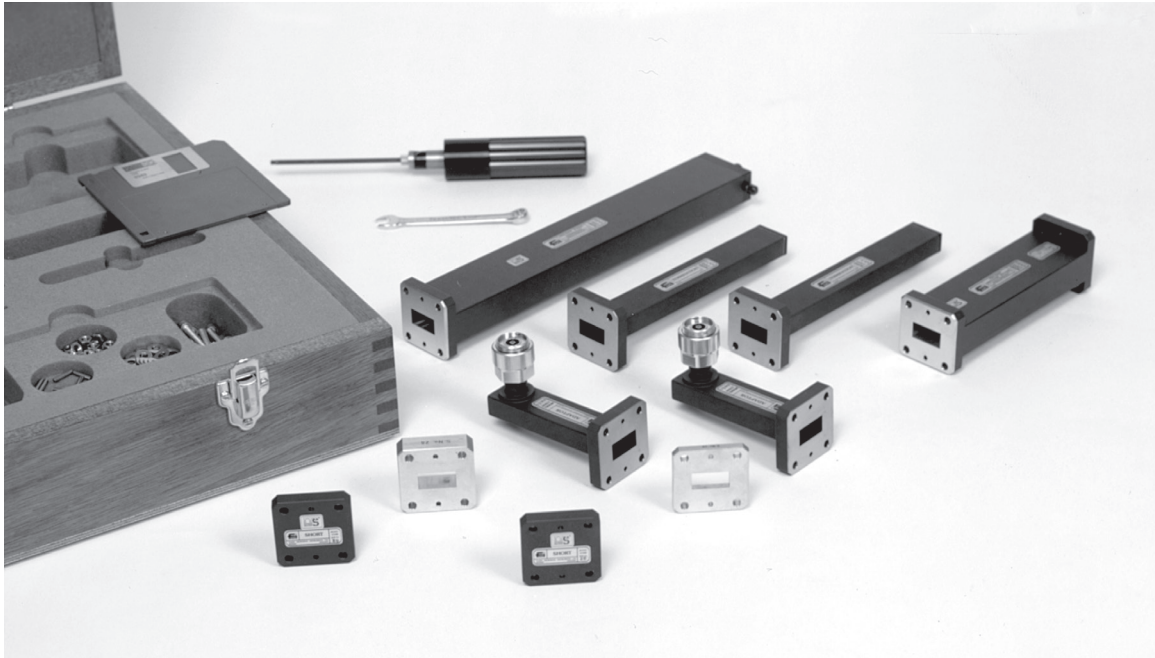


# Waveguide Calibration Kits

- **Three Grades, each with defined accuracy**



**For use with Vector Network Analysers - 1.14 GHz to 500 GHz.**

**Three grades of calibration kits and components are available that enable VNA users to select the one most suitable for the analyser type and measurement requirement. Various manufacturing techniques are employed and selected according to waveguide size and required accuracy.**

Critical components in each grade of kit have defined accuracies - a feature unique to Flann Waveguide Calibration Kits.

Flann calibration kits contain all the components necessary to fully calibrate VNAs configured for waveguide measurements. A typical kit would include waveguide to coax adaptors, fixed terminations, a sliding termination, offsets, flush shorts and a waveguide section. Kits are supplied in a fitted hardwood case complete with connecting hardware, data disc and handbook.



# Waveguide Calibration Kits

## Model Selection Table

Kit Grade	Kit Type	
	OOL	TRL / LRL
Metrology Bronze	708 series	703 series
Metrology Silver	730 series	720 series
Metrology Gold	750 series	740 series

## Each kit type contains the following components

Components	Contents	
	OOL	TRL / LRL
<b>Waveguide to Coax Adaptors</b> 1.14 GHz to 22 GHz (WG6, WR650, R14) to (WG19, WR51, R180)	2 off	2 off
17.6 GHz to 110 GHz (WG20, WR42, R220) to (WG27, WR10, R900)	2 off optional extra	2 off optional extra
<b>Fixed Termination</b>	2 off	2 off
<b>Flush Short</b>	2 off	2 off
<b>1/8 λ Offset</b>	1 off	optional extra
<b>1/4 λ Offset</b>	optional extra	1 off
<b>3/8 λ Offset</b>	1 off	optional extra
<b>Waveguide Section</b>	1 off	1 off
<b>Sliding Termination</b>	1 off	optional extra
<b>Data Disk</b>	included	included
<b>Torque Driver</b>	included	included
<b>Flange Bolts etc</b>	1 set included	1 set included
<b>Precision Flange dowels</b>	1 set included	1 set included
<b>Hardwood Case</b>	included	included
<b>Handbook</b>	included	included

### Note 1 - Flanges

Flann Calibration Kit components are fitted with “Precision Flanges” that are fully compatible with standard flanges whilst providing enhanced accuracy and repeatability. Please see page 126 - 128 for details. Kits are also available fitted with alternative flange styles or special flanges to customer specification. Details on request.

### Note 2 - Waveguide to Coax Adaptors

The Waveguide to Coax Adaptors supplied with Flann Calibration Kits are of sufficient length to ensure the decay of unwanted evanescent modes.

### Note 3 - Offsets

The length of each Flann offset section is designed to provide a phase balanced response over the recommended frequency range. Fractional wavelengths are specified with respect to a wavelength  $\lambda_{g^{\circ}}$  where:-

$$\lambda_{g^{\circ}} = 2 \sqrt{\frac{\lambda_{ghf} \cdot \lambda_{glf}}{\lambda_{ghf} + \lambda_{glf}}}$$

$\lambda_{glf}$  is the waveguide wavelength at the lowest frequency of the operating range and  $\lambda_{ghf}$  is the waveguide wavelength at the highest frequency of the operating range.

### ORDERING INFORMATION REQUIRED

1. Waveguide designation (size)  
Example: WG27
2. Series selected  
Example: 730 see above
3. Description  
Example: Metrology Silver Grade, OOL type
4. Vector analysers to be used  
Example: HP8513

Complete Ordering Example: 27730 Metrology Silver Waveguide Calibration Kit type OOL for use with HP8513 vector network analysers

Please Note: Calibration Kits in WG 20 and higher frequencies (17.6 GHz upwards) do not include Waveguide to Coax Adaptors. Please state at time of ordering if adaptors are required to be included in the kit.

# A Guide to Calibration Kit Selection

Flann Calibration Kits have been developed in close cooperation with manufacturers and users of network analysers. Kits are available in each of the three grades, suitable for analyser configurations requiring OOL, TRL and LRL calibration kit styles. The selection of a calibration kit and its contents is largely dictated by the combination of analyser model, test set model and type of calibration routine to be implemented, i.e. full 12 term, single path 2 port, reflection only or TRL/LRL.

**OOL - Offset/Offset/Load**

**TRL - Thru/Reflect/Line**

**LRL - Line/Reflect/Line**

The waveguide Calibration Kits, as described in the preceding pages, contain the components necessary to fully calibrate Vector Network Analysers. Flann Calibration Kit components are available individually or to supplement standard kits. Specialised Calibration Kits or components for use with alternative measurement systems, such as six port reflectometers, are also available. Full details are available on request.

**Note:** The components included in Flann Offset/Offset/Load type calibration kits can also be used with the Anritsu/Wiltron 360 to achieve an LRL calibration.

The specifications and capabilities of network analysers are subject to constant evolution and development. Please consult us for Calibration Kit applications assistance if required.

## Note 1 - Flanges

Flann Calibration Kit components are fitted with "Precision Flanges" that are fully compatible with standard flanges whilst providing enhanced accuracy and repeatability. Please see page 126 - 129 for details. Kits are also available fitted with alternative flange styles or special flanges to customer specification. Details on request.

## Note 2 - Waveguide to Coax Adaptors

The Waveguide to Coax Adaptors supplied with Flann Calibration Kits are of sufficient length to ensure the decay of unwanted evanescent modes.

## Note 3 - Corner Radius

Calibration Kits with specified corner radius are available - please contact our Sales Department for more details

**Please Note: Calibration Kits in WG 20 and higher frequency sets (17.6 GHz upwards) do not include waveguide to coax adaptors. Please state at time of ordering if adaptors will be required.**

**Double Ridge Waveguide Calibration Kits are also available - please see page 110**

### ORDERING INFORMATION

Calibration Kit Model: model of specific analyser model with which Calibration Kit is to be used; Description

Example: Model 22730-HP8513 waveguide calibration kit, metrology silver, OOL, for use with HP 8513 analyser

# METROLOGY BRONZE CALIBRATION KITS - 703 & 708 Series

Modest cost components realised from selected precision drawn waveguide intended for routine use offering a performance comparable to other commercially available kits. Suitable for basic measurement standards.



New

Calibration devices up to 500 GHz have been developed and supplied to support worldwide measurement activities. Please contact our Sales Team for further details

NOW UP TO 500 GHz

Waveguide Designation	WG WR R	06 650 1.4	08 430 2.2	09A 340 2.6	10 284 3.2	11A 229 4.0	12 187 4.8	13 159 5.8	14 137 7.0	15 112 8.4	16 90 10.0	17 75 12.0	18 62 14.0	19 51 18.0	20 42 22.0	21 34 26.0	22 28 32.0	23 22 40.0	24 19 50.0	25 15 62.0	26 12 74.0	27 10 90.0
Frequency Range (GHz)		1.14 to 1.7	1.72 to 2.61	2.17 to 3.30	2.60 to 3.95	3.30 to 4.90	3.94 to 5.99	4.64 to 7.05	5.38 to 8.18	6.58 to 10.0	8.20 to 12.50	9.84 to 15.0	11.9 to 18.0	14.5 to 22.0	17.6 to 26.7	21.7 to 33.0	26.4 to 40.1	33.0 to 50.1	39.3 to 59.7	49.9 to 75.8	60.5 to 92.0	73.8 to 112.0
Definitive Waveguide Dimensions (mm)		165.10 x 82.55	109.22 x 54.61	86.36 x 43.18	72.14 x 34.04	58.17 x 29.083	47.55 x 22.149	40.390 x 20.193	34.85 x 15.799	28.499 x 12.624	22.86 x 10.16	19.05 x 9.525	15.799 x 7.899	12.954 x 6.477	10.668 x 4.318	86.36 x 4.318	7.112 x 3.556	5.690 x 2.845	4.775 x 2.388	3.759 x 1.880	3.099 x 1.549	2.540 x 1.270
Precision Flange Type	(See Note 1)	UG417BU	UG435BU	UDR26	UDR32	UDR40	UAR48	UAR58	UAR70	UBR84	UBR100	UBR120	UBR140	UBR180	UBR220	UBR260	UG599U	UG383U mod	UG383U	UG385U	UG387U mod	UG387U mod
Waveguide Aperture/Tolerance (microns)		130	v90	80	60	50	40	35	35	30	20	20	18	18	15	15	15	15	15	15	15	15
WAVEGUIDE TO COAX ADAPTOR Model**091 VSWR (better than) Connector Type	(See Note 2)	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.10 APC7	1.20 K	1.20 K	1.25 K	1.20 K	1.30 K	1.3 V	1.25* V		
FIXED TERMINATION Model**045 VSWR (better than)		1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.015	1.015	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.035	1.04
FLUSH SHORT Model**191 Flatness (better than) (microns)		70	60	60	50	30	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
OFFSET (1/8 λ <sub>g</sub> , 2 port) Model**491-01 Nominal Length (mm) Measured Length Tolerance (microns)		34.665 ±0.20	23.310 ±0.20	18.240 ±0.20	15.227 ±0.20	12.032 ±0.10	10.051 ±0.10	8.537 ±0.10	7.356 ±0.10	6.016 ±0.10	4.815 ±0.10	4.012 ±0.10	3.334 ±0.10	2.730 ±0.10	2.251 ±0.10	1.824 ±0.05	1.499 ±0.05	1.199 ±0.04	1.007 ±0.03	0.793 ±0.03	0.654 ±0.02	0.537 ±0.02
OFFSET (1/4 λ <sub>g</sub> , 2 port) Model**491-02 Nominal Length (mm) Measured Length Tolerance (microns)		69.331 ±0.20	46.026 ±0.20	36.480 ±0.20	30.453 ±0.20	24.063 ±0.10	20.102 ±0.10	17.074 ±0.10	14.711 ±0.10	12.032 ±0.10	9.630 ±0.10	8.025 ±0.10	6.668 ±0.10	5.461 ±0.10	4.501 ±0.10	3.648 ±0.05	2.997 ±0.05	2.399 ±0.04	2.014 ±0.03	1.587 ±0.03	1.308 ±0.02	1.074 ±0.02
OFFSET (3/8 λ <sub>g</sub> , 2 port) Model**491-03 Nominal Length (mm) Measured Length Tolerance (microns)		103.996 ±0.20	69.039 ±0.20	54.720 ±0.20	45.680 ±0.20	36.095 ±0.10	30.154 ±0.10	25.611 ±0.10	22.067 ±0.10	18.048 ±0.10	14.445 ±0.10	12.037 ±0.10	10.003 ±0.10	8.191 ±0.10	6.752 ±0.10	5.472 ±0.05	4.496 ±0.05	3.598 ±0.04	3.021 ±0.03	2.380 ±0.03	1.963 ±0.02	1.612 ±0.02
SLIDING TERMINATION Model**541 Element VSWR (better than)		1.02	1.02	1.02	1.015	1.015	1.01	1.01	1.01	1.008	1.006	1.006	1.008	1.01	1.01	1.015	1.015	1.02	1.025	1.03	1.035	1.04
WAVEGUIDE SECTION Model**440 Nominal Length (mm) Measured Length Tolerance (microns)		590 ±0.20	495 ±0.20	450 ±0.20	410 ±0.20	360 ±0.10	320 ±0.10	273 ±0.10	236 ±0.10	192 ±0.10	154 ±0.10	128 ±0.10	107 ±0.10	87 ±0.10	71 ±0.10	65 ±0.05	60 ±0.05	46 ±0.04	39 ±0.03	35 ±0.03	35 ±0.02	35 ±0.02

Note 1 - See Page 105 for details

Note 2 - See Page 105 for details

\* VSWR is specified to 67 GHz, V Connector overmodes at 72 GHz

# METROLOGY SILVER CALIBRATION KITS - 720 & 730 Series

Precision components suitable for applications where modest accuracies are required.



New

Calibration devices up to 500 GHz have been developed and supplied to support worldwide measurement activities. Please contact our Sales Team for further details

NOW UP TO 500 GHz

Waveguide Designation	WG WR R	06 650	14	08 430 22	09A 340 26	10 284 32	11A 229 40	12 187 48	13 159 58	14 137 70	15 112 84	16 90 100	17 75 120	18 62 140	19 51 180	20 42 220	21 34 260	22 28 320	23 22 400	24 19 500	25 15 620	26 12 740	27 10 900	
Frequency Range (GHz)		1.14 to 1.73	2.17 to 3.30	3.30 to 4.90	3.94 to 5.99	4.64 to 7.05	5.38 to 8.18	6.58 to 10.0	8.20 to 12.50	9.84 to 15.0	11.9 to 18.0	14.5 to 22.0	17.6 to 26.7	21.7 to 33.0	26.4 to 40.1	39.3 to 59.7	49.9 to 75.8	60.5 to 92.0	73.8 to 112.0					
Definitive Waveguide Dimensions (mm)		165.10 x 82.55	72.14 x 34.04	58.17 x 29.083	47.55 x 22.149	40.390 x 20.193	34.85 x 15.799	28.499 x 12.624	22.86 x 10.16	19.05 x 9.525	15.799 x 7.899	12.954 x 6.477	10.668 x 4.318	86.36 x 4.318	7.112 x 3.556	4.775 x 2.388	3.759 x 1.880	3.099 x 1.549	2.540 x 1.270					
Precision Flange Type	(See Note 1)	UG417A/U	UG435A/U	UDR40	UAR48	UAR58	UAR70	UBR84	UBR100	UBR120	UBR140	UBR180	UBR220	UBR260	UG599/U	UG383/U	UG385/U	UG387/U	UG387/U					
Waveguide Aperture/Tolerance (microns)		65	45	30	20	20	15	15	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
WAVEGUIDE TO COAX ADAPTOR Model**094 VSWR (better than) Connector Type	(See Note 2)		1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.07 APC7	1.07 APC7	1.10 K	1.10 K	1.15 K	1.15 K	1.3 V	1.25* V							
FIXED TERMINATION Model**043 VSWR (better than)		1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.015	1.015	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.035	1.04					
FLUSH SHORT Model**192 Flatness (better than) (microns)		35	30	15	10	10	10	10	10	10	10	10	10	10	10	10	6	6	6					
OFFSET (1/8 λ <sub>g</sub> , 2 port) Model**492-01		Nominal Length (mm) 34.665 Tolerance (mm) 0.20 Measure Length (microns) 50	23.310 0.20 50	18.240 0.20 50	15.227 0.20 25	12.032 0.10 25	10.051 0.10 25	8.537 0.10 25	7.356 0.10 20	6.016 0.10 15	4.815 0.10 15	4.012 0.10 10	3.334 0.10 10	2.730 0.10 10	2.251 0.10 10	1.824 0.05 10	1.499 0.05 10	1.199 0.04 10	0.793 0.03 10	0.654 0.02 10	0.537 0.02 10			
OFFSET (1/4 λ <sub>g</sub> , 2 port) Model**492-02		Nominal Length (mm) 69.331 Tolerance (mm) 0.20 Measure Length (microns) 50	46.026 0.20 50	36.480 0.20 50	30.453 0.20 25	24.063 0.10 25	20.102 0.10 25	17.074 0.10 25	14.711 0.10 20	12.032 0.10 15	9.630 0.10 15	8.025 0.10 10	6.668 0.10 10	5.461 0.10 10	4.501 0.10 10	3.648 0.05 10	2.997 0.05 10	2.399 0.04 10	1.587 0.03 10	1.308 0.02 10	1.074 0.02 10			
OFFSET (3/8 λ <sub>g</sub> , 2 port) Model**492-03		Nominal Length (mm) 103.996 Tolerance (mm) 0.20 Measure Length (microns) 50	69.039 0.20 50	54.720 0.20 50	45.680 0.20 25	36.095 0.10 25	30.154 0.10 25	25.611 0.10 25	22.067 0.10 20	18.048 0.10 15	14.445 0.10 15	12.037 0.10 10	10.003 0.10 10	8.191 0.10 10	6.752 0.10 10	5.472 0.05 10	4.496 0.05 10	3.598 0.04 10	2.380 0.03 10	1.963 0.02 10	1.612 0.02 10			
SLIDING TERMINATION Model**542 Element VSWR (better than)		1.02	1.02	1.015	1.01	1.01	1.01	1.008	1.006	1.006	1.008	1.01	1.01	1.015	1.015	1.025	1.03	1.035	1.04					
WAVEGUIDE SECTION Model**442		Nominal Length (mm) 590 Tolerance (mm) 0.20 Measure Length (microns) 140	495 0.20 100	450 0.20 90	410 0.20 75	360 0.10 65	320 0.10 50	273 0.10 45	236 0.10 40	192 0.10 35	154 0.10 30	128 0.10 30	107 0.10 25	87 0.10 20	71 0.10 15	60 0.05 10	35 0.03 10	35 0.02 10	35 0.02 10	35 0.02 10	35 0.02 10	35 0.02 10	35 0.02 10	

Note 1 - See Page 105 for details

Note 2 - See Page 105 for details

\* VSWR is specified to 67 GHz, V Connector overmodes at 72 GHz

# METROLOGY GOLD CALIBRATION KITS - 740 & 750 Series

High precision components eminently suited to demanding applications which extend VNA measurement capability.



New

Calibration devices up to 500 GHz have been developed and supplied to support worldwide measurement activities. Please contact our Sales Team for further details

NOW UP TO 500 GHz

Waveguide Designation	WG WR R	06 650 14	08 430 22	09A 340 26	10 284 32	11A 229 40	12 187 48	13 159 58	14 137 70	15 112 84	16 90 100	17 75 120	18 62 140	19 51 180	20 42 220	21 34 260	22 28 320	23 22 400	24 19 500	25 15 620	26 12 740	27 10 900
Frequency Range (GHz)		1.14 to 1.73	1.72 to 2.61	2.17 to 3.30	2.60 to 3.95	3.30 to 4.90	3.94 to 5.99	4.64 to 7.05	5.38 to 8.18	6.58 to 10.0	8.20 to 12.50	9.84 to 15.0	11.9 to 18.0	14.5 to 22.0	17.6 to 26.7	21.7 to 33.0	26.4 to 40.1	33.0 to 50.1	39.3 to 59.7	49.9 to 75.8	60.5 to 92.0	73.8 to 112.0
Definitive Waveguide Dimensions (mm)		165.10 x 82.55	109.22 x 54.61	86.36 x 43.18	72.14 x 34.04	58.17 x 29.083	47.55 x 22.149	40.390 x 20.193	34.85 x 15.799	28.499 x 12.624	22.86 x 10.16	19.05 x 9.525	15.799 x 7.899	12.954 x 6.477	10.668 x 4.318	86.36 x 4.318	7.112 x 3.556	5.690 x 2.845	4.775 x 2.388	3.759 x 1.880	3.099 x 1.549	2.540 x 1.270
Precision Flange Type	(See Note 1)	UG417BU	UG435BU	UDR26	UDR32	UDR40	UAR48	UAKS8	UAR70	UBR84	UBR100	UBR120	UBR140	UBR180	UBR220	UBR260	UG599U	UG383U mod	UG383U	UG385U	UG387U mod	UG387U mod
Waveguide Aperture/Tolerance (microns)		35	25	20	15	15	10	10	7	7	5	5	5	5	5	5	5	5	5	5	5	5
WAVEGUIDE TO COAX ADAPTOR Model**095 VSWR (better than) Connector Type	(See Note 2)	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.05 APC7	1.07 APC7	1.07 APC7	1.10 K	1.10 K	1.15 K	1.15 K	1.30 2.4mm	1.3 V	1.25* V		
FIXED TERMINATION Model**044 VSWR (better than)		1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.015	1.015	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.035	1.04
FLUSH SHORT Model**193 Flatness (better than) (microns)		15	15	15	12	8	8	5	5	5	5	5	5	5	5	5	3	3	3	3	3	3
OFFSET (1/8 λ <sub>g</sub> , 2 port) Model**493-01 Nominal Length (mm) Measured Length Tolerance (mm) Measured Length Tolerance (microns)		34.665 to 0.20 to 25	23.310 to 0.20 to 25	18.240 to 0.20 to 25	15.227 to 0.20 to 15	12.032 to 0.10 to 15	10.051 to 0.10 to 12	8.537 to 0.10 to 12	7.356 to 0.10 to 10	6.016 to 0.10 to 7	4.815 to 0.10 to 7	4.012 to 0.10 to 5	3.334 to 0.10 to 5	2.730 to 0.10 to 5	2.251 to 0.10 to 5	1.824 to 0.05 to 5	1.499 to 0.05 to 5	1.199 to 0.04 to 5	1.007 to 0.03 to 5	0.793 to 0.03 to 5	0.654 to 0.02 to 5	0.537 to 0.02 to 5
OFFSET (1/4 λ <sub>g</sub> , 2 port) Model**493-02 Nominal Length (mm) Measured Length Tolerance (microns)		69.331 to 0.20 to 25	46.026 to 0.20 to 25	36.480 to 0.20 to 25	30.453 to 0.20 to 15	24.063 to 0.10 to 15	20.102 to 0.10 to 12	17.074 to 0.10 to 12	14.711 to 0.10 to 10	12.032 to 0.10 to 7	9.630 to 0.10 to 7	8.025 to 0.10 to 5	6.668 to 0.10 to 5	5.461 to 0.10 to 5	4.501 to 0.10 to 5	3.648 to 0.05 to 5	2.997 to 0.05 to 5	2.399 to 0.04 to 5	2.014 to 0.03 to 5	1.587 to 0.03 to 5	1.308 to 0.02 to 5	1.074 to 0.02 to 5
OFFSET (3/8 λ <sub>g</sub> , 2 port) Model**493-03 Nominal Length (mm) Measured Length Tolerance (microns)		103.996 to 0.20 to 25	69.039 to 0.20 to 25	54.720 to 0.20 to 25	45.680 to 0.20 to 15	36.095 to 0.10 to 15	30.154 to 0.10 to 12	25.611 to 0.10 to 12	22.067 to 0.10 to 10	18.048 to 0.10 to 7	14.445 to 0.10 to 7	12.037 to 0.10 to 5	10.003 to 0.10 to 5	8.191 to 0.10 to 5	6.752 to 0.10 to 5	5.472 to 0.05 to 5	4.496 to 0.05 to 5	3.598 to 0.04 to 5	3.021 to 0.03 to 5	2.380 to 0.03 to 5	1.963 to 0.02 to 5	1.612 to 0.02 to 5
SLIDING TERMINATION Model**543 Element VSWR (better than)		1.02	1.02	1.02	1.015	1.015	1.01	1.01	1.01	1.008	1.006	1.006	1.008	1.01	1.01	1.015	1.015	1.02	1.025	1.03	1.035	1.04
WAVEGUIDE SECTION Model**443 Nominal Length (mm) Measured Length Tolerance (microns)		590 to 0.20 to 70	495 to 0.20 to 50	450 to 0.20 to 45	410 to 0.20 to 40	360 to 0.10 to 35	320 to 0.10 to 30	273 to 0.10 to 25	236 to 0.10 to 20	192 to 0.10 to 18	154 to 0.10 to 15	128 to 0.10 to 15	107 to 0.10 to 12	87 to 0.10 to 10	71 to 0.10 to 7	65 to 0.05 to 7	60 to 0.05 to 5	46 to 0.04 to 5	39 to 0.03 to 5	35 to 0.03 to 5	35 to 0.02 to 5	35 to 0.02 to 5

Note 1 - See Page 105 for details

Note 2 - See Page 105 for details

\* VSWR is specified to 67 GHz. V Connector overmodes at 72 GHz