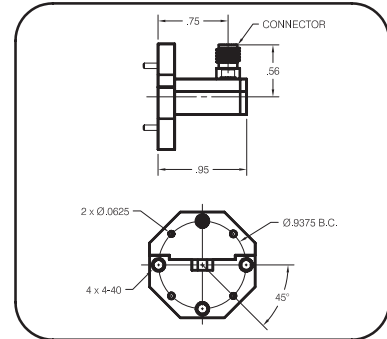
## Outline Drawings/Mechanical Specifications



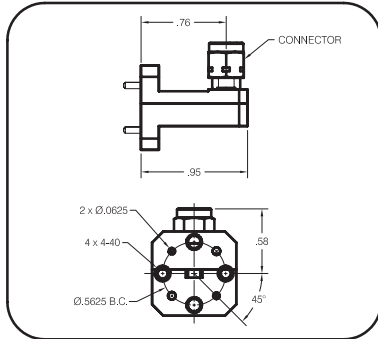
QWA15R18F



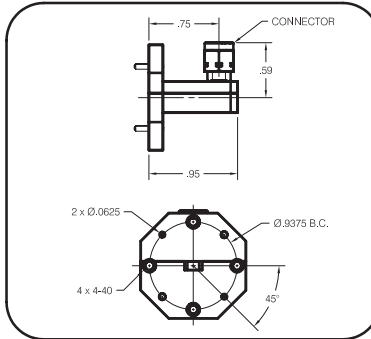
QWA19R18F



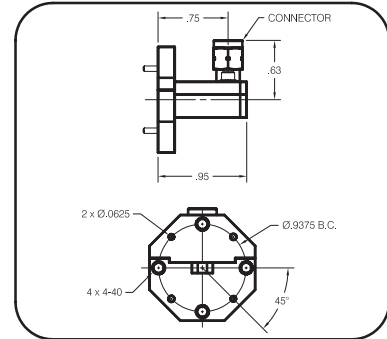
QWA22R24F



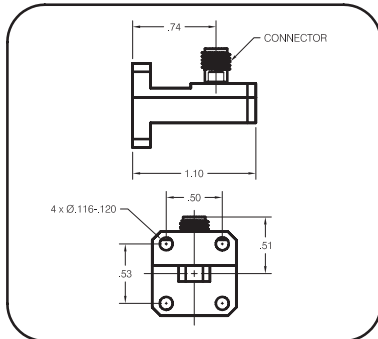
QWA15R18M



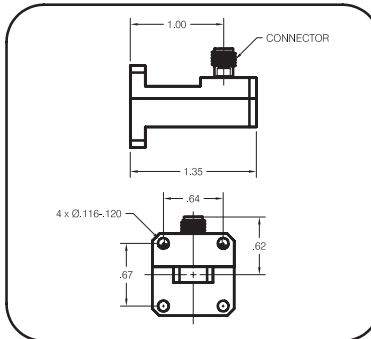
QWA19R18M



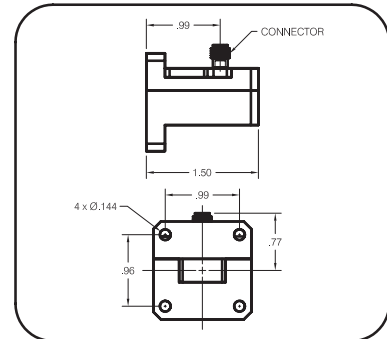
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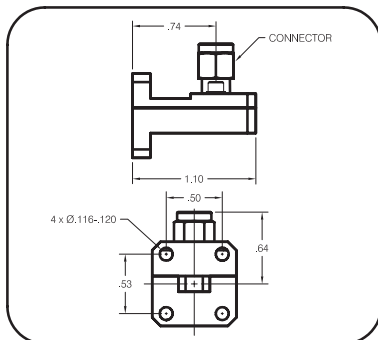
QWA28S29F



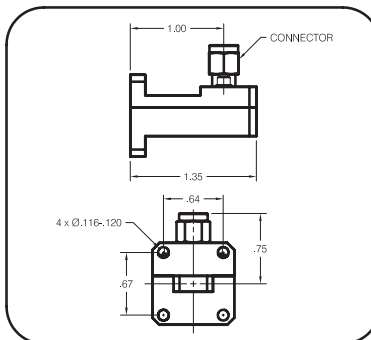
QWA42S29F



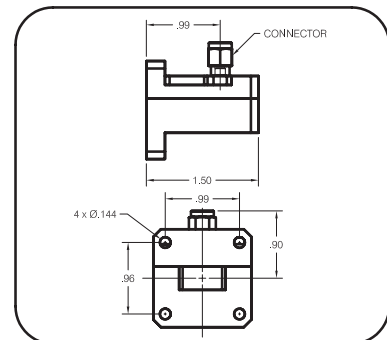
QWA62S35F



QWA28S29M

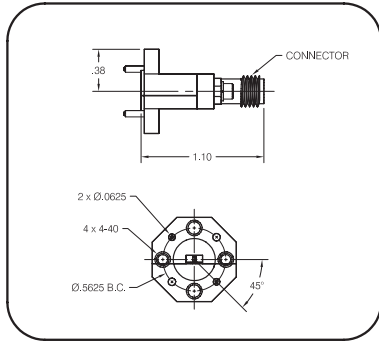


QWA42S29M

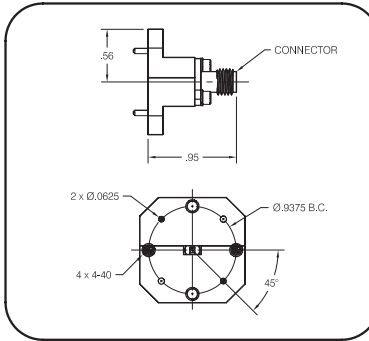


QWA62S35M

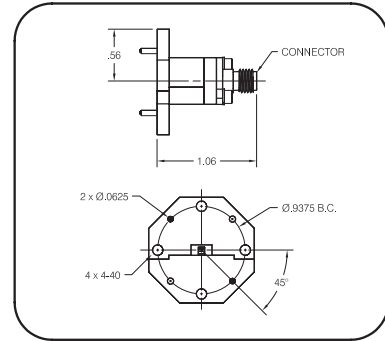
## Outline Drawings/Mechanical Specifications



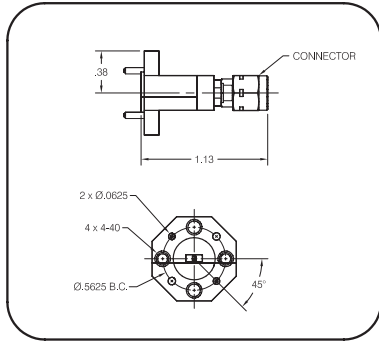
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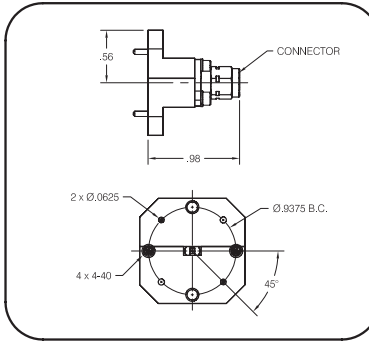
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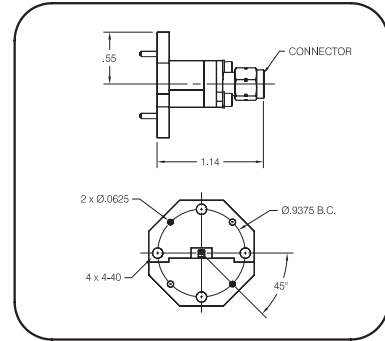
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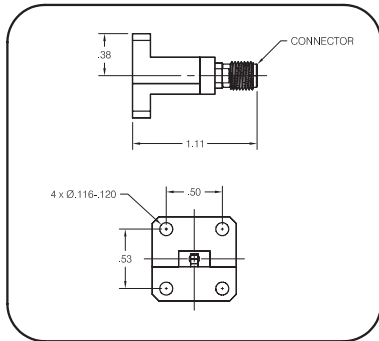
QWA15R18ME



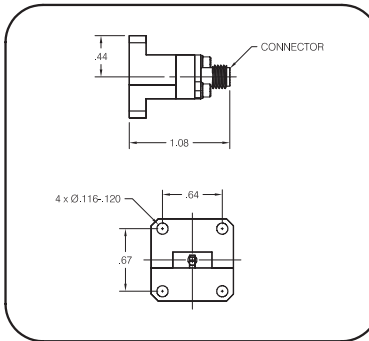
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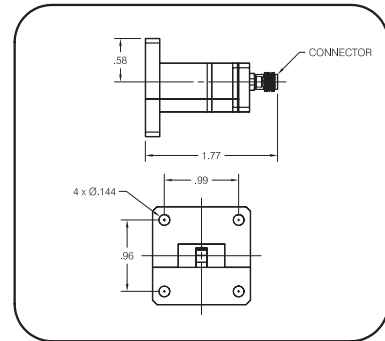
QWA22R24ME



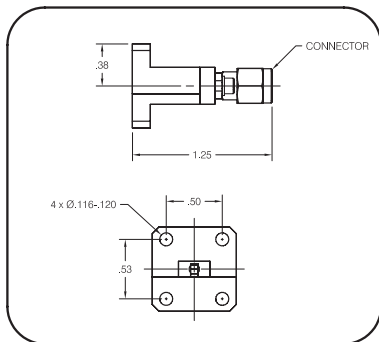
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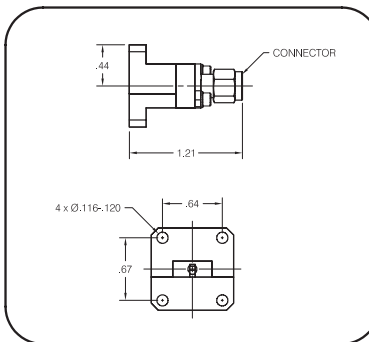
QWA42S29FE



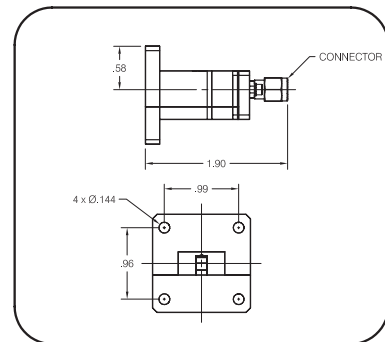
QWA62S35FE



QWA28S29ME



QWA42S29ME



QWA62S35ME



# Waveguide to Coax Adapters

## QWA

### Ordering Information

Model Number **QWA -**

**A B C D E F G H**

waveguide band designator

62 = WR-62  
51 = WR-51  
42 = WR-42  
34 = WR-34  
28 = WR-28  
DR = WRD 180 (double ridge)  
22 = WR-22  
19 = WR-19  
15 = WR-15

flange pattern

R = round  
S = square

custom options

0 = standard product  
Z = custom product

end launch option

0 = right angle version  
E = end-launch version

connector gender

M = male  
F = female

coaxial connector type

N0 = N-type Connector  
SM = SMA Connector  
29 = 2.9 mm (K-connector)  
24 = 2.4 mm  
18 = 1.85 mm (V-connector)

## Section 6

# Test Equipment & Instrumentation Products

Product Title	Model No.	Page Number
<b>Test Equipment and Instrumentation Products</b>		141
Manual Waveguide Switches	<b>QWM</b>	142
Electromechanical Waveguide Switches	<b>QWZ</b>	143
Micrometer type Level Set Attenuators and Variable Phase Shifters, Fixed Attenuators	<b>QAF/QAL/QAS</b>	145
Dial type Level Set Attenuators and Variable Phase Shifters	<b>QDA/QDP</b>	147
Direct Reading Attenuators and Phase Shifters	<b>QAD/QPS</b>	149
Motorized, Programmable Attenuators	<b>QPA</b>	152
Motorized, Programmable Phase Shifters	<b>QMP</b>	154



# Manual Waveguide Switches

**QWM**

## Characteristics

- ◆ Full Waveguide Band
- ◆ Low Loss
- ◆ High Isolation
- ◆ Smooth, Accurate Positioning

## Product Description

QuinStar Technology's series **QWM waveguide switches** are manual 4-port devices. They have a 3-channel rotor accurately indexed to eight 45 degree positions that allows each port to be connected or isolated from any other port. The switches are available in seven waveguide bands covering the frequency range of 18-110 GHz and are

precision machined with bearing and indexing grooves for smooth operation and accurate positioning. They are useful in test set-ups and system applications where transfer switching is required. In addition to standard manual switches, custom electromechanical waveguide switches are also available.

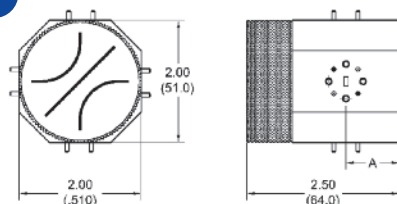


## Specifications

FREQUENCY BAND	K <sup>1</sup>	Ka	Q	U	V	E	W
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Flange Pattern	UG-595/U	UG-599/U	UG-383/U	UG-383/U	UG-385/U	UG-387/U	UG-387/U
Bandwidth (GHz)	Full						
Isolation (dB typical)	60						
Insertion Loss (dB max)	0.4	0.4	0.5	0.5	0.6	0.7	0.8
VSWR (typical)	1.15:1						
Dimension "A" (inches/mm)	0.74/18.7	0.73/18.5	0.72/18.3	0.71/18.0	0.70/17.8	0.69/17.5	0.68/17.2

<sup>1</sup> K-band two-channel bidirectional rotor.

## Outline Drawing



## Ordering Information

Model Number **QWM - A 00000**

waveguide band designator

K = K-band    Q = Q-band    V = V-band    W = W-band  
A = Ka-band    U = U-band    E = E-band



# Electromechanical Waveguide Switches

QWZ

## Characteristics

- ◆ Full Waveguide Band
- ◆ High Isolation/Low Loss
- ◆ Accurate Positioning
- ◆ Bi-directional

## Product Description

QuinStar Technology's series **QWZ electromechanical waveguide switches** are 4-port mechanical devices that are rotational solenoid driven and electronically controlled. They have a bi-directional rotor accurately indexed to 90 degree positions that allows each port to be connected to either of the adjacent ports. The switches are available in

seven waveguide bands covering the frequency range of 18-110 GHz and are precision machined with bearing and indexing grooves for smooth operation and accurate positioning. They are useful in automated test set ups and system applications where remotely controlled transfer switching is required.



## Specifications

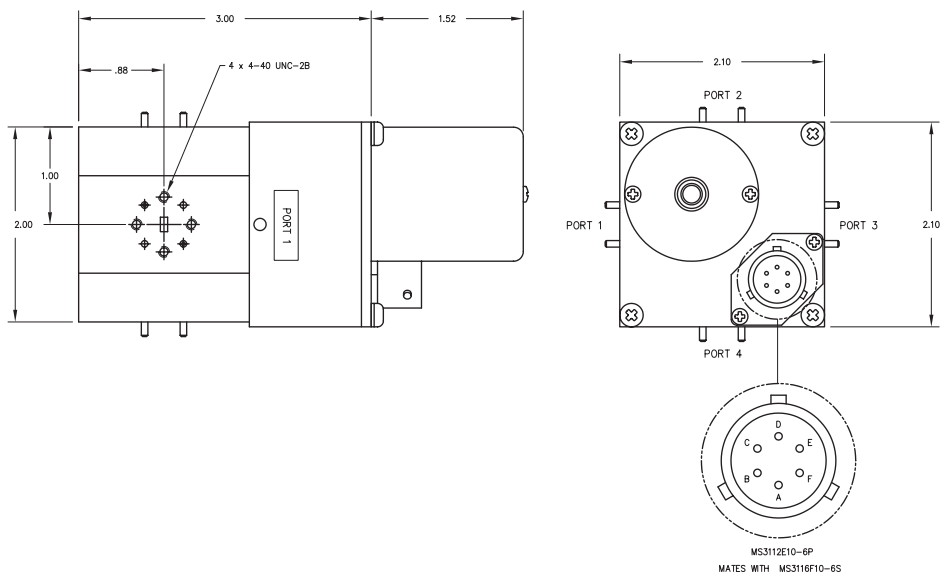
FREQUENCY BAND	K	Ka	Q	U	V	E	W
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Flange Pattern	UG-595/U	UG-599/U	UG-383/U	UG-383/U	UG-385/U	UG-387/U	UG-387/U
Bandwidth (GHz)	Full						
Isolation (dB typical)	60						
Insertion Loss (dB max)	0.4	0.4	0.5	0.5	0.6	0.7	0.8
VSWR (typical)	1.15:1						
Control Interface	TTL or microswitch						
Switching Speed (ms typ)	50						
DC Power Requirement	15VDC/2.0A or 28VDC/1.0A pulse typical						



# Electromechanical Waveguide Switches

## QWZ

### Outline Drawing



### Ordering Information

Model Number **QWZ -**

**A B CD 00**

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band

supply voltage

15 = 15 VDC  
28 = 28 VDC

control interface

T = TTL  
M = microswitch



# .....Micrometer Type Level Set Attenuators, Variable Phase Shifters and Fixed Attenuators QAF/QAL/QAS

## Characteristics

- ◆ Broadband Operation
- ◆ 3-30 dB Fixed Attenuation
- ◆ 0-25 dB Variable Attenuation
- ◆ 0-180° Variable Phase Shift

## Product Description

QuinStar Technology's **QAF** and **QAL** series **fixed and level set attenuators** and **QAS** series **variable phase shifters** are available in seven waveguide bands covering the frequency range of 18 to 110 GHz. The fixed attenuators feature low VSWR in five standard values of attenuation. Custom fixed attenuators with 5w power rating are also available. The level set attenuators and phase shifters



incorporate a micrometer which enables very fine and repeatable adjustments to be made. They are fabricated using a straight waveguide section into which is placed either a lossy material for the attenuators, or a dielectric vane for the phase shifters. Operating characteristics are relatively constant over full waveguide bandwidths.

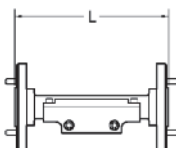
## Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
Fixed Attenuator Attenuation Values	03, 06, 10, 20, 30 dB or customer specific value						
Power Rating, Watts	2.0	2.0	2.0	2.0	1.0	1.0	1.0
VSWR (typ)	1.15:1						
Level Set Attenuator Range	0 to 25 dB variable						
Insertion Loss (dB typ)	0.3	0.3	0.4	0.5	0.6	0.7	0.8
VSWR (typ)	Attenuation < 20 dB 1.2:1, attenuation > 20 dB: 1.5:1						
Variable Phase Shifter Range	0-180 degrees						
Insertion Loss (dB typ)	0.5	0.5	0.6	0.7	0.8	0.9	1.0
VSWR (typ)	1.4:1						
Power Rating (Level set attenuator & phase shifter)	0.5 Watts up to 60 GHz, 0.3 Watts beyond						

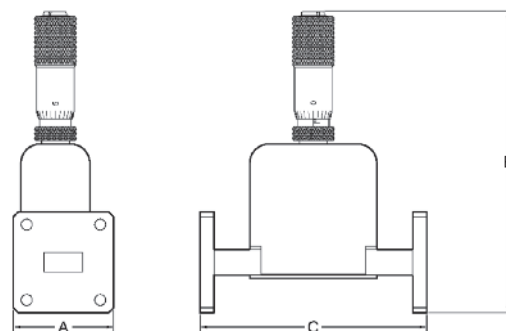


# Micrometer Type Level Set Attenuators, Variable Phase Shifters and Fixed Attenuators QAF/QAL/QAS

## Outline Drawings/Mechanical Specifications



Fixed Attenuator  
(round flange pattern shown)



Level Set Attenuator/Variable Phase Shifter  
(square flange pattern shown)

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm			
			LEVEL SET ATTENUATOR/PHASE SHIFTER			FIXED ATTENUATOR
			A	B	C	L
K	WR-42	UG-595/U	0.88/22.4	3.70/94.0	4.00/101.6	3.0/76.2
Ka	WR-28	UG-599/U	0.75/19.1	3.60/91.4	3.00/76.2	2.75/69.9
Q	WR-22	UG-383/U	1.125/28.6	3.60/91.4	3.00/76.2	2.75/69.9
U	WR-19	UG-383/U	1.125/28.6	3.60/91.4	3.00/76.2	2.75/69.9
V	WR-15	UG-385/U	0.75/19.1	3.60/91.4	3.00/76.2	2.0/50.8
E	WR-12	UG-387/U	0.75/19.1	3.60/91.4	3.00/76.2	2.0/50.8
W	WR-10	UG-387/U	0.75/19.1	3.60/91.4	3.00/76.2	2.0/50.8
F	WR-8	UG-387/U	0.75/19.1	3.60/91.4	3.00/76.2	2.0/50.8
D	WR-6	UG-387/U	0.75/19.1	3.60/91.4	3.00/76.2	2.0/50.8

## Ordering Information

Model Number **QA - A BC 000**

model prefix

F = fixed attenuator  
L = level set attenuator  
S = variable phase shifter

fixed attenuator value in dB  
("00" for level set attenuator  
and variable phase shifter)

waveguide band designator

K = K-band      E = E-band  
A = Ka-band    W = W-band  
Q = Q-band      F = F-band  
U = U-band      D = D-band  
V = V-band



# Dial Type Level Set Attenuator and Variable Phase Shifter

QDA/QDP

## Characteristics

- ◆ Broadband Operation
- ◆ 0 to 25 dB Attenuation Range
- ◆ Mechanically Stable, Lockable
- ◆ High resolution

## Product Description

QuinStar Technology's QDA and QDP series Level Set Attenuators and Phase Shifters operate over the full waveguide band, and are offered in 7 waveguide bands covering the frequency range of 18 to 110 GHz. These adjustable level-set attenuators and variable phase shifters are driven by a mechanically stable, multi-turn miniature



dial knob to allow accurate and repeatable setting of attenuation and phase shift. The locking feature of the dial allows reliable operation when used in laboratory test setup, subsystems and instruments. The dial can be calibrated at a specified frequency, if desired. These adjustable components offer broadband performance.

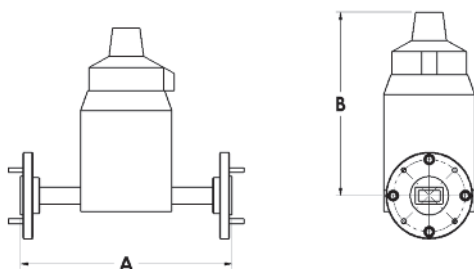
## Specifications

PERFORMANCE PARAMETER	K	Ka	Q	U	V	E	W
Frequency range, GHz	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Typical Insertion Loss, in dB, at 0 dB setting	0.3	0.3	0.4	0.5	0.6	0.7	0.8
Attenuation Range, dB (for Attenuator)	0-30	0-30	0-25	0-25	0-25	0-25	0-25
Average Power Handling, Watts	1.5	1.0	1.0	1.0	0.6	0.6	0.6
Phase Shift, degrees (for Phase Shifter)	0-180	0-180	0-180	0-180	0-180	0-180	0-180



# Dial Type Level Set Attenuator and Variable Phase Shifter QDA/QDP

## Outline Drawings/Mechanical Specifications



WAVEGUIDE BAND	OUTLINE DIMENSIONS, inches/mm	
	A	B
K	3.00/76.2	2.35/59.7
KA	2.75/69.9	2.16/54.9
Q	2.75/69.9	2.16/54.9
U	2.75/69.9	2.16/54.9
V	2.5/63.5	1.94/49.3
E	2.5/63.5	1.94/49.3
W	2.5/63.5	1.94/49.3

## Ordering Information

Model Number **QD - A 0000**

model prefix

A = Level Set Attenuator  
P = Variable Phase Shifter

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band



# Direct Reading Attenuators, and Phase Shifters

## QAD/QPS

### Characteristics

- ◆ Fullband Coverage
- ◆ Accurate Direct Readings
- ◆ Highly Repeatable Settings
- ◆ Easy to Use

### Product Description

QuinStar Technology's **direct reading attenuators**, and **phase shifters** are designed and built for precision millimeter-wave measurements. These instruments cover the range of 26.5-110 GHz in six waveguide bands. Series **QAD direct reading attenuators** and series **QPS direct reading phase shifters** are of classical rotary vane construction. They offer highly repeatable settings and frequency independent readings. Both instruments have low VSWR. In addition, the attenuator has negligible phase



shift versus attenuation setting while the phase shifter has low insertion loss.

Both instruments are well suited for accurate millimeter-wave measurements. Direct reading attenuators and phase shifters are available in motorized versions for ATE or other applications requiring remote control.

### Specifications

FREQUENCY BAND		K	Ka	Q	U	V	E	W
Frequency Range (GHz)		18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110
Waveguide Size		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
DIRECT READING PRECISION ATTENUATORS								
Insertion Loss (dB max)		0.5	0.5	0.6	0.7	0.8	1.0	1.2
VSWR (typical)		1.15	1.15	1.15	1.15	1.20	1.20	1.25
Average Power (Watts)		0.5	0.5	0.5	0.4	0.3	0.2	0.2
Attenuation Range¹		0 dB to 50 dB (above insertion loss) over full waveguide band						
Accuracy	Atten. ≥10dB	0.2 dB						
	Atten.	2%						
DIRECT READING PHASE SHIFTERS								
Accuracy (degrees)		3	3	3	4	4	4	4
Insertion Loss (dB)		1.0	1.2	1.3	1.5	1.8	2.0	2.0
VSWR (typical)		1.30	1.30	1.30	1.35	1.35	1.35	1.35
Average Power (Watts)		1.0	1.0	1.0	0.8	0.7	0.6	0.6
Phase Shift Range		0 to 360 degrees direct reading						
Read-Out		0 to 360 degrees in 5 degree divisions						
Loss Variation		1.0 dB (max)						

Other waveguide sizes are available.

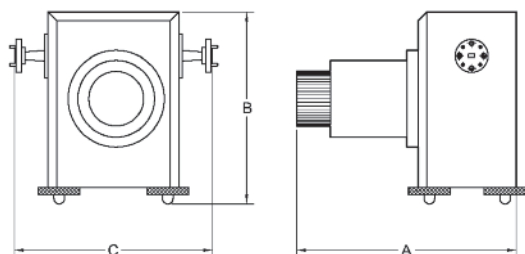
<sup>1</sup> Scale increments: 0dB to 0.1dB = 0.01dB; 0.1dB to 1.0dB = 0.05dB; 1.0dB to 10dB = 0.10dB; 10.0dB to 20.0dB = 0.20dB; 20.0dB to 30.0dB = 0.5dB; 30.0dB to 50.0dB = 1.0dB. Maximum setting 60dB typical.



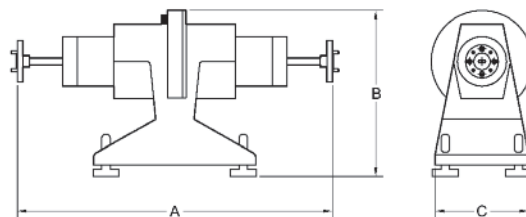
# Direct Reading Attenuators and Phase Shifters

## QAD/QPS

### Outline Drawings/Mechanical Specifications



Series QAD



Series QPS

SERIES QAD DIRECT READING ATTENUATOR				
FREQUENCY BAND	WAVEGUIDE SIZE	OUTLINE DIMENSIONS, inches/mm		
		A	B	C
Ka	WR-28	5.00/127.0	4.00/102.0	6.87/174.5
Q	WR-22	5.00/127.0	4.00/102.0	6.24/158.4
U	WR-19	5.00/127.0	4.00/102.0	6.0/152.4
V	WR-15	5.00/127.0	4.00/102.0	4.4/111.8
E	WR-12	5.00/127.0	4.00/102.0	4.2/106.7
W	WR-10	5.00/127.0	4.00/102.0	4.0/101.6

SERIES QPS DIRECT READING PHASE SHIFTER				
FREQUENCY BAND	WAVEGUIDE SIZE	OUTLINE DIMENSIONS, inches/mm		
		A	B	C
Ka	WR-28	8.53/216.7	3.66/93.0	3.22/81.8
Q	WR-22	6.85/174.0	3.66/93.0	3.22/81.8
U	WR-19	6.0/152.4	3.66/93.0	3.22/81.8
V	WR-15	4.85/123.2	3.66/93.0	3.22/81.8
E	WR-12	4.2/106.7	3.66/93.0	3.22/81.8
W	WR-10	3.7/94.0	4.00/102.0	4.50/114.3



# Direct Reading Attenuators and Phase Shifters

## QAD/QPS

### Ordering Information

Direct Reading Attenuators:

Model Number **QAD -** **A 00000**

waveguide band designator

K = K-band	V = V-band
A = Ka-band	E = E-band
Q = Q-band	W = W-band
U = U-band	

Direct Reading Phase Shifters:

Model Number **QPS -** **A 00000**

waveguide band designator

A = Ka-band	V = V-band
Q = Q-band	E = E-band
U = U-band	W = W-band



# Motorized, Programmable Attenuators

## QPA

### Characteristics

- ◆ Compact Size
- ◆ Offered over 7.0 to 170 GHz
- ◆ High Accuracy and Reliability
- ◆ Digital Readout, IEEE-488 Interface
- ◆ Manual/Motorized Operation Modes



### Product Description

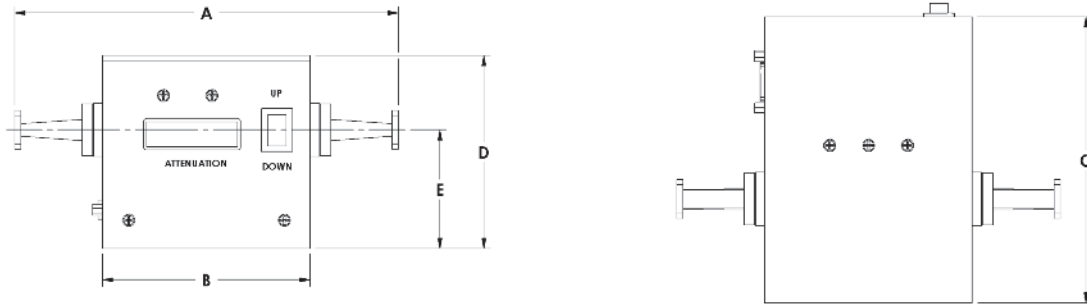
QuinStar Technology's precision Motorized Programmable Rotary Vane Attenuators are available in full waveguide bands from 7.0 to 170.0 GHz. Attenuation control can be either manual via a front panel or remote-controlled using a standard IEEE-488 interface. Series QPA motorized attenuator's small compact package incorporates both the electronic controller and microwave attenuator components. The unit operates with a single +24 volt DC source or with an optional AC adapter.

Attenuation range is from 0 to 50 dB in 0.1 dB steps with 0.05 dB steps over 0 to 20 dB. A digital readout is provided on the front panel to display the current attenuation setting. The attenuators are highly reliable and designed to be used in Automated Test Equipment and in applications requiring remote power control.

### Specifications

Waveguide Band	Frequency Band (GHz)	Insertion Loss (Max.)	VSWR (Max.)	Power (Max.)
XL (WR-112)	7.0 - 10.0	1.0 dB	1.2:1	5 watts
X (WR-90)	8.2 - 12.4	1.0 dB	1.2:1	2 watts
XS (WR-75)	10.0 - 15.0	1.0 dB	1.25:1	2 watts
KU (WR-62)	12.4 - 18.0	1.0 dB	1.25:1	2 watts
K (WR-42)	18.0 - 26.5	1.0 dB	1.15:1	1 watt
Ka (WR-28)	26.5 - 40.0	1.0 dB	1.15:1	0.5 watt
Q (WR-22)	33.0 - 50.0	1.0 dB	1.15:1	0.5 watt
U (WR-19)	40.0 - 60.0	1.0 dB	1.15:1	0.4 watt
V (WR-15)	50.0 - 75.0	1.0 dB	1.20:1	0.3 watt
E (WR-12)	60.0 - 90.0	1.4 dB	1.2:1	0.25 watt
W (WR-10)	75.0 - 110.0	1.5 dB typ.	1.25:1 typ.	0.25 watt
F (WR-08)	90.0 - 140.0	1.8 dB	1.3:1 typ.	0.2 watt
D (WR-06)	110.0 - 170.0	2.2 dB	1.3:1 typ.	0.2 watt

## Outline Drawings/Mechanical Specifications



WAVEGUIDE BAND	OUTLINE DIMENSIONS, inches/mm				
	A	B	C	D	E
XL	11.69/296.9	4.66/118.3	6.32/160.5	3.73/94.7	2.29/58.2
X	11.69/296.9	4.66/118.3	6.32/160.5	3.73/94.7	2.29/58.2
XS	11.19/284.2	4.66/118.3	6.32/160.5	3.73/94.7	2.29/58.2
KU	10.94/277.8	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
K	8.48/215.4	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
KA	6.87/174.5	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
Q	6.24/158.4	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
U	6.0/152.4	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
V	5.78/147.0	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
E	5.78/147.0	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
W	5.78/147.0	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
F	5.78/147.0	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2
G	5.78/147.0	4.00/101.6	5.50/139.7	3.73/94.7	2.29/58.2

## Ordering Information

Model Number **QPA -**

waveguide band

KU = Ku-band  
 K0 = K-band  
 A0 = Ka-band  
 Q0 = Q-band  
 U0 = U-band  
 V0 = V-band  
 E0 = E-band  
 W0 = W-band  
 F0 = F-band  
 G0 = G-band  
 XL = XL-band  
 XO = X-band  
 XS = XS-band

**AB C DEF G**

other options

0: Standard  
 Z: Custom

waveguide flange option

(See Appendix A-B)

interface options

I = IEEE-488  
 R = RS-232  
 X = Others (please specify)



# .....Motorized, Programmable Phase Shifters

## QMP

### Characteristics

- ◆ Offered over 18-110 GHz
- ◆ High Accuracy
- ◆ Digital Readout
- ◆ Low Insertion Loss
- ◆ Manual and Computer Controlled
- ◆ Full Waveguide Bands



### Product Description

QuinStar Technology offers Motorized Rotary Vane Phase Shifters in all waveguide bands from 18.0 to 110 GHz. The QMP series is a motorized, computer controllable version of QuinStar's standard Direct Reading Phase Shifter and provides a 0 to 360° phase shift range with 0.5 degree resolution.

The phase shifter is controlled by a precision stepping motor and all control and driver electronics are packaged within the phase shifter housing. Microprocessor-based electronics translates the desired phase shifter setting into the required motor position and provides the proper drive

signals to the motor. Motor speed is variable to ensure accurate positioning and smooth operation. The Phase Shifter can be controlled remotely through an IEEE-488 interface or manually with a front panel control. A three-digit readout on the front panel displays the setting. The product requires a 24-volt, 500 mA power supply.

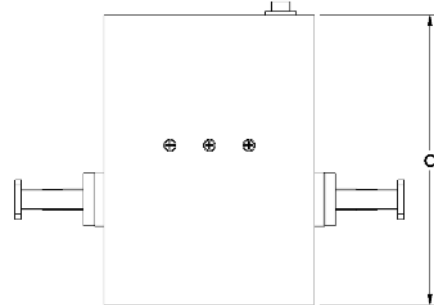
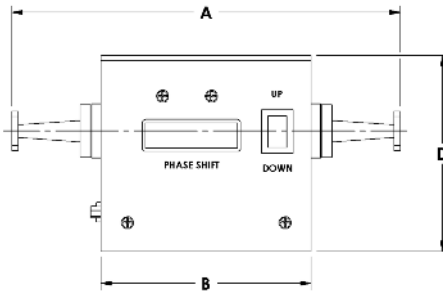
The QMP series motorized direct reading phase shifters are used in automated RF measurement systems. They are frequently used in RF substitution type test arrangements for precise measurement of phase characteristics including bridge circuits and phase networks.

### Specifications

Waveguide Band	Frequency Range (GHz)	Insertion Loss dB typical	VSWR	Average Power
K	18.0-26.5	1.0	1.30	1.0
Ka	26.5-40.0	1.0	1.15	1.0
Q	33.0-50.0	1.0	1.15	1.0
U	40.0-60.0	1.1	1.15	1.0
V	50.0-75.0	1.2	1.20	0.8
E	60.0-90.0	1.4	1.20	0.7
W	75.0-110.0	1.5	1.20	0.6

Resolution (degree)	Repeatability	Accuracy	Speed (sec) 0-360°
0.5	0.5	4 deg.	5 sec.

## Outline Drawings/Mechanical Specifications



WAVEGUIDE BAND	OUTLINE DIMENSIONS, inches/mm			
	A	B	C	D
K	8.48/215.4	4.00/101.6	5.50/139.7	3.73/94.7
KA	8.53/216.7	4.00/101.6	5.50/139.7	3.73/94.7
Q	6.85/174.0	4.00/101.6	5.50/139.7	3.73/94.7
U	6.0/152.4	4.00/101.6	5.50/139.7	3.73/94.7
V	5.78/146.8	4.00/101.6	5.50/139.7	3.73/94.7
E	5.78/146.8	4.00/101.6	5.50/139.7	3.73/94.7
W	5.78/146.8	4.00/101.6	5.50/139.7	3.73/94.7

## Ordering Information

Model Number **QMP -**

waveguide band

K = K-band      V = V-band  
A = Ka-band      E = E-band  
Q = Q-band      W = W-band  
U = U-band

interface options

I = IEEE-488  
R = RS-232  
X = Others (please specify)

**A B C D E F**

other options

0: Standard  
Z: Custom

waveguide flange option  
(See Appendix A-B)





## Section 7

# Antenna Products

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# Application Notes

**QuinStar Technology** is a leading supplier of millimeter wave antennas and associated products for frequencies ranging from 18 to above 140 GHz. The range of products offered cover virtually every application and functional requirement. Several options in terms of physical construction or operating principle are generally available to achieve an optimal solution for a specific application or requirement. The half-power beamwidth of a typical antenna is determined by the aperture diameter  $D$  and is typically  $70 \times \text{Wavelength}/D$  over much of the band. Figure 1 shows the relationship between gain, beamwidth and antenna size as a function of operating frequency. QuinStar's antennas exhibit high overall efficiency and achieve the maximum possible gain. Custom products are designed to meet special requirements and configurations specific to a system application. Key product families produced by QuinStar and their associated technology are described here.

## Feeds, Orthomode Transducers and Related Products

QuinStar offers a wide range of standard and customer specific feed horns, orthomode transducers, polarizers and other antenna-related products for virtually any application and system requirement. We have an extensive library of fully developed and proven designs in this area. Our entire antenna feed products and related components are fully tested for all pertinent characteristics and specifications. In particular, QuinStar has designs for optimal performance and compact or miniaturized versions of many complex products.

## Quasi-Optical Products Capability

Free space propagation of millimeter waves is exploited for achieving low loss in many antenna-related components. QuinStar uses quasi-optics concepts in combination with other techniques to produce high performance antennas for many systems such as radar, surveillance, remote sensing, material measurements, radioastronomy and plasma diagnostics. The major advantage of quasi-optical transmission over conventional waveguide is its low loss, especially at high millimeter wave frequencies. The actual loss in propagation between optical elements can be made extremely small by proper design and fabrication. The reflection loss from metal mirrors is virtually immeasurable throughout the millimeter wave region, and the loss from well designed lenses is only a few tenths of dB. Other important advantages of free space transmission over waveguide-based components include the ability to support all possible polarizations. Very high isolation (often greater than 30 dB) can be obtained between orthogonal polarizations.

## Applications of Quasi-Optical Components and Subsystems

Quasi-optical antenna assemblies can be made very compact in comparison to equivalent systems utilizing waveguide components. Devices such as frequency duplexers, polarization diplexers, circular-to-linear polarizers, and phase shifters can be placed in the otherwise unutilized space between the lens or mirrors and the feed system instead of being added externally. Adding waveguide components such as a circular-to-linear polarizer, a circular-to-rectangular transition or an orthomode transducer to a quasi-optical lens antenna would increase the overall length by over 50%. Figure 2

shows various antenna functions and polarization options using quasi-optical waveguide components and their corresponding waveguide counterparts.

## Reflector Antennas

QuinStar offers Cassegrain reflector antennas in diameters ranging from 6 to 48 inches. Other modified versions of Cassegrain reflector antenna are also available by special order. These offset reflector antennas have no beam blockage, which makes the sidelobes significantly lower and the gain higher than that of symmetric Cassegrain antennas. Cassegrain antennas are frequently used in millimeter wave radars, communication systems or data links, and in special applications. Our near-field and far-field antenna ranges are ideal tools for evaluating antennas and related systems.

## Glossary of Antenna and Quasi-optics terms:

**Antenna** – Component or structure for radiating or receiving electromagnetic waves.

**Antenna efficiency of an aperture-type antenna** – For an antenna with a specified planar aperture, the ratio of the maximum effective area of the antenna to the physical aperture area.

**Aperture of an antenna** – A surface, near or on an antenna, on which it is convenient to make assumptions regarding the field values for the purpose of computing fields at external points. NOTE: The aperture is often taken as the portion of a plane surface near the antenna, perpendicular to the direction of maximum radiation, through which the major part of the radiation passes.

**Aperture blockage** – A blocking of or interfering with the radiation from the feed of secondary radiator by obstacles such as the feed itself or support struts.

**Aperture illumination** – The field over the aperture as described by amplitude, phase and polarization distributions.

**Axial ratio** – The ratio of the axes of the polarization ellipse, denoting the ratio of two orthogonal polarizations.

**Bandwidth of an antenna** – The range of frequencies within which the performance of the antenna, with respect to some antenna characteristics (gain, VSWR, beam shape, etc.), conforms to a specified specifications.

**Beam of an antenna** – The major lobe of the radiation pattern of an antenna.

**Boresight** – See electrical boresight; reference boresight.

**Boresight error** – The angular deviation of the electrical boresight of an antenna from its reference boresight.

**Cassegrain reflector antenna** – A dual-reflector antenna with a subreflector (usually hyperboloidal) located between the focal point and the vertex of the main reflector.

**Conical scanning** – A form of sequential lobing in which the direction of maximum radiation generates a cone whose vertex angle is of the order of the antenna halfpower beamwidth.

**Cross polarization** – The polarization orthogonal to a reference polarization. NOTE: Two fields have orthogonal polarizations if their polarization ellipses have the same axial ratio, major axes at right angles, and opposite sense of rotation.

**Directive gain** - In a given direction,  $4\pi$  times the ratio of the radiation intensity in that direction to the total power radiated by the antenna. NOTE: The directive gain is fully realized on reception only when the incident polarization is the same as the polarization of the antenna on transmission.

**Directivity** - The value of the directive gain in the direction of its maximum value.

**Effective area of an antenna** - In a given direction, the ratio of the power available at the terminals of a receiving antenna to the power per unit area of a plane wave incident on the antenna from that direction, polarized coincident with the polarization that the antenna would radiate.

**Efficiency** - See antenna efficiency; aperture illumination efficiency; radiation efficiency.

**Electrical boresight** - The tracking axis as determined by an electrical indication, such as the null direction of a conical scanning or monopulse antenna system, or the beam maximum direction of a highly directive antenna.

**E-plane, principal** - For a linearly polarized antenna, the plane containing the electric field vector and the direction of maximum radiation.

**Far-field region** - That region of the field of an antenna where the angular field distribution is essentially independent of the distance of the antenna. NOTE: 1.) If the antenna has a maximum overall dimension  $D$  which is large compared to the wavelength, the far-field region is commonly taken to exist at distances greater than  $2D^2/\lambda$  from the antenna,  $\lambda$  being the wavelength. 2.) For an antenna focused at infinity, the far-field region is sometimes referred to as the Fraunhofer region on the basis of analogy to optical terminology.

**Feed of an antenna** - That portion of an antenna coupled to the terminals which functions to produce the aperture illumination. NOTE: A feed may consist of a distribution network and a primary radiator.

**Front-to-back ratio** - The ratio of the directivity of an antenna to its directive gain in a specified direction toward the back.

**Gain** - See directive gain.

**Half-power beamwidth** - In a plane containing the direction of the maximum of a beam, the angle between the two directions in which the radiation intensity is one half the maximum value of the beam.

**Horn antenna** - A radiating element having the shape of a horn.

**Isolation between antennas** - A measure of power transfer from one antenna to another. NOTE: The isolation between antennas is the ratio of power input to one antenna to the power received by the other, usually expressed in decibels.

**Lens antenna** - An antenna consisting of an electromagnetic lens and a radiating feed.

**Main lobe** - See major lobe.

**Major lobe (main lobe)** - The radiation lobe containing the direction of maximum radiation.

**Monopulse** - In radar, simultaneous lobing whereby direction-finding information is obtainable from a single pulse

**Near-field region, radiating** - That region of the field of an antenna between the reactive near-field region and the far-field region wherein radiation fields predominate and wherein the angular field distribution is dependent upon distance from the antenna. NOTE: 1.) If the antenna has a maximum overall dimension which is not large compared to the wavelength, this field region may not exist. 2.) For an antenna focused at infinity, the radiating near-field region is sometimes referred to as the Fresnel region on the basis of analogy to optical terminology.

**Noise temperature of an antenna** - The temperature of a resistor having an available thermal noise power per unit bandwidth equal to that at the antenna output at a specified frequency. NOTE: Noise temperature of an antenna depends on its coupling to all noise sources in its environment as well as noise generated within the antenna.

**Paraboloidal reflector** - A reflector which is a portion of a paraboloid of revolution.

**Pattern** - See radiation pattern.

**Pencil beam antenna** - A unidirectional antenna having a narrow major lobe with approximately circular contours of equal radiation intensity in the region of the major lobe.

**Phase center** - In a given direction and for a specified polarization, the center of curvature of the wavefront of the radiation from an antenna in a given plane.

**Plane of polarization** - A plane containing the polarization ellipse. NOTE: 1.) When the ellipse degenerates into a line segment, the plane of polarization is not uniquely defined. In general, any plane containing the segment is acceptable; however, for a plane wave in an isotropic medium, the plane of polarization is taken to be normal to the direction of propagation. 2.) In optics, the expression plane of polarization is associated with a linearly polarized plane wave (sometimes called a plane polarized wave) and is defined as a plane containing the field vector of interest and the direction of propagation. This usage would contradict the above one and is deprecated.

**Polarization of an antenna** - In a given direction the polarization of the wave radiated by the antenna. Alternatively, the polarization of a plane wave incident from the given direction which results in maximum available power at the antenna terminals. NOTE: 1.) The polarization of these two waves is the same in the following sense. In the plane perpendicular to the direction considered, their electric fields describe similar ellipses. The sense of rotation of these ellipses is the same if each one is referred to the corresponding direction of propagation, outgoing for the radiated field, incoming for the incident plane wave.

**Polarization of a plane wave** - The polarization of a specified field vector in the plane wave. NOTE: 1.) It is the convention in electrical engineering to specify the polarization of the plane wave by that of the electrical field vector. 2.) In an isotropic medium, the plane of polarization is the plane perpendicular to the direction of propagation. It is the convention in electrical engineering to describe the sense of polarization at a fixed point in space as righthand (clockwise) or lefthand (counterclockwise) by choosing the direction of propagation as the reference direction. 3.) The

polarization of a plane wave is the same at every point in space.

**Power gain** – In a given direction, 4 p\_times the ratio of the radiation intensity in that direction of the net power accepted by the antenna from the connected transmitter. NOTE: 1.) When the direction is not stated, the power gain is usually taken to be the power gain in the direction of its maximum value. 2.) Power gain does not include reflection losses arising from mismatch of impedance.

**Power gain referred to a specified polarization** – The power gain of an antenna, reduced by the ratio of that portion of the radiation intensity corresponding to the specified polarization to the radiation intensity.

**Primary radiator** – A feed which illuminated a secondary radiator.

**Pyramidal horn antenna** – A horn antenna the sides of which form a pyramid.

**Radiating element** – A basic subdivision of an antenna which in itself is capable of effectively radiating or receiving radio waves. NOTE: Typical examples of a radiating element are a slot, horn or dipole antenna.

**Radiation efficiency** – The ratio of the total power radiated by an antenna to the net power accepted by the antenna from the connected transmitter.

**Radiation pattern (antenna pattern)** – A graphical representation of the radiation properties of the antennas a function of space coordinates. NOTE: 1.) In the usual case, the radiation pattern is determined in the far-field region and is represented as a function of directional coordinates. 2.) Radiation properties include power flux density, field strength, phase and polarization.

**Radome** – An enclosure for protecting an antenna from the harmful effects of its physical environment, generally intended to leave the electrical performance of the antenna unaffected.

**Reference boresight** – A direction defined by an optical, mechanical, or electrical axis of an antenna established as a reference for the alignment. See also electrical boresight.

**Reflector antenna** – An antenna consisting of a reflector and a radiating feed.

**Scan angle (beam angle)** – The angle between the maximum of the major lobe of an antenna. NOTE: Reference boresight is usually chosen as the reference direction.

**Scanning, of a beam antenna** – A repetitive motion given to the major lobe of an antenna.

**Shaped beam antenna** – An antenna which is designed to have a prescribed pattern shape differing substantially from that obtained from a uniform-phase aperture of the same size.

**Sidelobe** – A radiation lobe in any direction other than that of the intended lobe. NOTE: When the intended lobe is not specified, it shall be taken to be the major lobe.

**Sidelobe level, maximum relative** – The relative level of the highest sidelobe.

**Spillover** – That part of the power radiated by a feed not intercepted by the secondary radiator.

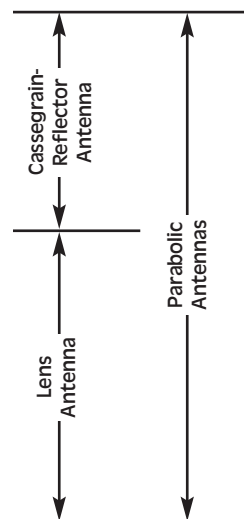
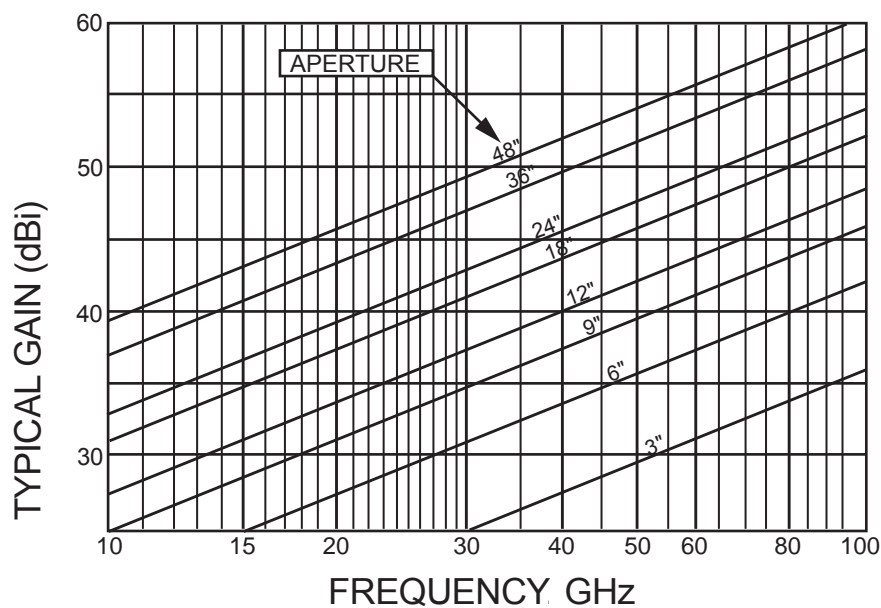
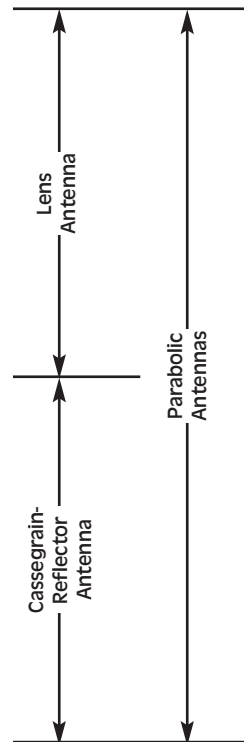
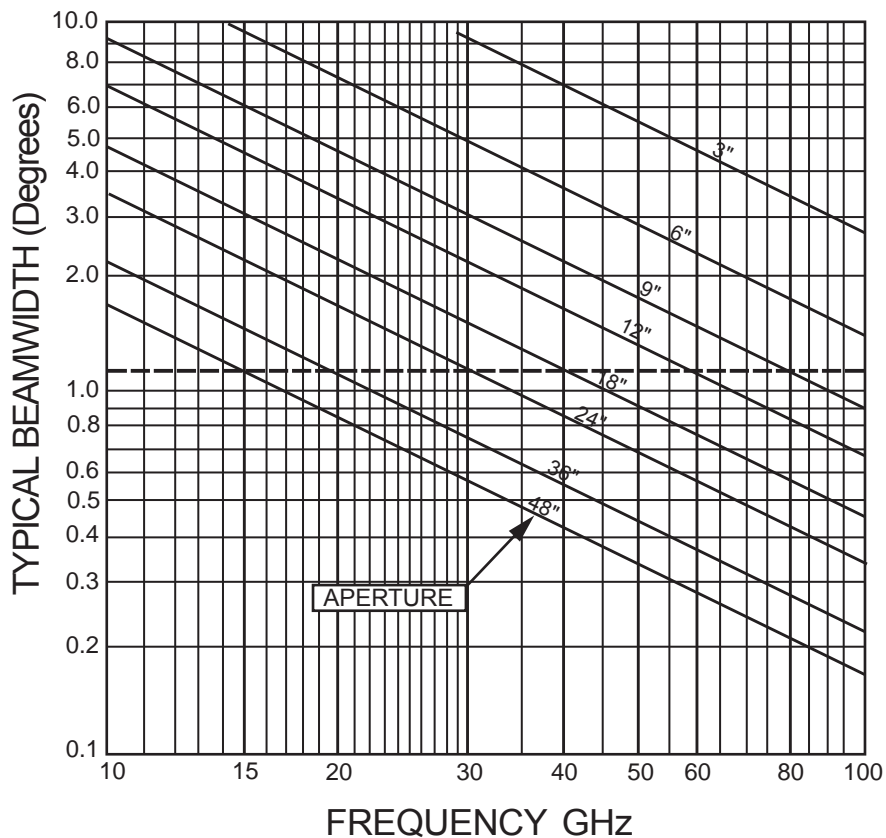
**Squint angle** – A small difference in pointing angle between a reference beam direction and the direction of maximum radiation.

**Subreflector** – A reflector which redirects the power radiated from the feed to the main reflector.

**Tracking (angle tracking)** – A motion given to the major lobe of an antenna such that a selected moving target is contained within the major lobe.

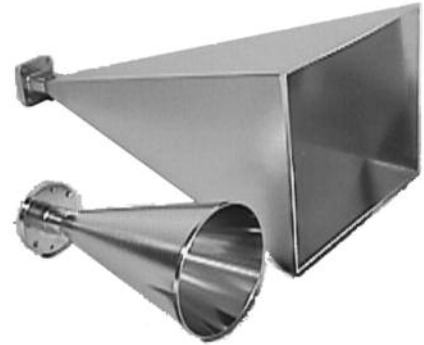
**Vertically polarized plane wave** – A plane wave in which the electric vector is in the vertical plane containing the direction of propagation.

# Antenna Beamwidth and Gain Characteristics



## Characteristics

- ◆ Pyramidal or Conical Shape
- ◆ Rectangular or Circular Waveguide Input
- ◆ Low VSWR



## Product Description

QuinStar Technology's **QWH** series of **standard gain horn antennas** cover the frequency range of 18 to 220 GHz in ten waveguide bands. They are available with either a rectangular aperture (pyramidal shape) for connecting to rectangular waveguide or a round aperture (conical shape) for use with either rectangular or circular waveguide. The pyramidal horns have a nominal mid-band gain of 24dB, with 21dB typical for the circular horns.

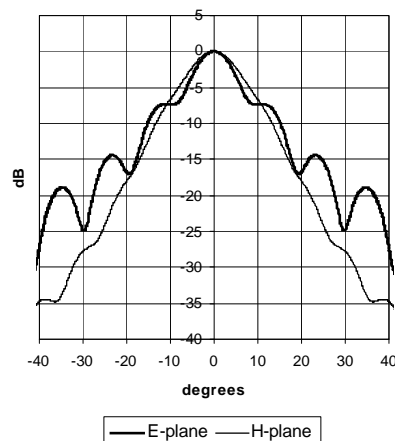
Standard gain horns are useful for a wide variety of propagation applications, including antenna testing and RF

radiation measurements. These horns are often employed as calibration standard or reference for antenna gain measurements. Conical horns can be used to radiate or receive either linearly or circularly polarized waves. Both shapes are also usable as feed horns for lens and reflector antennas. The horns are precisely fabricated to control the aperture size and flare angle. Horns capable of producing customer-specific beam shapes and gain covering broad ranges are also available. Refer to series QRR custom feed horns.

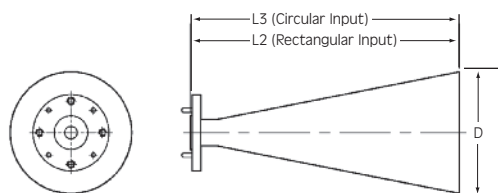
## Specifications

FREQUENCY BAND	K	Ka	Q	U	V	E	W	F	D	G
Frequency Range (GHz)	18-26.5	26.5-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170	140-220
Waveguide Size	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-6	WR-5
VSWR (max)	1.10:1	1.10:1	1.10:1	1.10:1	1.15:1	1.15:1	1.15:1	1.20:1	1.25:1	1.25:1
Pyramidal Horn Mid-band Gain (dB typ)	24									
Conical Horn Mid-band Gain (dB typ)	21									

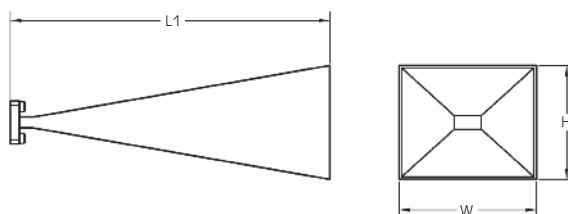
**Pyramidal Horn Antenna Pattern**



## Outline Drawings/Mechanical Specifications



**Conical**  
(circular waveguide with  
round flange pattern shown)



**Pyramidal**  
(rectangular waveguide with  
square flange pattern shown)

PYRAMIDAL AND CONICAL HORNS WITH RECTANGULAR WAVEGUIDE INPUT							
Frequency Band	Waveguide Size	Flange Pattern	Outline Dimensions, inches/mm				
			Pyramidal Horns			Conical Horns	
			W	H	L1	D	L2
Ku	WR-62	UG-419/U	5.60/142.2	4.16/105.7	11.95/303.5	4.0/101.6	7.0/177.8
K	WR-42	UG-595/U	4.12/104.6	3.12/79.2	7.48/190.0	2.37/60.2	5.0/127.0
Ka	WR-28	UG-599/U	2.73/69.3	2.12/53.8	5.0/127.0	1.87/47.5	4.2/106.7
Q	WR-22	UG-383/U	2.24/56.9	1.71/43.4	4.08/103.6	1.51/38.4	3.2/81.3
U	WR-19	UG-383/U	1.88/47.8	1.44/36.6	3.49/88.6	1.25/31.8	3.05/77.5
V	WR-15	UG-385/U	1.49/37.8	1.15/29.2	2.78/70.6	1.02/25.9	2.4/61.0
E	WR-12	UG-387/U	1.24/31.5	0.96/24.4	2.35/59.7	0.85/21.6	2.05/52.1
W	WR-10	UG-387/U	1.03/26.2	0.80/20.3	1.94/49.3	0.7/18.0	1.4/35.6
F	WR-8	UG-387/U	0.83/21.1	0.65/16.5	1.56/39.6	0.58/14.7	1.40/35.6
D	WR-6	UG-387/U	0.69/17.5	0.54/13.7	1.26/32.0	0.49/14.7	1.15/20.1
G	WR-5	UG-387/U	0.55/14.0	0.43/10.9	1.04/26.4	0.40/10.2	0.9/22.9

CONICAL HORNS WITH CIRCULAR WAVEGUIDE INPUT				
Frequency Band	Waveguide Diameter, inches/mm	Flange Pattern	Outline Dimensions, Inches/mm	
			D	L3
K	0.455/11.5	UG-381/U	2.37/60.2	4.0/101.6
Ka	0.315/8.0	UG-381/U	1.87/47.5	3.3/83.8
Q	0.251/6.3	UG-383/U	1.51/38.4	2.7/68.5
U	0.211/5.3	UG-383/UM	1.25/31.8	2.25/57.1
V	0.166/4.1	UG-385/U	1.02/25.9	1.90/40.2
E	0.137/3.4	UG-387/U	0.85/21.6	1.60/40.6
W	0.113/2.8	UG-387/UM	0.71/18.0	1.30/33.0
F	0.090/2.2	UG-387/UM	0.58/14.7	1.10/27.9
D	0.073/1.8	UG-387/UM	0.49/12.5	0.90/22.8
G	0.058/1.4	UG-387/UM	0.40/10.2	0.75/19.0



# Standard Gain Horn Antennas

QWH

## Ordering Information

Model Number **QWH - A B C D 00**

waveguide band designator

K = K-band  
A = Ka-band  
Q = Q-band  
U = U-band  
V = V-band  
E = E-band  
W = W-band  
F = F-band  
D = D-band  
G = G-band

horn shape

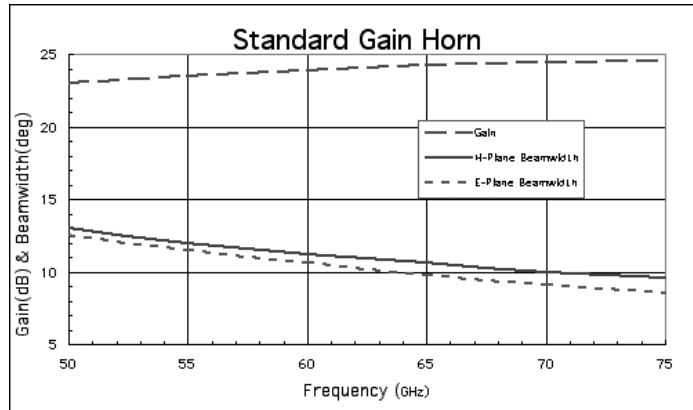
C = conical  
P = pyramidal

flange type

R = round  
S = square

waveguide input

C = circular (conical only)  
R = rectangular (conical and pyramidal)



Pyramidal Standard Gain Horn

## Characteristics

- ◆ Custom Performance
- ◆ Low Sidelobes
- ◆ High Gain
- ◆ Low VSWR

## Product Description

QuinStar Technology offers a wide range of custom horns available in the 18-140 GHz frequency range. Products include conical and scalar (corrugated) horns and very wide beam pyramidal and sectoral horns. These horn antennas can be designed and produced to satisfy virtually any application or equipment requirement and can be fully tested at QuinStar to determine their precise radiation patterns and gain.

Beamwidth of the majority of conical and scalar horns is in the range of 6 to 40 degrees while broad beam pyramidal and sectoral horns range from 25 to 90 degrees at half-power full width points (3 dB beamwidth). The geometric design of the horns is carefully conducted to provide the best possible performance in a relatively compact size. The length of the antenna is determined by the beam pattern requirements and desired VSWR.

Horns provided by QuinStar are linearly polarized unless circular or dual polarization is requested. In addition, customized beam patterns, special materials and unique geometry can be provided. Some of the more commonly used horns are described below:

**Conical Horn:** Least expensive horn and well suited for the majority of general purpose applications. Beam patterns in the E- and H-planes are dissimilar and gain ranges from 10 to 26 dB for most frequencies depending on aperture (beamwidth) and frequency.

**Pyramidal Horn:** Relatively inexpensive and well suited for most general purpose applications. Beam patterns in the E- and H-planes are generally dissimilar and gain ranges from 10 to 27 dB depending on aperture and frequency.

**Sectoral Horn:** Radiates a fan-shaped beam which is broad in one plane and relatively narrow in the other for



wide angular coverage. Typical beamwidths are in the range of 30 to 120 degrees in one plane and relatively narrow in the other plane. The narrow beam can be obtained in either of the two planes (E- or H-plane). The gain of these antennas is largely determined by their beam patterns, and is generally in the 9-24 dB range.

**Scalar Horn:** More expensive and highest performance horn. Beam shape is virtually independent of rotational angle (i.e., E- and H-plane radiation patterns are very similar). They are ideal when highly symmetrical antenna patterns are desired and well suited for reflector or lens antenna system feeds. Low VSWR and low sidelobes are also among the benefits of these horns.

**Special Application Horns:** A variety of system applications, such as plasma diagnostics, depth or range measurement and receiver/transmitter arrays, require specially designed and produced horns or antennas. QuinStar can custom design such antennas and provide detailed measurements on their radiation characteristics.

The following parameters are necessary to completely specify a horn. However, QuinStar can propose a solution for your application if only some of the parameters are provided:

- ◆ Horn type—conical, pyramidal, scalar, sectoral, or custom (if unspecified QuinStar will select the best type);
- ◆ Beam shape—beamwidth in E- and H-plane, beam symmetry and any special features;
- ◆ Aperture—size and length constraints, if any;
- ◆ VSWR requirements;
- ◆ Sidelobe levels and cross polarization isolation requirements.



# Custom Horn Antennas

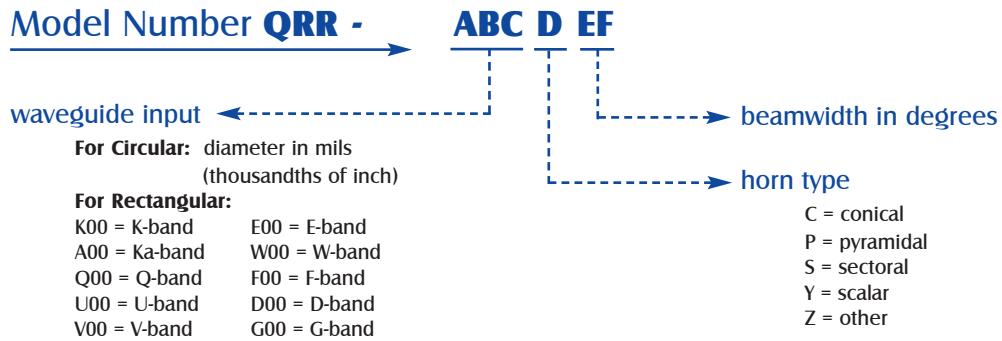
## QRR

### Specifications

CHARACTERISTIC	PYRAMIDAL	CONICAL	SCALAR	SECTORAL
Beamwidth Range (degrees typ)	7-60	7-60	7-60	Broadbeam plane: 30 to 120 Other: 8 to 40
Gain Range (dB typ)	10-27	10-26	10-27	9-24
First Sidelobe Level (dB typ)	-12 to -16	-12 to -16	-20 to -25	-12 to -16

Consult QuinStar for outline drawings and mechanical specifications.

### Ordering Information





# Narrow and Wide Beam Scalar Horns QSH/QSW

## Characteristics

- ◆ Symmetrical Beam in E and H-planes
- ◆ Large Range of Beam Widths Offered
- ◆ Low VSWR, Low Sidelobes
- ◆ Polarization Insensitive

## Product Description

QuinStar Technology series QSH and QSW narrow and wide beam scalar horn antennas have been designed for use in antenna applications requiring highly symmetric beam pattern, low VSWR and low sidelobes. The radiation patterns are polarization-independent, i.e., relatively independent of plane of measurement. Scalar horn with half-power full beam width ranging from about 10 degrees

to 60 degrees are available, with standard design at 25 degrees. These horns are ideally suited for illuminating lens (in Lens Horn Antennas) and as feeds for Cassegrain Reflector Antennas with virtually any f/D ratio. QuinStar's Scalar Horns offer a fairly broad operating bandwidth, up to 40% of center frequency, and high cross-polarization isolation (typically 30 dB).



## Specifications

Performance Characteristics	Available Range
Beamwidth (Half Power Full Width)	Series QSH: 10 to 40 degrees Series QSW: 40 to 60 degrees
Pattern Variation between E- and H- Planes	+/- 1.5 dB over main lobe
Sidelobe Level	Typically 25 dB below main beam
Cross Polarization Isolation	30 dB typical
Bandwidth	40% of center freq.

## Ordering Information

Model Number → **QS - A BC 0 0**

model prefix

H= Narrow Beam Scalar Horn  
W=Wide Beam Scalar Horn

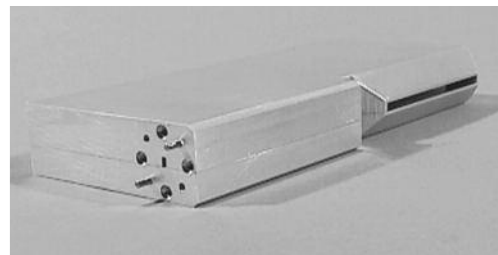
waveguide band designator

K = K-band      V = V-band  
A = Ka-band    E = E-band  
Q = Q-band    W = W-band  
U = U-band    F = F-band  
0 = circular waveguide

beam width in degrees

## Characteristics

- ◆ Customized Beam Patterns in both Planes
- ◆ Optimum Gain Characteristics



## Product Description

QuinStar Series QSF Sectoral Horn Antennas are custom products designed and manufactured to meet specific broad beam patterns in one of the planes, and relatively narrow beam ion the other orthogonal plane. These antennas are offered for frequencies from 18 to 110 GHz. The horn geometry and mechanical features are designed to create a precise beam shape to match the application requirement in both planes. Broad beam (fan beam) pattern can be offered in either polarization, oriented in either azimuth or elevation plane with the narrower beam

in the other plane. Several standard products are also offered to suit a majority of system applications.

The directional gain of the antenna may be estimated using the following formula:

$$\text{Gain} = 27,000 / (B1 \times B2)$$

where B1 and B2 are beamwidths (full width at half power points) in azimuth and elevation planes, in degrees

## Specifications

Frequency range and Bandwidth	Range of Beamwidths in Broad Beam Plane	Range of Beamwidths in Narrow Beam Plane
18-110 GHz		
10 % of Center Frequency	30 to 120 degrees	2 to 20 degrees

## Ordering Information

Model Number **QSF -**

**A BCD EFG H**

waveguide band designator

K = K-band      V = V-band  
A = Ka-band      E = E-band  
Q = Q-band      W = W-band  
U = U-band

polarization

V= Vertical  
H= Horizontal

beam width in azimuth plane, in degrees

beam width in elevation plane, in degrees



# Omnidirectional Antennas

## QOD

### Characteristics

- ◆ Offered over 18-110 GHz
- ◆ Uniform 360 degree Coverage in Azimuth
- ◆ Narrow Elevation Beam with Moderate Gain

### Product Description

QuinStar series QOD Omnidirectional Antennas provide a uniform 360 degrees coverage in the azimuth plane and a relatively narrower beam in elevation plane. They offer a reasonable gain over approximately 5% bandwidth. The elevation beamwidth can be designed to be in the 8 to 30 degree range to suit most common applications. The beam can be pointed up or down with respect to the horizon, if desired. An integral radome is normally provided with these Omnidirectional Antennas. Custom designs to suit

specific needs can be readily produced and fully tested. Typical interface is a standard rectangular waveguide, with options for circular waveguide. Antennas with circular polarization are also available as custom products. QuinStar also offers a wide range of Sectoral Coverage Antennas

Omnidirectional Antennas find applications in millimeter wave communications, EW/ESM and sensing.



### Specifications

Performance Parameter	Typical Range
Frequency Range	18-110 GHz
Bandwidth	5% typical
Elevation Beam Angle Range (Half Power Full Width)	Between 8 and 30 degrees
Gain Range (for Elevation Beam Range)	14 to 5 dB

### Ordering Information

Model Number **QOD - AB CD E F**

center frequency in GHz

beam width in elevation plane,  
in degrees

options

0 = Standard Product, No options  
Z = Special

waveguide band and type

K = K-band      E = E-band  
A = Ka-band    W = W-band  
Q = Q-band    F = F-band  
U = U-band    0 = Circular Waveguide  
V = V-band    X = Coaxial Interface

### Characteristics

- ◆ Low Sidelobes
- ◆ High Gain and Efficiency
- ◆ Broadband
- ◆ Low Cost

### Product Description

QuinStar Technology's **QLA** series **lens antennas** are available with apertures ranging from 3 to 12 inches (76-300 mm) for any frequency in the 18-140 GHz range. These antennas consist of a lens which is fed (illuminated) by a specially-designed feed horn. They have inherently low sidelobes, particularly in comparison to Cassegrain reflector antennas, as there is no blockage of the main beam by a subreflector or feed structure. Specially designed lenses when combined with high performance feeds produce high gain, precise beam patterns and efficiency comparable to the best reflector antennas, even at high millimeter wave frequencies. They operate over a fairly wide frequency range, which is generally determined by the characteristics of the input circular waveguide and feed horn. Standard antennas are focused at infinity (far field). However, custom designs focused at a finite range, generally 4 to 40 inches (0.1 to 1 meter) from the lens, can be provided.

The length of the antenna is nearly equal to its lens diameter ( $f/D = 1$ ) to achieve a reasonable size with optimal performance, although other  $f/D$  ratios are available as special products. The feed horn for these antenna may be either conical (standard product) or scalar



feed horn (symmetrical, low side lobe). Typical lenses have a smooth external surface and operate virtually independent of frequency. However, for specific narrowband applications, the lens can be zoned to reduce size and weight. The interface to these antennas is a circular waveguide of suitable diameter for the center frequency. However, an integral circular-to-rectangular waveguide transition is available as well as a variety of other options including a detachable circular-to-rectangular transition, orthomode transducer (OMT), circular polarizer (fixed or adjustable) and mountable bore-sighted telescope.

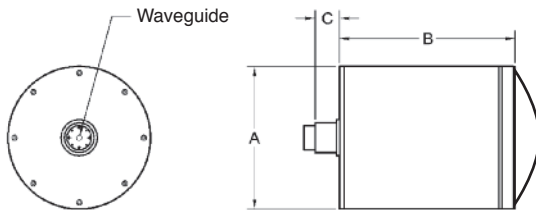
QuinStar can also provide antennas with dual-polarization capability and dual-frequency band operations as customized products.

Lens antennas are most practical in 3 to 12 inch (75 to 300 mm) diameters in the 18 to 140 GHz frequency range for applications where high performance, particularly low sidelobes, is critical. They can also be produced at a fairly low cost in large quantity. In addition, the antenna housing can be used as an enclosure for other components, system electronics or the entire system.

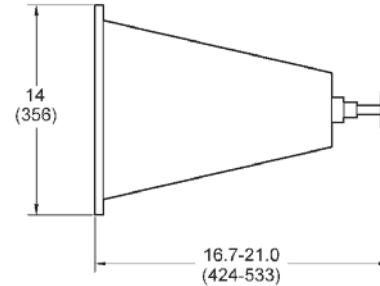
### Specifications

CHARACTERISTIC	SPECIFICATION	COMMENTS
Frequency Range	18-140 GHz	Minimum allowable lens diameter depends on frequency
Bandwidth	50% waveguide band	Dependent on circular waveguide
Lens Diameter Range	3-12 inches (76-300 mm)	Larger sizes available as custom products
Gain Range	25 to 50 dB depending on frequency and diameter	Refer to page 161 for expected gain and beamwidth associated with antenna size and frequency.
Beamwidth Range	0.5 to 10 degrees depending on frequency and diameter	Efficiency is typically greater than 50% for most combinations.
Input VSWR (typ)	1.15:1	Feed dependent
Sidelobes (typ)	>25 dB	Feed dependent

### Outline Drawings/Mechanical Specifications



Cylindrical



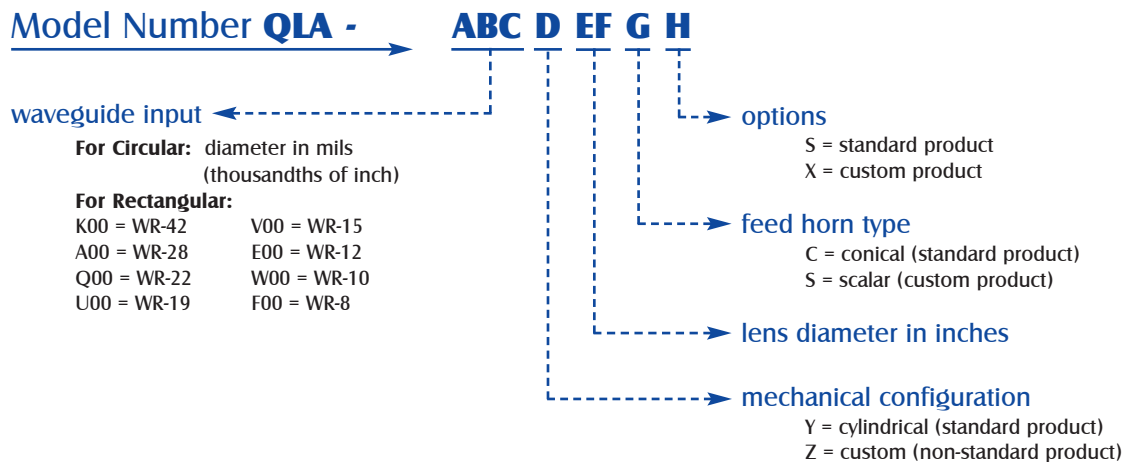
Conical (12 inch lens diameter only)

LENS DIAMETER, inches/mm nominal	OUTLINE DIMENSIONS, inches/mm nominal <sup>1</sup>		
	A	B	C <sup>2</sup>
3.0/76.2	3.5/89	3.8/96.5	1.0-3.0/25-76
6.0/152	6.63/168.4	7.4/188	1.0-3.0/25-76
9.0/229	9.5/235	11.0/279	1.0-3.0/25-76
12.0/305	12.75/324	14.5/368.3	1.0-3.0/25-76

<sup>1</sup> Actual dimensions may vary slightly due to adjustments and mechanical tolerances.

<sup>2</sup> Range of "C" dimension provided to show variation due to adjustments and feed horn variations.

### Ordering Information





# Prime Focus Antenna QRP

## Characteristics

- ◆ Compact, Light weight
- ◆ Low Sidelobes
- ◆ Low Cost

## Product Description

QuinStar Technology's series **QRP Prime Focus Antennas** consist of a primary feed which directly illuminates the parabolic main reflector from its focal point. A low profile support structure may be used to support the feed. These antennas offer high gain, good efficiency and relatively low sidelobes because of minimal blockage by the feed structure. They are available in reflector sizes from 3 to 48 inches for frequencies in the 18 to 140 GHz range. The gain and beam width are determined mainly by the reflector size and operating frequency. Prime focus antennas are

relatively compact and lower in cost than other options or types for the same aperture size.

Standard reflectors are parabolic with feed located on the main axis. However, QuinStar can produce antennas with offset feed and non-circular reflector geometry. A wide selection of reflector diameters, surface finish and material is available to suit each specific application. Typical interface is a rectangular waveguide



## Specifications

CHARACTERISTIC	SPECIFICATION	COMMENTS
Frequency Range	18-140 GHz	
Reflector Diameter	3 to 48 inches (76 to 1200 mm)	Not all sizes are suitable at a given frequency
Beam Width	0.2 to 10 degrees depending on diameter and frequency	Refer to plots page 161 for gain and beam width for a selected diameter and frequency
Gain	25 to 50 dBi depending on diameter and frequency	
Sidelobes	17 dB typical	Feed dependent
VSWR	1.25:1 typical	Feed dependent

## Ordering Information

Model Number **QRP -**

**ABC DE F**

waveguide input

**For Circular:** diameter in mils  
(thousandths of inch)

**For Rectangular:**

K00 = K-band      V00 = V-band  
A00 = Ka-band      E00 = E-band  
Q00 = Q-band      W00 = W-band  
U00 = U-band      F00 = F-band

options for feed

C = conical  
P = pyramidal  
Z = custom  
K = coaxial

reflector diameter in inches

## Characteristics

- ◆ Compact and Low Profile
- ◆ High Gain
- ◆ Low VSWR
- ◆ 1 to 4 Foot Diameters

## Product Description

QuinStar Technology's **QRC** series **Cassegrain reflector antennas** are available in diameters ranging from 10 inches to 4 feet (25 to 120 cm) for any frequency in the 18-140 GHz range. They operate over a fairly wide frequency range which is limited only by the circular waveguide bandwidth. Gain is determined by antenna diameter, frequency of operation and feed illumination. These antennas are typically more efficient than the prime focus antennas, as the feed line losses are eliminated and a better match is obtained.

The main reflector is parabolic in shape and machined very accurately of either aluminum or a composite material. The subreflector is optimally designed and adjusted for best performance. The subreflector and support structure create minimal blockage and hence produce reasonably low sidelobe levels, generally below 16 dB. The feed horns

are selected to produce optimal illumination for low sidelobes and high gain. The interface to these antennas is a circular waveguide of suitable diameter for the center frequency. However, an integral circular-to-rectangular waveguide transition is available as well as a variety of other options, including a detachable circular-to-rectangular transition, orthomode transducer (OMT), circular polarizer (fixed or adjustable) and mountable bore-sighted telescope.

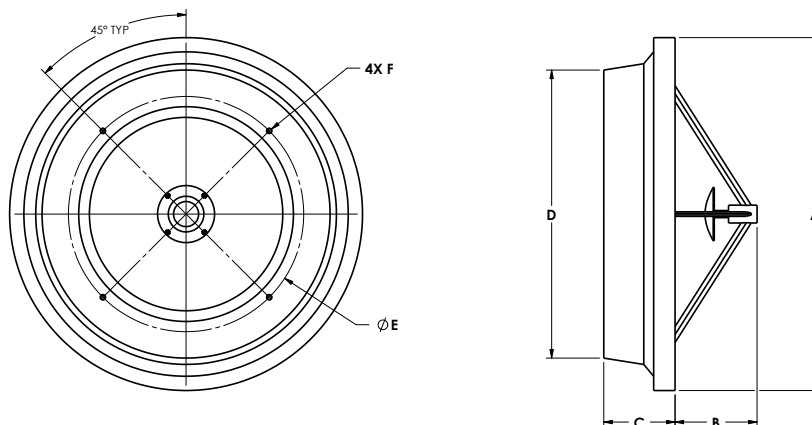
QuinStar's series QRC Cassegrain reflector antennas are ideally suited for applications requiring relatively low depth and good input match. However, Cassegrain antennas of diameters smaller than 10 inches (25 cm) are not recommended, particularly for frequencies below 30 GHz.

## Specifications

CHARACTERISTIC	SPECIFICATION	COMMENTS
Frequency Range	18-140 GHz	Ideal above 30 GHz
Bandwidth	Please see appendix	Dependent on circular waveguide
Reflector Diameter Range	10-48 inches (25-120 cm)	24 inch (60 cm) and larger for frequencies below 30 GHz
Gain Range	25 to 50 dB depending on frequency and diameter	Refer to page 161 for expected gain and beamwidth associated with antenna size and frequency. Efficiency is typically greater than 50% for most combinations.
Beamwidth Range	0.2 to 6 degrees depending on frequency and diameter	
Input VSWR (typ)	1.15:1	Feed dependent
Sidelobes (typ)	16 dB	Dependent on operating frequency and diameter of main and subreflectors



## Outline Drawing/Mechanical Specifications



REFLECTOR DIAMETER, inches/cm nominal	OUTLINE DIMENSIONS, inches/cm					
	A	B	C	D	E	F
6/15.2	6/15.2	3.025/7.683	1.315/3.340	4.9/12.45	4/10/6	5/16-24UNC
10/25.4	10/25.4	3.48/8.84	2.23/5.66	7.9/20.1	7/17.8	3/8-16UNC
12/30.5	12/30.5	3.75/9.53	2.63/6.68	11/27.9	10/25.4	3/8-16UNC
13/33.0	13/33.0	3.92/9.96	2.79/7.09	11/27.9	10/25.4	3/8-16UNC
15/38.1	15/38.1	4.47/11.35	3.16/8.03	12/30.5	10/25.4	3/8-16UNC
18/45.7	18.75/47.63	4.87/12.37	3.76/9.55	12/30.5	10/25.4	3/8-17UNC
24/60.9	24.75/62.87	5.75/14.61	5/12.7	20.2/51.3	16.5/41.9	3/8-16UNC
36/91.4	36.75/93.34	7.5/19.0	7.38/18.74	30.2/76.7	24/61.0	3/8-17UNC
48/121.9	49.2/124.97	11/27.9	9.75/24.77	41.3/104.9	36/91.4	1/2-13UNC

## Ordering Information

Model Number **QRC -**

**ABC DE**

waveguide input

reflector diameter in inches

**For Circular:** diameter in mills  
(thousandths of inch)

**For Rectangular:**

K00 = WR-42

V00 = WR-15

A00 = WR-28

E00 = WR-12

Q00 = WR-22

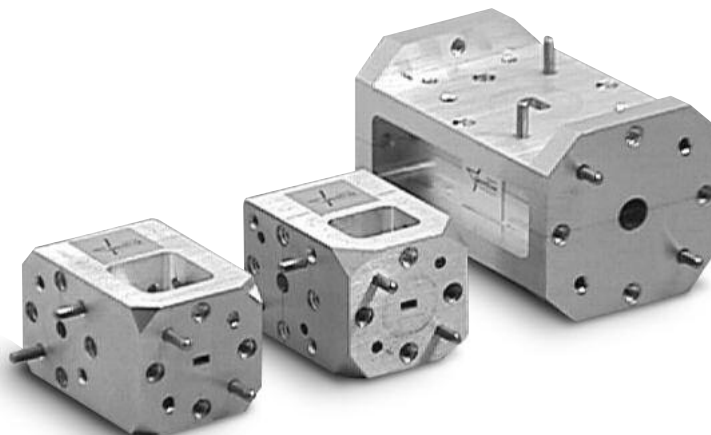
W00 = WR-10

U00 = WR-19

F00 = WR-8

## Characteristics

- ◆ High isolation
- ◆ Low VSWR
- ◆ Minimum Insertion Loss
- ◆ Compact
- ◆ Broadband



## Product Description

QuinStar Technology's **QWO** series **orthomode transducers** cover the frequency range of 26.5 to 110 GHz in six waveguide bands. They are used to separate a signal applied to the circular waveguide port into vertical and horizontal components at the two linear ports with greater than 25 dB isolation.

In reverse, two orthogonal linearly-polarized signals can be combined, producing an output in the circular waveguide port. The resultant polarization may be linear, circular, or elliptical depending on the relative phase and amplitude of

the two orthogonal input signals. Orthomode transducers require a circular - to rectangular waveguide transition with mode-suppressor included.

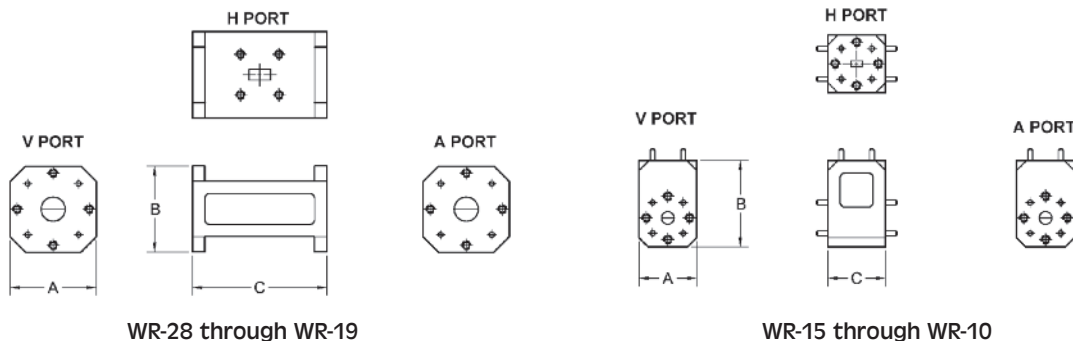
Orthomode transducers operate over a bandwidth of typically 50% of waveguide band centered at a specific operating frequency. They are used in multipolarization radars, sensors, radiometers and instrumentation. For products covering full waveguide band, please see series QOT

## Specifications

PERFORMANCE PARAMETER	TYPICAL CHARACTERISTICS
Frequency Range	26.5 to 110 GHz
Operating Bandwidth <sup>1</sup>	50% of waveguide band
Isolation	25 dB minimum
VSWR (typ)	1.3:1 26.5 to 75 GHz; 1.4:1 75 to 110 GHz

<sup>1</sup> See model QOT for full waveguide band version.

## Outline Drawings/Mechanical Specifications



FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm		
			A	B	C
Ka	WR-28	See Note <sup>1</sup>	1.12/28.4	1.12/28.4	1.75/44.5
Q	WR-22	UG-383/U	1.12/28.4	1.12/28.4	1.75/44.5
U	WR-19	UG-383/U	1.12/28.4	1.12/28.4	1.75/44.5
V	WR-15	UG-385/U	0.75/19.1	1.12/28.4	0.75/19.1
E	WR-12	UG-387/U	0.75/19.1	1.12/28.4	0.75/19.1
W	WR-10	UG-387/U	0.75/19.1	1.12/28.4	0.75/19.1

<sup>1</sup> "H" port is UG-599/U. "V" and "A" ports are UG-381/U (circular cover flange).

## Ordering Information

Model Number **QWO -** **AB C D E O**

center frequency rounded to nearest GHz

(A0 = 100 GHz, A1 = 101 GHz, B1 = 111 GHz, etc.)

configuration

A = standard  
R = optional circular to rectangular V-port transition  
Z = custom

waveguide band designator

A = Ka-band      V = V-band  
Q = Q-band      E = E-band  
U = U-band      W = W-band

circular waveguide diameter

L = low band (large)  
M = mid band (medium)  
H = high band (small)  
Z = custom



# Full Waveguide Band Orthomode Transducer QOT

## Characteristics

- ◆ Full Waveguide Bandwidth
- ◆ High Isolation
- ◆ Low Insertion Loss
- ◆ Compact
- ◆ Low VSWR



## Product Description

QuinStar Technology offers **QOT** Series **orthomode transducers** covering full waveguide bands from K band through W band covering 18 to 110 GHz in seven bands. These orthomode transducers (OMT) are used to separate a signal applied to the circular waveguide input port into its two linear orthogonal components at the rectangular waveguide output ports with greater than 32 dB isolation between the polarizations. In reverse, two orthogonal linearly polarized signals can be combined, producing an output in the circular waveguide port. The resulting

polarization may be linear, circular or elliptical depending on the relative phase and amplitude of the two orthogonal input signals.

Typical insertion loss of these orthomode transducers is less than 0.5 dB over the full waveguide band and return loss greater than 15 dB. These products are used for instrumentation, multipolarization radars, sensors, radiometers and communication systems.

## Specifications

PERFORMANCE PARAMETER	TYPICAL CHARACTERISTICS
Frequency Range	18 to 110 GHz
Operating Bandwidth	Full Waveguide Band
Insertion Loss	0.5 dB typical
Isolation Between Polarization	32 dB minimum
VSWR	1.4:1 max. over the band

## Ordering Information

Model Number **QOT - A BCD 00**

waveguide band for the  
rectangular ports

Circular waveguide diameter in mils  
(thousandths of inch)

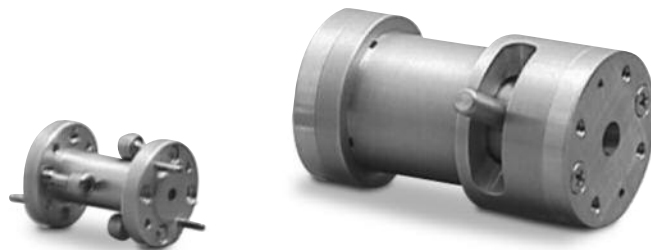


# Linear-to-Circular Fixed and Switchable Polarizers

QWL/QWQ

## Characteristics

- ◆ Low VSWR
- ◆ Minimum Insertion Loss
- ◆ Fixed; Manual and Motorized Switching
- ◆ Linear, LHCP and RHCP



## Product Description

QuinStar Technology's **QWL** and **QWQ** series **linear-to-circular fixed** and **switchable polarizers** cover the frequency range of 26.5 to 110 GHz in six waveguide bands. Fixed polarizers are sections of circular waveguide with a built-in polarization converter that converts a linearly-polarized signal to either a left- or right-hand circularly-polarized signal, depending on the orientation of the waveguide section.

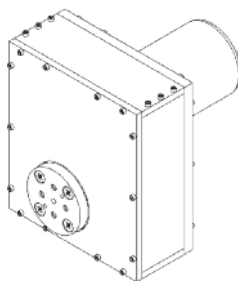
Series **QWQ** **switchable polarizers** have an internal polarizing card that can be manually rotated to change the

signal between right- and left-hand circular polarization without disconnecting the waveguide. A center position on the switch allows linearly-polarized signals to pass through the waveguide without changing polarization. These polarizers operate over a bandwidth of typically  $\pm 10\%$  centered at a specific operating frequency.

QuinStar also offers a motorized (electromechanical) version of the switchable polarizer. The motorized version has only two positions corresponding to right- and left-hand circular polarizations.

## Specifications

PERFORMANCE PARAMETER	TYPICAL CHARACTERISTICS
Frequency Range	26.5 to 110 GHz
Operating Bandwidth	20% of waveguide band
Axial Ratio (max)	1 dB
VSWR (typ)	1.3:1



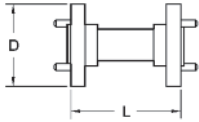
Motorized Polarizer



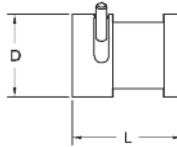
# Linear-to-Circular Fixed and Switchable Polarizers

## QWL/QWQ

### Outline Drawings/Mechanical Specifications



**Fixed Polarizer**  
(round flange pattern shown)



**Switchable Polarizer**  
(round flange pattern shown)

FREQUENCY BAND	WAVEGUIDE SIZE	FLANGE PATTERN	OUTLINE DIMENSIONS, inches/mm			
			Switchable Polarizer		Fixed Polarizer	
			Diameter (D)	Length (L)	Diameter (D)	Length (L)
Ka	WR-28	UG-381/U	1.25/31.8	2.12/53.8	1.13/28.7	1.50/38.1
Q	WR-22	UG-383/U	1.25/31.8	2.12/53.8	1.13/28.7	1.50/38.1
U	WR-19	UG-383/U	1.25/31.8	2.12/53.8	1.13/28.7	1.50/38.1
V	WR-15	UG-385/U	1.00/25.4	1.5/38.1	0.75/19.1	1.00/25.4
E	WR-12	UG-387/U	1.00/25.4	1.5/38.1	0.75/19.1	1.00/25.4
W	WR-10	UG-387/U	1.00/25.4	1.5/38.1	0.75/19.1	1.00/25.4

### Ordering Information

**Model Number** → **QW - AB C D E O**

**model prefix** →  
L = linear-to-circular fixed polarizer  
Q = switchable polarizer

**center frequency rounded to nearest GHz** →  
(A0 = 100 GHz, A1 = 101 GHz, B0 = 110 GHz, etc.)

**switch type** →  
S = switchable, manually  
F = fixed  
M = switchable, motorized

**waveguide band designator** →  
A = Ka-band      V = V-band  
Q = Q-band      E = E-band  
U = U-band      W = W-band

**circular waveguide diameter** →  
L = low band (large)  
M = mid band (medium)  
H = high band (small)  
Z = custom



# Circular-to-Rectangular Waveguide Transitions

QWC

## Characteristics

- ◆ 26.5 to 220 GHz
- ◆ Low VSWR
- ◆ Minimum Insertion Loss

## Product Description

QuinStar Technology's **QWC** series **circular-to-rectangular waveguide transitions** cover the frequency range of 18 to 220 GHz in ten waveguide bands. The waveguide transitions are used to connect standard rectangular waveguide to circular waveguide with a minimum of loss

and reflections. They are available with a variety of flange types to join two components of the same waveguide size which differ in both waveguide aperture size and flange types. The transitions have a wide bandwidth and low VSWR.

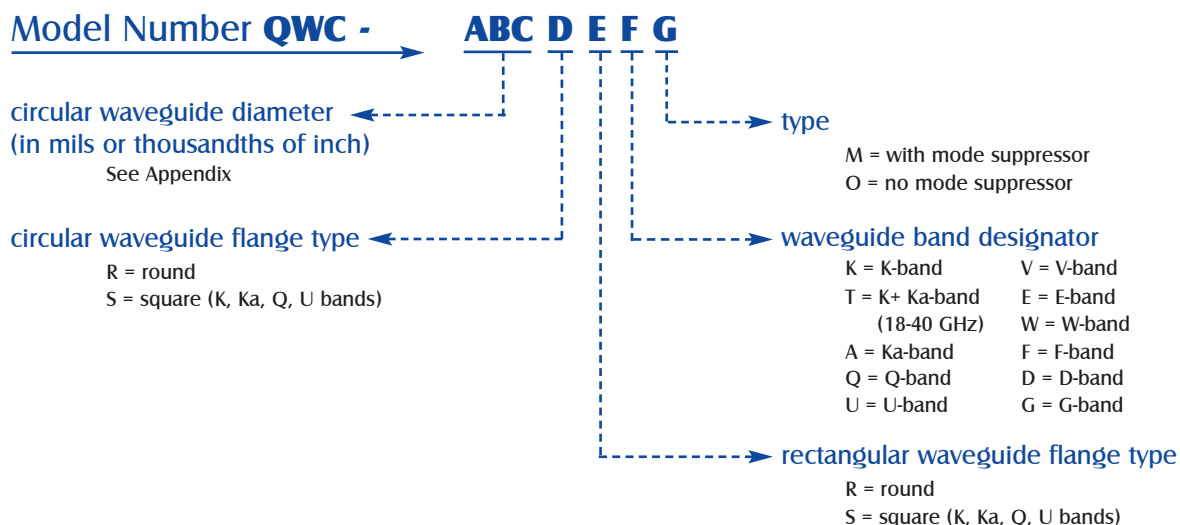


## Specifications

FREQUENCY BAND	K	Ka	T	Q	U	V	E	W	F	D	G
Frequency Range (GHz)	18-26.5	26.5-40	18-40	33-50	40-60	50-75	60-90	75-110	90-140	110-170	140-220
Insertion Loss (dB max)	0.3	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.8	1.0	1.0
VSWR (max)	1.10	1.10	1.10	1.10	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Length, inches/mm (typ)	2.0/50.8	1.50/38.1	1.50/38.1	1.50/38.1	1.50/38.1	1.10/27.9	1.10/27.9	1.10/27.9	1.10/27.9	1.10/27.9	1.10/27.9
Flange Pattern	UG-595/U	UG-599/U	WRD-180	UG-383/U	UG-383/U	UG-385/U	UG-387/U	UG-387/U-M	UG-387/U-M	UG-387/U-M	UG-387/U-M

Other waveguide sizes are available.

## Ordering Information





# Mode Transitions TE<sub>01</sub> to TE<sub>10</sub> QMT

## Characteristics

- ◆ Minimal Insertion Loss, Low VSWR
- ◆ Optional Pressurized Models Available
- ◆ Efficient Conversion

## Product Description

QuinStar Technology's QMT series TE<sub>01</sub> to TE<sub>10</sub> mode transitions are available for operation from 18.0 to 140.0 GHz. These reciprocal devices have a standard rectangular TE<sub>10</sub> mode waveguide input and a circular waveguide TE<sub>01</sub> mode output. Because of the larger frequency ranges of rectangular waveguide when compared to a circular TE<sub>01</sub> mode waveguide, it is possible for a mode transition with a rectangular waveguide input to have one of several different circular waveguide size outputs, depending on frequency range of interest.

The QMT series circular mode transition features low VSWR and low insertion loss. The flanges used for circular

waveguide output are QuinStar's standard male/female type. For maximum mode purity, mode filters are recommended.

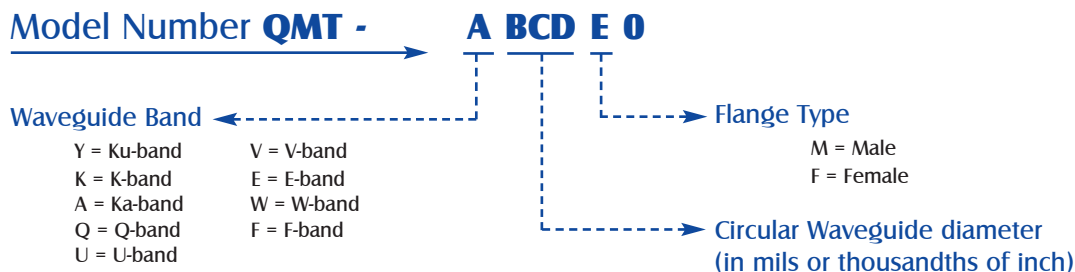
The QMT series waveguide mode transitions are useful in millimeter wave radar systems or laboratory setups where long transmission lines are required. These transitions will provide efficient conversion from the TE<sub>10</sub> rectangular waveguide mode to the TE<sub>01</sub> circular waveguide mode for high-power low-loss transmission.



## Specifications

Rectangular Waveguide Band	Ku	K	Ka	Q	U	V	E	W	F
Frequency Band (GHz)	12.4-18.0	18.0-26.5	26.5-40.0	33.0-50.0	40.0-60.0	50.0-75.0	60.0-90.0	75.0-110.0	90.0-140.0
Insertion Loss (dB) Max.	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.8
VSWR Max.	1.4:1	1.4:1	1.4:1	1.4:1	1.4:1	1.4:1	1.4:1	1.5:1	1.60
Bandwidth	6%	6%	6%	6%	5%	5%	4%	4%	3%
Average Power (Watts)	4000	2000	1000	1000	600	400	200	100	50
Peak Power (kW)	20	10	5	4	3	2	1	0.5	0.2

## Ordering Information



### Characteristics

- ◆ Low Loss
- ◆ High Spurious Mode Attenuation

### Product Description

QuinStar Technology's QMF series Mode Filters provide a solution to the critical need for mode purity when using  $TE_{01}$  mode circular waveguide. Due to the similarities between the  $TE_{01}$  and  $TM_{11}$  modes, even the slightest irregularities in the circular waveguide cause mode conversion from  $TE_{01}$  to  $TM_{11}$ . The large waveguide diameters will readily propagate  $TE_{M1}$  modes, which degrade the purity of the  $TE_{01}$  signal. Extraneous  $TE_{M1}$  and  $TE_{MN}$  modes cannot be reconverted to the  $TE_{10}$  rectangular mode – they show up as large spurious losses.

Each QMF series mode filter consists of a section of lossy wall waveguide. Because the higher order modes ( $TM_{M1}$ ,  $TE_{MN}$ ) have wall currents, they are sharply attenuated and do not propagate. Although the energy transferred to



these modes is minimal, mode filters must be placed periodically along the transmission line. The  $TE_{01}$  mode, which does not have wall currents, passes through this section unaffected. The QMF series mode filters are available in circular waveguide sizes from 12.4 to 140 GHz.

The QMF series mode filters are used to prevent  $TE_{01}$  conversion to higher order modes. By attenuating unwanted  $TE_{M1}$  modes, the QMF series filters allow for the low loss transmission of  $TE_{01}$ ,  $TE_{02}$  modes in circular waveguide and eliminate unwanted resonance, it is recommended that the QMF series filters be placed at least every 10 feet apart.

### Specifications

Frequency Band (GHz)	11.6-48.0	48.0-96.0	96.0-150.0
Insertion Loss $TE_{01}$ (dB) Max.	0.2	0.3	0.4
Attenuation $TE_{11}$ (dB) Min.	10.0	10.0	10.0
VSWR Min.	1.20	1.20	1.25

Note: Contact factory for outlines

### Ordering Information

Model Number **QMF - ABC 000**

Circular Waveguide diameter  
(in mils or thousandths of inch)

### Characteristics

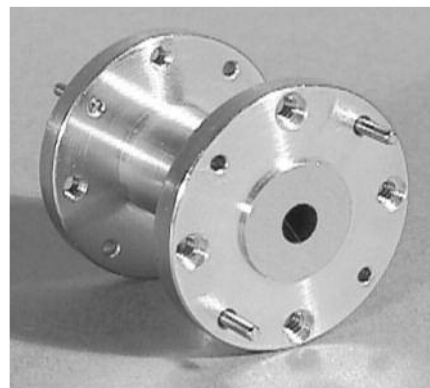
- ◆ Available in Internal Diameter from 0.059-0.660 inch
- ◆ Precise Dimensions

### Product Description

QuinStar Technology offers circular waveguides (flanged and unflanged) for operation in the  $TE_{11}$  mode for frequencies from 12 to 220 GHz in all standard and many custom internal diameters ranging from 0.059 to 0.660 inches. The bandwidth associated with these  $TE_{11}$  mode circular waveguides is narrower than a typical rectangular waveguide in the same general frequency range. Since several internal circular waveguide diameters are

applicable for a given frequency, please contact QuinStar with your specific requirement.

QuinStar also can supply rectangular to circular waveguide transitions (Series QWC) for all applicable combinations of these circular and rectangular waveguides.



### Specifications

See Appendix for Mechanical Specifications for Circular Waveguide Flanges

Table Of Internal Diameters for  $TE_{11}$  Circular Waveguides

Band Designation	Frequency Range, GHz	Internal Diameter, inch	Band Designation	Frequency Range, GHz	Internal Diameter, inch
Ku-1	12.4-14.6	0.660	E-0	58-68	0.141
Ku-2	14.6-17.5	0.550	E-1	68-77	0.125
K-1	17.5-20.5	0.470	E-2	77-87	0.110
K-2	20.5-24.5	0.396	E-3	87-100	0.094
K-3	24.5-26.5	0.328	W-0	77-87	0.110
Ka-0	26-28.5	0.328	W-1	87-100	0.094
Ka-1	28.5-33	0.281	W-2	100-112	0.082
Ka-2	33-38.5	0.250	F-0	87-100	0.094
Ka-3	38.5-43	0.219	F-1	100-112	0.082
Q-0	33-38.5	0.250	F-2	112-125	0.075
Q-1	38.5-43	0.219	F-3	125-140	0.067
Q-2	43-50	0.188	D-0	100-112	0.082
U-0	38.5-43	0.219	D-1	112-125	0.075
U-1	43-50	0.188	D-2	125-140	0.067
U-2	50-58	0.165	D-3	140-160	0.059
V-0	50-58	0.165	G-0	125-140	0.067
V-1	58-68	0.141	G-1	140-220	0.059
V-2	68-77	0.125			



# Circular Waveguide Sections and Flanges

QCW

## Ordering Information

Model Number **QCW** - **A BCD EF GH**

flange type

F = Flanged Section of Waveguide  
U = Unflanged Length of Waveguide  
0 = Flange only

waveguide internal diameter  
(in mils or thousandths of inch)

Example BCD = 094 for Internal  
Diameter = 0.094 inch

waveguide length in inches  
(00 for flange only)

flange designation  
(00 for unflanged length  
of waveguide)



# Circular Waveguide Terminations

QTC

## Characteristics

- ♦ Low VSWR
- ♦ Full Circular Waveguide Bandwidth

## Product Description

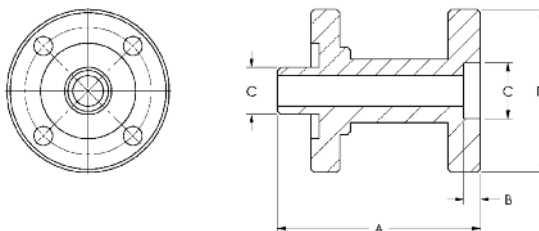
QuinStar Technology's QTC series termination is a section of circular waveguide with an integral conical load made from a dielectric absorber material. The long precise taper allows

optimum absorption of the microwave energy with minimum reflection. Each termination is fitted with a standard male or female circular flange, specified at the time of order. The QTC terminations are used in experimental and developmental test set-ups where a low VSWR waveguide load is essential for measurement validity. When measuring the VSWR that results from insertion of various waveguide components in a system, these terminations ensure precise determination of the individual effects.

## Specifications

Frequency Range (GHz)	11.6-48.0	48.0-96.0	96.0-150.0
VSWR	1.05	1.08	1.10

## Outline Drawings/Mechanical Specifications



CIRCULAR WAVEGUIDE INTERNAL DIAMETER	OUTLINE DIMENSIONS, inches/mm			
	A	B	C	D
0.210	2.22/56.39	.211/5.36	.250/6.35	1.20/30.48
0.250	2.22/56.39	.211/5.36	.291/7.39	1.20/30.48
0.291	2.22/56.39	.211/5.36	.375/9.53	1.20/30.48
0.353	2.22/56.39	.211/5.36	.437/11.10	1.20/30.48
0.495	4.26/108.2	.264/6.71	.625/15.88	1.95/49.53
0.545	3.76/95.5	.264/6.71	.625/15.88	1.95/49.53
0.634	3.76/95.5	.264/6.71	.750/19.05	1.95/49.53
0.688	4.76/120.9	.264/6.71	.788/20.02	1.95/49.53

Contact QuinStar for other circular waveguide diameters.

## Ordering Information

Model Number **QTC -**

**A BCD 00**

Flange Type

M = Male  
F = Female

Circular waveguide diameter  
(in mils or thousandths of inch)



# TE<sub>01</sub> Waveguide Sections and Flanges

## QCL/QCF

### Characteristics

- ♦ Very Low Loss
- ♦ Low VSWR
- ♦ Precise Dimensions

### Product Description

QuinStar Technology's series QCL flanged and unflanged TE<sub>01</sub> mode circular waveguides are available in standard sizes from internal diameters of 0.186 to 1.500 inch for use over 11.6 to 171 GHz. These waveguide sections are fitted with standard male/female flanges. Both waveguide types are manufactured primarily in copper. QuinStar recommends using the Series QMF mode filters in any circular waveguide system to maintain mode purity.

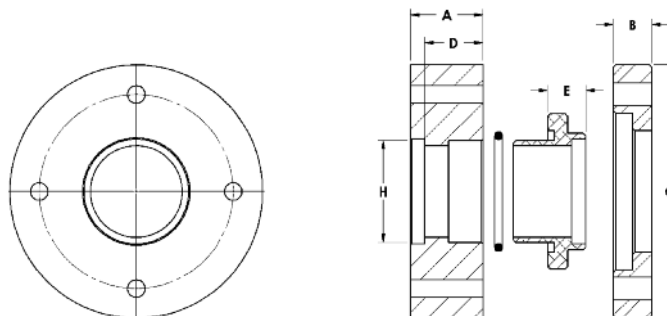
QuinStar Technology's Series QCF circular waveguide flanges have been designed specifically for the TE<sub>01</sub> low loss mode circular waveguide components. These flanges

are precision-machined to facilitate low loss, low reflection waveguide connections at millimeter wave frequencies. O-ring gaskets are included to make these flanges appropriate for use in pressurized waveguide systems. The circular waveguide flanges are self aligning male/female connectors and are available in both standard and custom size waveguide.

Since a wide variation of circular diameters is applicable for a given frequency, please contact QuinStar with your specific requirement.

### Specifications

Series QCL TE <sub>01</sub> Circular Waveguide						
Standard Waveguide			MIL-W-23068 Circular Waveguide			
I.D	O.D (inches)	Frequency (GHz)	I.D.	O.D. (inches)	Frequency (GHz)	Designation
1.500	1.750	11.6-16.0	1.500	1.700	11.6-16.0	WRC530D1
1.265	1.375	13.2-18.9	1.281	1.441	13.2-18.9	WRC621D1
1.106	1.250	15.9-21.9	1.094	1.224	15.9-21.9	WRC727D1
0.951	1.125	18.6-25.6	0.938	1.068	18.6-25.6	WRC849D1
0.686	0.750	25.3-34.9	0.797	0.897	21.9-30.1	WRC997D1
0.688	0.888	25.3-34.9	0.688	0.788	25.3-34.9	WRC116C1
0.634	0.750	27.3-38.0	0.594	0.674	29.3-40.4	WRC134C1
0.545	0.625	32.0-44.0				N/A
0.495	0.625	34.8-48.0	0.500	0.580	34.8-48.0	WRC159C1
			0.438	0.518	39.8-54.8	WRC182C1
0.370	0.500	46.4-63.9	0.375	0.435	46.4-63.9	WRC212C1
0.353	0.438	50.0-68.0	0.328	0.388	53.1-73.1	WRC243C1
0.291	0.375	62.0-84.0	0.281	0.341	61.9-85.2	WRC283C1
0.249	0.313	69.7-95.9	0.250	0.290	69.7-95.9	WRC318C1
0.201	0.290	86.0-115.0	0.219	0.259	79.6-110.0	WRC364C1
0.186	0.250	93.0-128.0	0.188	0.228	92.9-128.0	WRC424C1
			0.172	0.212	101.0-139.0	WRC463C1
			0.141	0.181	124.0-171.0	WRC566C1



Series QCL TE <sub>01</sub> Circular Waveguide Flanges						
CIRCULAR WAVEGUIDE INTERNAL DIAMETER, INCH	OUTLINE DIMENSIONS, inches/mm					
	A	B	C	D	E	H
0.688	0.55/13.97	0.30/7.62	1.95/49.53	.450/11.43	.185/4.70	.788/20.02
0.635	0.55/13.97	0.30/7.62	1.95/49.53	.450/11.43	.185/4.70	.750/19.05
0.545	0.55/13.97	0.30/7.62	1.95/49.53	.450/11.43	.185/4.70	.625/15.88
0.495	0.55/13.97	0.30/7.62	1.95/49.53	.450/11.43	.185/4.70	.625/15.88
0.353	0.40/10.16	0.27/6.86	1.20/30.48	.300/7.62	.141/3.58	.437/11.10
0.291	0.40/10.16	0.27/6.86	1.20/30.48	.300/7.62	.141/3.58	.375/9.35
0.250	0.40/10.16	0.27/6.86	1.20/30.48	.300/7.62	.141/3.58	.291/7.39

## Ordering Information

Model Number → **QC - A BC DEF**

L = TE<sub>01</sub> Waveguide Section  
F = Flanges for Circular Waveguide

F = Flanged Section of Waveguide  
U = Unflanged Section of Waveguide  
0 = Flange only (for Series QCF)

→ waveguide internal diameter  
(in mils or thousandths of inch)

Example DEF = 291 for  
Internal Diameter = 0.291 inch

→ waveguide length in inches

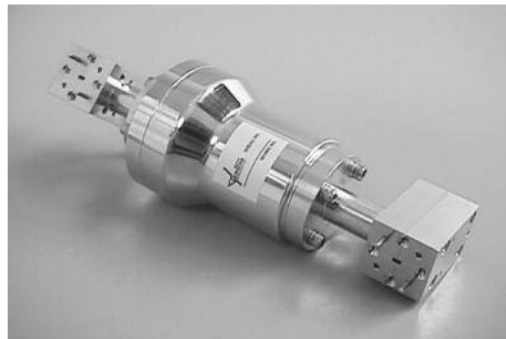
### Characteristics

- ◆ Minimal Variation With Rotation
- ◆ Reliable, Rugged and Light Weight

### Product Description

QuinStar Technology's Series QRJ rotary joints are available in standard circular waveguide sizes to cover frequencies from 11.6 to 150 GHz. Each rotary joint consists of two circular waveguide sections mounted on ball bearings. Connections to the guides are made using standard male and female circular flanges. Precise alignment of the waveguide sections prevents spurious mode generation, and the very small gap between abutting surfaces results in only a negligible loss in the  $TE_{01}$  circular mode. Amplitude variation with rotation is less than 0.2 dB and phase variation is less than 2 degrees for all models.

The QRJ rotary joints provide efficient energy transfer in radar antenna systems or in other applications requiring for



low phase variation, low insertion loss, and low return loss. They are also useful in special laboratory test set-ups for the measurement of millimeter wave parameters including phase variation in radiated fields. These rotary joints are designed for use with (or to interface with) circular waveguides.

The QRJ rotary joint can also be fitted with two Series QMT Mode Transitions and a Series QMF Mode Filter to provide a rotary joint assembly for rectangular waveguide applications.

### Specifications

Frequency Range	11.6-48.0 GHz	48.0-96.0 GHz	96.0-150.0 GHz
Insertion Loss $TE_{01}$ (dB) Typ.	0.8	1.0	1.5
VSWR Typ.	1.2	1.3	1.4

### Ordering Information

Model Number **QRJ - ABC 00**

Circular waveguide  
internal diameter  
(in mils or thousandths of inch)



## QuinStar Technology Antenna Development Capability and Measurement Facility:

QuinStar has technical capability and analysis tools to develop advanced and special-purpose antennas and optics for use in the entire microwave and millimeter wave spectrum. For detailed evaluation and testing of these antennas and optical components, QuinStar has also created a well-instrumented and fully equipped measurement facility. For accurately measuring and rigorously diagnosing a very wide range of antenna sizes and types operating over a significantly large frequency interval, QuinStar has configured several different types of measurement facilities for optimal results and efficiency/speed.

### Fully Automated MW / MMW Antenna Measurement System:

QuinStar's new near-field antenna measurement system is designed to measure near-field antenna patterns and to generate near-field and calculated-far-field characteristics of the antenna response and performance. The system is composed of an Antcom NFH0003-8 scanner housed in a state-of-the-art, 13- by 17-foot anechoic chamber, capable of making planar scans for high gain narrow beam reflector, lens, and phased array antennas; spherical scans for low gain broad beam horn and lens antennas; and cylindrical scans for fan beam, omnidirectional, and linear array antennas. Additionally, it can take measurements at

multiple frequencies during each scan, and can process the near-field data to produce far-field graphical patterns.

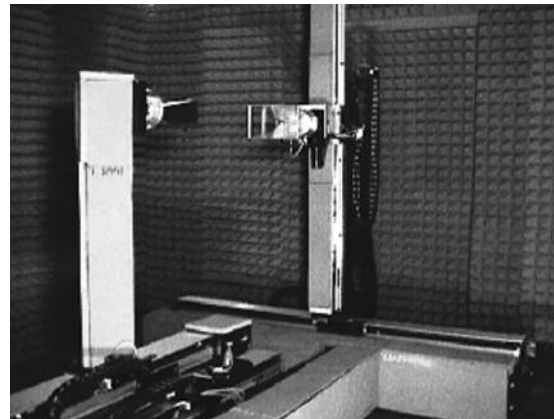
Graphical and numerical presentations include radiation patterns for co- and cross-polarizations, axial ratio, gain (amplitude) and phase, rectangular and polar cuts, contour and 3D visualization, and elevation and azimuth cuts for different angles. The system can make presentations in color or grayscale plots, and create data tables exportable to Microsoft Excel and other programs.

The scanner can accommodate antennas up to five feet in diameter and up to a combined total of 142 foot-pounds in weight at the mounting point. The antenna under test can automatically be rotated 360° along the vertical mounting axis, and 360° along the horizontal mounting axis (typically the E-H plane axis). The center point for rotation on the vertical axis is software-selectable.

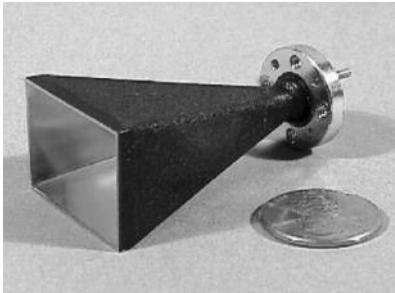
The system has been instrumented to measure antennas in the 1 to 140 GHz region. In addition to evaluating QuinStar's own antennas, this near-field antenna measurement system is also available for testing customer's antennas. Testing can be performed by QuinStar personnel, or under special arrangement, by the customer themselves using their own signal-generating and retrieval equipment. Please contact our Sales Department for information.



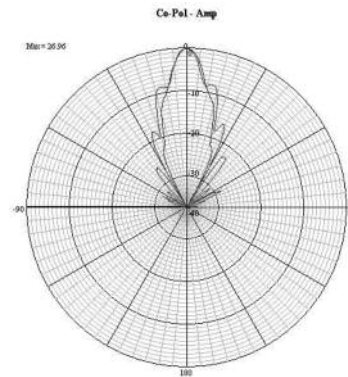
Above: A Com-Power AH-118 1-18 GHz wide-band probe (left antenna) illuminates a K-band horn Antenna Under Test (AUT, right antenna). The AUT rides on two tracks, the lower being the z-axis adjustment, while the upper track (actually a 360° horizontally-rotating boom) is used to adjust the AUT aperture directly over the vertical axis of rotation (phase center adjustment in spherical scans). Additionally, both AUT and probe can be rotated 360° along the z-axis (polarization).



Above: The probe (right antenna) moves along the x- and y-axis and rotates 360° along the z-axis. The system can perform planar polar (pie-section), planar rectangular (raster), planar linear, spherical and cylindrical scans. All movement is under software control. Signals are generated by, and data is gathered from, a vector network analyzer.

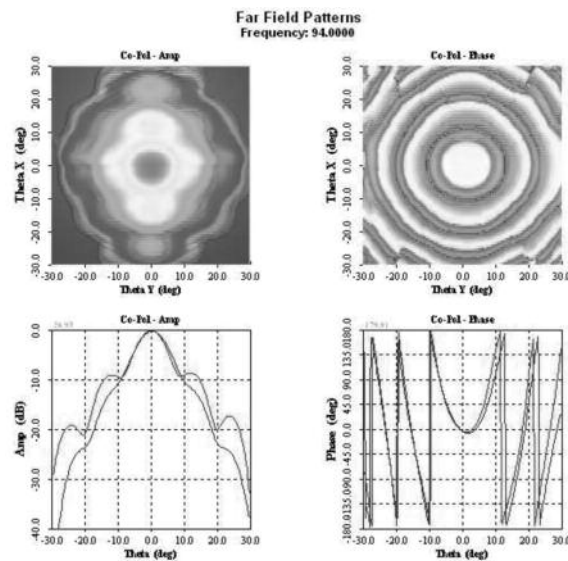


Antenna under test: 94-GHz Standard Gain Horn

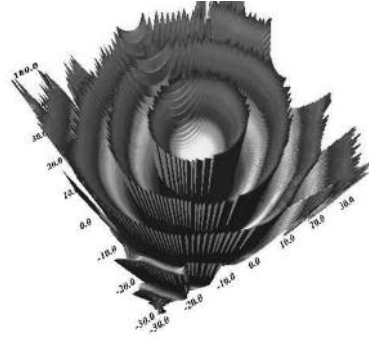
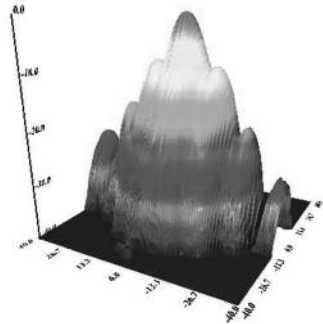


Polar far-field gain pattern

## Far-Field W-band Standard Gain Horn Patterns Generated From a Near-Field Antenna Measurement System



Rectangular far-field gain and phase patterns.



Three-dimensional representation of horn's far-field gain and phase patterns  
(The measurement system allows image rotation for viewing from any side or angle)

### Standard Far Field Measurement Antenna Range

In addition to the Near-Field Antenna range, QuinStar also has an anechoic chamber that houses a conventional antenna measurement range. This facility is equipped to operate between 12 and 170 GHz. This range includes an Az-El antenna positioner, source/receiver instrumentation and data acquisition subsystem for automated measurement of radiation patterns of most antennas.

### Design and Development Antenna Tools for Antenna Products:

QuinStar has a suite of computer simulation and design tools for the design and development of novel antenna products and subsystems.

### Antenna Measurement Services

QuinStar offers antenna measurement services to its customers contingent upon availability of the facility and the staff. Both near-field range and standard far-field anechoic chamber are made available for evaluating and characterizing antennas and optics. QuinStar can also provide the support of its technical staff for conducting the tests and measurements. Please contact QuinStar Technology's Sales Department with your specific measurement needs.





## Section 8

# Assemblies, Subsystems & Systems

Product Title	Model No.	Page Number
<b>Assemblies &amp; Subsystems</b>		193
Cryogenically Coolable Products and Capability		194
Subsystem and Assembly Experience		195
Block Diagrams and Architectures for Assemblies		197
System Products		201



## Cryogenically Coolable Products and Capability

QuinStar Technology offers a selection of cryogenically-coolable products and measurement services associated with them. Standard products as well as custom designed products are offered in these product areas. The following are offered as standard products:

- Low Noise Amplifiers
- Receivers
- Isolators and Circulators
- Loads
- Passive Components and Waveguide Products

Capabilities and general information about the cryogenically coolable Low Noise Amplifiers and Receivers are presented in Section 1.

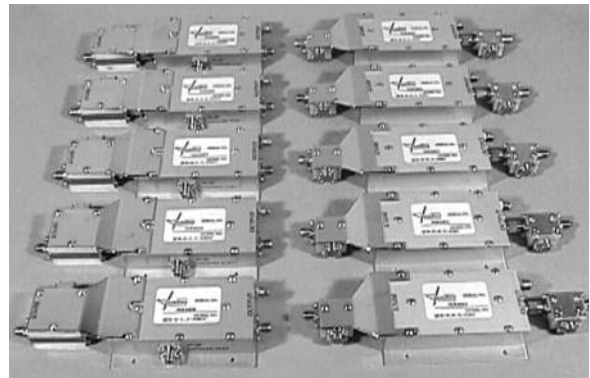
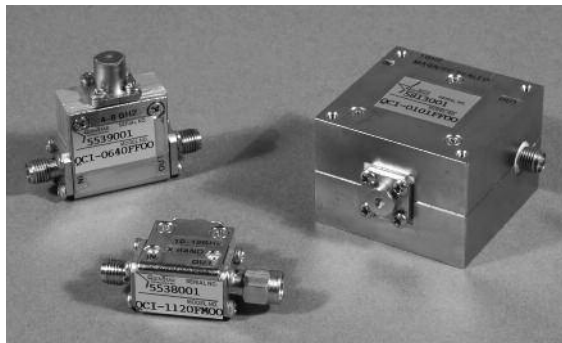
QuinStar offers a complete line of coolable coaxial ferrite products operating in the frequency range of 300 MHz to

50 GHz. Waveguide-based ferrite components, passive components, and waveguide components operating over 18-140 GHz frequency range are also available for cooled operation (down to around 4 deg. K).

### Measurement Services at Low Temperatures:

QuinStar has facilities and personnel to conduct extensive measurements on components and subsystems at cryogenic temperatures (4 degree to 100 deg. K). Test and evaluation services are offered for the following:

- Measurement and Characterization of Active and Passive Components
- Subsystem Evaluation and Testing





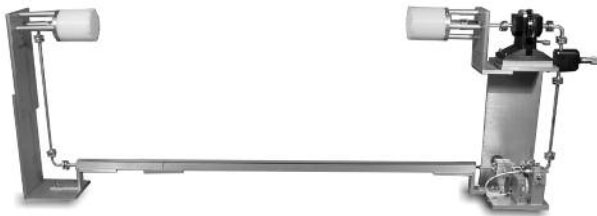
## Characteristics

- ◆ Customized
- ◆ Compact
- ◆ State-of-the-Art Performance
- ◆ Quick Delivery
- ◆ Cost Effective

## Applications

- ◆ Rapid Prototyping
- ◆ Application-Specific Test Equipment
- ◆ Communication, Sensor and Receiver Systems

QuinStar Technology, Inc. specializes in producing a broad range of fully integrated and customized millimeter-wave assemblies and subsystems meeting customer-specific application requirements for digital and analog **Sensor**,



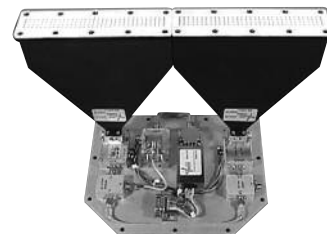
W-Band Interferometer Subsystem

**Communications** and **Test** applications. QuinStar has designed, produced and delivered dozens of different millimeter-wave assemblies and subsystems ranging from **Miniature Transceivers** and **Broadband Receivers** to **Antenna Subsystems** and **Communication Front Ends**.

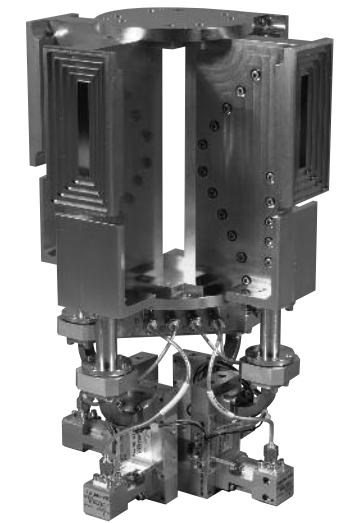
QuinStar's in-house oscillator, amplifier and frequency multiplier product design and manufacturing resources greatly enhance our capability to offer **State-of-the-Art** solutions for **Rapid Prototyping** and **Proof of Concept Demonstration** all the way through **Production**. The level of integration, circuit complexity, packaging and testing

provided by QuinStar are all determined by the customers' precise needs, budget limitations and environmental constraints. In addition, customers are often able to select from a vast variety of existing generic millimeter-wave assemblies and subsystems that are fully developed and readily producible. This results in significant cost savings, quick delivery and avoidance of developmental risks.

QuinStar can develop and produce customized assemblies and subsystems from virtually any starting point in the customers' application development cycle and on the basis of any degree of definition or specification. We can work from just a **Conceptual Design** or **Generic Description**, or convert a **Functional Block Diagram** or **Circuit Schematic** into a customized assembly or subsystem. We are also well positioned to economically manufacture an assembly or subsystem on a **Build to Print** basis if desired.



FMCW Radar with Fan Beam Antenna



Omni Directional Receiver Subsystem using 4 Sectoral Antennas.



## Assemblies and Subsystems

Some of QuinStar's commonly produced millimeter-wave assemblies and subsystem products include:

**Sensitive Receivers:** QuinStar has developed a complete line of sensitive receiver front ends that operate over the 18-140 GHz frequency interval. These receiver front ends may be used in systems ranging from EW receivers to environmental sensors and meteorological radiometers. Low-noise amplifiers produced by QuinStar allow us to offer state-of-the-art performance.

**Generic Transceivers:** Front ends for radars with virtually any waveform (CW, FMCW, pulsed or various other complex modulation waveforms) have been produced to meet requirements ranging from automobile collision warning systems to plasma diagnostic instruments. QuinStar's strength in high performance transmitter components, such as amplifiers and oscillators, greatly enhances the performance of these custom products. In addition, our significant experience allows us to deliver a cost-effective, fully compliant assembly or subsystem well matched to the application. Antennas and other assemblies can also be integrated with these transceivers.

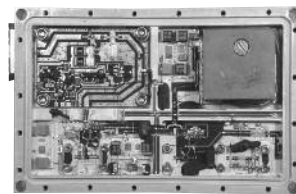


High Power Millimeter Wave Transceiver Module

**Antenna-Related Subsystems:** QuinStar routinely provides complex antenna product assemblies consisting of a variety of antennas, polarizers, orthomode transducers and associated waveguide products integrated to achieve customer-specified performance.

**Special Test and Measurement Equipment:** QuinStar produces customized test and measurement equipment for special applications and/or dedicated production measurements. These include Noise/Gain Test Sets, Voltage Standard Measurement Systems and Frequency Extension Kits for Network Analyzers.

**Transmitters and Sources:** Sources especially suited for transmitters for communication equipment, sensors, seekers, plasma diagnostic instruments and test equipment are offered as customized products. These are based on QuinStar's broad active component product line. In addition, frequency agile (sweepers), synthesized and phase-locked sources are offered.



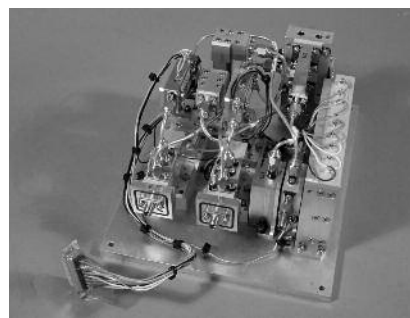
Integrated Automotive Radar Front End



Dual Antenna



Programmable Ka-band FMCW Exciter



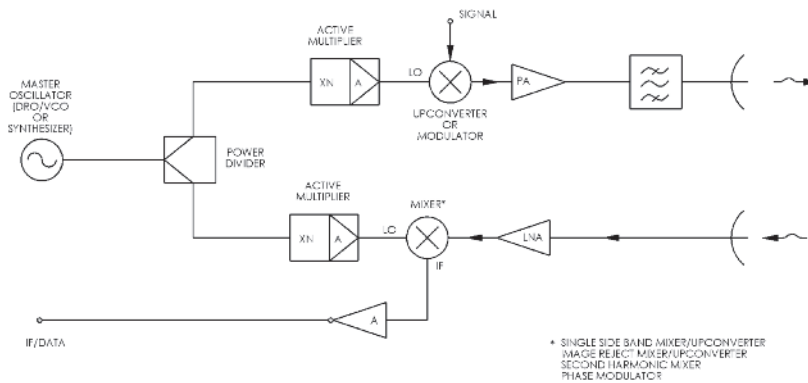
Broadband Downconverter

## Millimeter Wave Subsystems and Assemblies for Various Applications using QuinStar Products:

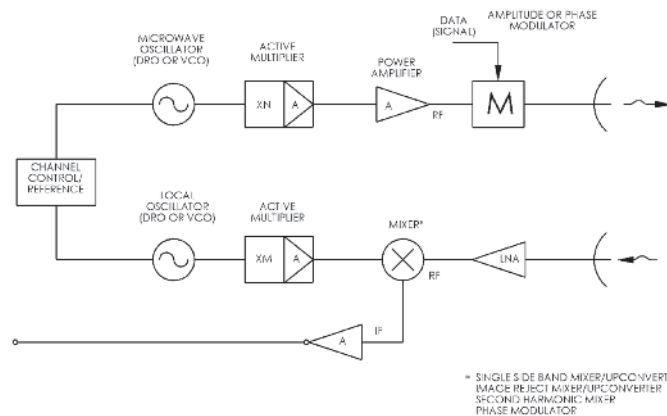
QuinStar Technology provides all critical components, interconnects and antennas to allow the customers to create virtually any millimeter wave subsystem, test and measurement configuration or application-specific assembly. Some of the most commonly used configurations or architectures are shown here. QuinStar can also develop fully integrated assemblies or subsystems in modular format to suit its customer's performance requirements and physical constraints.

### A. Millimeter Wave Communication Radios and Data Links:

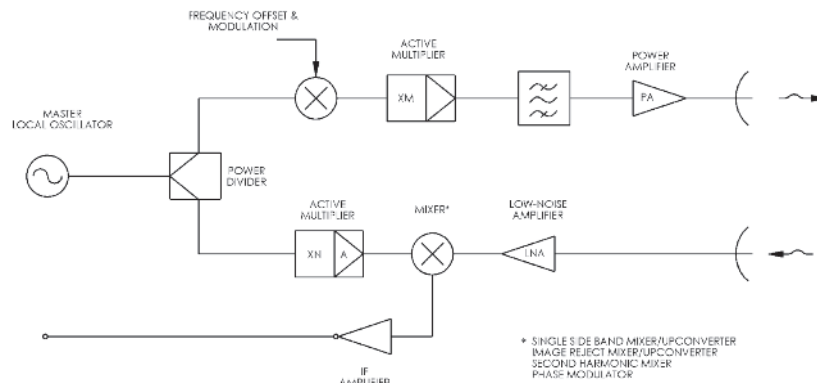
**COMMUNICATION DATA LINK-ARCHITECTURE**



**COMMUNICATION DATA LINK-ARCHITECTURE**

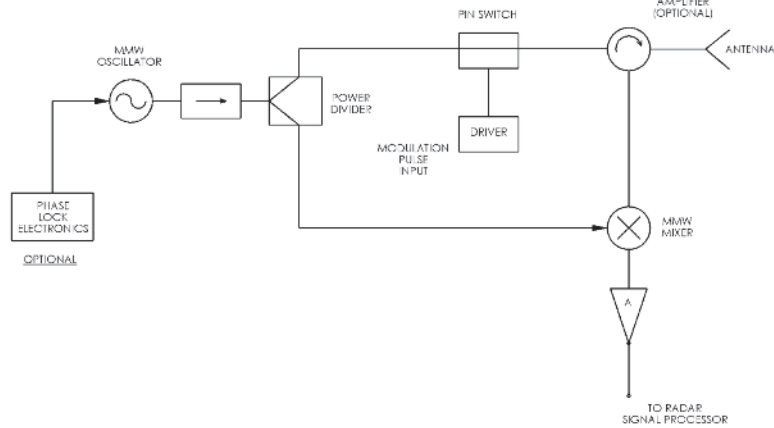


**COMMUNICATION DATA LINK-ARCHITECTURE**

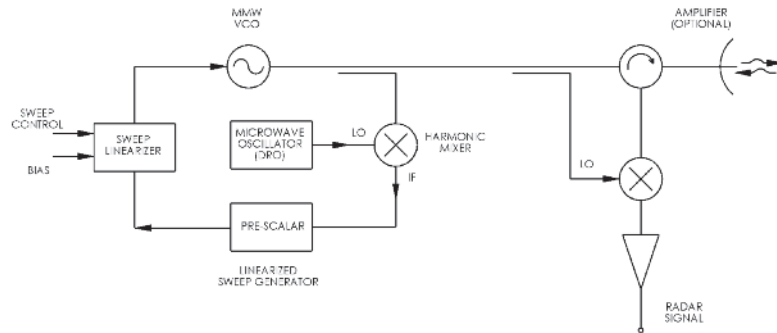


## B. Pulsed and FMCW Radar:

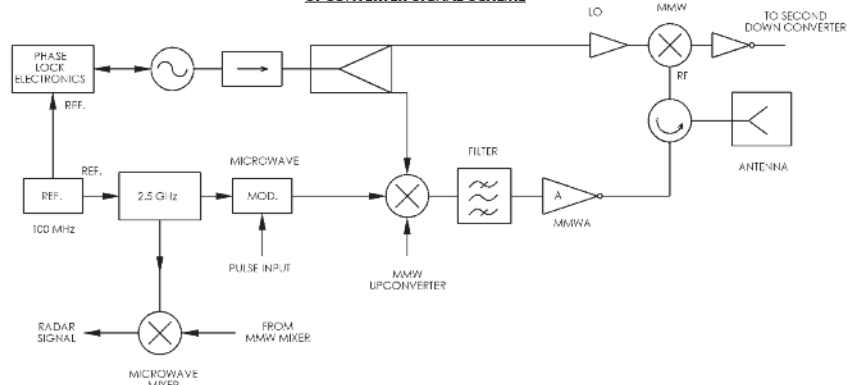
**DIRECT PULSE MODULATION SCHEME**



**FMCW RADAR**

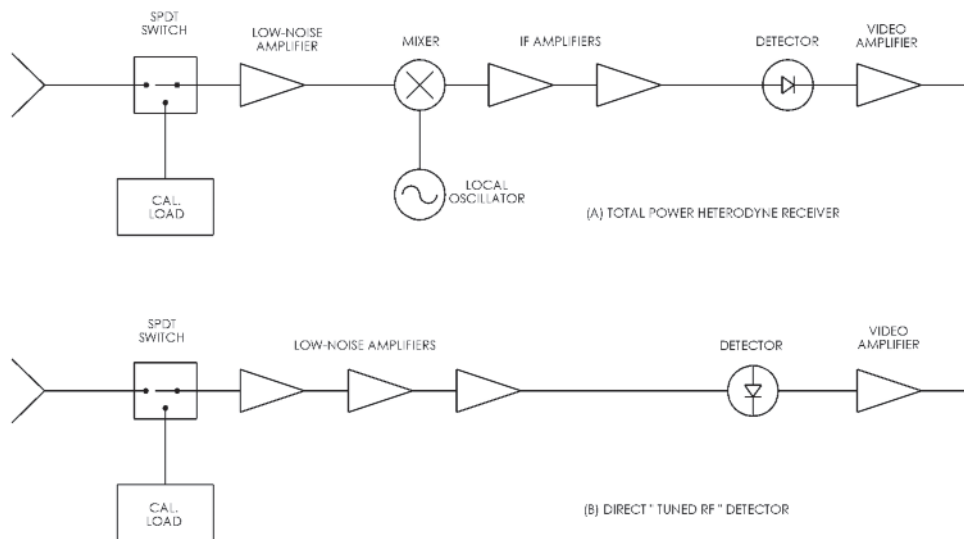


**UPCONVERTER SIGNAL SCHEME**



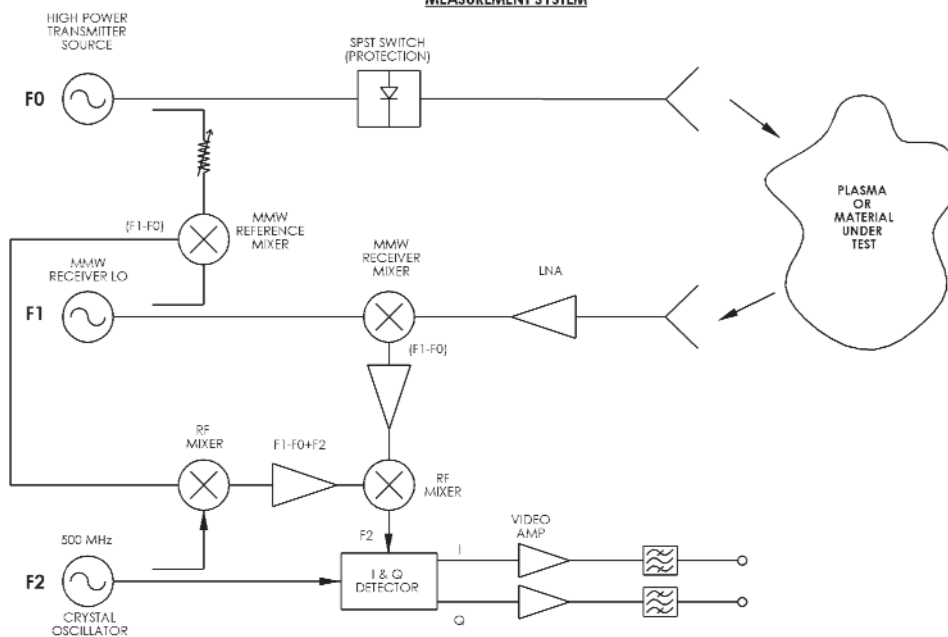
## C. Millimeter Wave Radiometer & Radiometric Receivers

### RADIOMETERS & RADIOMETRIC RECEIVERS

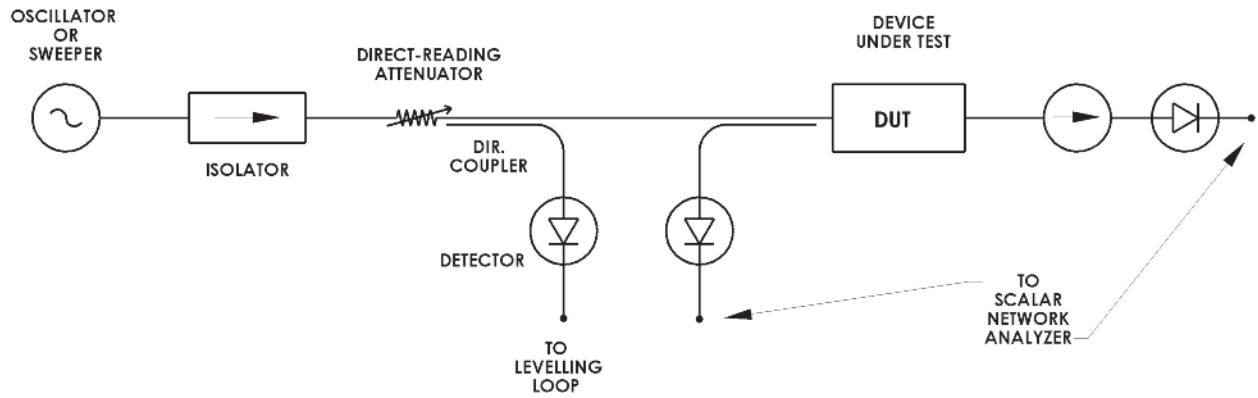


## D. Plasma Diagnostics and Material Measurement System

### PLASMA AND MATERIAL MEASUREMENT SYSTEM

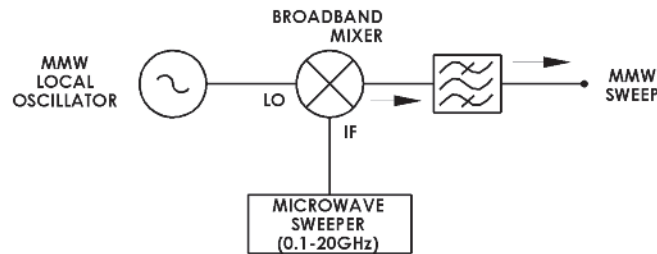


## E. Component Evaluation Test Set

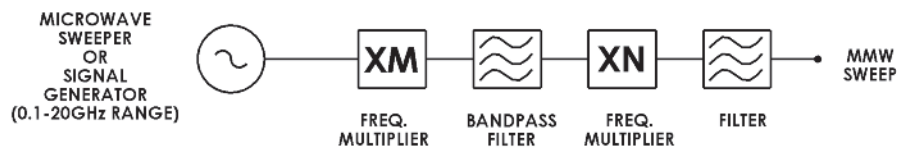


## F. Frequency-Extension Subsystem

### UPCONVERTER APPROACH



### MULTIPLIER APPROACH





# Systems Products Capability

QuinStar produces a broad range of millimeter-wave systems and equipment for applications as diverse as **broadband communications** and **seeker front ends** to **collision warning sensors** and **radiometers**. QuinStar has the technical capabilities, facilities, design and development skills, and program management experience to execute major development and production programs and provide application-specific solutions.

- ☐ System Design, Development and Testing Experience
- ☐ Complete Receiver, Radar and Radiometer Products (Sensors)
- ☐ MMIC-Based Transceivers and Sensor Specific Antennas
- ☐ System Level Knowledge of Millimeter-Wave Applications
- ☐ Infrastructure to Support Major Programs

## Sensor Products

- ☐ Automotive Collision Warning Sensors
- ☐ Traffic Monitoring Sensors
- ☐ Non-Contacting Sensors
- ☐ Instrumentation Radars
- ☐ Plasma Diagnostic Instruments
- ☐ Antenna Subsystems



Radar Exciter Module

## Surveillance and EW Products

- ☐ Broadband Sensitive Receivers
- ☐ EW and Direction Finding Instruments
- ☐ Special Antenna Subsystems



Receiver Assembly

## Communication Products



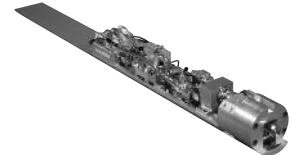
Ka-band Receiver

- ☐ Broadband Communication Products
- ☐ Millimeter-Wave Radios
- ☐ Antennas

## Remote Sensing Products



3-Channel Radiometer Subsystem

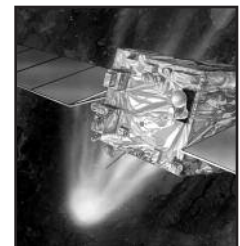


W-Band High Power Transmitter

- ☐ Cloud Measurement Radar Front Ends
- ☐ Satellite-Based Monitoring Systems
- ☐ Molecular Spectroscopy
- ☐ Environmental Measurement Radiometers

## Space-Related Products and Services

- ☐ Space-Qualified Components
- ☐ Subsystems for Space Instruments
- ☐ Spaceborne Receivers and Transmitters

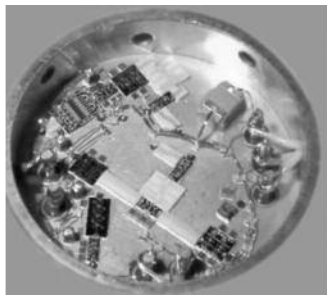


Submillimeter-Wave Receiver LO



## Sensor Products

QuinStar offers Millimeter-Wave Sensor System Products in the 18-140 region. A wide range of fully developed products is available with a variety of useful options and accessories. These products range in complexity from specialized antennas and transceiver front ends to complete turnkey systems including pedestal-positioners, operating software and associated peripherals.



Integrated MMW Radar Sensor Front End

QuinStar's Sensor Products are designed and manufactured to provide a reliable, cost effective solution that meets the customers' application-specific requirements. In addition, QuinStar can provide specialized engineering, measurement and evaluation, and technical field support.

For programs with large volume production potential, QuinStar offers design capabilities, manufacturing experience and production facilities to provide a

low-cost, application-specific solution. The insertion of newly developed MMICs and other novel products result in optimal millimeter-wave sensors that can satisfy virtually any requirement from accurate motion sensing and ranging to seeker front ends, cloud radars and automobile collision warning systems.



FMCW Radar with Narrow Beam Antenna



77 GHz Automobile Radar Front End

## Space Systems Capability

QuinStar has significant experience and capability in millimeter-wave systems for space application. Critical components and assemblies have been, and continue to be, developed by QuinStar for various receivers and radiometers for millimeter-wave sensors and chemistry measurement systems supporting multiple flight programs. These incorporate Gunn oscillators, mixers, amplifiers, phase-locked sources and associated circuits. QuinStar can supply space-qualified components as well as major microwave and millimeter-wave subsystems. We have the infrastructure and experience to conclusively demonstrate the quality and reliability aspects of these products to satisfy virtually any flight application.

QuinStar has an established, highly capable and dependable vendor base for electronic components, lower frequency parts and material associated with most millimeter-wave space systems. In addition, our employees have obtained the necessary training and certifications to perform on and comply with the program requirements of most Space Agencies. QuinStar's unique product development capability in combination with our facilities and experience offers low-risk and cost-competitive product solutions for Space Programs.

## Recent Experience in Space Programs

- ☐ Complete Millimeter-Wave Local Oscillators
- ☐ Components and Assemblies for Radiometric Measurement (EOS-MLS)
- ☐ Components for Environmental Sensors
- ☐ New Generation of Radiometers for Space-Based Instruments (JASON II)
- ☐ High Frequency Sources for Space Programs (MIRO)
- ☐ High Power Isolator for Lunar Reconnaissance Orbiter

## Section 9

# Appendices & Technical Reference Manual

Product Title	Model No.	Page Number
<b>Appendices &amp; Technical Reference Material</b>		203
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B- Waveguide and Flange Dimensions (Round Flanges)		205
C- Blank Round Flange Dimensions		206
D- Waveguide and Flange Dimensions (pin-contact, threaded ring)		207
E- Blank Flange Dimensions (pin-contact, threaded ring)		207
F- WR-62 (Ku-band) Flange Blank and Waveguide Dimensions		208
G- Waveguide and Flange Dimensions (choke Flange)		208
H- Square Flange Waveguide Dimensions		209
I- Flange Blanks (Square)		209
J- Circular Waveguide Sizes		210
K- Circular Waveguide Sizes (Alternative Set)		211
L- VSWR, Return Loss, Reflection Coefficient Conversion Table		
Noise Figure to Noise Temperature Conversion Table		212
M- Conversion of microwatt, milliwatt and Watt to dBm		213
N- Effect of VSWR on Transmitted Power and Return Loss		214
Reference Information		215
QuinStar Warranty Policy		216



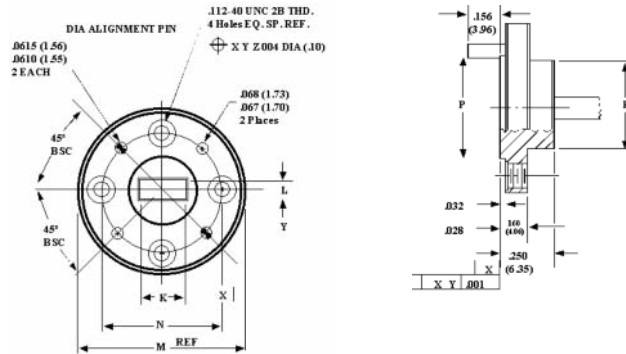
## Appendix A Rectangular Waveguide

Waveguide Band	Designation	Dimensions (inch)	Frequency (GHz)	Cut-off (GHz)	Theoretical Attenuation Lowest to Highest Frequency (dB/ft)	Historic Designation	New MIL Part Number
Ku	RG-91/U WR-62	0.622 x 0.311	12.4-18.0	9.486	.064 - .030	UG-419/U	M3922/53-4/005
						UG-541/U	M3922/59-2/001
K	RG-53/U WR-42	0.420 x 0.170	18.0-26.5	14.047	.17-.11	UG-595/U	M3922/54-4/001
						UG-596A/U	M3922/59-2/003
Ka	RG-96/U WR-28	0.280 x 0.140	26.5-40.0	21.081	0.22-0.15	UG-425/U	M3922/67-2/004
						UG-599/U	M3922/54-4/003
Q	RG-97/U WR-22	0.224 x 0.112	33.0-50.0	26.342	0.31-0.21	UG-600/U	M3922/59-2/005
						UG-381/U	M3922/67-2/005
U	WR-19	0.188 x 0.094	40.0-60.0	31.357	0.39-0.27	UG-383/U	M3922/53-4/005
						MPI-719	M3922/59-2/001
V	RG-98/U WR-15	0.148 x 0.074	50.0-75.0	39.863	0.57-0.39	MPI-719T	
						UG-383/U-M	M3922/53-4/005
E	RG-99/U WR-12	0.122 x 0.061	60.0-90.0	48.350	0.78-0.53	MPI-710	M3922/59-2/001
						MPI-720T	
W	WR-10	0.100 x 0.050	75.0-110.0	59.010	1.02-0.71	UG-385/U	M3922/67-2/008
F	RG-138/U WR-8	0.080 x 0.040	90.0-140.0	73.764	1.52-0.98	UG-387/U	M3922/67-2/009
D	RG-136/U WR-6	0.065 x 0.0325	110.0-170.0	90.786	2.12-1.35	UG-387/U-M	M3922/67-2/010
G	RG-135/U WR-5	0.051 x 0.0255	140.0-220.0	115.71	3.05-1.93	MPI-714	M3922/74-001
						UG-387/U-M	N/A
						MPI-716	M3922/74-002
						UG-387/U-M	N/A
						MPI-715	M3922/74-003
						UG-387/U-M	N/A

Modified (-M) means waveguide opening has been reduced appropriately. Screw and pin pattern are unchanged.

## Appendix B

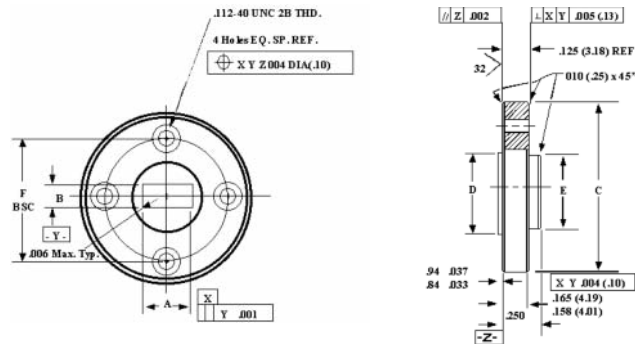
### Waveguide and Flange Dimensions (Round Flanges)



Waveguide Band	Frequency Band Band (GHz)	MIL Part Number M3922/67	EIA Waveguide Designation	Flange Designation	K ± .0015 (.04)	L ± .0015 (.04)	M ± .000/.002 (.05)	N BSC ± .005	P ± .005 (.13)	R ± .005 (.13)
K	18.0 26.5	-004	WR-42	UG-425/U	.4200 (10.67)	.1700 (4.32)	1.125 (28.58)	.9375 (23.81)	.625 (15.88)	.625 (15.88)
Ka	26.5 40.0	-005	WR-28	UG-381/U	.2800 (7.11)	.1400 (3.56)	1.125 (28.58)	.9375 (23.81)	.500 (12.70)	.468 (11.89)
Q	33.0 50.0	-006	WR-22	UG-383/U	.2240 (5.69)	.1120 (2.84)	1.125 (28.58)	.9375 (23.81)	.500 (12.70)	.468 (11.89)
U	40.0 60.0	-007	WR-19	UG-383/U-M	.1880 (4.78)	.0940 (2.39)	1.125 (28.58)	.9375 (23.81)	.500 (12.70)	.468 (11.89)
V	50.0 75.0	-008	WR-15	UG-385/U	.1480 (3.76)	.0740 (1.88)	.750 (19.05)	.5625 (14.29)	.375 (9.53)	.312 (7.92)
E	60.0 90.0	-009	WR-12	UG-387/U	.1220 (3.10)	.0610 (1.55)	.750 (19.05)	.5625 (14.29)	.375 (9.53)	.312 (7.92)
W	75.0 110.0	-010	WR-10	UG-387/U-M	.1000 (2.54)	.0500 (1.27)	.750 (19.05)	.5625 (14.29)	.375 (9.53)	.312 (7.92)
F	90.0 140.0	N/A	WR-8	UG-387/U-M	.0800 (2.03)	.0400 (1.02)	.750 (19.05)	.5625 (14.29)	.375 (9.53)	.312 (7.92)
D	110.0 170.0	N/A	WR-6	UG-387/U-M	.0650 (1.65)	.0325 (.83)	.750 (19.05)	.5625 (14.29)	.375 (9.53)	.312 (7.92)
G	140.0 220.0	N/A	WR-5	UG-387/U-M	.0510 (1.30)	.0255 (.65)	.750 (19.05)	.5625 (14.29)	.375 (9.53)	.312 (7.92)

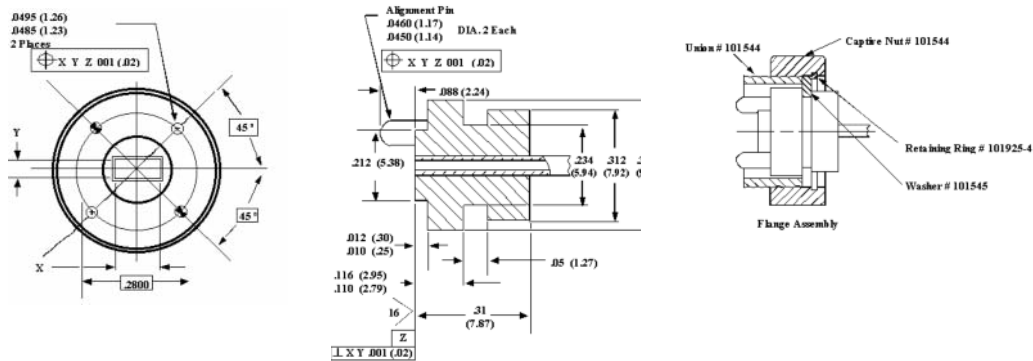
## Appendix C

### Blank Round Flange Dimensions



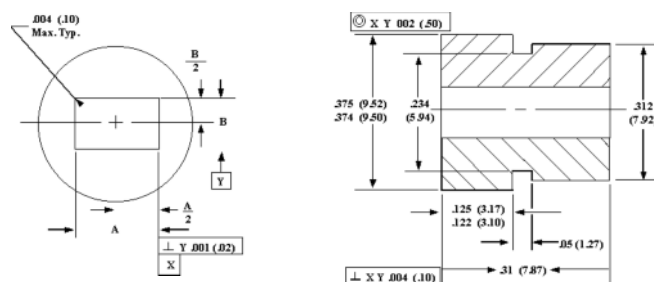
Band	Frequency Band (GHz)	MIL Part Number M3922/67	A ±.002/- .000 (.05)	B ±.002/- .000 (.05)	C ±.000/- .002 (.05)	D ± .005 (.13)	E ± .005 (.13)	F BSC	Flange Designation
K	18.0 26.5	-004	.502 (12.75)	.252 (6.40)	1.125 (28.58)	.625 (15.88)	.625 (15.88)	.312 (7.92)	UG-425/U
Ka	26.5 40.0	-005	.362 (9.19)	.222 (5.64)	1.125 (28.58)	.500 (12.70)	.468 (11.89)	.9375 (23.81)	UG-381/U
Q	33.0 50.0	-006	.306 (7.77)	.194 (4.93)	1.125 (28.58)	.500 (12.70)	.468 (11.89)	.9375 (23.81)	UG-383/U
U	40.0 60.0	-007	.270 (6.86)	.167 (4.47)	1.125 (28.58)	.500 (12.70)	.468 (11.89)	.5625 (14.29)	UG-383/U-M
V	50.0 75.0	-008	.230 (5.84)	.156 (3.96)	.750 (19.05)	.375 (9.53)	.312 (7.92)	.5625 (14.29)	UG-385/U
E	60.0 90.0	-009	.204 (5.18)	.143 (3.63)	.750 (19.05)	.375 (9.53)	.312 (7.92)	.5625 (14.29)	UG-387/U
W	75.0 110.0	-010	.182 (4.62)	.132 (3.35)	.750 (19.05)	.375 (9.53)	.312 (7.92)	.5625 (14.29)	UG-387/U-M
F	90.0 140.0	N/A	.141 (3.58)	.101 (2.56)	.750 (19.05)	.375 (9.53)	.312 (7.92)	.5625 (14.29)	UG-387/U-M
D	110.0 170.0	N/A	.126 (3.20)	.094 (2.39)	.750 (19.05)	.375 (9.53)	.312 (7.92)	.5625 (14.29)	UG/387/U-M
G	140.0 220.0	N/A	.112 (2.84)	.089 (2.21)	.750 (19.05)	.375 (9.53)	.312 (7.92)	.9375 (23.81)	UG-387/U-M

## Appendix D Waveguide and Flange Dimensions (pin-contact, threaded ring)



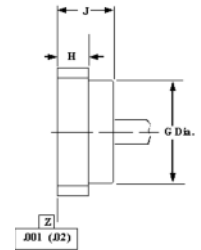
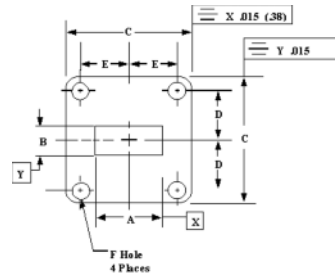
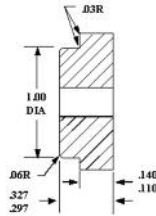
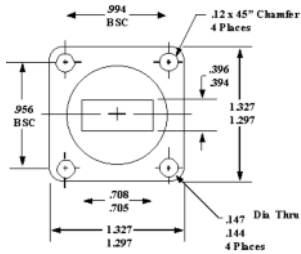
Band	Frequency Band (GHz)	MIL Part Number M3922/74	C inch (mm)	D inch (mm)	EIA Waveguide Designation
F	90.0-140.0	-001	.0800-(2.03)	.0400-(1.02)	WR8
D	110.0-170.0	-002	.0650-(1.63)	.0325-(.83)	WR7
G	140.0-220.0	-003	.0510-(1.30)	.0255-(.65)	WR5
H	180-260.50	-004	.430-(1.09)	.0215-(.55)	WR4
J	220.0-325.0	-005	.0340-(.86)	.0170-(.43)	WR3

## Appendix E Blank Flange Dimensions (pin-contact, threaded ring)



Band	Frequency Band (GHz)	A inch (mm)	B inch (mm)	EIA Waveguide Designation
F	90.0-140.0	.143-(3.63)	.103-(2.62)	WR8
D	110.0-170.0	.128-(3.25)	.098-(2.49)	WR7
G	140.0-220.0	.115-(2.92)	.089-(2.26)	WR5
H	170.0-260.5	.430-(1.09)	.0845-(2.15)	WR4
J	220.0-325.0	.106-(2.69)	.080-(2.03)	WR3

## Appendix F WR-62 (Ku-band) Flange Blank and Waveguide Dimensions



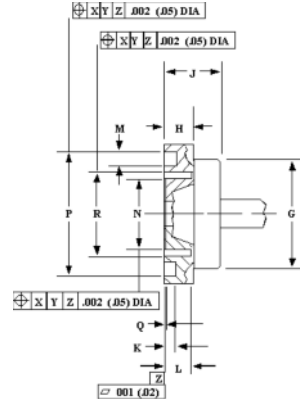
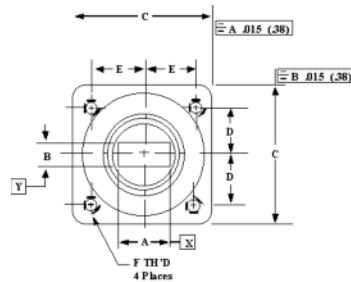
Flange Blank

Finished Waveguide & Flange

Band (mm)(mm)	Frequency Band (GHz) (.38)	MIL Part Number M3922/53	A inch	B inch (.08)	C .015 (.38)	D BSC (.38)	E BSC (.38)	F ±.003	G ±.015	H ±.015	J ±.015	Flange Bank
Ku	12.4- 18.0	-4/005	.622 ± .002 (15.8) (.05)	.311 ± .002 (.79) (.05)	1.312 (33.32)	4.78 (12.14)	.497 (12.62)	.144 (3.66)	1.000 (25.40)	.125 (3.18)	.313 (7.95)	UG-419/U

All dimensions in inch (mm)

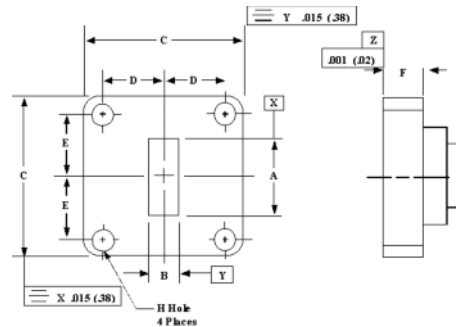
## Appendix G Waveguide and Flange Dimensions (Choke Flange)



Band	Frequency Band (GHz)	MIL Part Number M3922/59	Flange Desig.	A	B	C .015 (.38)	D BSC	E BSC	F	G ±.015 (.38)	H ±.015 (.38)	J ±.015 (.38)	K ±.002 (.05)	L ±.002 (.05)	M ±.002 (.05)	N ±.002 (.05)	P ±.002 (.05)	Q ±.001 (.03)	R ±.002 (.05)
Ku	12.4 18.0	-2/001	UG541	.622±.002 (15.8)(.05)	.311±.002 (7.9)(.05)	1.312 (33.32)	.478 (12.14)	.497 (12.62)	.138-32 UNC-2B	1.000 (25.40)	.188 (4.78)	.375 (9.53)	.113 (2.87)	.190 (4.83)	1.58 (4.01)	.710 (18.03)	1.208 (30.68)	.0075 (.19)	.828 (21.03)
K	18.0 26.5	-2/003	UG596	.420±.002 (10.67)(.05)	.170±.002 (4.32)(.05)	.875 (22.23)	.335 (8.51)	.320 (8.13)	.112-40 UNC-2B	.625 (15.88)	.156 (3.96)	.285 (7.24)	.042 (1.07)	.129 (3.28)	0.87 (2.21)	.472 (11.99)	.761 (19.33)	.005 (.13)	.536 (13.61)
Ka	26.5 40.0	-2/005	UG600	.280±.0014 (7.11)(.04)	.140±.0014 (3.56)(.04)	.750 (19.05)	.265 (6.73)	.250 (6.35)	.112-40 UNC-2B	.500 (12.70)	.109 (2.77)	.210 (5.33)	.050 (1.27)	.086 (2.18)	.096 (2.44)	.321 (8.15)	.596 (15.14)	.003 (.08)	.372 (9.45)

All dimensions in inch (mm)

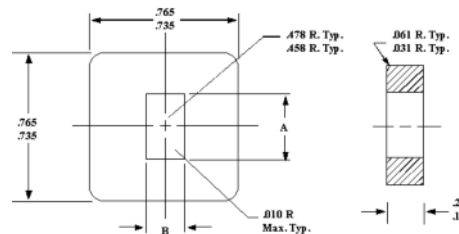
## Appendix H Square Flange and Waveguide Dimensions



Band	Frequency Band (GHz)	MIL Part Number M3922/54-4	A ±.0015 (.04)	B ±.0015 (.04)	C	D BSC	E BSC	F	H	Flange
K	18.0 26.5	-001	.4200 (10.67)	.1700 (4.32)	.875±.015 (22.22)(.38)	.335 (8.51)	.320 (8.13)	.156±.015 (3.96)(.38)	.116±.002 (2.95)(.05)	UG-595/U
Ka	26.5 40.0	-003	.2800 (7.11)	.1400 (3.56)	.750±.005 (19.05)(1.3)	.265 (6.75)	.250 (6.35)	.109±.00 (2.77)(.38)	.116±.002 (2.95)(.05)	UG-599/U
Q	33.0 50.0	N/A	.2240 (5.69)	.1120 (2.84)	.750±.005 (19.05)(1.3)	.265 (6.75)	.250 (6.35)	.156±.005 (3.96)(.38)	.116±.002 (2.95)(.05)	(UG-599/UM)
Q	33.0 50.0	N/A	.2240 (5.69)	.1120 (2.84)	.750±.005 (19.05)(1.3)	.265 (6.75)	.250 (6.35)	.156±.005 (3.96)(.38)	.112-40 UNC-2B	
U	40.0 60.0	N/A	.1880 (4.78)	.0940 (2.39)	.750±.005 (19.05)(1.3)	.265 (6.75)	.250 (6.35)	.187±.005 (4.75)(.38)	.116±.002 (2.95)(.05)	
U	40.0 60.0	N/A	.1880 (4.78)	.0940 (2.39)	.750±.005 (19.05)(1.3)	.265 (6.75)	.250 (6.35)	.187±.005 (4.75)(.38)	.112-40 UNC-2B	

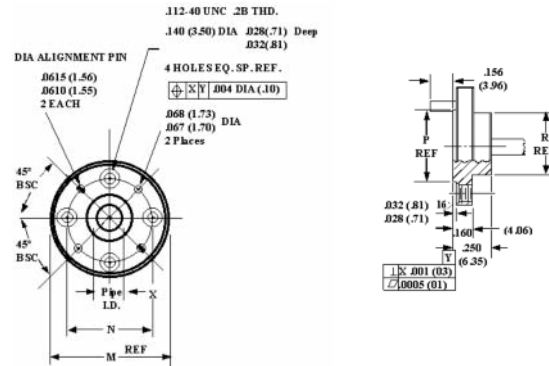
All dimensions in inch (mm)

## Appendix I Flange Blanks



Flange Designation	A	B	C	D BSC	E BSC
UG 599A	.364 .362	.224 .222	.755 .745	.530	.500
UG 595K	.505 .503	.255 .253	.890 .860	.670	.640

## Appendix J Circular Waveguide Sizes



Band	Internal Diameter (inch)	Frequency Band
Ku-1	.660	12.4 - 14.6
Ku-2	.550	14.6 - 17.5
K-1	.470	17.5 - 20.5
K-2	.396	20.5 - 24.5
K-3	.328	24.5 - 26.5
A-0	.328	26 - 28.5
A-1	.281	28.5 - 33
A-2	.250	33 - 38.5
A-3	.219	38.5 - 43
B-0	.250	33 - 38.5
B-1	.219	38.5 - 43
B-2	.188	43 - 50
U-0	.219	38.5 - 43
U-1	.188	43 - 50
U-2	.165	50 - 58
V-0	.165	50 - 58
V-1	.141	58 - 68
V-2	.125	68 - 77
E-0	.141	58 - 68
E-1	.125	68 - 77
E-2	.110	77 - 87
E-3	.094	87 - 100
W-0	.110	77 - 87
W-1	.094	87 - 100
W-2	.082	100 - 112
F-0	.094	87 - 100
F-1	.082	100 - 112
F-2	.075	112 - 125
F-3	.067	125 - 140
D-0	.082	100 - 112
D-1	.075	112 - 125
D-2	.067	125 - 140
D-3	.059	140 - 160
G-0	.067	125 - 140
G-1	.059	140 - 220

Band	M +.000/.002 (.05)	N BSC	P +.005 (.13)	R +.005 (.13)	Flange Designation
Ku	1.44 (36.58)	1.250 (28.6)	.967 (24.6)	.967 (24.6)	
K	1.125 (28.58)	.9375 (23.8)	.625 (15.88)	.625 (15.88)	UG-425/U
Ka	1.125 (28.58)	.9375 (23.81)	.500 (12.70)	.468 (11.89)	UG-381/U
Q	1.125 (28.58)	.9375 (23.81)	.500 (12.70)	.468 (11.89)	UG-383/U
U	1.125 (28.58)	.9375 (23.81)	.500 (12.70)	.468 (11.89)	UG-385/U-M
V	.750 (19.05)	.5625 (14.29)	.375 (9.53)	.312 (7.92)	UG-387/U
E	.750 (19.50)	.5625 (14.29)	.375 (9.53)	.312 (7.92)	UG-387/U-M
W	.750 (19.50)	.5625 (14.29)	.375 (9.53)	.312 (7.92)	UG-387/U-M
F	.750 (19.50)	.5625 (14.29)	.375 (9.53)	.312 (7.92)	UG-387/U-M
D	.750 (19.50)	.5625 (14.29)	.375 (9.53)	.312 (7.92)	UG-387/U-M
G	.750 (19.50)	.5625 (14.29)	.375 (9.53)	.312 (7.92)	UG-387/U-M

All dimensions in inch (mm)



## Appendix K Circular Waveguide Sizes (Alternative Set)

Frequency Band	Frequency Range, GHz		Circular Waveguide Diameter, Inches(mm)
K	LOW	17-22	0.500(12.7)
	MID	21-27	0.396(10.1)
	HIGH	25-33	0.328(8.3)
Ka	LOW	25-33	0.328(8.3)
	HIGH	33-44	0.250(6.4)
Q	LOW	33-44	0.250(6.4)
	MID	38-50	0.219(5.6)
	HIGH	43-58	0.188(4.8)
U	LOW	38-50	0.219(5.6)
	MID	43-58	0.188(4.8)
	HIGH	58-77	0.141(3.6)
V	LOW	43-58	0.188(4.8)
	HIGH	58-77	0.141(3.6)
E	LOW	58-77	0.141(3.6)
	HIGH	75-100	0.109(2.8)
W	LOW	75-100	0.109(2.8)
	HIGH	88-116	0.094(2.4)
F	LOW	88-116	0.094(2.4)
	HIGH	110-146	0.075(1.9)
D	LOW	110-146	0.075(1.9)
	HIGH	140-185	0.059(1.5)
G	LOW	140-185	0.059(1.5)
	HIGH	183-240	0.046(1.2)



## Appendix L

### VSWR, Return Loss, Reflection Coefficient Conversion Table

$$VSWR = (1 + \Gamma) / (1 - \Gamma)$$

$$R.L. = 20 \log |\Gamma|$$

$$R.L. = 20 \log \left( \frac{VSWR - 1}{VSWR + 1} \right)$$

VSWR (xxx:1)	Return Loss (dB) R.L.	Reflection Coefficient, $\Gamma$
1.00	Infinity	0.000
1.01	46.06	0.005
1.02	40.09	0.010
1.03	36.61	0.015
1.04	34.15	0.020
1.05	32.26	0.024
1.06	30.71	0.029
1.07	29.42	0.034
1.08	28.30	0.038
1.09	27.32	0.043
1.10	26.44	0.048
1.20	20.83	0.091
1.30	17.69	0.130
1.40	15.56	0.167
1.50	13.98	0.200
1.60	12.74	0.231
1.70	11.73	0.259
1.80	10.88	0.286
1.90	10.16	0.310
2.00	9.54	0.333
2.50	7.36	0.429
3.00	6.02	0.500
3.50	5.11	0.556
4.00	4.44	0.600
4.50	3.93	0.636
5.00	3.52	0.667
6.00	2.92	0.714
8.00	2.18	0.778
10.00	1.74	0.818
100.00	0.17	0.980
Infinity	0.00	1.000

### Noise Figure to Noise Temperature Conversion Table

$$NF = 10 \log [(NT/295) + 1]$$

Noise Figure, NF (dB)	Noise Temperature, NT (K)
1.00	76
1.20	94
1.40	112
1.60	131
1.80	152
2.00	173
2.20	195
2.40	218
2.60	242
2.80	267
3.00	294
3.20	321
3.40	350
3.60	381
3.80	413
4.00	446
4.20	481
4.40	517
4.60	556
4.80	596
5.00	638
5.20	682
5.40	728
5.60	776
5.80	827
6.00	879
6.20	935
6.40	993
6.60	1053
6.80	1117
7.00	1184
7.20	1253
7.40	1326
7.60	1403
7.80	1483
8.00	1566
8.20	1654
8.40	1746
8.60	1842
8.80	1943
9.00	2048
9.20	2159
9.40	2274
9.60	2395
9.80	2522
10.00	2655

## Appendix M

### Conversion of uW, mW and W to dBm

Microwatt	
uW	dBm
1	-30.0
2	-27.0
3	-25.2
4	-24.0
5	-23.0
6	-22.2
7	-21.5
8	-21.0
9	-20.5
10	-20.0
20	-17.0
30	-15.2
40	-14.0
50	-13.0
60	-12.2
70	-11.5
80	-11.0
90	-10.5
100	-10.0
200	-7.0
300	-5.2
400	-4.0
500	-3.0
600	-2.2
700	-1.5
800	-1.0
900	-0.5
1000	0.0

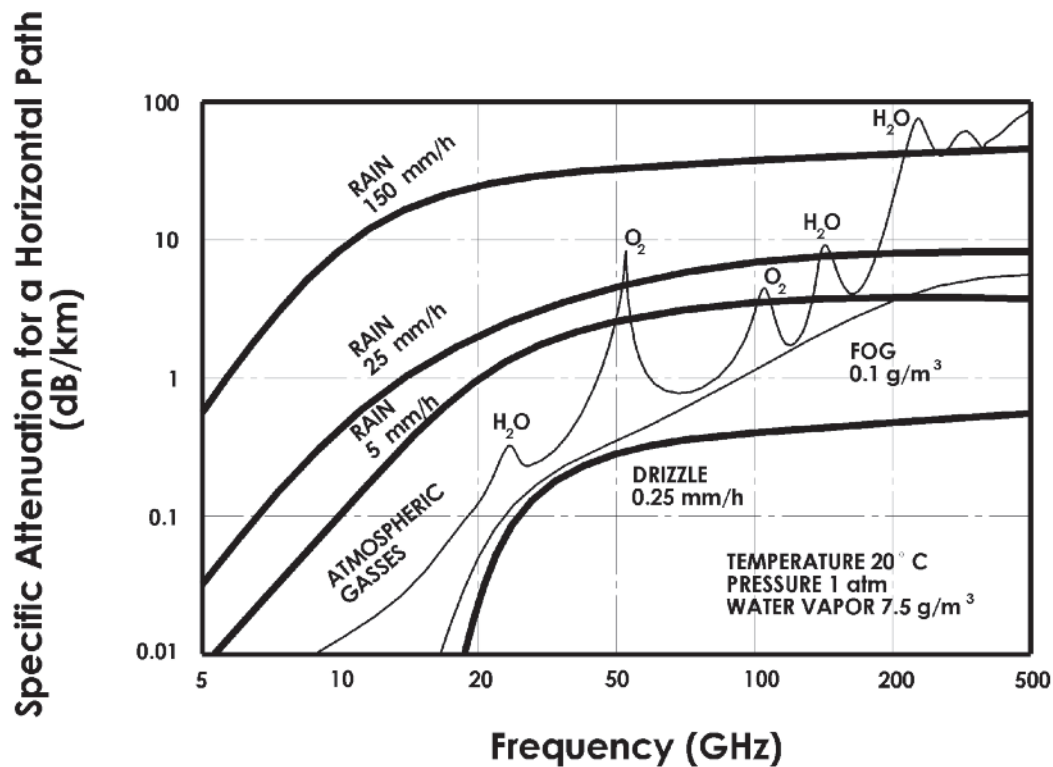
Milliwatt	
mW	dBm
1	0.0
2	3.0
3	4.8
4	6.0
5	7.0
6	7.8
7	8.5
8	9.0
9	9.5
10	10.0
20	13.0
30	14.8
40	16.0
50	17.0
60	17.8
70	18.5
80	19.0
90	19.5
100	20.0
200	23.0
300	24.8
400	26.0
500	27.0
600	27.8
700	28.5
800	29.0
900	29.5
1000	30.0

Watt	
W	dBm
1	30.0
2	33.0
3	34.8
4	36.0
5	37.0
6	37.8
7	38.5
8	39.0
9	39.5
10	40.0
20	43.0
30	44.8
40	46.0
50	47.0
60	47.8
70	48.5
80	49.0
90	49.5
100	50.0
200	53.0
300	54.8
400	56.0
500	57.0
600	57.8
700	58.5
800	59.0
900	59.5
1000	60.0

## Appendix N

### Effect of VSWR on Transmitted Power and Return Loss

VSWR	VSWR, dB	Return Loss, dB	Transmission Loss, dB	Power Transmission, %	Power Reflection, %	VSWR	VSWR, dB	Return Loss, dB	Transmission Loss, dB	Power Transmission, %	Power Reflection, %
1	0.0		0.000	100.0	0.0	1.52	3.6	13.7	0.189	95.7	4.3
1.01	0.1	46.1	0.000	100.0	0.0	1.54	3.8	13.4	0.201	95.5	4.5
1.02	0.2	40.1	0.000	100.0	0.0	1.56	3.9	13.2	0.213	95.2	4.8
1.03	0.3	36.6	0.001	100.0	0.0	1.58	4.0	13.0	0.225	94.9	5.1
1.04	0.3	34.2	0.002	100.0	0.0	1.6	4.1	12.7	0.238	94.7	5.3
1.05	0.4	32.3	0.003	99.9	0.1	1.62	4.2	12.5	0.250	94.4	5.6
1.06	0.5	30.7	0.004	99.9	0.1	1.64	4.3	12.3	0.263	94.1	5.9
1.07	0.6	29.4	0.005	99.9	0.1	1.66	4.4	12.1	0.276	93.8	6.2
1.08	0.7	28.3	0.006	99.9	0.1	1.68	4.5	11.9	0.289	93.6	6.4
1.09	0.7	27.3	0.008	99.8	0.2	1.7	4.6	11.7	0.302	93.3	6.7
1.1	0.8	26.4	0.010	99.8	0.2	1.72	4.7	11.5	0.315	93.0	7.0
1.11	0.9	25.7	0.012	99.7	0.3	1.74	4.8	11.4	0.329	92.7	7.3
1.12	1.0	24.9	0.014	99.7	0.3	1.76	4.9	11.2	0.342	92.4	7.6
1.13	1.1	24.3	0.016	99.6	0.4	1.78	5.0	11.0	0.356	92.1	7.9
1.14	1.1	23.7	0.019	99.6	0.4	1.8	5.1	10.9	0.370	91.8	8.2
1.15	1.2	23.1	0.021	99.5	0.5	1.82	5.2	10.7	0.384	91.5	8.5
1.16	1.3	22.6	0.024	99.5	0.5	1.84	5.3	10.6	0.398	91.3	8.7
1.17	1.4	22.1	0.027	99.4	0.6	1.86	5.4	10.4	0.412	91.0	9.0
1.18	1.4	21.7	0.030	99.3	0.7	1.88	5.5	10.3	0.426	90.7	9.3
1.19	1.5	21.2	0.033	99.2	0.8	1.9	5.6	10.2	0.440	90.4	9.6
1.2	1.6	20.8	0.036	99.2	0.8	1.92	5.7	10.0	0.454	90.1	9.9
1.21	1.7	20.4	0.039	99.1	0.9	1.94	5.8	9.9	0.468	89.8	10.2
1.22	1.7	20.1	0.043	99.0	1.0	1.96	5.8	9.8	0.483	89.5	10.5
1.23	1.8	19.7	0.046	98.9	1.1	1.98	5.9	9.7	0.497	89.2	10.8
1.24	1.9	19.4	0.050	98.9	1.1	2	6.0	9.5	0.512	88.9	11.1
1.25	1.9	19.1	0.054	98.8	1.2	2.5	8.0	7.4	0.881	81.6	18.4
1.26	2.0	18.8	0.058	98.7	1.3	3	9.5	6.0	1.249	75.0	25.0
1.27	2.1	18.5	0.062	98.6	1.4	3.5	10.9	5.1	1.603	69.1	30.9
1.28	2.1	18.2	0.066	98.5	1.5	4	12.0	4.4	1.938	64.0	36.0
1.29	2.2	17.9	0.070	98.4	1.6	4.5	13.1	3.9	2.255	59.5	40.5
1.3	2.3	17.7	0.075	98.3	1.7	5	14.0	3.5	2.553	55.6	44.4
1.32	2.4	17.2	0.083	98.1	1.9	5.5	14.8	3.2	2.834	52.1	47.9
1.34	2.5	16.8	0.093	97.9	2.1	6	15.6	2.9	3.100	49.0	51.0
1.36	2.7	16.3	0.102	97.7	2.3	6.5	16.3	2.7	3.351	46.2	53.8
1.38	2.8	15.9	0.112	97.5	2.5	7	16.9	2.5	3.590	43.8	56.3
1.4	2.9	15.6	0.122	97.2	2.8	7.5	17.5	2.3	3.817	41.5	58.5
1.42	3.0	15.2	0.133	97.0	3.0	8	18.1	2.2	4.033	39.5	60.5
1.44	3.2	14.9	0.144	96.7	3.3	8.5	18.6	2.1	4.240	37.7	62.3
1.46	3.3	14.6	0.155	96.5	3.5	9	19.1	1.9	4.437	36.0	64.0
1.48	3.4	14.3	0.166	96.3	3.7	9.5	19.6	1.8	4.626	34.5	65.5
1.5	3.5	14.0	0.177	96.0	4.0	10	20.0	1.7	4.807	33.1	66.9



### Useful Web Sites for Millimeter Wave Applications and Resources

Frequency Allocations: US Federal Communication Commission-  
[www.fcc.gov](http://www.fcc.gov)

Technical Information: [www.nist.gov](http://www.nist.gov), [www.noaa.gov](http://www.noaa.gov), [www.fcc.gov/oet](http://www.fcc.gov/oet)

Radio Astronomy: [www.nrao.edu](http://www.nrao.edu)

Space Programs: [www.nasa.gov](http://www.nasa.gov), [www.jpl.nasa.gov](http://www.jpl.nasa.gov), [www.esa.int](http://www.esa.int)



## Warranty

QuinStar warrants to you and your customers that on the date Products are delivered, they shall meet applicable specifications, be free from defects in material and manufacture and, to the extent not manufactured to your designs, be merchantable.

THIS WARRANTY SHALL APPLY ONLY TO DEFECTS THAT APPEAR WITHIN ONE YEAR FROM DATE THE PRODUCTS ARE DELIVERED. You must notify QuinStar of any such defects within 60 days after discovery of the defect, but in any event not more than 12 months after the date the Products are delivered.

New replacement Products, reconditioned replacement Products and repaired Products are warranted as new for the longer of the remainder of the original warranty period or 90 days from the date of shipment of the repaired or replaced Product.

This warranty does not cover defects caused by abuse, mishandling, accident, improper installation or application, the malfunction of another component or part of any device in which the Product is installed with which the Product interfaces, or extend to products which have been modified or repaired by anyone except QuinStar or its authorized service representative, or whose serial numbers or identification marks have been altered or removed.

QUINSTAR MAKES NO OTHER WARRANTIES OTHER THAN THOSE EXPRESSLY STATED HEREIN, INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE, IMPLIED WARRANTIES ARISING FROM A COURSE OF DEALING OR USAGE OF TRADE, AND IMPLIED WARRANTIES AGAINST PATENT, COPYRIGHT OR TRADEMARK INFRINGEMENT. IF APPLICABLE LAW DOES NOT PERMIT QUINSTAR TO DISCLAIM IMPLIED WARRANTIES, ANY WARRANTIES IMPLIED BY LAW ARE LIMITED TO THE TERM OF THE EXPRESS WARRANTY GIVEN HEREIN.

TO THE FULLEST EXTENT ALLOWED BY LAW, QUINSTAR SHALL NOT BE LIABLE FOR INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES HEREUNDER. QUINSTAR'S MAXIMUM AGGREGATE LIABILITY FOR ANY AND ALL OTHER DAMAGES FOR WHICH LIABILITY IS NOT DISCLAIMED OR OTHERWISE LIMITED, SHALL NOT EXCEED THE PRICE YOU HAVE PAID FOR THE PRODUCT WHICH IS SUBJECT TO THE DAMAGE CLAIM.

Your SOLE AND EXCLUSIVE REMEDY under this warranty is REPAIR OR REPLACEMENT at QuinStar's option and such repair or replacement shall satisfy QuinStar's warranty obligation to you, whether in contract, tort, negligence, strict liability or otherwise.

Prior to returning a Product for warranty adjustment, you shall request a return authorization number from QuinStar. The return authorization number shall be placed conspicuously on the outer package shipping label. Returned Products shall be accompanied by a written description of the reasons for the return, the circumstances under which the defect became apparent and the date the defect was discovered. Return Products to QuinStar's facility shipping charges prepaid. QuinStar shall reimburse you for shipping costs if the returned Products are found to be defective and such are covered by this warranty.

If a returned Product is found not to be defective, QuinStar shall ship the Product back to you and shall invoice you for the costs of testing and return shipment.

If a returned Product is found to contain a defect which is not covered by this warranty, QuinStar shall provide a written quotation showing the estimated cost of repair or the price of the replacement. In the event that you do not provide instructions as to disposition of the Product within 30 days from receipt of such estimate or quotation, QuinStar shall ship the Product back to you and shall invoice you for the costs of testing and return shipment.

If a returned Product is found to be defective and such defect is covered by this warranty, QuinStar shall at its option and at no charge to you, repair or replace the Product or offer you the choice of a refund or credit in the amount of the purchase price paid for the Product. Following such repair or replacement, QuinStar shall ship the Product back to you at QuinStar's expense.

At your request, QuinStar shall provide a written failure analysis and corrective action report with respect to each defect corrected under the terms of this warranty.