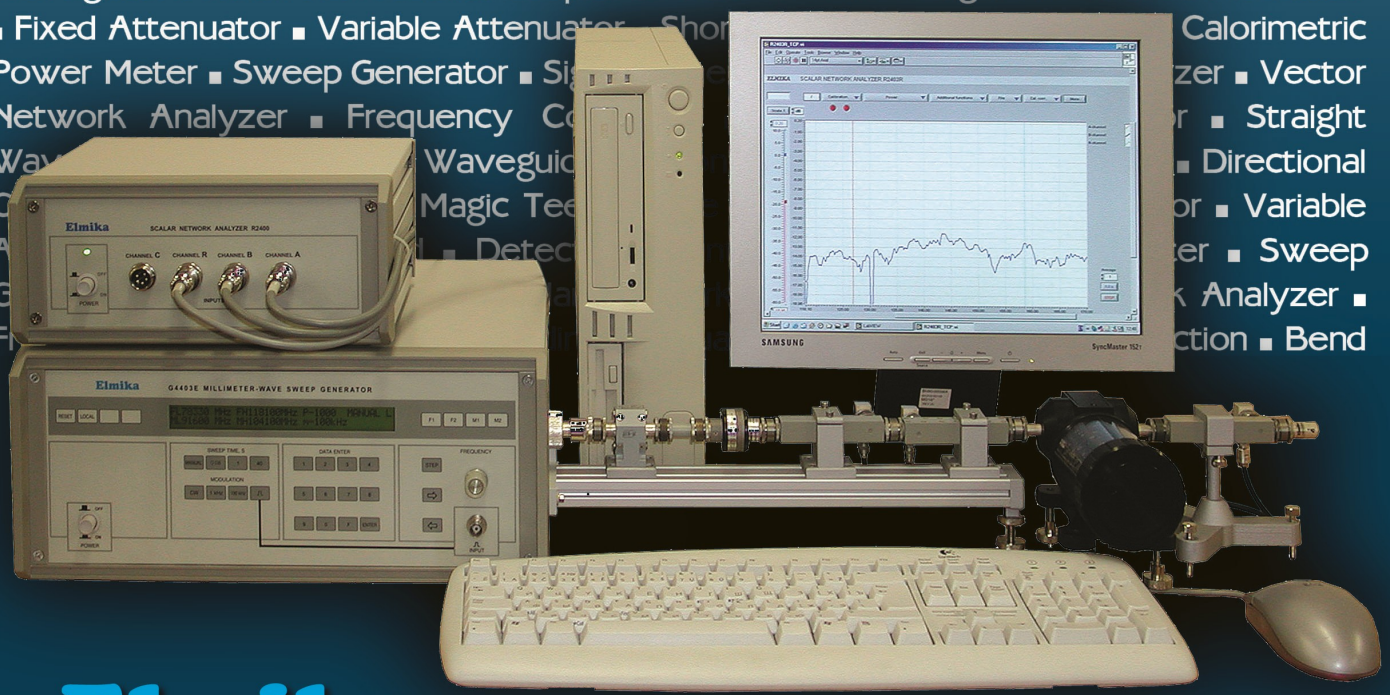
# TEST AND MEASUREMENT INSTRUMENTS FOR MILLIMETER WAVES

## Catalog




Elmika

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# SWEEP GENERATOR



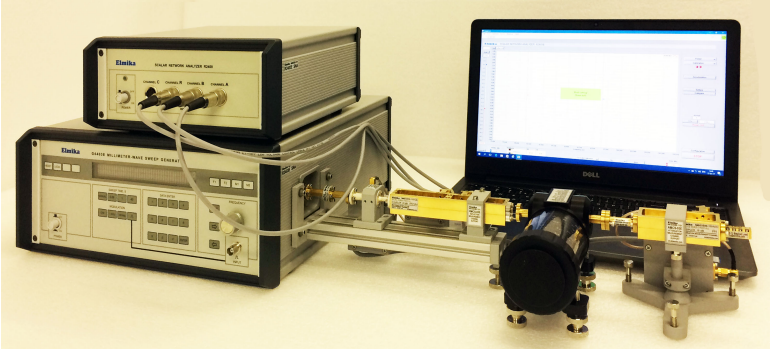

- **Full waveguide bandwidth**
- **BWO source**
- **High output power**
- **GPIB, USB, RS-232 programmable**

The **G440XE** Sweep Generators are portable powerful wideband general-purpose sources for swept and CW microwave measurements local, remote, manual or automated testing. It incorporates the efficiency of micro-processing control with state-of-the-art BWO oscillator to produce a high performance sweep generator system suited for either manual or automatic measurements.

| Model | Frequency range, GHz | Frequency accuracy, % | Frequency stability | Residual FM | Min/Typ* output power, mW | Output VSWR |
|---|---|---|---|---|---|---|
| G44-06E | 33 - 50 | ±0.2 | $2x10^{-4}$ | $2x10^{-6}$ | 5/25 | 1.5 |
| G44-04E | 50 - 75 | ±0.2 | $2x10^{-4}$ | $2x10^{-6}$ | 5/25 | 1.5 |
| G44-035E | 60 - 90 | ±0.2 | $2x10^{-4}$ | $2x10^{-6}$ | 3/10 | 1.5 |
| G44-03E | 75 - 110 | ±0.2 | $2x10^{-4}$ | $2x10^{-6}$ | 3/10 | 1.5 |
| G44-02E | 110 - 170 | ±0.2 | $2x10^{-4}$ | $2x10^{-6}$ | 2/5 | 1.5 |
| CW, internal square-wave modulation and external pulse modulation modes | | | | | | |
| Internal square-wave modulation frequencies: 1 and 100 kHz | | | | | | |
| External pulse modulation (with external pin modulator, optional)<br>- pulse duration: 50 ns<br>- pulse repetition rate: 1-10 kHz | | | | | | |
| External square-wave modulation frequencies: 0.3-10 kHz | | | | | | |
| Operating temperature range: 5-40 ºC | | | | | | |
| Sweep time: 0.08, 1.0, 40 s | | | | | | |
| Remote programming: IEEE-488, USB, RS-232C | | | | | | |
| Mains power source requirements: 220±20 V, 50-60, 400 Hz | | | | | | |
| Power consumption: 250 V□A | | | | | | |
| Dimensions: 360 x 160 x 380 mm | | | | | | |
| Weight: 12 kg | | | | | | |

* Required output power is a subject of negotiation with customer

# SCALAR NETWORK ANALYZER



- **Automated scalar measurements from 33 to 170 GHz**
- **Full waveguide bandwidth**
- **PC based Instrument**
- **ETHERNET programmable**

The **R24XE** Scalar Network Analyzers provide both manual and automated VSWR, insertion and return losses' measurements in five rectangular waveguide bands from 33 to 225 GHz. The system consists of sweep generator, waveguide reflectometer, network analyzer and personal computer*.

| Model | Frequency range, GHz | Frequency accuracy, % | VSWR meas range | VSWR meas accuracy, % | Transmission loss meas. range, dB | Transmission loss meas. accuracy, dB |
|---|---|---|---|---|---|---|
| R24-12E | 18 - 26.5 | ±0.2 | 1.1 - 5.0 | ±(5K+5) for K=1.1-2.0 | 0 - 35 | ±(0.6+0.06A) A=0-30 dB |
| R24-08E | 26.5 - 40 | ±0.2 | 1.1 - 5.0 | ±(5K+5) for K=1.1-2.0 | 0 - 35 | |
| R24-06E | 33 - 50 | ±0.2 | 1.1 - 5.0 | ±(5K+5) for K=1.1-2.0 | 0 - 35 | |
| R24-04E | 50 - 75 | ±0.2 | 1.1 - 5.0 | ±(5K+5) for K=1.1-2.0 | 0 - 35 | |
| RS24-035E | 60 - 90 | ±0.2 | 1.1 - 5.0 | ±(5K+5) for K=1.1-2.0 | 0 - 35 | ±(0.6+0.06A) A=0-25 dB; ±(0.8+0.08A) A>25 dB |
| R24-03E | 75 - 110 | ±0.2 | 1.1 - 5.0 | ±(5K+6) for K=1.1-2.0 | 0 - 35 | |
| R24-02E | 110 - 170 | ±0.2 | 1.1 - 5.0 | ±(5K+6) for K=1.1-2.0 | 0 - 35 | |
| R24-015E | 170 - 225 | ±0.2 | 1.1 - 5.0 | ±(5K+6) for K=1.1-2.0 | 0-30 @ 170-215 GHz<br>0-20 @ 215-225 GHz | |

| | |
|---|---|
| Operating temperature range | 5-40 ºC |
| Mains power source requirements: | 220±20 V, 50-60 Hz |
| Power consumption | 400 V·A |
| Remote programming | ETHERNET |

* PC is not included into delivery set of the Instrument

# VECTOR NETWORK ANALYZER



- **Automated vector measurements in frequency range from 33 to 170 GHz**
- **Full waveguide frequency bandwidth**
- **PC based Instrument**
- **ETHERNET programmable**

The **R44XXE** Vector Network Analyzers are designed for measuring of S-parameters, VSWR and impedance of waveguide networks in the full frequency ranges of rectangular waveguides between 33 and 170 GHz. Frequency accuracy is ±0.2%. The measurement range of reflection factor modulus is from 0 to 1. The measurement range of reflection factor phase is from 0 to ±180° for $0.1 < |\mathbf{G_X}| < 1$ with accuracy ±7.5° in 18-75 GHz frequency range and ±9.6° in 75-170 GHz frequency range.

The measurement range of transmission factor phase is from 0 to ±180° with accuracy $\pm(5+0.1\,|\mathbf{A_X}|)°$ for $\mathbf{A_X}$ >-50 dB in frequency range to 75 GHz, for $\mathbf{A_X}$ >-30 dB - to 170 GHz. Data can be displayed in the rectangular, Smith or polar diagrams.

| Model | Frequency range, GHz | VSWR meas. range | Attenuation meas. range, dB | VSWR meas. accuracy, % | Reflection factor modulus meas. accuracy | Attenuation meas. accuracy, dB |
|---|---|---|---|---|---|---|
| R45-08E | 26.5 - 4.0 | 1.03 - 5 | +10 ÷ -60 | ±10 for K=1.03-2 | ±0.044 for $\|\Gamma_X\|$ =0.33 | $\pm(0.2+0.03\|\mathbf{A_X}\|)$ K < 1.2 |
| R44-06E* | 33 - 50 | 1.03 - 5 | +10 ÷ -60 | ±10 for K=1.03-2 | ±0.044 for $\|\Gamma_X\|$ =0.33 | $\pm(0.2+0.03\|\mathbf{A_X}\|)$ K < 1.2 |
| R44-04E* | 50 - 75 | 1.03 - 5 | +10 ÷ -60 | ±10 for K=1.03-2 | ±0.044 for $\|\Gamma_X\|$ =0.33 | $\pm(0.2+0.03\|\mathbf{A_X}\|)$ K < 1.2 |
| R44-03E* | 75 - 110 | 1.03 - 5 | 0 ÷ -50 | +13.5 -11.5 for K=1.03-2 | ±0.056 for $\|\Gamma_X\|$ =0.33 | $\pm(0.3+0.04\|\mathbf{A_X}\|)$ K < 1.2 |
| R44-02E* | 110 - 170 | 1.03 - 5 | 0 ÷ -50 | +13.5 -11.5 for K=1.03-2 | ±0.056 for $\|\Gamma_X\|$ =0.33 | $\pm(0.3+0.04\|\mathbf{A_X}\|)$ K < 1.2 |

| | |
|---|---|
| Operating temperature range | 5-40 ºC |
| Mains power source requirements: | 220±20 V; 50-60 Hz |
| Power consumption | 400 V·A |

* discontinued models; new models are under construction.

# DIRECT READING ATTENUATOR




manual




programmable; wit remote control via USB port.

The **DAXE** Millimeter-Wave Direct Reading Attenuator is a measurement instrument for attenuation measurements in waveguide networks as well as for signal level setting. It also can be used for calibration of other attenuation measurement instruments. Direct Reading Attenuators have rotary-vane design. The attenuation is a function of the rotation angle of the absorbing element with respect to the electric field direction. Attenuation value does not depend on frequency. The remote control attenuator can be used in local (via front panel) or remote (via USB) operation modes.
The Attenuators are provided in waveguide bands between 18 GHz and 325 GHz.

| Model | Frequency range, GHz | Waveguide type | Waveguide flange | Attenuation accuracy | Insertion loss, dB, max | VSWR, max |
|---|---|---|---|---|---|---|
| DA-12E | 18 - 26.5 | WR-42 | UG 595/U | ±0.2dB for A=0÷10dB; ±0.02·A for A=10÷50dB; ±[1+0.08·(A-50)]dB for A=50÷60dB, where A is attenuation in dB. | 0.5 | 1.2 |
| DA-08E | 26.5 - 40 | WR-28 | UG 599/U | | 0.6 | 1.2 |
| DA-06E | 33 - 50 | WR-22 | UG 383/U | | 0.8 | 1.2 |
| DA-04E | 50 - 75 | WR-15 | UG 385/U | | 1.0 | 1.2 |
| DA-035E | 60 - 90 | WR-12 | UG 387/U | | 1.2 | 1.2 |
| DA-03E | 75 - 110 | WR-10 | UG 387/UM | | 1.5 | 1.2 |
| DA-025E | 90 - 140 | WR-08 | UG 387/UM | | 2.0 | 1.2 |
| DA-02E | 110 - 170 | WR-6.5 | UG 387/UM | | 3.0 (110-114 GHz)<br>2.5 (114-120 GHz)<br>2.0 (120-170 GHz) | 1.3 (110-114 GHz)<br>1.2 (114-170 GHz) |
| DA-015E | 170 - 220 | WR-5.1 | UG 387/UM | ±0.3dB for A=0÷10dB; ±0.02·A for A=10÷40dB; | 3.0 | 1.3 |
| DAD-010E (w/remote control) | 220 - 325 | WR-3.4 | UG 387/UM | ±0.4dB for A=0÷10dB; ±0.02·A for A=10÷40dB; | ≤5.0 @ 220-230GHz<br>≤4.0 @ 230-325GHz | 1.55 |

Attenuation range 0 ÷ 60 dB for WR-42, WR-28, WR-22, WR-15, WR-12, WR-10, WR-08, WR-6.5 models
Attenuation range 0 ÷ 30-40 dB for WR-5.1, WR-3.4 models

Max input power (CW, avg): 10-350 mW, depending on the frequency range

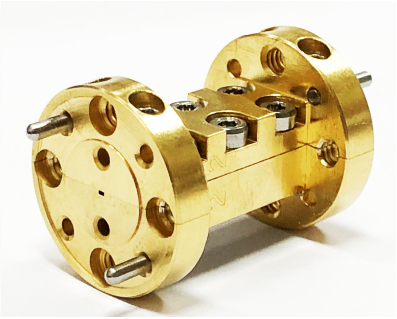
# STRAIGHT WAVEGUIDE SECTION



Flanged w/g tube



round-neck (RN)



split-block (SB)

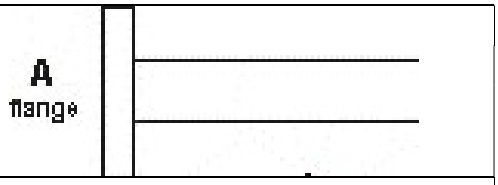
● Precision flanges (optional); ● Low VSWR; ● Low insertion losses

Straight sections are used to make connections between components in waveguide systems. Lengths and combinations are available on special order. VSWR is better than 1.1 over the full waveguide frequency band (within 33-220 GHz).

| Model | Frequency range, GHz | Waveguide size | VSWR |
|---|---|---|---|
| SW-06E/L | 33 - 50 | WR-22 | 1.1 |
| SW-04E/L | 50 - 75 | WR-15 | 1.1 |
| SW-035E/L | 60 - 90 | WR-12 | 1.1 |
| SW-03E/L | 75 - 110 | WR-10 | 1.1 |
| SW-025E/L | 90 - 140 | WR-8 | 1.1 |
| SW-02E/L | 110 - 170 | WR-6.5 | 1.1 |
| SW-015E/L | 140 - 220 | WR-5.1 (1.295x0.648(mm)) | 1.1 |
| SW-012E/L | 170 - 260 | WR-4.3 (1.092x0.546(mm)) | 1.2 |
| SW-010E/L | 220 - 325 | WR-3.4 (0.864x0.432(mm)) | 1.25 |
| SW-008E/L-SB | 260 - 400 | WR-2.8 (0.711x0.356(mm)) | 1.3 |
| SW-006E/L-SB | 325 - 500 | WR-2.2 (0.559x0.279(mm)) | 1.3 |
| SW-005E/L-SB | 400 - 600 | WR-1.9 (0.483x0.241(mm)) | 1.4* |
| SW-004E/L-SB | 500 - 750 | WR-1.5 (0.381x0.191(mm)) | 1.5* |
| SW-0035E/L-SB | 600 - 900 | WR-1.2 (0.305x0.152(mm)) | 1.5* |
| SW-003E/1"-SB | 750 - 1100 | WR-1.0 (0.254x0.127(mm)) | 1.5* |

*estimated parameter, not measured

# ORDER INFORMATION

| | | |
|---|---|---|
| XX | Operation range wave length, mm |   |
| L | Waveguide length, mm | |
| F | Finish code (flanges):<br>S – silver<br>G - gold | |
| D | Design type:<br>Flanged waveguide tube<br>RN-Rigid "Round Neck"<br>SB-Rigid "Split-block" | SW-XXE/L-D-F |
| | | **Example: SW-06E/50-S** |
| | | Straight section for 33 - 50 GHz frequency range, 50mm length, flanged waveguide tube, silver plated. |

# E- & H-plane BEND WAVEGUIDE SECTIONs



Flanged w/g tube



Split-block, cube



Split-block

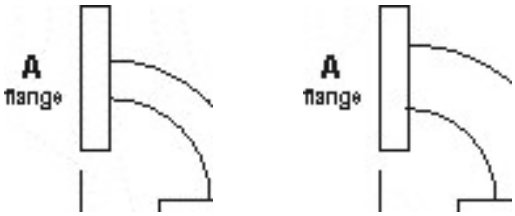
- Precision flanges (optional)
- Low VSWR
- Low insertion losses

E- or H-Plane Bends are essential parts of every waveguide network. E- or H-Plane formed bends are available with angles of 15º, 30º, 45º, 90º. Maximum VSWR is 1.1 (within 33-170 GHz). The sizes and combinations are available on request.

| Model | Frequency range, GHz | Waveguide size | VSWR |
|---|---|---|---|
| BE90-06E<br>BH90-06E | 33 - 50 | WR-22 | 1.1 |
| BE90-04E<br>BH90-04E | 50 - 75 | WR-15 | 1.1 |
| BE90-035E<br>BH90-035E | 60 - 90 | WR-12 | 1.1 |
| BE90-03E<br>BH90-03E | 75 - 110 | WR-10 | 1.1 |
| BE90-025E<br>BH90-025E | 90 - 140 | WR-8 | 1.1 |
| BE90-02E<br>BH90-02E | 110 - 170 | WR-6.5 | 1.1 |
| BE90-015E<br>BH90-015E | 140 - 220 | WR-5.1 | 1.15 |
| BE90-012E<br>BH90-012E | 170 - 260 | WR-4.3 | 1.15 |
| BE90-010E<br>BH90-010E | 220 - 325 | WR-3.4 | 1.2 |
| BE90-008E/SB<br>BH90-008E/SB | 260 - 400 | WR-2.8 | 1.3 |
| BE90-006E/SB<br>BH90-006E/SB | 325 - 500 | WR-2.2 | 1.3 |

## ORDERING INFORMATION

| | |
|---|---|
| XX | Operation range wave length, mm |
| L | Arms length, (mm) |
| E | E - plane bend |
| H | H – plane bend |
| F | Finish (flanges):<br>S – silver G - gold |
| A | Angle<br>90º, 45º, 30º, 15º, (and others) |
| D | Design type: Flanged waveguide tube, SB-Split-block, C-Split-block cube 15x15mm |




**BEA-XXE/L-D-F**

**Example: BE90-06E/50-S**

E-Plane Bend for 33 - 50 GHz frequency range, 90° angle, 50mm length, flanged waveguide tube, silver plated.

# TWIST WAVEGUIDE SECTION







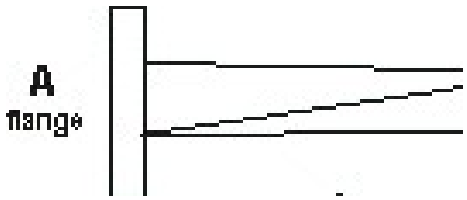
- Precision flanges (optional)
- Low VSWR
- Low insertion losses

Twists of 90º and 45º are used for changing of polarization in waveguide networks. Twists with different angles and combinations of bends are available on special order. Maximum VSWR is less than 1.10 over the full frequency range (within 33-170 GHz).

| Model | Frequency range, GHz | Waveguide size | VSWR |
|---|---|---|---|
| TW90-06E | 33 - 50 | WR-22 | 1.1 |
| TW90-04E | 50 - 75 | WR-15 | 1.1 |
| TW90-035E | 60 - 90 | WR-12 | 1.1 |
| TW90-03E | 75 - 110 | WR-10 | 1.1 |
| TW90-025E | 90 - 140 | WR-8 | 1.1 |
| TW90-02E | 110 - 170 | WR-6 | 1.1 |
| TW90-015E | 140 - 220 | WR-5 | 1.15 |
| TW90-012E | 170 - 260 | WR-4 | 1.15 |
| TW90-010E | 220 - 325 | WR-3 | 1.2 |
| TW90-008E | 260 - 400 | WR-2.8 | 1.3 |
| TW90-006E | 325 - 500 | WR-2.2 | 1.3 |

# ORDERING INFORMATION

| | |
|---|---|
| XX | Operation range wave length, mm |
| L | Length, (mm) |
| A | Twist angle<br>90º, 45º, (and others) |
| F | Finish (flanges):<br>S – silver<br>G - gold |
| D | Design type: flanged waveguide tube, C-Split-block Cube |




**TWA-XXE/D-L-F**

**Example: TW90-06E/50-S**

Twist for 33 - 50 GHz frequency range, 90° twist angle, flanged waveguide tube, 50mm length, silver plated.

# DIRECTIONAL COUPLER



- **High directivity**
- **Minimum coupling variation and insertion loss**
- **Low VSWR**

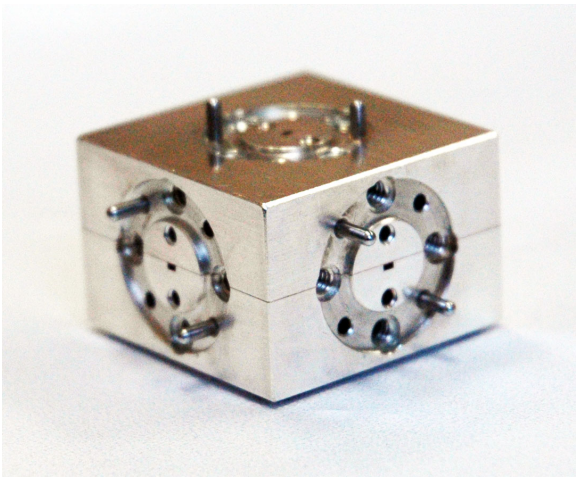
The **DCZ-XXE/Y** directional couplers are used for extracting or introducing RF power flow in a transmission line without distortion of signal characteristics. The available coupling values are 3, 6, 10, 15, 20 or 30 dB; minimum directivities are 20 - 35 dB depending on the operation frequency band. 4-ports directional couplers are available in bi-directional (BDC4-XXE/Y) and dual-directional (DDC4-XXE/Y, reflectometer) configurations.

| Model | Frequency range, GHz | Waveguide size | Main line VSWR | Secondary line VSWR | Insertion loss, dB | Coupling accuracy, % |
|---|---|---|---|---|---|---|
| DCZ-12E/Y | 18 - 26.5 | WR-42 | 1.05 | 1.1 | 0.8 | 7 |
| DCZ-08E/Y | 26.5 - 40 | WR-28 | 1.05 | 1.1 | 0.8 | 7 |
| DCZ-06E/Y | 33 - 50 | WR-22 | 1.05 | 1.1 | 0.8 | 7 |
| DCZ-04E/Y | 50 - 75 | WR-15 | 1.08 | 1.1 | 1.1 | 7 |
| DCZ-035/Y | 60 - 90 | WR-12 | 1.1 | 1.15 | 1.5 | 10 |
| DCZ-03E/Y | 75 - 110 | WR-10 | 1.1 | 1.15 | 1.5 | 10 |
| DCZ-025/Y | 90 - 140 | WR-8 | 1.15 | 1.2 | 2.5 | 10 |
| DCZ-02E/Y | 110 - 170 | WR-6 | 1.15 | 1.2 | 2.5 | 10 |
| DCZ-015E/Y | 140 - 220 | WR-5 | 1.15 | 1.2 | 2.5 | 12 |
| DCZ-012E/Y | 170 - 260 | WR-4 | | | | 12 |
| DCZ-010E/Y | 220 - 325 | WR-3 | | | | 15 |
| DCZ-008E/Y | 260 - 400 | WR-2.8 | | | | 15 |
| DCZ-006E/Y | 325 - 500 | WR-2.2 | | | | 20 |
| Coupling flatness ±( 0.7 ÷ 1.2) dB, depending on the operation frequency range | | | | | | |

# ORDERING INFORMATION

| | | |
|---|---|---|
| XX | Operation range wave length, mm |   |
| Z | 3 – 3 ports<br>4 – 4 ports | |
| Y | Coupling value<br>3, 6, 10, 15, 20 dB | |
| F | Finish:<br>S - silver<br>G - gold | **DCZ-XXE/Y-F** |
| | | Example: DC3-06E/20-S |
| | | 3-ports Directional Coupler for 33 ÷ 50 GHz frequency range, 20dB coupling value, silver plated. |

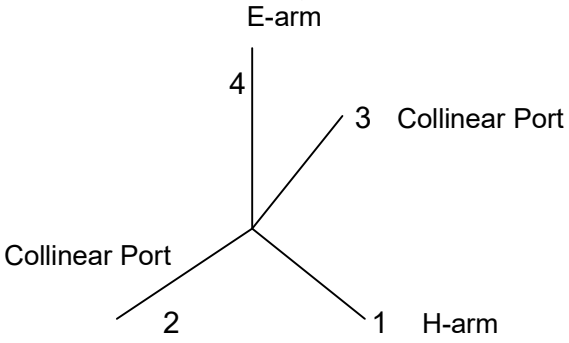
# MAGIC TEE





● Low insertion losses; ● High matching / isolation; ● Low power split unbalance

The **MHT-XXE** Magic Tees (Matched Hybrid Couplers) for millimeter wave are matched power dividers for variety of applications (general purpose power splitters, power combining, phase measurement circuits, phase / frequency discriminators). The **MHT-XXE** Magic Tee Hybrid Couplers are available in waveguide bands between 33 and 220 GHz. These couplers are four-port transmission line components with a port configuration as shown in figure. Operation bandwidth is limited to 20÷90% waveguide operation frequency range depending on performance specifications.




$S_{24} = -S_{34}$ $S_{22} = S_{33}$
$S_{24} = S_{34}$ $S_{14} = 0$

| Model | Frequency range, GHz | Waveguide size | Insertion loss, dB | Isolation, (min) dB E-H/Col | VSWR max | | Balance, dB |
|---|---|---|---|---|---|---|---|
| | | | | | E-arm | H-arm | |
| MHT-06E | 33 - 50 | WR-22 | 0.7 | 30/20 | 1.5 | 1.5 | ±0.5 |
| MHT-04E | 50 - 75 | WR-15 | 1.0 | 30/20 | 1.5 | 1.5 | ±0.5 |
| MHT-035E | 60 - 90 | WR-12 | 1.2 | 30 | 1.6 | 1.6 | ±0.5 |
| MHT-03E | 75 - 110 | WR-10 | 1.2 | 30/20 | 1.6 | 1.6 | ±0.5 |
| MHT-025E | 90 - 140 | WR-8 | 1.5 | 30 | 1.6 | 1.6 | ±0.5 |
| MHT-02E | 110 - 170 | WR-6.5 | 1.5 | 30/20 | 1.6 | 1.6 | ±0.5 |
| MHT-015E | 140 - 220 | WR-5.1 | | | | | |
| MHT-012E | 170 - 260 | WR-4.3 | | | | | |
| MHT-010E | 220 - 325 | WR-3.4 | | | | | |

The above presented specifications can be reached not in full (60-90%) frequency band.

## ORDERING INFORMATION

| XX | Operation wave length range, mm | **MHT-XXE/F** |
|---|---|---|
| F | Finish:<br>S – silver<br>G - gold | **Example: MHT-06E/S**<br><br>Hybrid coupler for 33 - 50 GHz frequency range, silver plated. |

## FIXED ATTENUATOR




- **Full waveguide bandwidth**
- **High attenuation accuracy**
- **Low VSWR**

The **FA-XXE** Fixed Attenuators can be used as a lab standard against which other instruments or device are calibrated. The attenuators consist of the waveguide section with resistive plate in the waveguide diagonal plane or of the coupling plate between two waveguide channels. The **FA-XXE** 3, 6, 10, 15, 20, 30 dB attenuators are available in waveguide bands from 18 through 325 GHz.

| Model | Frequency range, GHz | Waveguide size | Attenuation, dB | VSWR |
|---|---|---|---|---|
| FA-12E | 18 - 26.5 | WR-42 | 3±0.5<br>6±1.0<br>10±1.5<br>20±2.0<br>30±3.0 | 1.15 |
| FA-08E | 26.5 - 40 | WR-28 | | 1.15 |
| FA-06E | 33 - 50 | WR-22 | | 1.15 |
| FA-04E | 50 - 75 | WR-15 | | 1.15 |
| FA-035E | 60 - 90 | WR-12 | 3, 6, 10, 20 | 1.15 |
| FA-03E | 75 - 110 | WR-10 | 3, 6, 10, 20, 30 | 1.15 |
| FA-025E | 90 - 140 | WR-8 | 3, 6, 10, 20 | 1.15 |
| FA-02E | 110 - 170 | WR-6.5 | 3, 6, 10, 20, 30 | 1.15 |
| FA-015E | 140 - 220 | WR-5.1 | 3, 6, 10, 20 | 1.15 |
| FA-012E | 170 - 260 | WR-4.3 | 3, 6, 10, 20 | 1.2 |
| FA-010E | 220 - 325 | WR-3.4 | 3, 6, 10, 20 | 1.25 |
| FA-008E | 260 - 400 | WR-2.8 | 3, 6, 10, 20 | 1.3 |
| FA-006E | 325 - 500 | WR-2.2 | 3, 6, 10, 20 | 1.3 |

## ORDERING INFORMATION

XX Operation range wave length, mm

F Finish:
S – silver
G - gold

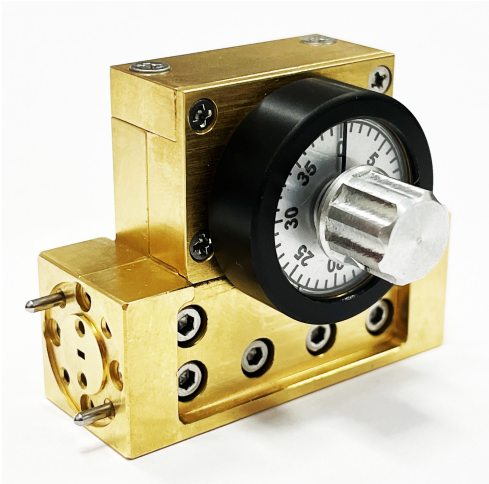
A Attenuation, dB

**FA-XXE/A-F**

**Example: FA-06E/15-S**

10 dB fixed attenuator for 33 - 50 GHz (λ=6mm) frequency range, silver plated.

## VARIABLE ATTENUATOR



Attenuator with round scale



Attenuator with micrometric screw

- **Wide attenuation range, (40 dB typ.)**
- **Low VSWR**
- **Low insertion losses**
- **Full waveguide bandwidth**

The **VA-XXE** Variable Attenuators are used for level-setting. The Attenuators consist of a waveguide section with a movable resistive element.

The Attenuators has 0÷30 dB minimum attenuation range. The **VA-XXE** Attenuators are available in waveguide bands between 33 GHz and 500 GHz; can be calibrated on specified frequencies.

| Model | Frequency range, GHz | Waveguide size | Attenuation range, dB, min | VSWR max | Insertion loss, dB |
|---|---|---|---|---|---|
| VA-06E | 33 - 50 | WR-22 | 0÷30 | 1.15 | 0.5 |
| VA-04E | 50 - 75 | WR-15 | 0÷30 | 1.15 | 0.5 |
| VA-035E | 60 - 90 | WR-12 | 0÷30 | 1.2 | 0.7 |
| VA-03E | 75 - 110 | WR-10 | 0÷30 | 1.15 | 0.7 |
| VA-025E | 90 - 140 | WR-8 | 0÷30 | 1.2 | 1.0 |
| VA-02E | 110 - 170 | WR-6.5 | 0÷30 | 1.2 | 1.0 |
| VA-015E | 140 - 220 | WR-5.1 | 0÷30 | 1.25 | 1.0 |
| VA-012E | 170 - 260 | WR-4.3 | 0÷30 | 1.3 | 1.3 |
| VA-010E | 220 - 325 | WR-3.4 | 0÷30 | 1.3 | 1.3 |
| VA-008E | 260 - 400 | WR-2.8 | 0÷30 | | |
| VA-006E | 325 - 500 | WR-2.2 | 0÷30 | | |

## ORDERING INFORMATION

| | |
|---|---|
| XX | Operation wave length range, mm |
| C | Control via:<br>RS – Round Dial Scale<br>μ – Micro Metric Screw |
| F | Finish:<br>S – silver<br>G - gold |

**VA-XXE/C - F**

**Example: VA-06E/RS - G**

Variable attenuator for 33 - 50 GHz frequency range, round dial scale, gold plated.

## SHORT



Fixed waveguide short





Tunable waveguide short

The **FS-XE** Fixed Waveguide Shorts and the **TS-XE** Tunable Shorts are designed to create the shorts circuit conditions in waveguides.

The **TS-XE** Tunable Waveguide Shorts are movable shorts, adjustable through at least half a wavelength at the low frequency end of the band. The **TS-XE** Shorts consist of movable noncontacting choked plungers within a straight section of waveguide.

The **FS-XE** and **TS-XE** Shorts are provided in five waveguide bands between 33 and 225 GHz.

| Model | Frequency range, GHz | Waveguide size | VSWR |
|---|---|---|---|
| FS-06E | 33 - 50 | WR-22 | 30 |
| FS-04E | 50 - 75 | WR-15 | 30 |
| FS-035E | 60 - 90 | WR-12 | 20 |
| FS-03E | 75 - 110 | WR-10 | 20 |
| FS-025E | 90 - 140 | WR-8 | 20 |
| FS-02E | 110 - 170 | WR-6 | 20 |
| FS-015E | 170 - 225 | WR-5 | 20 |
| | | | |
| TS-06E | 33 - 50 | WR-22 | 30 |
| TS-04E | 50 - 75 | WR-15 | 30 |
| TS-035E | 60 - 90 | WR-12 | 20 |
| TS-03E | 75 - 110 | WR-10 | 20 |
| TS-025E | 90 - 140 | WR-8 | 20 |
| TS-02E | 110 - 170 | WR-6 | 20 |
| TS-015E | 170 - 225 | WR-5 | 20 |

## ORDERING INFORMATION

| | | |
|---|---|---|
| XX | Operation wave length range, mm | **TS-XXE/F** |
| F | Finish:<br>S - silver | **Example: TS-06E/S**<br><br>Tunable short for 33 - 50 GHz frequency range, silver plated. |

## MATCHED LOAD




**Sliding Matched Load**




**Matched Load**

The **SMLXE** Sliding Matched Loads and the **MLXE** fixed Matched Loads consist of tapered absorber within a waveguide section. The **SMLXE** Loads utilize a micro-metric tuning mechanism allowing the microwave absorber to be positioned within the guide while maintaining a constant magnitude of reflection coefficient.

The **MLXE** Terminations and the **SMLXE** Sliding Matched Loads are provided in five waveguide bands between 33 GHz and 225 GHz.

| Model | Frequency range, GHz | Waveguide size | VSWR |
|---|---|---|---|
| SML-06E | 33 - 50 | WR-22 | 1.05 |
| SML-04E | 50 - 75 | WR-15 | 1.05 |
| SML-035E | 60 - 90 | WR-12 | 1.05 |
| SML-03E | 75 - 110 | WR-10 | 1.05 |
| SML-025E | 90 - 140 | WR-8 | 1.05 |
| SML-02E | 110 - 170 | WR-6.5 | 1.05 |
| SML-015E | 140 - 220 | WR-5.1 | 1.1 |
| | | | |
| ML-06E | 33 - 50 | WR-22 | 1.07 |
| ML-04E | 50 - 75 | WR-15 | 1.07 |
| ML-035E | 60 - 90 | WR-12 | 1.07 |
| ML-03E | 75 - 110 | WR-10 | 1.07 |
| ML-025E | 90 - 140 | WR-8 | 1.07 |
| ML-02E | 110 - 170 | WR-6.5 | 1.07 |
| ML-015E | 140 - 220 | WR-5.1 | 1.1 |
| ML-010E | 220 - 325 | WR-3.4 | 1.2 |

## ORDERING INFORMATION

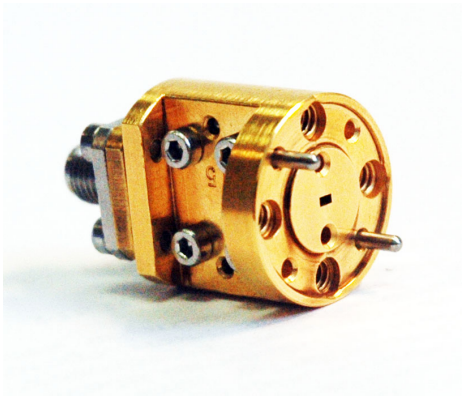
XX Operation wave length range, mm

F S – silver
G - gold

**ML-XXE/F**

**Example: ML-06E/S**
Matched Load for 33 - 50 GHz frequency range, silver plated.

## DETECTOR MOUNT





- **Millimeter wave detection**
- **Full waveguide bandwidth**

The **DMXE** Detector Mounts are broadband devices designed for operation in millimeter wave range. The Detectors are optimized for broadband performance and are used in mm-wave test setups to detect, monitor and measure modulated signals.

The **DMXE** Detector Mounts use Schottky Barrier packaged diodes and are provided in five waveguide bands between 33 GHz and 225 GHz.

| Model | Frequency range, GHz | Waveguide size | Sensitivity, min, mV/mW | Maximum input, mW | Sensitivity flatness (Smax / Smin) |
|---|---|---|---|---|---|
| DM-08E | 26.5 - 40 | WR-28 | 1000 | 15 | 2.5 |
| DM-06E | 33 - 50 | WR-22 | 300 | 15 | 2.5 |
| DM-04E | 50 - 75 | WR-15 | 300 | 15 | 2.5 |
| DM-035E | 60 - 90 | WR-12 | 400 | 15 | 2.5 |
| DM-03E | 75 - 110 | WR-10 | 200 | 15 | 2.5 |
| DM-025E | 90 - 140 | WR-8 | 100 | 15 | 2.5 |
| DM-02E | 110 - 170 | WR-6.5 | 100 | 15 | 2.5 |
| DM-015E | 170 - 225 | WR-5.1 | 100 | 15 | 3.0 |

## ORDERING INFORMATION

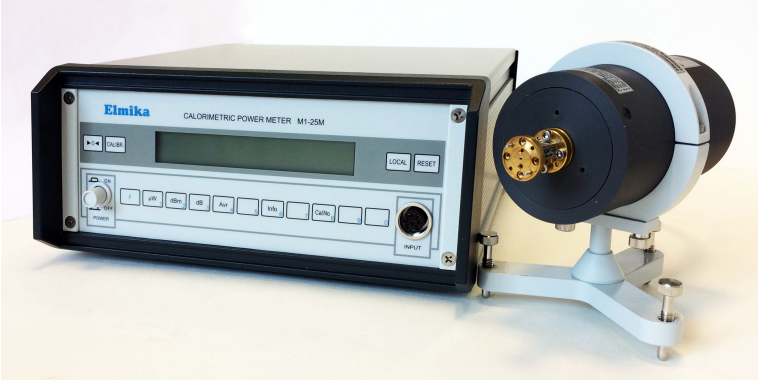
| | |
|---|---|
| XX | Operation wave length range, mm |
| F | Finish:<br>S – silver<br>G - gold |

**DM-XXE/F**

**Example: DM-06E/S**

Detector mount for 33 - 50 GHz frequency range, silver plated.

## CALORIMETRIC POWER METER




- **High Accuracy**
- **High Sensitivity**
- **Automated Measurements**
- **Full Waveguide Frequency Band**

The Calorimetric Power Meter M1-25M/XX is a high precision broadband calorimetric microwave power measurement instrument operating in millimeter and sub-millimeter wave range.

The Instrument has a waveguide type Calorimetric Sensor for corresponding frequency ranges. The sensor has a self compensation transistor transducers that substitute the absorbed microwave power with direct current power. The five sensors' models provide accurate absolute power measurement in single mode waveguides, and one – in multimode Metal-Dielectric Waveguide (MDW). The last model could be a priority for terahertz (THz) physics and technology.

The Calorimetric Power Meter M1-25M provides PC connection via RS-232 interface.

| Model | Frequency range, GHz | Input Waveguide Port | Power measurement range, mW | Power measurement error | VSWR, max |
|---|---|---|---|---|---|
| M1-25M/06E | 33 - 50 | WR-22, UG383/U | 0.020-20 | 3%+2μW | 1.1* |
| M1-25M/04E | 50 - 75 | WR-15, UG385/U | 0.020-20 | 3%+2μW | 1.1 |
| M1-25M/035E | 60 - 90 | WR-12, UG387/U | 0.020-20 | 3%+2μW | 1.1 |
| M1-25M/03E | 75 - 110 | WR-10, UG387/UM | 0.020-20 | 3%+2μW | 1.1 |
| M1-25M/025E | 90 - 140 | WR-8, UG387/UM | 0.020-20 | 3%+2μW | 1.1 |
| M1-25M/02E | 110 - 170 | WR-6.5, UG387/UM | 0.020-20 | 3%+2μW | 1.1 |
| M1-25M/015E | 140 - 220 | WR-5.1, UG387/UM | 0.020-20 | 5%+2μW | 1.15 |
| M1-25M/012E | 170 - 260 | WR-4.3, UG387/UM | 0.020-20 | 5%+2μW | 1.2 |
| M1-25M/010E | 220 - 325 | WR-3.4, UG387/UM | 0.020-20 | 5%+2μW | 1.25 |
| M1-25M /008E | 260 - 400 | WR-2.8 (0.711 x 0.356) | 0.020-20 | 10%+2μW | - |
| M1-25M /006E | 325 - 500 | WR-2.2 (0.559 x 0.279) | 0.020-20 | 10%+2μW | - |
| M1-25M /005E | 400 - 600 | WR-1.9 (0.48 x 0.24) | 0.020-20 | | |
| M1-25M/004 | 500 - 750 | WR-1.5 (0.38 x 0.19) | 0.020-20 | | |

* VSWR 1.2 max in 33-37.5 GHz frequency range;

## BAND PASS FILTERS





- **Custom design of pass / rejection bands**

High-Pass (HPF series), Low Pass (LPF series) and Band Pass (BPF series) Filters are available, providing desired skirt, selectivity and rejection levels with minimum possible insertion loss in the pass band. The filters are offered in all standard waveguide bands covering 18 to 400 GHz depending on our possibility to fulfil the customers' requirements.
Dimensions of filters depends on required specifications. Please contact us for any questions.

| Model | Frequency range, GHz | Waveguide Ports | Pass Band Insertion Loss, dB, max[1)] | Pass Band width, %[2)] | Pass Band VSWR, typ.[3)] |
|---|---|---|---|---|---|
| BPF-06E | 33 - 50 | WR-22, UG383/U | 1.0 | ≥20 | 1.5 |
| BPF-04E | 50 - 75 | WR-15, UG385/U | 1.0 | ≥20 | 1.5 |
| BPF-035E | 60 - 90 | WR-12, UG387/U | 1.5 | ≥20 | 1.5 |
| BPF-03E | 75 - 110 | WR-10, UG387/UM | 1.5 | ≥20 | 1.5 |
| BPF-025E | 90 - 140 | WR-8, UG387/UM | 2.0 | ≥20 | 1.5 |
| BPF-02E | 110 - 170 | WR-6.5, UG387/UM | 2.0 | ≥20 | 1.5 |
| BPF-015E | 140 - 220 | WR-5.1, UG387/UM | 2.0 | ≥20 | 1.6 |
| BPF-012E | 170 - 260 | WR-4.3, UG387/UM | 3.0 | ≥20 | 1.7 |
| BPF-010E | 220 - 325 | WR-3.4, UG387/UM | 3.0 | ≥20 | 1.8 |
| BPF-008E | 260 - 400 | WR-2.8, UG387/UM | 4.0 | ≥20 | 2.0 |

[1)] , [3)] Depends on required specifications like rejection level and skirt selectivity
[2)] Depends on applied design technology

## ORDERING INFORMATION

XX — Operation range wave length, mm

S-F — Start-Finish frequencies of the pass band

P — Plating:
S – silver
G - gold

BPF-XXE/S-F/P
Example: BPF-06E/35-40S
Band Pass filter with the pass band of 35 - 40 GHz frequency range, silver plated.

## GENERAL REFERENCE INFORMATION

### Relative (dBm) vs absolute (W) power

| Power | | | | | | | |
|---|---|---|---|---|---|---|---|
| dBm | µW | dBm | mW | dBm | mW | dBm | W |
| -60 | 0.001 | -30 | 0.001 | 0 | 1 | 30 | 1 |
| -59 | 0.00126 | -29 | 0.00126 | 1 | 1.2589 | 31 | 1.2589 |
| -58 | 0.00158 | -28 | 0.00158 | 2 | 1.5849 | 32 | 1.5849 |
| -57 | 0.00200 | -27 | 0.00200 | 3 | 1.9953 | 33 | 1.9953 |
| -56 | 0.00251 | -26 | 0.00251 | 4 | 2.5119 | 34 | 2.5119 |
| -55 | 0.00316 | -25 | 0.00316 | 5 | 3.1623 | 35 | 3.1623 |
| -54 | 0.00398 | -24 | 0.00398 | 6 | 3.9811 | 36 | 3.9811 |
| -53 | 0.00501 | -23 | 0.00501 | 7 | 5.0119 | 37 | 5.0119 |
| -52 | 0.00361 | -22 | 0.00631 | 8 | 6.3096 | 38 | 6.3096 |
| -51 | 0.00794 | -21 | 0.00794 | 9 | 7.9433 | 39 | 7.9433 |
| -50 | 0.01 | -20 | 0.01 | 10 | 10 | 40 | 10 |
| -49 | 0.01259 | -19 | 0.01259 | 11 | 12.589 | 41 | 12.589 |
| -48 | 0.01585 | -18 | 0.01585 | 12 | 15.849 | 42 | 15.849 |
| -47 | 0.01995 | -17 | 0.01995 | 13 | 19.953 | 43 | 15.953 |
| -46 | 0.02512 | -16 | 0.02512 | 14 | 25.119 | 44 | 25.119 |
| -45 | 0.03162 | -15 | 0.03162 | 15 | 31.623 | 45 | 31.623 |
| -44 | 0.03981 | -14 | 0.03981 | 16 | 39.811 | 46 | 39.811 |
| -43 | 0.05012 | -13 | 0.05012 | 17 | 50.199 | 47 | 50.119 |
| -42 | 0.06310 | -12 | 0.06310 | 18 | 63.096 | 48 | 63.096 |
| -41 | 0.07943 | -11 | 0.07943 | 19 | 79.433 | 49 | 79.433 |
| -40 | 0.1 | -10 | 0.1 | 20 | 100 | 50 | 100 |
| -39 | 0.12589 | -9 | 0.12589 | 21 | 125.89 | 51 | 125.89 |
| -38 | 0.15849 | -8 | 0.15849 | 22 | 158.49 | 52 | 158.49 |
| -37 | 0.19953 | -7 | 0.19953 | 23 | 199.53 | 53 | 199.53 |
| -36 | 0.25119 | -6 | 0.25119 | 24 | 251.19 | 54 | 251.19 |
| -35 | 0.31623 | -5 | 0.31623 | 25 | 316.23 | 55 | 316.23 |
| -34 | 0.39811 | -4 | 0.39811 | 26 | 398.11 | 56 | 398.11 |
| -33 | 0.50119 | -3 | 0.50119 | 27 | 501.19 | 57 | 501.19 |
| -32 | 0.63096 | -2 | 0.63096 | 28 | 630.96 | 58 | 630.96 |
| -31 | 0.79433 | -1 | 0.79433 | 29 | 794.33 | 59 | 794.33 |
| -30 | 1 | 0 | 1 | 30 | 1000 | 60 | 1000 |






## GENERAL REFERENCE INFORMATION

### Absolute (W) vs relative (dBm) power

| Power | | | | | | | |
|---|---|---|---|---|---|---|---|
| **µW** | **dBm** | **mW** | **dBm** | **mW** | **dBm** | **W** | **dBm** |
| | | | | | | | |
| 0.001 | -60 | 0.001 | -30 | 1 | 0 | 1 | 30 |
| 0.002 | -56.99 | 0.002 | -26.99 | 2 | 3.0103 | 2 | 33.010 |
| 0.003 | -55.23 | 0.003 | -25.23 | 3 | 4.7712 | 3 | 34.771 |
| 0.004 | -53.98 | 0.004 | -23.98 | 4 | 6.0206 | 4 | 36.021 |
| 0.005 | -53.01 | 0.005 | -23.01 | 5 | 6.9897 | 5 | 36.990 |
| 0.006 | -52.22 | 0.006 | -22.22 | 6 | 7.7815 | 6 | 37.782 |
| 0.007 | -51.55 | 0.007 | -21.55 | 7 | 8.4510 | 7 | 38.451 |
| 0.008 | -50.97 | 0.008 | -20.97 | 8 | 9.0309 | 8 | 39.031 |
| 0.009 | -50.46 | 0.009 | -20.46 | 9 | 9.5424 | 9 | 39.542 |
| 0.01 | -50 | 0.01 | -20 | 10 | 10 | 10 | 40 |
| 0.02 | -46.99 | 0.02 | -16.99 | 20 | 13.010 | 20 | 43.010 |
| 0.03 | -45.23 | 0.03 | -15.23 | 30 | 14.771 | 30 | 44.771 |
| 0.04 | -43.98 | 0.04 | -13.98 | 40 | 16.021 | 40 | 46.021 |
| 0.05 | -43.01 | 0.05 | -13.01 | 50 | 16.990 | 50 | 46.990 |
| 0.06 | -42.22 | 0.06 | -12.22 | 60 | 17.782 | 60 | 47.782 |
| 0.07 | -41.55 | 0.07 | -11.55 | 70 | 18.451 | 70 | 48.451 |
| 0.08 | -40.97 | 0.08 | -10.97 | 80 | 19.031 | 80 | 49.031 |
| 0.09 | -40.46 | 0.09 | -10.46 | 90 | 19.542 | 90 | 49.542 |
| 0.1 | -40 | 0.1 | -10 | 100 | 20 | 100 | 50 |
| 0.2 | -36.99 | 0.2 | -6.990 | 200 | 23.010 | 200 | 53.010 |
| 0.3 | -35.23 | 0.3 | -5.229 | 300 | 24.771 | 300 | 54.771 |
| 0.4 | -33.98 | 0.4 | -3.979 | 400 | 26.021 | 400 | 56.021 |
| 0.5 | -33.10 | 0.5 | -3.010 | 500 | 26.990 | 500 | 56.990 |
| 0.6 | -32.22 | 0.6 | -2.218 | 600 | 27.782 | 600 | 57.782 |
| 0.7 | -31.55 | 0.7 | -1.549 | 700 | 28.451 | 700 | 58.451 |
| 0.8 | -30.97 | 0.8 | -0.9691 | 800 | 29.031 | 800 | 59.031 |
| 0.9 | -30.46 | 0.9 | -45.76 | 900 | 29.542 | 900 | 59.542 |
| 1 | -30 | 1 | 0 | 1000 | 30 | 1000 | 60 |

## GENERAL REFERENCE INFORMATION

**Power ratio in times vs power ratio in dB.**

| Power ratio (times) | Power ratio (dB) | Power ratio (times) | Power ratio (dB) | Power ratio (times) | Power ratio (dB) |
|---|---|---|---|---|---|
| | | | | | |
| 0.001 | -30 | 0.1258 | -9 | 12.589 | 11 |
| 0.00125 | -29 | 0.1584 | -8 | 15.848 | 12 |
| 0.0158 | -28 | 0.1995 | -7 | 19.952 | 13 |
| 0.00199 | -27 | 0.251 | -6 | 25.11 | 14 |
| 0.00251 | -26 | 0.31622 | -5 | 31.6227 | 15 |
| 0.00316 | -25 | 0.3981 | -4 | 39.8107 | 16 |
| 0.00398 | -24 | 0.5011 | -3 | 50.118 | 17 |
| 0.00501 | -23 | 0.6309 | -2 | 63.095 | 18 |
| 0.0063 | -22 | 0.7943 | -1 | 79.4328 | 19 |
| 0.00794 | -21 | 1 | 0 | 100 | 20 |
| 0.01 | -20 | 1.258 | 1 | 125.89 | 21 |
| 0.01258 | -19 | 1.584 | 2 | 158.48 | 22 |
| 0.01584 | -18 | 1.995 | 3 | 199.52 | 23 |
| 0.0199 | -17 | 2.511 | 4 | 251.1 | 24 |
| 0.0251 | -16 | 3.1622 | 5 | 316.22 | 25 |
| 0.03162 | -15 | 3.981 | 6 | 398.107 | 26 |
| 0.03981 | -14 | 5.0118 | 7 | 501.187 | 27 |
| 0.0501 | -13 | 6.3095 | 8 | 630.957 | 28 |
| 0.0631 | -12 | 7.9432 | 9 | 794.328 | 29 |
| 0.07943 | -11 | 10 | 10 | 1000 | 30 |

GENERAL REFERENCE INFORMATION

**Standard circular waveguides**
(IEC & EIA (Electronic Industries Association) version)

| Waveguide freq. band | Circular waveguide undersize (L / M / S) | Freq.range, GHz (wave mode $TE_{01}$) | Inner diameter of circular waveguide (inches / mm) |
|---|---|---|---|
| K | Large | 17.5 - 20.5 | 0.455/11.56 |
| | Middle | 20.0 - 24.5 | 0.396/10.06 |
| | Small | 24.0 - 26.5 | 0.328/8.33 |
| Ka | Large | 26.5 - 33.0 | 0.315/8.0 |
| | Middle | 33.0 - 38.5 | 0.250/6.35 |
| | Small | 38.5 - 40.0 | 0.219/5.56 |
| Q | Large | 33.0 - 38.5 | 0.250/6.35 |
| | Middle | 38.5 - 43.0 | 0.219/5.56 |
| | Small | 43.0 - 50.0 | 0.188/4.78 |
| U | Large | 40.0 - 43.0 | 0.210/5.33 |
| | Middle | 43.0 - 50.0 | 0.188/4.78 |
| | Small | 50.0 - 60.0 | 0.165/4.19 |
| V | Large | 50.0 - 58.0 | 0.165/4.19 |
| | Middle | 58.0 - 68.0 | 0.141/3.58 |
| | Small | 68.0 - 75.0 | 0.125/3.18 |
| E | Large | 60.0 - 66.0 | 0.136/3.45 |
| | Middle | 66.0 - 82.0 | 0.125/3.18 |
| | Small | 82.0 - 90.0 | 0.094/2.39 |
| W | Large | 75.0 - 88.0 | 0.112/2.84 |
| | Small | 88.0 - 110.0 | 0.094/2.39 |
| F | Large | 90.0 - 115.0 | 0.089/2.26 |
| | Small | 115.0 - 140.0 | 0.075/1.91 |
| D | Large | 110.0 - 140.0 | 0.073/1.85 |
| | Small | 140.0 - 160.0 | 0.059/1.50 |
| G | Large | 140.0 - 180.0 | 0.058/1.47 |
| | Small | 180.0 - 220.0 | 0.045/1.14 |
| H | — | 170.0 - 260.0 | 0.049/1.25 |
| J | — | 220.0 - 325.0 | 0.039/0.99 |

## GENERAL REFERENCE INFORMATION

### Transmitted and reflected power dependence on VSWR

| VSWR | Return loss (dB) | VSWR (dB) | $K_{ref}$ voltage | Transmis-sion loss (dB) | Transmitted power (%) | Reflected power (%) | VSWR | Return loss (dB) | VSWR (dB) | $K_{ref}$ voltage | Transmis-sion loss (dB) | Transmitted power (%) | Reflected power (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.006 | 50.00 | 0.05 | 0.00 | .0000 | 100. | 0.00 | 1.31 | 17.45 | 2.35 | 0.13 | 0.08 | 98.20 | 1.80 |
| 1.01 | 46.06 | 0.09 | 0.00 | .0001 | 100. | 0.00 | 1.32 | 17.21 | 2.41 | 0.14 | 0.08 | 98.10 | 1.90 |
| 1.011 | 45.00 | 0.10 | 0.01 | .0001 | 100. | 0.00 | 1.329 | 17.00 | 2.47 | 0.14 | 0.09 | 98.00 | 2.00 |
| 1.02 | 40.09 | 0.17 | 0.01 | .0004 | 99.99 | 0.01 | 1.33 | 16.98 | 2.48 | 0.14 | 0.09 | 97.99 | 2.01 |
| 1.020 | 40.00 | 0.17 | 0.01 | .0004 | 99.99 | 0.01 | 1.34 | 16.75 | 2.54 | 0.15 | 0.09 | 97.89 | 2.11 |
| 1.03 | 36.61 | 0.26 | 0.01 | .0009 | 99.98 | 0.02 | 1.35 | 18.54 | 2.61 | 0.15 | 0.10 | 97.78 | 2.22 |
| 1.036 | 35.00 | 0.31 | 0.02 | .0014 | 99.97 | 0.03 | 1.36 | 16.33 | 2.61 | 0.15 | 0.10 | 97.67 | 2.33 |
| 1.04 | 34.15 | 0.34 | 0.02 | .0017 | 99.96 | 0.04 | 1.37 | 16.13 | 2.73 | 0.16 | 0.11 | 97.56 | 2.44 |
| 1.045 | 33.15 | 0.38 | 0.02 | .0021 | 99.95 | 0.05 | 1.377 | 16.00 | 2.78 | 0.16 | 0.11 | 97.49 | 2.51 |
| 1.05 | 32.26 | 0.42 | 0.02 | .0026 | 99.94 | 0.06 | 1.38 | 15.94 | 2.80 | 0.16 | 0.11 | 97.45 | 2.55 |
| 1.06 | 30.71 | 0.51 | 0.03 | .0037 | 99.92 | 0.08 | 1.39 | 15.75 | 2.86 | 0.16 | 0.12 | 97.34 | 2.66 |
| 1.065 | 30.00 | 0.55 | 0.03 | .0043 | 99.90 | 0.10 | 1.40 | 15.56 | 2.92 | 0.17 | 0.12 | 97.22 | 2.78 |
| 1.07 | 29.42 | 0.59 | 0.03 | .0050 | 99.89 | 0.11 | 1.41 | 15.38 | 2.98 | 0.17 | 0.13 | 97.11 | 2.89 |
| 1.08 | 28.30 | 0.67 | 0.04 | .0064 | 99.85 | 0.15 | 1.42 | 15.21 | 3.05 | 0.17 | 0.13 | 96.99 | 3.01 |
| 1.09 | 27.32 | 0.75 | 0.04 | .0081 | 99.81 | 0.19 | 1.43 | 15.04 | 3.11 | 0.18 | 0.14 | 96.87 | 3.13 |
| 1.10 | 26.44 | 0.83 | 0.05 | .0099 | 99.77 | 0.23 | 1.433 | 15.00 | 3.12 | 0.18 | 0.14 | 96.84 | 3.16 |
| 1.11 | 25.66 | 0.91 | 0.05 | .0118 | 99.73 | 0.27 | 1.44 | 14.88 | 3.17 | 0.18 | 0.14 | 96.75 | 3.25 |
| 1.119 | 25.00 | 0.98 | 0.06 | .0138 | 99.68 | 0.32 | 1.45 | 14.72 | 3.23 | 0.18 | 0.15 | 96.63 | 3.37 |
| 1.12 | 24.94 | 0.98 | 0.06 | .0139 | 99.68 | 0.32 | 1.46 | 14.56 | 3.29 | 0.19 | 0.15 | 96.50 | 3.50 |
| 1.13 | 24.29 | 1.06 | 0.06 | .0162 | 99.63 | 0.37 | 1.464 | 14.50 | 3.31 | 0.19 | 0.16 | 96.45 | 3.55 |
| 1.135 | 24.00 | 1.10 | 0.06 | .0173 | 99.60 | 0.40 | 1.47 | 14.41 | 3.35 | 0.19 | 0.16 | 96.38 | 3.62 |
| 1.14 | 23.69 | 1.14 | 0.07 | .0186 | 99.57 | 0.43 | 1.48 | 14.26 | 3.41 | 0.19 | 0.17 | 96.25 | 3.75 |
| 1.15 | 23.13 | 1.21 | 0.07 | .0212 | 99.51 | 0.49 | 1.49 | 14.12 | 3.46 | 0.20 | 0.17 | 96.13 | 3.87 |
| 1.152 | 23.00 | 1.23 | 0.07 | .0218 | 99.50 | 0.50 | 1.499 | 14.00 | 3.51 | 0.20 | 0.18 | 96.02 | 3.98 |
| 1.16 | 22.61 | 1.29 | 0.07 | .0239 | 99.45 | 0.55 | 1.50 | 13.96 | 3.52 | 0.20 | 0.18 | 96.00 | 4.00 |
| 1.17 | 22.12 | 1.36 | 0.08 | .0267 | 99.39 | 0.61 | 1.536 | 13.50 | 3.73 | 0.21 | 0.20 | 95.53 | 4.47 |
| 1.173 | 22.00 | 1.38 | 0.08 | .0275 | 99.37 | 0.63 | 1.55 | 13.32 | 3.81 | 0.22 | 0.21 | 95.35 | 4.65 |
| 1.18 | 21.66 | 1.44 | 0.08 | .0297 | 99.32 | 0.68 | 1.577 | 13.00 | 3.96 | 0.22 | 0.22 | 94.99 | 5.01 |
| 1.19 | 21.23 | 1.51 | 0.09 | .0328 | 99.25 | 0.75 | 1.60 | 12.74 | 4.08 | 0.23 | 0.24 | 94.67 | 5.33 |
| 1.196 | 21.00 | 1.55 | 0.09 | .0346 | 99.21 | 0.79 | 1.622 | 12.50 | 4.20 | 0.24 | 0.25 | 94.38 | 5.62 |
| 1.20 | 20.83 | 1.58 | 0.09 | .0360 | 99.17 | 0.83 | 1.65 | 12.21 | 4.35 | 0.25 | 0.27 | 93.98 | 6.02 |
| 1.21 | 20.44 | 1.66 | 0.10 | .0394 | 99.10 | 0.90 | 1.671 | 12.00 | 4.46 | 0.25 | 0.28 | 93.69 | 6.31 |
| 1.22 | 21.08 | 1.73 | 0.10 | .0429 | 99.02 | 0.98 | 1.70 | 11.73 | 4.61 | 0.26 | 0.30 | 93.28 | 6.72 |
| 1.222 | 20.00 | 1.74 | 0.10 | .0436 | 99.00 | 1.00 | 1.725 | 11.50 | 4.74 | 0.27 | 0.32 | 92.92 | 7.08 |
| 1.23 | 19.73 | 1.80 | 0.10 | .0464 | 98.94 | 1.06 | 1.75 | 11.29 | 4.86 | 0.27 | 0.34 | 92.56 | 7.44 |
| 1.24 | 19.40 | 1.87 | 0.11 | .0501 | 98.85 | 1.15 | 1.785 | 11.00 | 5.03 | 0.28 | 0.36 | 92.06 | 7.94 |
| 1.25 | 19.08 | 1.94 | 0.11 | .0540 | 98.77 | 1.23 | 1.80 | 10.88 | 5.11 | 0.29 | 0.37 | 91.84 | 8.16 |
| 1.253 | 19.00 | 1.96 | 0.11 | .0550 | 98.74 | 1.26 | 1.851 | 10.50 | 5.35 | 0.30 | 0.41 | 91.09 | 8.16 |
| 1.26 | 18.78 | 2.01 | 0.12 | .0579 | 98.68 | 1.32 | 1.90 | 10.16 | 5.58 | 0.31 | 0.44 | 90.37 | 9.63 |
| 1.27 | 18.49 | 2.08 | 0.12 | .0619 | 98.59 | 1.41 | 1.925 | 10.00 | 5.69 | 0.32 | 0.46 | 90.00 | 10.00 |
| 1.28 | 18.22 | 2.14 | 0.12 | .0660 | 98.49 | 1.51 | 2.00 | 9.54 | 6.02 | 0.33 | 0.51 | 88.89 | 11.11 |
| 1.288 | 18.00 | 2.20 | 0.13 | .0694 | 98.42 | 1.58 | 2.50 | 7.36 | 7.96 | 0.43 | 0.88 | 81.63 | 18.37 |
| 1.29 | 17.95 | 2.21 | 0.13 | .0702 | 98.40 | 1.60 | 3.00 | 6.02 | 9.54 | 0.50 | 1.25 | 75.00 | 25.00 |
| 1.30 | 17.89 | 2.28 | 0.13 | .0745 | 98.30 | 1.70 | 3.50 | 5.11 | 10.88 | 0.56 | 1.60 | 69.14 | 30.86 |

## GENERAL REFERENCE INFORMATION

**Rectangular waveguides' specifications** (IEC version)

| Freq.band name | W/G size (EIA) | Freq. range (GHz) | Inner dimensions (inches / mm) | Cut off freq. $TE_{10}$, GHz | Power limit | | Insertion loss, dB/m |
|---|---|---|---|---|---|---|---|
| | | | | | $P_{peak}$, MW (kW) | $P_{ave}$, CW kW (W) | |
| R band | WR-430 | 1.70 - 2.60 | 4.300x2.150 / 109.22x54.61 | | 18.230 | | |
| D band | WR-340 | 2.20 - 3.30 | 3.400x1.700 / 86.36x43.18 | | 11.870 | | |
| S band | WR-284 | 2.60 - 3.95 | 2.840x1.420 / 72.14x34.04 | 2.08 | 7.64-10.85 | 13.4-19.6 | 0.03-0.02 |
| E band | WR-229 | 3.30 - 4.90 | 2.290x1.150 / 58.17x29.08 | | 7.65 | | 0.05-0.03 |
| G band | WR-187 | 3.95 - 5.85 | 1.870x0.940 / 47.55x22.15 | 3.155 | 3.30-4.69 | 5.2-7.4 | 0.06-0.04 |
| F band | WR-159 | 4.90 - 7.05 | 1.590x0.800 / 40.39x20.19 | | 3.30 | | 0.09-0.05 |
| C band | WR-137 | 5.85 - 8.20 | 1.370x0.690 / 34.85x15.80 | 4.285 | 1.97-2.53 | 2.08-3.70 | 0.12-0.06 |
| H band | WR-112 | 7.05 - 10.00 | 1.120x0.560 / 28.5x12.62 | 5.26 | 1.28-1.70 | 1.61-2.07 | 0.14-0.11 |
| X band | WR-90 | 8.2 - 12.4 | 0.900x0.450 / 22.860x10.160 | 6.56 | 0.76-1.12 | 0.86-1.25 | 0.21-0.15 |
| | WR-75 | 10.0 - 15.0 | 0.75x0.375 / 19.050x9.525 | 7.847 | 0.62-0.90 | 0.66-0.95 | 0.25-0.17 |
| Ku band | WR-62 | 12.4 - 18.0 | 0.622x0.311 / 15.799x7.899 | 9.49 | 0.46-0.63 | 0.45-0.61 | 0.32-0.23 |
| K band | WR-51 | 15.0 - 22.0 | 0.510x0.255 / 12.954x6.477 | 11.54 | 0.31-0.43 | 0.29-0.40 | 0.43-0.31 |
| K band | WR-42 | 18.0 - 26.5 | 0.420x0.170 / 10.668x4.318 | 14.08 | 0.17-0.25 | 0.16-0.21 | 0.68-0.50 |
| | WR-34 | 22.0 - 33.0 | 0.340x0.170 / 8.636x4.318 | | | | |
| Ka band | WR-28 | 26.5 - 40.0 | 0.280x0.140 / 7.112x3.556 | 21.1 | (96-146) | (110-160) | 1.13-0.77 |
| Q band | WR-22 | 33 - 50 | 0.224x0.112 / 5.690x2.845 | 26.3 | (64-97) | (69-101) | 1.6-1.1 |
| U band | WR-19 | 40 - 60 | 0.188x0.094 / 4.775x2.388 | 31.4 | (48-70) | (51-71) | 1.3-0.94 |
| V band | WR-15 | 50 - 75 | 0.148x0.074 / 3.759x1.880 | 39.9 | (30-40) | (30-44) | 1.98-1.35 |
| E band | WR-12 | 60 - 90 | 0.122x0.061 / 3.099x1.549 | 48.4 | | | |
| W band | WR-10 | 75 - 110 | 0.100x0.050 / 2.540x1.270 | 59.0 | (14-20) | (15-21) | 3.46-2.44 |
| F band | WR-8 | 90 - 140 | 0.080x0.040 / 2.032x1.016 | 73.8 | | | |
| D band | WR-6.5 | 110 - 170 | 0.0650x0.0325 / 1.651x0.826 | 90.8 | | | |
| G band | WR-5.1 | 140 - 220 | 0.0510x0.0255 / 1.295x0.648 | 115.7 | | | |
| | WR-4.3 | 170 - 260 | 0.0430x0.0215 / 1.092x0.546 | 137.2 | | | |
| J band | WR-3.4 | 220 - 325 | 0.0340x0.0170 / 0.864x0.432 | 173.6 | | | |
| | WR-2.8 | 260 - 400 | 0.0280x0.0140 / 0.711x0.356 | 210.8 | | | |
| Y-band | WR-2.2 | 325 - 500 | 0.0200x0.0100 / 0.559x0.279 | 268.2 | | | |
| | WR-1.9 | 400 - 600 | 0.0190x0.0095 / 0.483x0.241 | 310.6 | | | |
| | WR-1.5 | 500 - 750 | 0.0150x0.0075 / 0.381x0.191 | 393.4 | | | |
| | WR-1.2 | 600 - 900 | 0.0120x0.0060 / 0.305x0.152 | 491.8 | | | |
| | WR-1.0 | 750 - 1100 | 0.0100x0.0050 / 0.254x0.127 | 590.1 | | | |

## GENERAL REFERENCE INFORMATION

### Rectangular waveguides' dimensions and operation frequency ranges

| Waveguide size a x b, mm (line №) | Freq.range, GHz | Waveguide type | Waveguide size a x b, mm | Freq.range, GHz | Flange type |
|---|---|---|---|---|---|
| by OST 4.206.000 edition 1-77 | | by EIA version | | | |
| 0.7 x 0.35 (2) | 258.4 - 405.1 | WR-2.8 | 0.711x0.356 | 260 - 400 | UG 387/UM |
| 0.9 x 0.45 (1) | 218.8 - 315.6 | WR-3 | 0.864x0.432 | 220 - 325 | UG 387/UM |
| 1.1 x 0.55 (2) | 178.4 - 258.4 | WR-4 | 1.092x0.546 | 170 - 260 | UG 387/UM |
| 1.3 x 0.65 (1) | 142.8 - 218.8 | WR-5 | 1.295x0.648 | 140 - 220 | UG 387/UM |
| 1.6 x 0.80 (2) | 118.1 - 178.4 | WR-6 | 1.651x0.826 | 110 -170 | UG 387/UM |
| 2.0 x 1.0 (1) | 94.28 - 142.8 | WR-8 | 2.032x1.016 | 90 - 140 | UG 387/UM |
| 2.4 x 1.20 (2) | 78.33 - 118.1 | WR-10 | 2.540x1.270 | 75 - 110 | UG 387/UM |
| 3.0 x 1.50 (1) | 63.79 - 94.28 | WR-12 | 3.099x1.549 | 60 - 90 | UG 387/U |
| 3.6 x 1.80 (2) | 53.57 - 78.33 | WR-15 | 3.759x1.880 | 50 - 75 | UG 385/U |
| 4.4 x 2.2 (1) | 44.09 - 63.79 | WR-19 | 4.775x2.388 | 40 - 60 | UG 383/UM |
| 5.2 x 2.60 (2) | 37.50 - 53.57 | WR-22 | 5.690x2.845 | 33 - 50 | UG 383/U |
| 6.2 x 3.1 (1) | 30.91 - 44.09 | | | | |
| 7.2 x 3.40 (2) | 25.95 - 37.50 | WR-28 | 7.112x3.556 | 26.5 - 40 | UG 381/U<br>UG 599/U |
| 9.0 x 4.5 (1) | 21.43 - 30.93 | WR-34 | 8.636x4.318 | 22 - 33 | UG 1530/U |
| 11.0 x 5.50 (2) | 17.44 - 25.95 | WR-42 | 10.668x4.318 | 18 - 26.5 | UG 595/U |
| 13.0 x 6.5 (1) | 14.71 - 21.43 | WR-51 | 12.954x6.477 | 15 - 22 | |
| 16.0 x 8.00 (2) | 12.05 - 17.44 | WR-62 | 15.799x7.899 | 12.4 - 18 | UG 419/U |
| (17.0 x 8.00) (2) | 11.55 - 16.66 | | | | |
| 19.0 x 9.5 (1) | 9.93 - 14.71 | WR-75 | 19.050x9.525 | 10 - 15 | |
| 23 x 10.0 (2) | 8.15 - 12.05 | WR-90 | 22.860x10.160 | 8.2 - 12.4 | UG 39/U |
| | | WR-102 | 25.908x12.954 | 7 - 11 | |
| 28.5 x 12.6 (1) | 6.85 - 9.93 | WR-112 | 28.499x12.624 | 7.05 - 10 | UG 51/U |
| 35 x 15.0 (2) | 5.64 - 8.15 | WR-137 | 34.849x15.799 | 5.85 - 8.2 | UG 344/U |
| 40.0 x 20.0 (1) | 4.80 - 6.85 | WR-159 | 40.386x20.193 | 4.9 - 7.05 | UG 1730/U |
| 48 x 24.0 (2) | 3.94 - 5.64 | WR-187 | 47.549x22.149 | 3.95 - 5.85 | UG 149A/U |
| 58.0 x 29.0 (1) | 3.20 - 4.80 | WR-229 | 58.166x29.083 | 3.3 - 4.9 | UG 1726/U |
| 72 x 34 (2) | 2.59 - 3.94 | WR-284 | 72.136x34.036 | 2.6 - 3.95 | UG 53/U |
| 90.0 x 45.0 (1) | 2.14 - 3.20 | WR-340 | 86.360x43.180 | 3.4 - 1.7 | UG 1712/U |
| 110 x 55 (2) | 1.72 - 2.59 | WR-430 | 109.22x54.610 | 1.7 - 2.6 | UG 1716/U |
| (120 x 57) (2) | 1.56 - 2.38 | | | | |
| 130.0 x 65.0 (1) | 1.45 - 2.14 | | | | |
| 160 x 80 (2) | 1.16 - 1.72 | | | | |

## ABOUT US

"Elmika" Joint Stock Company was established in the 1993 as a former mm-wave division of Vilnius Scientific Research Institute of Radio Measurement Instruments.

Now "Elmika" is a research, development and manufacturing company, which works in the area of mm-wave and sub-mm wave (THz) measurement instruments.

We design and manufacture sweep and signal generators, scalar and vector network analyzers, power meters, direct reading attenuators, frequency measurement instruments.

"Elmika" also produces waveguides and waveguide components for measurement instruments and wireless applications.

At present, "Elmika" has about 35 employees, more than half of them are degreed scientists and engineers.

"Elmika" provides integration and test services to match individual customers' needs. Complete turnkey systems including installation services are offered. Custom design sub-systems and components are designed, developed, and manufactured at our facilities.

Our engineering and fine mechanics' staff welcomes your special requirements and the opportunity to be useful for your needs.

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## NOTES