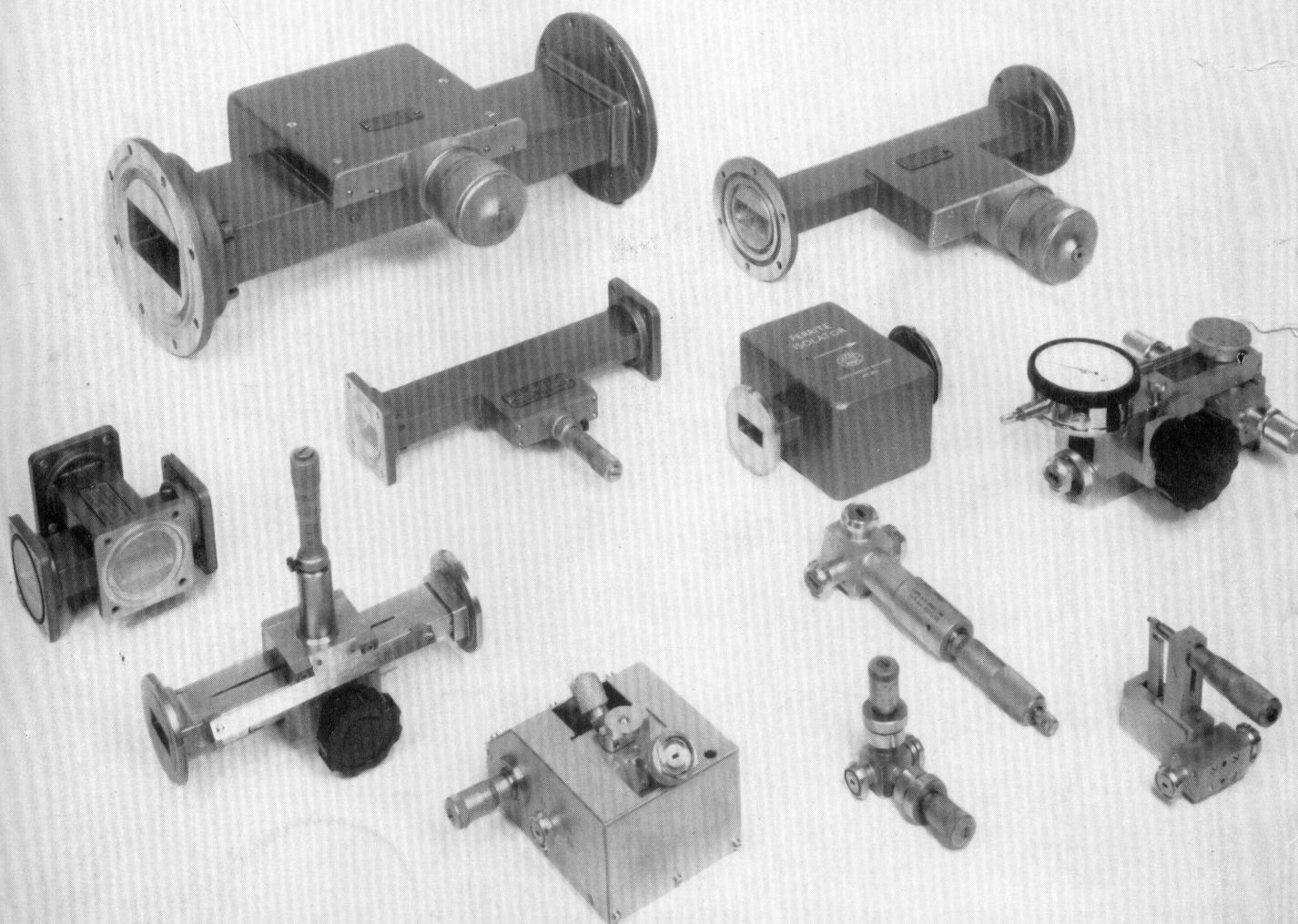


MICROWAVE INSTRUMENTS LIMITED

NORTH SHIELDS

Microwave Components for mm and cm wavelengths



SALES OFFICE 98 ST PANCRAS WAY LONDON NW1

MICROWAVE COMPONENTS



MICROWAVE INSTRUMENTS LTD

NORTH SHIELDS

A MEMBER OF THE HILGER & WATTS GROUP

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Index for Section S

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S 8	Crystal holders. Short circuit. Coaxial to waveguide transformer.
S 9	Klystrons and mounts.

MICROWAVE COMPONENTS

for the 10 cm waveband (S band)

The waveguide aperture of all Microwave components for the 10 cm waveband conforms to the WG 10 size of the British Radio Components Standardization Committee, the size recommended in the United Kingdom and the United States as a standard for wavelengths from 7.59 to 11.53 cm (frequencies from 2.60 to 3.95 Gc/s).

Components are normally finished as follows:

- (a) Electrical surfaces: silver plated
- (b) Controls: satin-chrome plated
- (c) External surfaces: hammer-finish enamelled

Waveguide supports (see page X 1 for details), together with flanges and lengths of waveguide, can be supplied separately to enable customers to assemble their own components.

Waveguide dimensions

Nominal internal size	2.840 · 1.340 in. (7.21 · 3.4 cm)
Tolerance on internal size	0.004 in. (0.1 mm)
Nominal wall thickness	0.08 in. (2.0 mm)
Nominal external size	3.000 · 1.500 in. (7.62 · 3.8 cm)
Tolerance on external size	0.004 in. (0.1 mm)

The illustrations in this catalogue are not binding in detail. We reserve the right to amend specifications without notice.

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Bench-stand for mounting components and instruments

This is similar to that used in section X, page X 3.

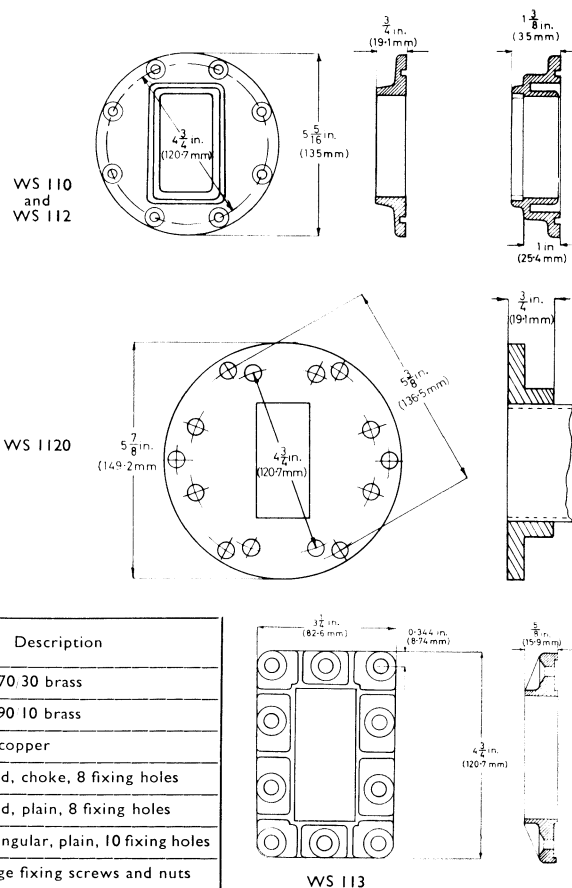
Waveguide and flanges

All waveguide is drawn to R.C.S.C. specification for WG 10. It can be supplied in standard lengths of 12 ft (3.66 m), or cut to customers' specifications. Materials are 70 30 or 90 10 brass or copper. Aluminium waveguide can be supplied on special request.

Flanges: Unless otherwise requested all instruments are supplied fitted with circular flanges J.S.C. No. 5985 99 083 0010 (plain) and 5985 99 083 0009 (choke). The convention followed is that the choke flange faces the source of RF power, and all output flanges, whether on the main waveguide run or branch waveguides, are plain. **Instruments incapable of handling high power are fitted with plain flanges in all positions.**

Any of the instruments in the catalogue can be fitted with flanges to suit customers' requirements. Obsolete types may be fitted if it is essential that new instruments should mate with existing equipment.

Adaptors for connecting different types of flanges can also be supplied by mounting the flanges on a short length of waveguide.



Cat. No.	Old or R.C.S.C. No.	Joint Services Cat. No.	WG size	U.S. equivalent	Description
WS 100	—	5985-99-083-0068	10	—	Waveguide 70 30 brass
WS 101	—	5985-99-012-0043	10	—	Waveguide 90 10 brass
WS 102	—	5985-99-083-0067	10	—	Waveguide copper
WS 110	Z 830009	5985-99-083-0009	10	UG 54A U	Flange, round, choke, 8 fixing holes
WS 112	Z 830010	5985-99-083-0010	10	UG 53 U	Flange, round, plain, 8 fixing holes
WS 113	Z 830058	5985-99-083-0058	10	—	Flange, rectangular, plain, 10 fixing holes
WS 114	—	—	10	—	Set of 8 flange fixing screws and nuts
WS 116	Z 830008	—	10	—	Complete coupler, round, 8 fixing holes
WS 117	100 1602	—	10	—	Flange, rectangular, plain, 10 fixing holes
WS 118	Z 831558	5985-99-083-1558	10	—	Flange, round, choke, 6 fixing holes
WS 120	Z 831560	5985-99-083-1560	10	—	Flange, round, plain, 6 fixing holes
WS 120	100 1605	—	10	—	Flange, round, plain, 14-hole, universal
WS 122	Z 831556	—	10	—	Complete coupler, round, 6 fixing holes

Note: 6-hole flanges are obsolescent and only supplied to special order.

Magic Tee

A broad band hybrid tee (known as a magic tee). It can be used in balanced mixer circuits and frequency-stabilizing circuits, or as an impedance bridge. The isolation between E and H plane arms is better than 45 dB over the range 2.7 to 3.5 Gc/s.

Cat. No.	Old No.	Description
WS 308	100 2970	Magic Tee

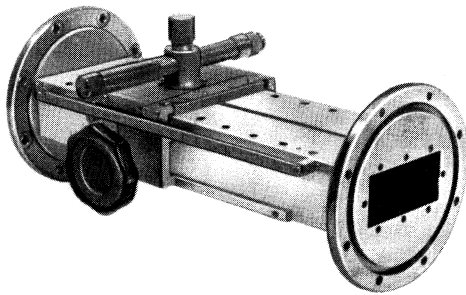
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Directional couplers

Directional couplers are made up in various combinations of coupling method and mechanical arrangement. The table below sets out various combinations available. Other types can be manufactured for specific requirements.

Please turn to the pull-out page on directional couplers at the end of the catalogue for diagrams of coupler designs.

Cat. No.	Old No.	WG size	Design Frequency	Bandwidth Gc/s	Coupling Value dB	Directivity dB	V.S.W.R.	Coupling Method	Coupling Tolerance
WS 408 etc.	100 1700	10	3 Gc/s	0.4 0.35	14, 17, 20 8, 10, 11	27-37	0.95-0.98	4 slot	± 0.5 dB
WS 464 etc.	100 1720	10	3 Gc/s	0.35 0.35	14, 17, 20 40	16-28	0.94-0.98	4 arm 90	± 0.5 dB



WS 800

Standing-wave indicator

Each instrument is fitted with a stainless-steel millimetre scale and vernier which indicates to 0.1 mm the position of the probe with respect to the output flange.

The WS 804 is a grade II instrument and is suitable for demonstration or routine test work. The waveguide body is made from selected stock, and great care is taken to maintain the section during machining and soldering. All units are fitted with a coaxial line tuner which connects the probe and detecting crystal. Resonance, and therefore maximum sensitivity, can be produced at all frequencies within the quoted range.

Grade I units have waveguides which are fabricated from solid brass and are of sufficient section to withstand heavy usage. The carriage runs on, and is guided by, P.T.F.E. pads which provide a low-friction suspension. Further, trouble from dust is avoided because the reference tracks are swept during each traverse. The mechanism requires no attention. The carriage is mechanically referred to the electrical working surface of the top plate, which ensures constancy of coupling of a high order. The waveguide and flanges have a very high standard of finish, the inside surface of the waveguide has a mirror finish, and the external surfaces are of polished brass.

Cat. No.	Old No.	Frequency Range Gc/s	Carriage Travel cm	Maximum reflection co-efficient	Variation of guide wavelength from nominal	Accuracy of indicated probe position	Grade	Finish	Length
WS 800	100 1350	2.6-3.9	17	0.001	0.2%	0.1 mm	I	Plain brass	12½ in. 311 mm
WS 804	100 1150	2.6-3.9	13.5	—	—	0.1 mm	II	Rhodium plate	13½ in. 352 mm

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Attenuators

The types of attenuator available are :

(i) Fixed :

Attenuation is obtained by mounting a resistive-coated vane parallel to the narrow face of the guide. The vane is mounted on two rods extending from one side of the guide, the length of rods determine the position of the vane and thus the amount of attenuation. The vane position is normally set and sealed during manufacture to the value specified by the customer, but the support rods can be left unsealed and long enough for the customer to make his own adjustment.

(ii) Variable uncalibrated attenuators :

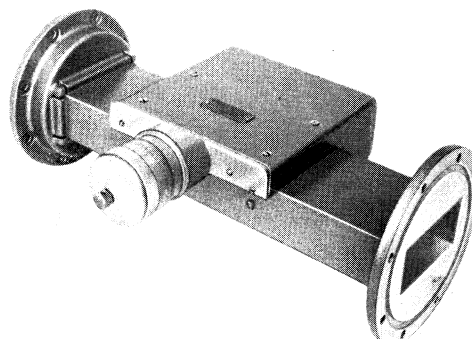
The resistive vane is carried on two support rods which are attached to, and moved by, a screw adjusting mechanism. A millimetre scale gives an indication of the vane position in the waveguide. The WS 604 is a level-setting attenuator.

(iii) Variable calibrated attenuators :

A resistive, high-stability glass vane is mounted in a similar way to the uncalibrated attenuator but the movement is governed by a micrometer and is supplied with a calibration chart. Calibration of S band items is carried out at 3.0 Gc/s.

Dissipative fibre vanes are constructed by laminating a carbon resistive element between two composition vanes and by using an adhesive that effectively excludes moisture from it. Glass-type vanes, such as Decca XT 141, XT 146, etc., have high stability.

Please turn to the pull-out page on attenuators at the end of the catalogue for illustrations.



WS 608

FIXED

Cat. No.	Old No.	WG size	Frequency Gc/s	Range dB	Setting Frequency Mc/s	Insertion V.S.W.R.	Length flange to flange	Depth	Height	Weight
WS 634	100 1900	10	2.6-3.8	10	3000	0.95	6 in. 152 mm	4½ in. 114 mm	3 in. 76 mm	3½ lb 1.6 kg
WS 642	100 1910	10	2.6-3.8	20	3000	0.95	9 in. 227 mm	4½ in. 114 mm	3 in. 76 mm	3½ lb 1.6 kg

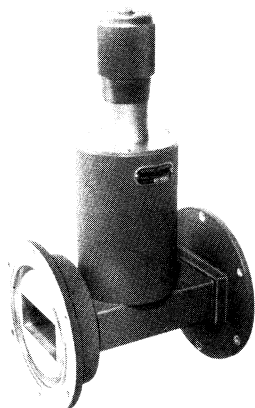
VARIABLE

Cat. No.	Old No.	WG size	Calibration Frequency	Overall Accuracy dB	Frequency Gc/s	Range dB	Insertion Loss dB	Lowest V.S.W.R.	Length flange to flange	Depth	Height	Weight
WS 604	100 670	10	—	—	2.6-3.8	30	0.5	0.95	13 in. 330 mm	8 in. 203 mm	6 in. 152 mm	10½ lb 4.7 kg
WS 608	100 2700	10	3000	0.8	2.6-3.9	15	0.5	0.95	13 in. 330 mm	8½ in. 216 mm	6 in. 152 mm	10 lb 4.5 kg
WS 610	100 2720	10	3000	0.1	2.6-3.4	40	0.5	0.95	13 in. 330 mm	8½ in. 216 mm	6 in. 152 mm	10 lb 4.5 kg

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Phase shifters

Vane-type phase shifters are similar in construction to the variable attenuators illustrated in the pull-out section at the end of this catalogue. They make use of the same movement but are fitted with a dielectric vane instead of the resistive vane fitted to the attenuators. In WS 678 control of movement is by micrometer head, and it is supplied complete with calibration chart.



WS 702

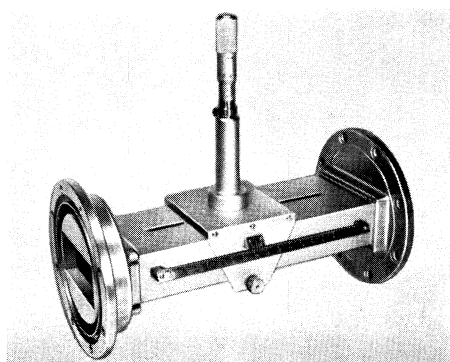
Cat. No.	Old No.	WG size	Calibration Frequency Gc/s	Degrees Phase Shift	V.S.W.R. (better than)	Reset Accuracy (average)	Equivalent Attenuator Movement
WS 674	100/2320	10	—	180	0.94	0.5°	WS 604
WS 678	100/2330	10	3.0	180	0.94	0.5°	WS 610

Wavemeters

The resonant-cavity types of wavemeter are tuned by a piston controlled by a micrometer head. WS 702 is coupled to the waveguide by an iris to give optimum coupling over the frequency range. WS 710 is fitted with a detector crystal and output cable and is bench-mounted. It is coupled to the waveguide via a coaxial connector WS 711 and sampling unit WS 712 which is a 3-in. (76 mm) length of waveguide inserted in the waveguide run.

Cat. No.	Old No.	WG size	Frequency Range Gc/s	Q Factor	Resonator Mode	Type	Calibration Accuracy	Average Dial Discrimination	Length	Depth	Height	Weight
WS 702	100/700	10	2.7-3.5	4000	H ₁₁₁	A	±2 in 10 ¹	0.5 Mc/s	7 in. 178 mm	4½ in. 114 mm	11½ in. 286 mm	12 lb 5.4 kg
WS 710	100/700 C	10	2.7-3.5	5500	H ₁₁₁	C	±2 in 10 ¹	0.5 Mc/s	7 in. 178 mm	4½ in. 114 mm	11½ in. 292 mm	12½ lb 5.6 kg

Note: Type A is absorption. Type C is cable-connected.



WS 822

Matching Units or Variable Reactances

The types available are:

- Calibrated matching unit which is provided with scales to measure probe position with respect to the output terminal, and probe penetration into the waveguide by means of a calibrated micrometer.
- Similar to the calibrated matching unit but has no scales and the probe is moved into the waveguide by means of a screw.
- Three-screw tuner which has three screws mounted along the waveguide at intervals spaced for broadband performance.

Matching units WS 822 and WS 820 are both capable of reducing a V.S.W.R. of 0.1 to unity.

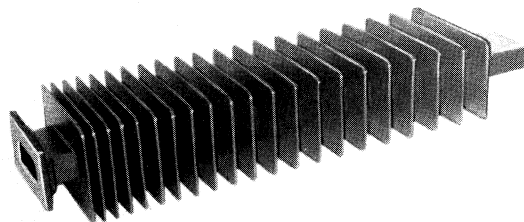
Cat. No.	Old No.	WG size	Adjustment	Probe dia.	Probe penetration	Length	Height	Weight
WS 820	100/2200	10	Screw	0.236 in. 6 mm	1 in. 25 mm	10½ in. 273 mm	7 in. 178 mm	8½ lb. 3.86 kg
WS 822	100/1400	10	Micrometer	0.198 in. 5 mm	1 in. 25 mm	10½ in. 273 mm	9½ in. 241 mm	8½ lb. 3.97 kg
WS 830	100/2210	10	3-screw	0.185 in. 4.7 mm	1 in. 25 mm	6½ in. 171 mm	8 in. 203 mm	7 lb 3.2 kg

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Terminating Loads

Terminating loads are of two types:

- (i) Low power loads which have a resin iron-powder wedge many wavelengths long and insensitive to frequency. Plain flanges are fitted to give good V.S.W.R.
- (ii) High power loads which have heat-resistant cement fillings are fitted with choke flanges to prevent sparking at contact faces. Cooling fins are fitted to the high power loads.



WS 906

LOW POWER ELEMENT

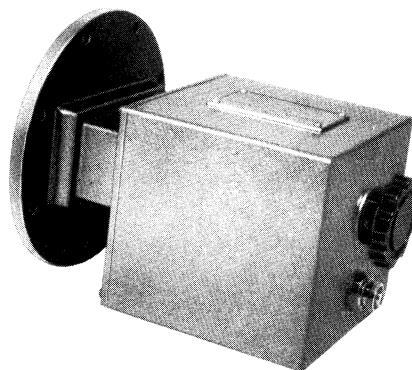
Cat. No.	Old No.	WG size	Design Frequency Gc/s	Termination Material	V.S.W.R.	Power Cap.	Length
WS 900	100 1835	10	3.0	Iron/resin	0.98	3W CW	13½ in. 336 mm
WS 902	100 1830	10	3.0	Iron/resin	0.99	3W CW	13½ in. 336 mm

HIGH POWER ELEMENT

Cat. No.	Old No.	WG size	Design Frequency Gc/s	Termination Material	V.S.W.R.	Power Cap.	Length
WS 904	100 1820	10	3.0	Cement	0.93-0.95	100 W Av	24 in. 610 mm
WS 906	100 1840	10	3.0	Cement	0.93-0.95	1 MW Peak 1 kW Av	24 in. 610 mm

Thermistor mounts

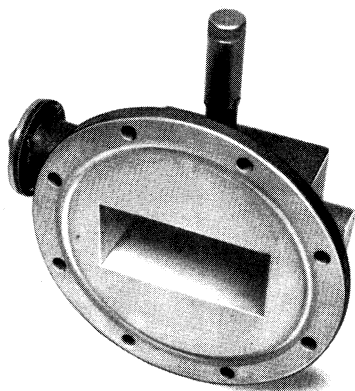
The thermistor mount, WS 922, operates over the frequency range 2.7 to 3.5 Gc/s, the tuning control selects any 200 Mc/s in that range. Two thermistors, type E 2631 20, are mounted as a termination to a coaxial line which is connected to the waveguide via a mode transformer. The bandwidth is 200 Mc/s for a V.S.W.R. of not less than 0.9 at the edge of the band. At optimum tuning, i.e. anywhere between 2.7 to 3.5 Gc/s, the V.S.W.R. is not less than 0.94.



WS 922

Cat. No.	Old No.	Frequency Range Gc/s	V.S.W.R.	Power Cap. (Max.)	Operating Resistance	Length	Depth	Height	Weight
WS 922	100 1200	2.7-3.5	0.94	40 mW	200 ohms	5 in. 127 mm	4½ in. 108 mm	4½ in. 108 mm	6 lb 2.7 kg

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WS 944

Crystal holders

The holders use the co-axial style of crystal such as the CV 2154, CS 9B, etc., in which the crystal is connected to the waveguide through a bar and post transformer. All crystal mounts are fitted with a miniature socket similar to BNC type 10H 20779, together with a 3-ft (91.4 cm) length of coaxial cable UR 76 having a BNC plug 10H/20780 at one end. Crystals type CV 2154 can, of course, be replaced by type CV 2155 in order to obtain reverse polarity D.C. output.

Cat. No.	Old No.	WG size	Frequency Mc/s	Crystal	Function	Length	Height	Weight
WS 944	100 1500	10	3000	CV 2154	Mixer	3 in. 76 mm	6 in. 152 mm	2 lb 0.9 kg
WS 946	100 1550	10	3000	CV 2154	Low-level detector	3 in. 76 mm	6½ in. 165 mm	3 lb 5 oz 1.5 kg



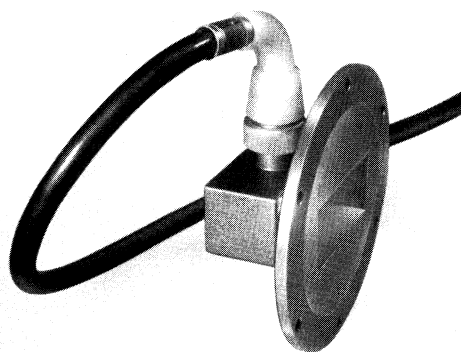
WS 970

Short circuit

The short circuit consists of a short length of standard waveguide housing a movable piston with a re-entrant choke whose two halves have a high ratio impedance for broad-band performance. The position of the actual short circuit is known to within $\pm 0.1\%$ and the standard reflection co-efficient is better than 0.995 (V.S.W.R. better than 500:1).

Plain flanges are fitted unless otherwise requested. Alternative flanges may be specified in accordance with the instructions on page S 3.

Cat. No.	Old No.	WG size	Design Frequency Gc/s	Bandwidth Gc/s	Discrimination		Movement	V.S.W.R.	Length	Weight
					Electrical	Mechanical				
WS 970	100 2100	10	3.0	0.8	0.30"	0.1 mm	12 cm	500:1	13 in. 330 mm	4 lb 8 oz 2 kg



WS 982

Coaxial to waveguide transformer

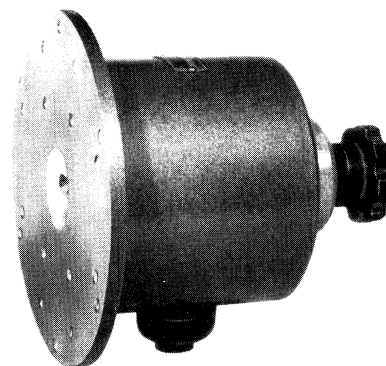
The coaxial to waveguide transformer has the well-known broad-band bar and post construction. WS 982 is supplied with a 3-ft (914 mm) length of U.R. 21 connected to the transformer by means of a cable-mounting socket type 5, R.A.E. drawing WT 31866. WS 980 is supplied with a type N 50 ohm connector only. They are 2½ in. (60.3 mm) long and the height and width are dependent on the flanges used. Weight 3 lb 3 oz (1.4 kg).

Cat. No.	Old No.	Description	Connector	Recommended cable
WS 980	100/501	50 ohms	Type N, UG 21B U	UR 67
WS 982	100/500	70 ohms	R.A.E. Type 5	UR 21

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Klystron oscillators WS 152 and WS 158

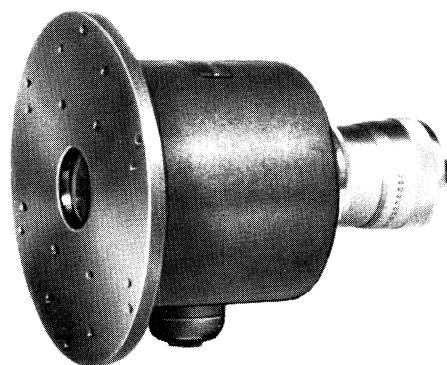
The mounts can be supplied with a klystron (CV 2116 or RK 6112A) which is mounted in a radial cavity. Both the types of klystron are similar in performance. Tuning is done by adjusting four pre-set screws. The mounts are fitted with a flange so as to launch power directly into the waveguide.



WS 152

Klystron mounts WS 162 and WS 164

These klystron mounts use a CV 2116 or RK 6112A mounted in a waveguide resonator. WS 162 is tuned by a piston and screw and WS 164 has a 2-in. (51mm) diameter micrometer head. The unit is mounted on a universal flange WS 1120 and enclosed in a spun-aluminium housing, power is connected through an octal plug and socket. Suitable power units are WE 38 and WE 39.



WS 164

Cat. No.	Old No.	WG size	Frequency Range Gc's	Output Power mW	Power Unit	Tuning	Length	Depth	Height	Weight
WS 152	100.420	10	3.2-3.5	80-100	WE 38 or WE 39	Radial screws	10 in. 254 mm	6 in. 152 mm	8½ in. 216 mm	2¾ lb 1.25 kg.
WS 158	100.422	10	2.9-3.25	80-100	WE 38 or WE 39	Radial screws	4½ in. 114 mm	3½ in. 89 mm	2¼ in. 57 mm	2¾ lb 1.25 kg.
WS 162	100.430	10	2.7-3.5	80-100	WE 38 or WE 39	Screw	6½ in. 159 mm	6 in. 152 mm	6 in. 152 mm	4¾ lb 2.2 kg.
WS 164	100.440	10	2.7-3.5	80-100	WE 38 or WE 39	Micrometer	6½ in. 159 mm	6 in. 152 mm	6 in. 152 mm	4¾ lb 2.2 kg.

MICROWAVE COMPONENTS



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Index for Section X

PAGE NO.	SUBJECT
X 1	Free standing supports. Insulated coupling ring.
X 2	Bends and Twists. Shutter Switch.
X 3	Bends and Twists—specifications.
X 5	Thermistor Bridge.
X 6	Klystron power unit.

The illustrations in this catalogue are not binding in detail. We reserve the right to amend specifications without notice.

Free Standing Supports

W-19 Series

The W-19 series of Free Standing Supports are highly-stable, quickly-adjustable bases to clamp all sizes of waveguide wherever an independent support is required.

While two or more Free Standing Supports can satisfactorily hold a Test Bench by themselves they are more commonly used to support either free items likely to be moved about during experiment or extensions to a waveguide run, for which purpose they can be aligned with our standard Waveguide Benches.

The height and rotation are freely adjustable yet immediately gripped with the powerful quarter-turn clamp. The rubber base prevents sliding or scratching, while the heavy distributed-weight pedestal with its low centre of gravity gives satisfactory stability.

The Pillar Support sections which clamp standard drawn waveguide may also be obtained independently (W-9 series) in order to use each pedestal with different sizes of waveguide.

Type Numbers

Waveguide Number	Band Letter	Complete Free Standing Support	Pedestal Only	Pillar Support Only
10	S	WS 19	WE 18	WS 9
14	C	WC 19	WE 18	WC 9
15	X	WX 1019	WE 18	WX 1009
16	X	WX 19	WE 18	WX 9
22	Q	WQ 19	WE 18	WQ 14
22 Precision (electroformed)	Q	WQ 1019	WE 18	WQ 15

Fittings for other sizes of waveguide or other purposes can be supplied to individual requirements.

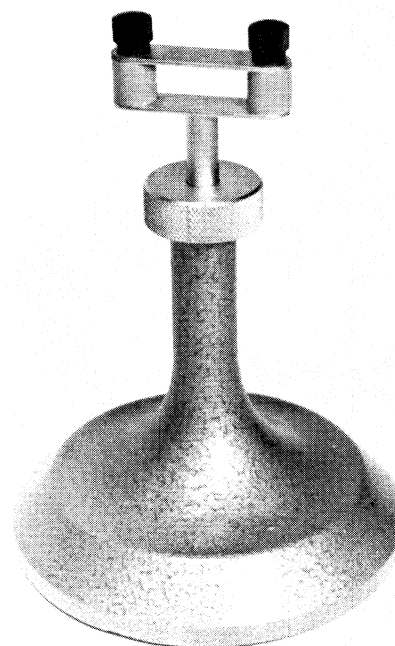
Insulated Coupling Ring

Type WX 119

The Type WX 119 Insulated Coupling Ring is a convenient means of breaking the electrical continuity of Waveguide 16 where required, such as to stop earth loop currents in sensitive detector circuits. The thin plastic diaphragm is also effective, used with gasketed flanges, to seal off a section of waveguide avoiding ingress of moisture, dirt, etc.

Specification

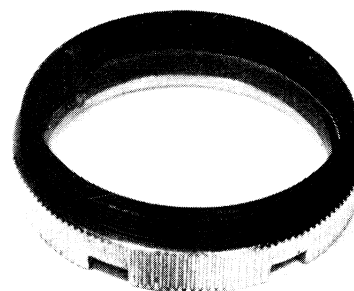
FREQUENCY RANGE: 8.2 to 12.5 Gc/s
 V.S.W.R. AT 9375 MC/s: Approx. 0.99 depending upon flanges
 CAPACITY: 15 pF between plain flanges



Specification

WEIGHT: 4½ lb (2.23 kg)
 PEDESTAL DIAMETER: 5 in. (127 mm)
 HEIGHT OF CENTRE OF GRAVITY: 1 in. (25.4 mm)
 HEIGHT ADJUSTMENT: *5 in. to 7 in. (127 to 178 mm) to underside of standard waveguide
 FINISH: Pedestal—dark grey polychromatic stove enamel
 Lock and pillar support—pearl chrome plate

*On Q-Band only height to C L of waveguide is 5½ in. to 7½ in. (140 to 191 mm).



Bends and Twists

In addition to specialising in tailor-made waveguide runs, Microwave Instruments Limited offer a stock range of Bends and Twists. While bends can be supplied in all waveguide sizes the table shows the preferred sizes for Waveguides 15 and 16.

In general, performance is not primarily dependent upon radius, being much as follows:—

E-Plane Bends

Typical V.S.W.R. from 0.97 to 0.95, decreasing with increasing frequency.

(Test Spec.: V.S.W.R. better than 0.94 from 8.4 to 12.5 Gc/s for W.G. 16)

H-Plane Bends

Typical V.S.W.R. from 0.96 to 0.93, decreasing with increasing frequency.

(Test Spec.: V.S.W.R. better than 0.91 from 8.4 to 12.5 Gc/s for W.G. 16)

Twists

Typical V.S.W.R. between 0.98 and 0.93.

(Test Spec.: V.S.W.R. better than 0.9 from 8.4 to 12.5 Gc/s for W.G. 16)

Standard flanges are R.C.S.C. styles, circular for W.G. 16 and rectangular for W.G. 15, with one choke and one plain flange in each case. Internal finish is clean brass; external finish is dark grey polychromatic stove enamel. Weights vary from 6 to 12 oz, dependent upon type.

Straight waveguides up to 10 ft long are supplied to individually-specified lengths with choke and/or plain flanges as required.



For DIMENSIONS see page X3

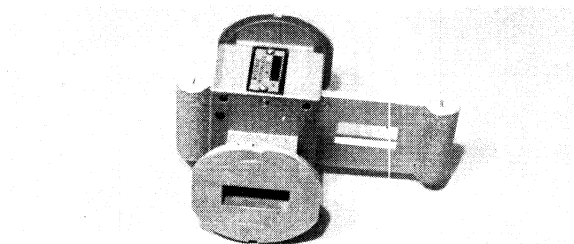
Shutter Switch

Type WX 202

The Type WX 202 Shutter Switch gives a quick means of inserting and removing a short circuit in Waveguide 16.

By immediately reflecting all the waveguide power without uncoupling and fitting different components it greatly speeds the calibration of a reflectometer arrangement. Alternatively, by cutting off all the incident power it gives an immediate check on the zero setting of a thermistor mount and its bridge or on the noise level in a crystal detector.

The waveguide window in the shutter is positioned in the waveguide by a spring indexing device. Choke sections on either side of the shutter produce efficient reflection from the shorting plate and avoid leakage.



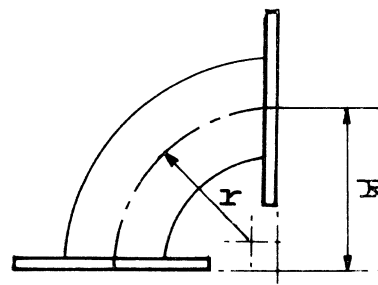
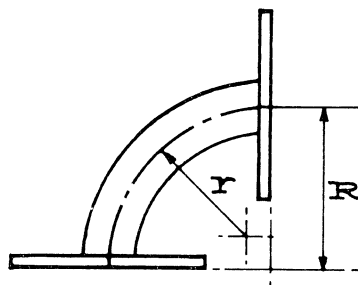
Specification

FREQUENCY RANGE:	8.2 to 12.5 Gc/s
ATTENUATION AT 9375 MC/S:	Open <0.04 dB Closed >70 dB
V.S.W.R. AT 9375 MC/S:	Open better than 0.975 Closed less than 0.08

Microwave Instruments Ltd, North Shields.

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90° Bends E-Plane H-Plane



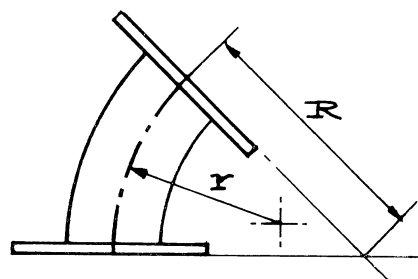
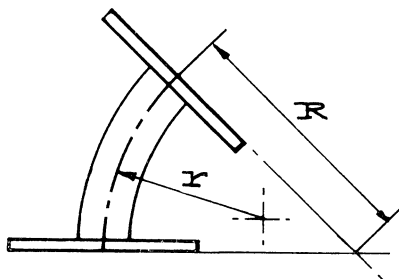
Waveguide No. 16

Type No.	Plane	Bend Radius (r)		Effective Radius (R)	
		in.	mm	in.	mm
WX 322	E	1 1/2	32	1 1/2	44
WX 324	E	1 1/2	33	2	51
WX 325	E	1 1/2	44	2 1/2	64
WX 329	E	2 1/2	57	3	76
WX 330	E	3 1/2	83	4	102
WX 332	E	4 1/2	117	5	127
WX 335	H	1 1/2	41	2 1/2	57
WX 338	H	2 1/2	64	3	76
WX 342	H	3	76	3 1/2	89
WX 344	H	3 1/2	89	4 1/2	114
WX 346	H	4 1/2	114	5	127

Waveguide No. 15

Type No.	Plane	Bend Radius (r)		Effective Radius (R)	
		in.	mm	in.	mm
WX 1327	E	2	51	2 1/2	64
WX 1329	E	2 1/2	56	3	76
WX 1331	E	3 1/2	81	4	102
WX 1339	H	2	51	2 1/2	70

45° Bends E-Plane H-Plane



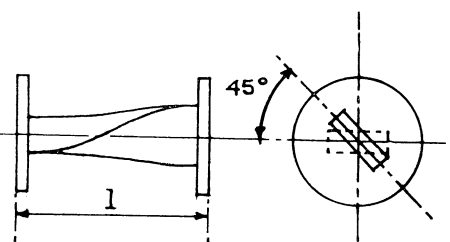
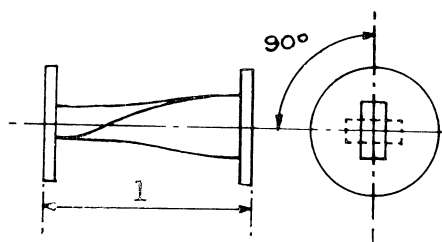
Waveguide No. 16

Type No.	Plane	Bend Radius (r)		Effective Radius (R)	
		in.	mm	in.	mm
WX 352	E	1 1/2	32	2	51
WX 358	E	2 1/2	57	3	76
WX 360	E	3 1/2	83	4	102
WX 362	E	4 1/2	117	5	127
WX 366	H	1 1/2	44	2 1/2	64
WX 368	H	2 1/2	64	3 1/2	89
WX 374	H	3 1/2	89	4 1/2	114
WX 376	H	4 1/2	114	5 1/2	140

Waveguide No. 15

Type No.	Plane	Bend Radius (r)		Effective Radius (R)	
		in.	mm	in.	mm
WX 1359	E	2	51	3	76
WX 1361	E	3 1/2	81	4 1/2	108
WX 1369	H	2	51	3 1/2	83

Twists



Waveguide No. 16

Type No.	Twist	Length (l)	
		in.	mm
WX 380	45° Anticlockwise	3 1/2	89
WX 388	45° Clockwise	3 1/2	89
WX 382	90° Anticlockwise	3 1/2	89

Waveguide No. 15

Type No.	Twist	Length (l)	
		in.	mm
WX 1381	45° Anticlockwise	4	102
WX 1389	45° Clockwise	4	102
WX 1383	90° Anticlockwise	3 1/2	89

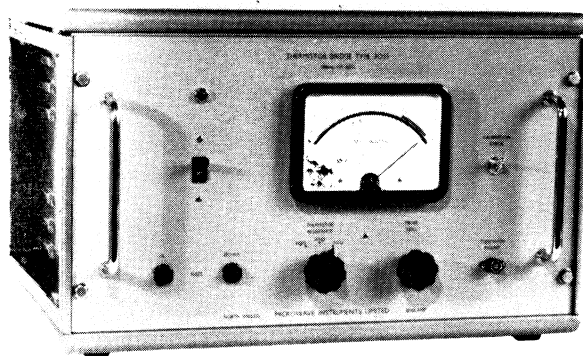
Thermistor Bridge
Type WE 55
(3055)

The Thermistor Bridge is used in conjunction with the bead thermistor in our Thermistor Mounts as an absolute means of measuring incident power along the particular waveguide to an absolute accuracy of 5%.

The Bridge circuit consists of a self-balancing audio-frequency oscillator arranged to maintain the thermistor at a constant resistance of 200, 250 or 300 ohms as selected by the front panel control, so that the match of the thermistor mount does not vary with power input. After setting the meter zero in the absence of R.F. power the meter gives a direct indication of the R.F. power applied to the thermistor in the single range of 0 — 2.5 mW.

In the case of the S-Band Thermistor Mount Type WS 922 (100/1200) two bead thermistors are employed and the Thermistor Bridge WE 55 should be specifically ordered for use with this mount only.

The instrument operates on 50 c/s mains supplies from 190 to 270 volts without adjustment, and is fully stabilised. The front panel is a standard G.P.O. size suitable for rack mounting if required and the unit is supplied complete in cabinet.



Specification

FOR THERMISTOR TYPE:	S.T.C. E23
THERMISTOR OPERATING RESISTANCE:	200, 250, 300 ohms
METER SENSITIVITY:	0-2.5 mW (First division 0.1 mW)
ACCURACY (OVERALL):	5% approx.
MAINS SUPPLY:	190-270 volts, 50 c/s only
WEIGHT:	58 lb (26.3 kg) in cabinet
OVERALL DIMENSIONS:	19½ in. × 12½ in. × 15½ in. (50 × 32 × 40 cm)
FINISH:	Front panel—Light grey BS.631 stove enamel Cabinet—Dark grey poly-chromatic stove enamel

Klystron Power Unit

Type WE 38

(380)

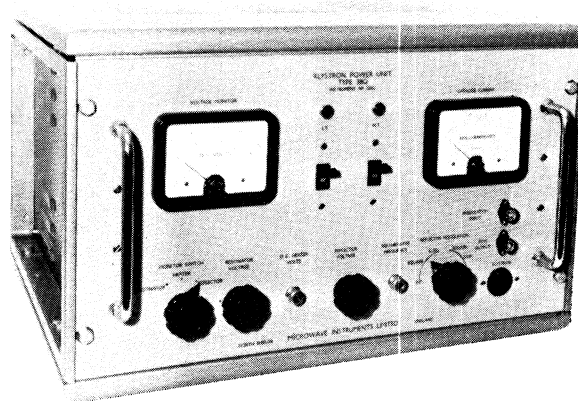
This is the top-quality power unit designed to obtain the best possible performance from low-voltage klystrons.

In addition to a fully-stabilised D.C. heater supply it contains first-grade resonator and reflector stabilisers with all three outputs adjustable and metered on the front panel. L.T. and H.T. are separately switched, while the multiturn reflector control gives particular ease of setting.

An internal modulator provides a precise audio-frequency square wave of adjustable amplitude for reflector modulation which is employed for high-sensitivity detection in conjunction with the TA3 Transistor Amplifier. Alternatively external modulation can be applied from the appropriate associated equipment either to switch the klystron or sweep frequency.

The instrument is built on a standard G.P.O. 19 in. (48 cm) rack mounting panel and supplied complete with cabinet.

Each Type WE 38 Klystron Power Unit is thoroughly tested to be within the following specification, which allows an ample margin beyond the typical operation. All potentiometers are wirewound and only paper capacitors are used above 160 volts.



Specification

(voltages relative to Klystron cathode)

Resonator

VOLTAGE RANGE: + 250 volts to + 350 volts
(positive earthed)
MAXIMUM CURRENT: 50 mA
STABILITY FACTOR: 250:1
D.C. OUTPUT IMPEDANCE: 5 ohms maximum
RIPPLE: 5 mV peak-peak

Reflector

VOLTAGE RANGE: 25 volts to + 275 volts
STABILITY FACTOR: 800:1
OUTPUT IMPEDANCE: 10 K to 110 K at D.C.
(25 ohms at 3.2 kc/s)
RIPPLE: 2 mV peak-peak

Heater

VOLTAGE RANGE: + 5.5 volts to + 6.5 volts
D.C.
MAXIMUM CURRENT: 0.75 amp
STABILITY FACTOR: 50:1
OUTPUT IMPEDANCE: 0.75 ohms
RIPPLE: 50 mV peak-peak at 6.3 V.
0.75 A.

Reflector Modulation

- (1) INTERNAL SQUARE WAVE
 - AMPLITUDE: 0 - 25 volts peak-peak
 - FREQUENCY: 2.5 kc/s to 4.0 kc/s
 - RISE TIME: 2 microseconds
 - DECAY OF TOP: 0.2 mV
- (2) C.W.
- (3) EXTERNAL SQUARE PULSE
- (4) EXTERNAL SAWTOOTH

Supply

VOLTAGE: 0 - 200, 220, 240 volts $\pm 8\%$
FREQUENCY: 45/60 c/s

Weight

77 lb (35 kg) in cabinet

Overall dimensions

19 $\frac{3}{4}$ in. \times 12 $\frac{1}{2}$ in. \times 15 $\frac{3}{4}$ in. (50 \times 32 \times 40 cm)

Finish

FRONT PANEL: Light grey BS.631 stove enamel
CABINET: Dark grey polychromatic stove enamel

Microwave Instruments Ltd, North Shields.

Sales Office: 98 St Pancras Way, London NW1

MICROWAVE COMPONENTS



MICROWAVE INSTRUMENTS LTD

A MEMBER OF THE HILGER & WATT'S GROUP

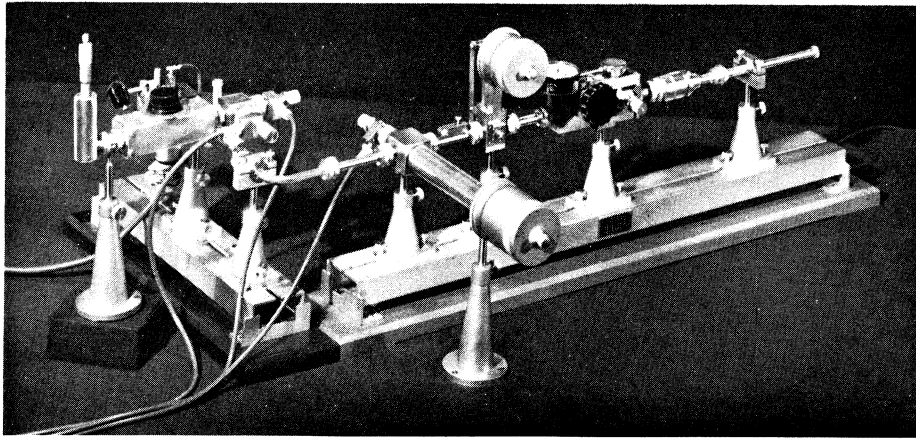
SALES OFFICE: 98 ST PANCRAS WAY, CAMDEN ROAD,
LONDON, NW1

Telephone: GULLiver 5636. Telex: 23852

Telegrams & cables: Sphericity, London, Telex

Index for Section Q

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Q 1	Introduction.
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Q 4	Waveguide and flanges. Connections to U.S. components.
Q 5	Coupling rings, waveguide bends and twists, flexible waveguide.
Q 6	Switches and ferrite components.
Q 7	Tees and junctions. Directional couplers.
Q 8	Attenuators.
Q 9	Micrometer plunger unit. Phase shifters.
Q 10	Wavemeters and reference cavities.
Q 11	Matching units.
Q 12	Crystal holders and balanced mixers.
Q 13	Standing-wave indicator. Horn radiators.
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Q 15	Klystrons.
Q 16	High-voltage klystron power unit.



MICROWAVE COMPONENTS

for the 8-10mm waveband (Q band)

The waveguide aperture of all Microwave components for the 8-10 mm waveband conforms to the WG 22 size of the British Radio Components Standardization Committee, the size recommended in the United Kingdom and the United States as a standard for wavelengths from 7.5 to 11.3 mm (frequencies from 26.5 to 40.0 Gc/s). The design frequency of all components in this band is at the band centre of 35 Gc/s unless otherwise specified. They are fitted with U.K. standard plain flanges (J.S.C. No. 5985-99-083-1553 or 5985-99-083-0018) suitable for use with the pressurized screwed-ring connector. All components are silver plated and, for durable protection against corrosion, flashed with rhodium.

Supports, lengths of waveguide, and flanges can be supplied separately so that customers can assemble their own components. The lengths of waveguide are of two types :

- (i) DRAWN—consisting of drawn rectangular tube.
- (ii) PRECISION—consisting of electroformed tube with a cylindrical exterior. This type is the more accurately made and should be used when making precision components.

Note : Components other than those described in this catalogue can be made to order for the same or for neighbouring wavebands.

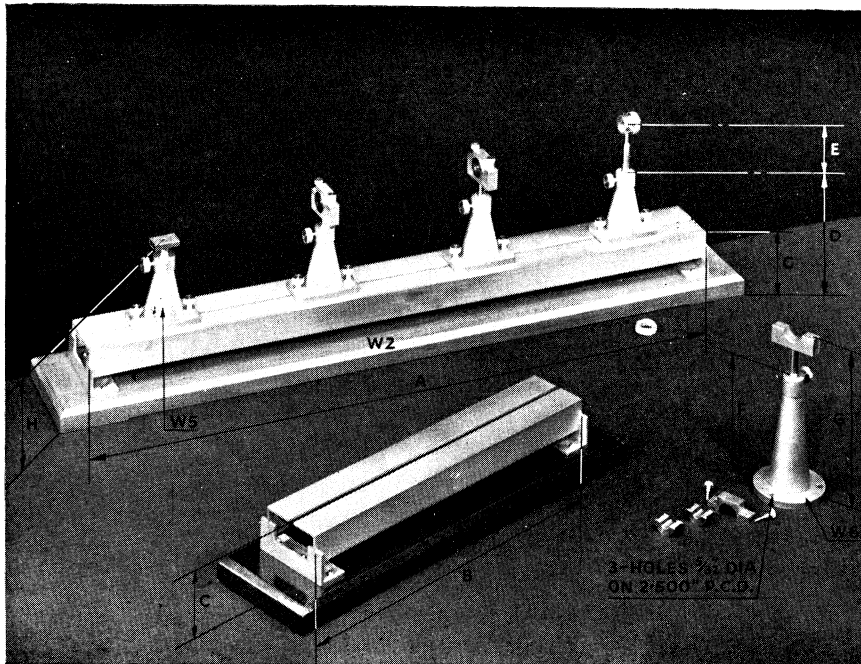
Why the Q band?

Because this band is of growing importance for purposes such as the following:

1. High-discrimination radar, e.g. airfield-control radar.
2. Wide-band communication, e.g. multichannel waveguide 'piped' systems.
3. Microwave spectroscopy, absorption or paramagnetic.
4. Apparatus for direct instruction in microwave techniques, for demonstrations of x-ray diffraction using analogue crystal models, etc.
5. Interferometry.
6. Scale-model aerial measurements.
7. Plasma diagnosis.
8. Dielectric measurements.
9. Maser amplifier circuits.

Waveguide dimensions

	DRAWN (WG 22)	PRECISION (WG 22P)
Nominal internal size	0.280 × 0.140 in. (7.11 × 3.56 mm)	0.2800 × 0.1400 in. (7.112 × 3.556 mm)
Tolerance on internal size	± 0.001 in. (0.025 mm) on each dimension	0.0002 in. (0.005 mm) on each dimension
Nominal wall thickness	0.040 in. (1.0 mm)	—
Outside diameter	—	0.4375 in. (11.1 mm)
Tolerance on external size	± 0.001 in. (0.025 mm) on each dimension	± 0.001 in. (0.025 mm)



Top: four pillar bases (WE 5) mounted on waveguide bench WE 2 and carrying, left to right, pillar supports WQ 16, WQ 14, WQ 15, WQ 17.

Below: waveguide bench WE 1 and pedestal WE 6.

A 30.0 in. (762 mm)
 B 15.0 in. (381 mm)
 C 2.875 in. (73.0 mm)
 D 5.875 in. (149.0 mm)
 E 3.833 in. (97.4 mm) max.
 1.250 in. (31.7 mm) min.
 F 5.00 in. (127.0 mm)
 G 7.75 in. (196.8 mm) max.
 5.75 in. (146 mm) min.
 H 8.125 in. (206.3 mm) max.
 6.125 in. (155.6 mm) min.
 Net weight WQ 14—7½ oz (212 g)
 WQ 15—7 oz (198 g)
 WQ 16—2 oz (56 g)
 WQ 17—3½ oz (99 g)

Bench-stand for mounting components and instruments

Waveguide components can be mounted in the following ways:

(a) ON WAVEGUIDE BENCHES: The benches are made so that two lengths of brass angle-section provide two parallel flat-topped rails with a narrow slot between them. This slot locates the bases of the pillar supports for the waveguides. A triangular-section bench similar to the X-band type is also available. All pillar supports are interchangeable with pillar bases on both R.R.E. type and triangular bar benches. The pillar supports are adjustable in height in the pillar bases, and can be grouped as three functional types:

- (i) Pillar supports to which waveguide can be clamped.
- (ii) Pillar supports to which certain specific components can be screwed.

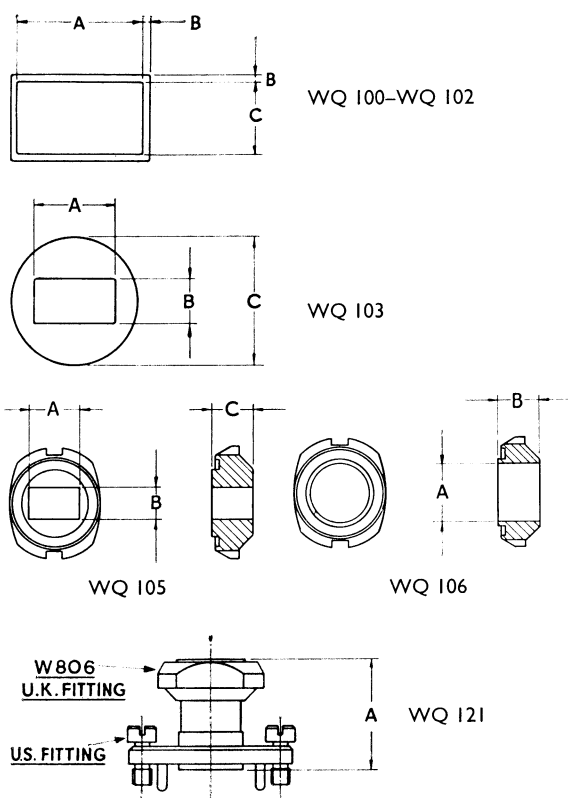
(iii) Pillar supports carrying, as an integral part, a three-quarter wavelength section of waveguide which can be fixed so that its broad face is either horizontal or vertical. The guide terminates in chokejoint faces and is fitted with a screwed ring and pair of nuts, so that two components can be supported each at one end.

(b) ON INDEPENDENT PEDESTALS: The pedestals can be screwed to a wooden baseboard or a table and will support any of the three types of pillar support described in the previous paragraph.

When choosing between these methods it should be remembered that the waveguides must not be mounted too rigidly, or the components may be distorted when the connecting rings are tightened.

All pillar supports fit WE 5 and WE 6.

Cat. No.	Old No.	DESCRIPTION
WE 1	W 1	R.R.E. waveguide bench, 15 inches (38 cm) long.
WE 2	W 2	R.R.E. waveguide bench, 30 inches (76 cm) long.
WE 5	W 5	Pillar base to fit R.R.E. waveguide bench.
WE 6	W 6	Independent pedestal, with screw holes for fixing to a baseboard.
WE 18	—	Pedestal, circular-based, free-standing support.
WQ 14	W 814	Pillar support for drawn waveguide. Will support the guide with its broad face at any angle.
WQ 15	W 815	Pillar support for precision waveguide.
WQ 16	W 816	Pillar support suitable for screwing to the following components: Phase shifter WQ 676 (page 9). Attenuator WQ 608 (page 8). Standing-wave indicator WQ 802 (page 13). The above three components are fitted with standard fixing-holes for mounting.
WQ 17	W 817	Waveguide pillar-support, ready fitted with a ¾-wavelength section of waveguide.
WQ 20	—	Waveguide bench, 15 inches (38 cm) long, complete with 3 supports for Q band guide.
WQ 21	—	Waveguide bench, 30 inches (76 cm) long, complete with 5 supports for Q band guide.



Waveguide and flanges for customers' use

Terminal flanges and lengths of WG 22 and WG 22 P waveguide can be supplied to customers wishing to make up connectors and components. Because of its greater accuracy it is generally wiser to use the precision type of guide in constructing components; but its large wall thickness and short length may make it unsuitable for some purposes. On the other hand drawn waveguide is preferable for long runs. Flanges are of U.K. standard (J.S.C. No. 5985-99-083-1553 or -0018).

Note : Drawn Waveguide must be ordered in lengths that are multiples of 6 inches (152 mm) up to a maximum of 60 in. (152 cm). Precision waveguide is supplied in lengths up to 9 in. (229 mm). All waveguide is supplied without flanges unless otherwise specified. [Lengths of 36 in. (91 cm) or less can be dispatched by post.]

Connections to U.S. components

Adaptors can be supplied to join U.K. components to those of U.S. manufacture. Alternatively, flanges of U.S. pattern can be supplied. These are normally made to suit A.N. type connector UG 381/U and have the same number as the corresponding English flange but with the prefix 1. The same system applies to components, e.g. standing wave indicator WQ 802 has English flanges and WQ 1802 has American flanges UG 381/U. For square American flanges, UG 599/U, the normal American number should be used but with an increase in the last digit of 1. Thus WQ 1803 is a standing-wave indicator with American flanges UG 599/U.

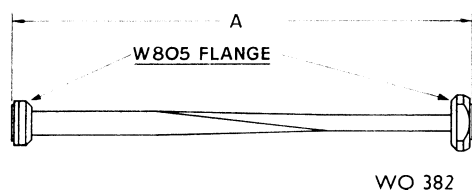
Cat. No.	Old No.	Description	A	B	C	Net weight
WQ 100	W 800	Drawn waveguide, solid silver	0.280 in. 7.11 mm	0.04 in. 1.00 mm	0.140 in. 3.56 mm	2½ oz (80 g) per 12 in. (305 mm)
WQ 101	W 801	Drawn waveguide, silver-lined copper	0.280 in. 7.11 mm	0.04 in. 1.00 mm	0.140 in. 3.56 mm	2½ oz (80 g) per 12 in. (305 mm)
WQ 102	W 802	Drawn waveguide, solid copper	0.280 in. 7.11 mm	0.04 in. 1.00 mm	0.140 in. 3.56 mm	2½ oz (80 g) per 12 in. (305 mm)
WQ 103	W 803	Precision waveguide	0.280 in. 7.11 mm	0.140 in. 3.56 mm	0.4375 in. 11.1 mm	3½ oz (92 g) per 5 in. (127 mm)
WQ 1100	W 1800	Cylindrical drawn waveguide, solid copper	Internal dia. 0.275 in. (6.99 mm) : 0.001 in. (0.025 mm) Wall thickness 0.032 in. (0.81 mm) : 0.001 in. (0.025 mm)			
WQ 1101	W 1801	Cylindrical drawn waveguide, solid copper	Internal dia. 0.250 in. (6.35 mm) : 0.001 in. (0.025 mm) Wall thickness 0.020 in. (0.51 mm) : 0.001 in. (0.025 mm)			
WQ 1102	W 1802	Cylindrical drawn waveguide, solid copper	Internal dia. 0.328 in. (8.33 mm) : 0.001 in. (0.025 mm) Wall thickness 0.030 in. (0.76 mm) : 0.001 in. (0.025 mm)			
WQ 1103	W 1807	Cylindrical precision waveguide, silver-lined copper	Internal dia. 0.328 in. (8.33 mm) : 0.0032 in. (0.005 mm) External dia. 0.4375 in. (11.1 mm)			
WQ 1104	W 1805	Cylindrical precision waveguide, silver-lined copper	Internal dia. 0.250 in. (6.35 mm) : 0.0032 in. (0.005 mm) External dia. 0.4375 in. (11.1 mm)			
WQ 105	W 805	Flanges for drawn waveguide, brass unfinished	0.362 in. 9.12 mm	0.222 in. 5.6 mm	0.280 in. 7.1 mm	¼ oz (7 g)
WQ 106	W 806	Flanges for precision waveguide, brass unfinished	0.4219 in. 10.72 mm	0.280 in. 7.11 mm	—	¼ oz (7 g)
WQ 121	W 821	Adaptor, U.S. (type UG 381/U) to U.K.	0.750 in. 19.1 mm	—	—	1¼ oz (35 g)
WQ 122	W 822	Adaptor, U.S. (type UG 599/U) to U.K.	—	—	—	—
WQ 1105	W 5805	U.S. flange for drawn waveguide (type UG 381/U)	—	—	—	—
WQ 1106	W 5806	U.S. flange for precision waveguide (type UG 381/U)	—	—	—	—
WQ 1107	W 5810	U.S. flange (type UG 599/U) rectangular hole	—	—	—	—

Coupling rings

A coupling ring and a pair of nuts are needed to join two components. Two gaskets per junction are required to obtain a pressurized joint. A spanner for tightening coupling-ring nuts is available.

Waveguide bends and twists

Ninety-degree twists, either continuous or of four-step binomial form, and E- and H-plane bends of various angles can be supplied. Solid-silver drawn waveguide is used for WQ 382, WQ 320, WQ 334, WQ 350, and WQ 364. WQ 384 fits direct on to WQ 105 or WQ 106 without the need for WQ 107.



Flexible waveguide

'WAVEFLEX' flexible waveguide is available to R.R.E. specification 33480 in various lengths complete with flanges.

BENDING RADII

For continuous flexing	E plane 2.5 in. (63.5 mm)
	H plane 4.5 in. (114 mm)
For intermittent flexing	E plane 0.75 in. (19 mm)
	H plane 1.4 in. (35.5 mm)

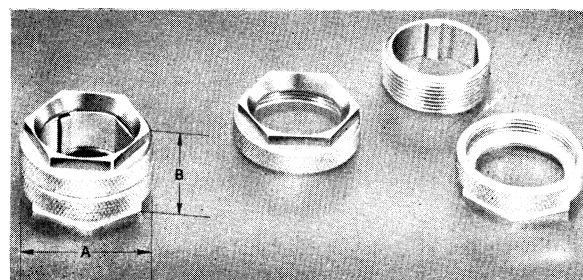
Twist is : 76 per foot (305 mm).

Maximum working pressure is 60 p.s.i. (4.2 kg/cm²)

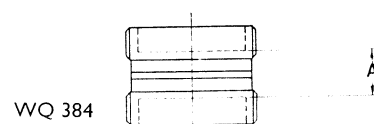
Temperature range -55° C to +125° C.

Maximum attenuation 0.6 db/ft.

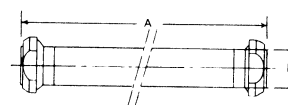
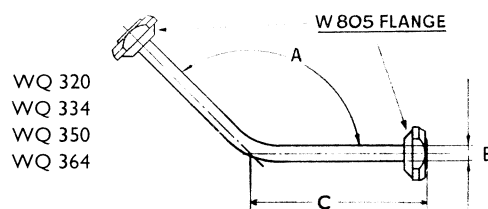
Minimum voltage-standing-wave ratio 0.95



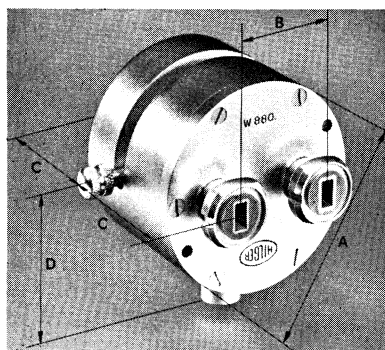
WO 107



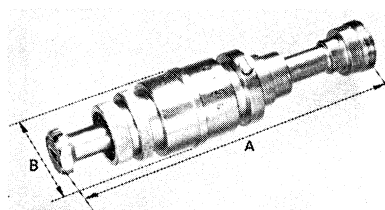
WQ 384



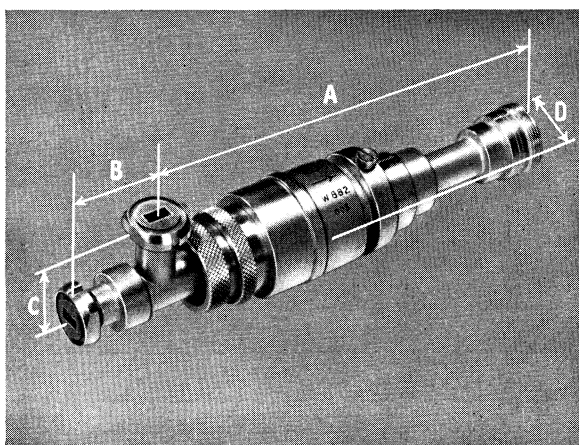
Cat. No.	Old No.	Description	A	B	C	Net weight
WQ 107	W 807	Coupling ring and pair of nuts	1 in. 25.4 mm	0.625 in.	—	1 oz (28 g)
WQ 108	W 808	Coupling gaskets (12)	—	—	—	—
WQ 109	W 809	Spanner for coupling nuts	—	—	—	—
WQ 382	W 830	Ninety-degree twist	6.25 in. 158.7 mm	—	—	2 oz (56 g)
WQ 384	W 829	Ninety-degree stepped twist (binomial)	0.318 in. 8.1 mm	—	—	1 oz (28 g)
WQ 386	W 824	Taper-section, 8—4 mm	—	—	—	—
WQ 320	W 831	E-plane bend, 90-degree	90	0.220 in. 5.6 mm	2.885 in. 73.3 mm	1 $\frac{3}{4}$ oz (49 g)
WQ 334	W 832	H-plane bend, 90-degree	90	0.360 in. 9.1 mm	2.885 in. 73.3 mm	1 $\frac{3}{4}$ oz (49 g)
WQ 350	W 833	E-plane bend, 135-degree	135	0.220 in. 5.6 mm	2.625 in. 66.7 mm	1 $\frac{3}{4}$ oz (49 g)
WQ 364	W 834	H-plane bend, 135-degree	135	0.360 in. 9.1 mm	2.625 in. 66.7 mm	1 $\frac{3}{4}$ oz (49 g)
WQ 123	W 835	Flexible waveguide	3.0 in. 76.2 mm	0.5 in. 12.7 mm	—	1.1 oz (30.8 g)
WQ 124	W 836	Flexible waveguide	6.0 in. 152.4 mm	1.0 in. 25.4 mm	—	1 $\frac{1}{2}$ oz (42 g)
WQ 125	W 840	Flexible waveguide	9.0 in. 228.6 mm	1.5 in. 38.1 mm	—	1.9 oz (53.5 g)



WQ 280



WQ 286



WQ 282

Switches and ferrite components

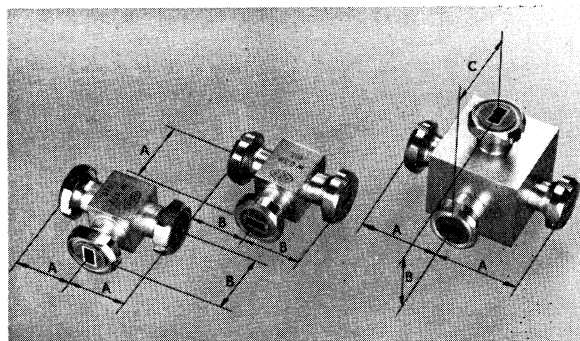
- (i) **WAVEGUIDE SWITCH**: This is a mechanically operated two-way semi-rotary switch. The rotor connects the input waveguide to either of the two output ports, the other being connected to a matched load in the rotor.
- (ii) **ISOLATOR**: This component makes use of the gyromagnetic properties of a ferrite to provide non-reciprocal transmission. The input and output guides have the standard rectangular aperture with similar planes of polarization, and a 45-degree twist is included in the instrument to correct for the rotation of the plane of polarization due to the ferrite pencil. When the propagation is in the reverse direction the rotations due to the ferrite and the twist are additive, and the total rotation is therefore 90 degrees. Thus the reverse power is not coupled to the input guide, but is absorbed by appropriately placed metallized glass vanes without sensible reduction of the input power.
- (iii) **THREE-PORT CIRCULATOR**: The three-port circulator is a low-power device, similar to the WQ 286 for forward transmission. Forward attenuation is less than 1 db and the input voltage-standing-wave ratio is better than 0.9. For reverse transmission the power is not absorbed but is coupled to a third port in the form of a side-arm near the input. The attenuation from the normal output to this third port is again less than 1 db and the voltage-standing-wave ratio is better than 0.9. The cross coupling from any input arm to an outlet other than those specified above is about 25 db below the input.

Cat. No.	Old No.	Description	Forward attenuation	Reverse attenuation	A	B	C	D	Net weight
WQ 280	W 880	Waveguide switch	—	—	Dia. 2.25 in. 57.1 mm	Centres 1.0625 in. 27.0 mm	1.5 in. 38.1 mm	1.5 in. 38.1 mm	28½ oz 800 g
WQ 286	W 881	Isolator, gyrator type	less than 1 dB	greater than 25 dB	5.78 in. 146.8 mm to flange face (not shown)	1.3 in. 33.0 mm	—	—	13½ oz 375 g
WQ 282	W 882	Three-port circulator	less than 1 dB	greater than 25 dB	5.104 in. 129.6 mm to flange face (not shown)	1.085 in. 27.5 mm	1.0 in. 25.4 mm	1.3 in. 33.0 mm dia.	15 oz 426 g

Tees and junctions

The following tees and junctions are available :

- (i) A simple series (or E-plane) junction.
- (ii) A simple shunt (or H-plane) junction.
- (iii) A broad-band hybrid tee (known as a 'magic tee') machined from the solid. This can be used in balanced-mixer units and frequency-stabilizing circuits, or as an impedance bridge. It gives a high degree of symmetry, and the discrimination between the series and shunt arms is better than 30 db. To provide a broad-band impedance match, the main and shunt arms are made half as deep as normal waveguide, the return to the full section being effected by quarter-wave transformers. Post and iris matching is used. More information is available on request.
- (iv) A hybrid ring, or 'rat race', which can be used instead of the hybrid tee. Its arms are all in one plane and are at angles of 0°, 60°, 120°, and 180° . The dimensions of the ring-shaped waveguide ensure that it gives a good impedance match. Because the discrimination between the arms depends upon electrical path-lengths in the ring the bandwidth of the hybrid ring is narrower than that of the hybrid tee.



WQ 300

WQ 304

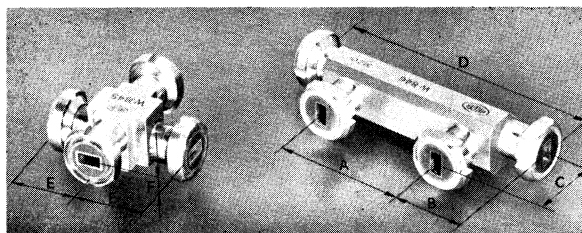
WQ 308

Cat. No.	Old No.	Description	A	B	C	Net weight
WQ 300	W 837	Series tee, unmatched	0.8125 in. 20.6 mm	0.875 in. 22.2 mm	—	2½ oz 78 g
WQ 304	W 838	Shunt tee, unmatched	0.945 in. 24.0 mm	0.8125 in. 20.6 mm	—	2½ oz 78 g
WQ 308	W 842	Hybrid tee, broad band (magic tee)	1.125 in. 28.6 mm	1.118 in. 28.4 mm	1.125 in. 28.6 mm	9½ oz 276 g
WQ 310	W 843	Hybrid ring (rat race)	—	—	—	—

Directional couplers

Two main types of directional couplers are available :

- (i) CROSS-OVER COUPLER : Made from precision waveguide, this provides a simple type of coupler for use where loose coupling is required and high directivity is not needed.
- (ii) MULTIPLE-HOLE COUPLERS : These couplers are for use when high directivity is required. The main and auxiliary arms are coupled through a number of holes of such sizes that directivity of about 25 db is obtained over a broad waveband. The range of couplers available is shown in the table below.



WQ 480

E 0.875 in. (22.2 mm)
F 0.220 in. (5.6 mm)
G 0.875 in. (22.2 mm)
Net weight 3½ oz (92 g)

WQ 400, WQ 436, WQ 438, WQ 440

A 1.625 in. (41.3 mm)
B 0.875 in. (22.2 mm)
C 0.900 in. (22.9 mm)
D 3.375 in. (85.7 mm)
Net weight 4½ oz (128 g)

Cat. No.	Old No.	Coupling value dB	Directivity dB	V.S.W.R. better than	Coupling method
WQ 480	W 845	40	10	—	2-hole cross-over
WQ 400	W 844	3	~ 25	0.95	multiple-slot
WQ 436	W 846	6	~ 25	0.95	multiple-hole
WQ 438	W 847	12	~ 25	0.95	multiple-hole
WQ 440	W 848	20	~ 25	0.95	multiple-hole

Attenuators

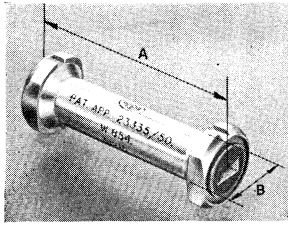
Three types of attenuator are available.

(i) **FIXED ATTENUATOR**: This consists of a short length of waveguide with a tapered insert of lossy material. It is useful in low-power applications as an attenuating pad.

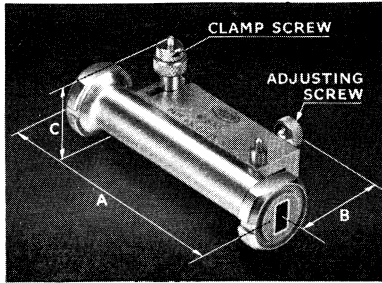
(ii) **SIMPLE VARIABLE ATTENUATOR**: The attenuating element is a small flap of carbon-coated paxolin, which can be moved by a knurled screw into or out of a slot in the waveguide, and subsequently clamped in any position.

(iii) **SIMPLE VARIABLE ATTENUATOR, calibrated**: A metallized glass vane is the attenuating element. It is moved across the guide by a single turn of a knob which is approximately calibrated in dB.

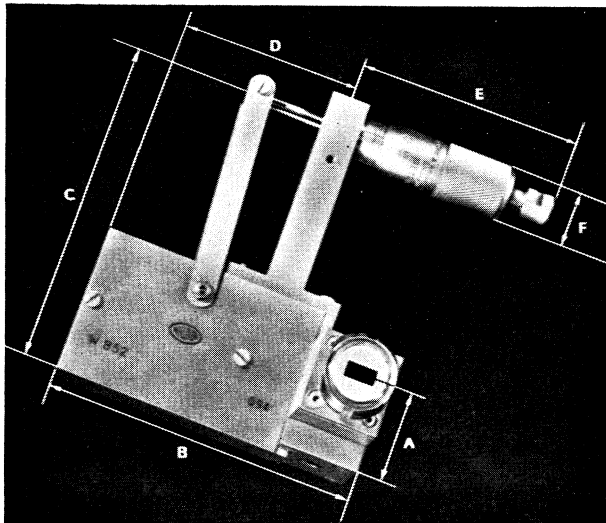
(iv) **PRECISION VARIABLE ATTENUATOR**: The lossy element, consisting of metallized glass for high stability, is enclosed within the guide and moved across by a micrometer. Accurately reproducible attenuation is provided over its whole range.



WQ 634
A 2.125 in. (54 mm)
B 0.4375 in. (11.1 mm)
Net weight 1½ oz (42 g)



WQ 604
A 2.625 in. (66.7 mm)
B 1.0625 in. (27.0 mm)
C 0.6875 in. (17.5 mm)
Net weight 2¾ oz (78 g)

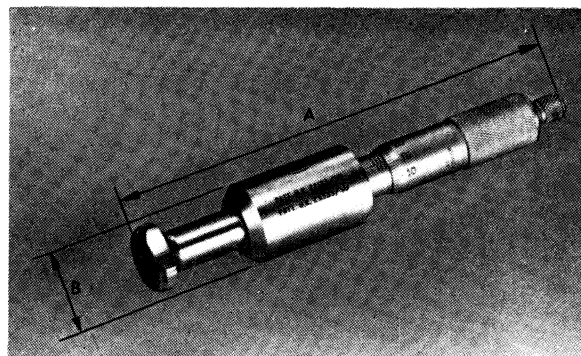


WQ 608
A 0.625 in. (15.9 mm)
B 2.895 in. (73.5 mm)
C 3.125 in. (79.4 mm)
D 1.687 in. (42.8 mm)
E 2.56 in. (65.0 mm) max.
F 0.540 in. (13.7 mm)
Flange to flange (not shown) 3.25 in. (82.6 mm)
Net weight 16 oz (454 g)

Cat. No.	Old No.	Description	V.S.W.R.	Maximum attenuation	Insertion loss
WQ 634	W 854	Fixed	0.95	—	7 dB
WQ 604	W 853	Simple variable	0.95 min.	25 dB	0.2 dB max.
WQ 602	W 867	Simple variable calibrated	0.95 min.	35 dB	0.2 dB max.
WQ 608	W 852	Precision	0.95 min.	30 dB	0.2 dB max.

Micrometer plunger unit (short circuit)

The micrometer plunger unit is an instrument for making accurate measurements of phase, etc. It consists of a length of precision waveguide in which a cylindrical choke-type plunger is moved by a standard micrometer to form, in effect, a short circuit, variable in position, over a range of 25 mm. Micrometers are graduated to 0.01 mm.



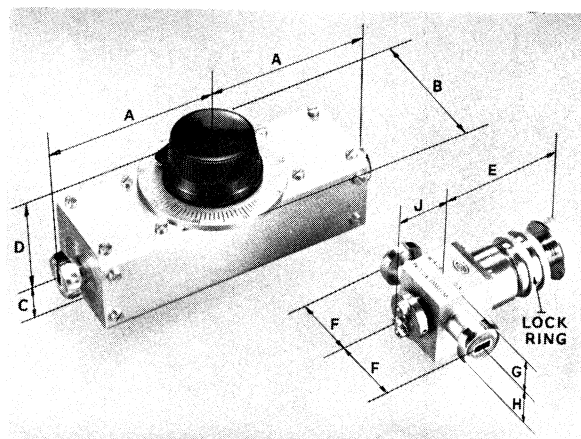
WQ 970

Cat. No.	Old No.	Input V.S.W.R.	A	B
WQ 970	W 857	0.005	6.00 in. max. 152.4 mm	0.875 in. 22.2 mm

Phase shifters

Phase shifters are made in two varieties :

- (i) SCREENED SQUEEZED-SECTION TYPE : The waveguide is suitably slotted and the required phase shift obtained by deforming its cross-section. The guide is screened by a metal case, and so is particularly suitable for use with sensitive receivers. A knob and an engraved dial are fitted to the drive spindle, which is brought out through a bush of lossy material.
- (ii) DIELECTRIC TYPE : The guide wavelength is decreased, and a phase shift thus introduced, by moving a strip of polystyrene (mounted with its length parallel to the axis) from the side to the middle of the waveguide. The movement is actuated by a knurled knob fitted with a locking ring.



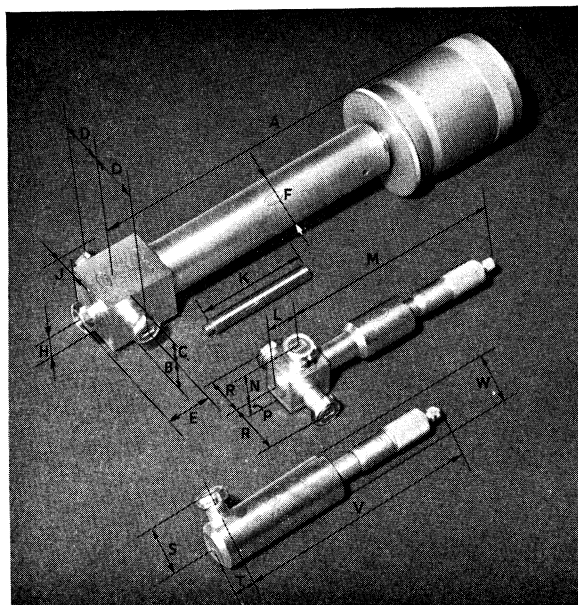
WQ 688 (left)

A 2.6165 in. (66.5 mm)
B 2.250 in. (57.1 mm)
C 0.653 in. (16.6 mm)
D 1.750 in. (44.4 mm)
Net weight 17½ oz (489 g)

WQ 676 (right)

E 2.3 in. (58.4 mm) max.
F 1.062 in. (27 mm)
G 0.563 in. (14.3 mm)
H 0.688 in. (17.5 mm)
J 0.9375 in. (23.8 mm) max.
Net weight 10½ oz (298 g)

Cat. No.	Old No.	Type	Max. phase shift	V.S.W.R.
WQ 676	W 849	Dielectric pattern	greater than 225	better than 0.93
WQ 688	W 851	Squeezed section	greater than 225	better than 0.93



WQ 708 (upper)

A 13.00 in. (330.2 mm)
 B 0.975 in. (24.8 mm) over support plate
 C 0.725 in. (18.4 mm)
 D 1.250 in. (31.7 mm)
 E 1.069 in. (27.2 mm)
 F 1.250 in. (31.7 mm)
 G 2.625 in. (66.7 mm)
 H 1.192 in. (30.3 mm) over support plate
 J 0.216 in. (5.5 mm) off centre
 K 2.625 in. (66.7 mm)
 Net weight 59½ oz (1009 g)

WQ 706 (lower)

S 1.00 in. (25.4 mm)
 T 0.500 in. (12.7 mm)
 V 5.875 in. (149.2 mm) max.
 W 1.000 in. (25.4 mm) dia.
 Net weight 11½ oz (326 g)

WQ 714 (centre)

L 0.600 in. (15.2 mm)
 M 6.25 in. (158.8 mm) max.
 N 0.930 in. (23.6 mm)
 P 0.603 in. (15.3 mm)
 R 1.0625 in. (27.0 mm)
 Net weight 13 oz (368 g)

Wavemeters and reference cavities

- (i) **STANDARD WAVEMETER**: This instrument, which has a cylindrical cavity resonating in H_{01n} modes of high order n , is used when high resolving power is needed and when small frequency changes are to be measured. The diameter of the cavity is 0.6830 in. (17.35 mm) giving the same cut-off frequency as for standard rectangular guide operating in the dominant mode and its length is such that losses in the end walls can be neglected. It suppresses unwanted modes by using a Bleaney-type feed and a non-contact plunger with absorbing material behind it. The E_{11} mode is separated by the spherical concavity of the plunger face. The plunger position is adjusted by a micrometer divided to 0.002 mm. The wavemeter is suitable for use as a reaction or as a transmission instrument. It needs a pedestal (WE 5 or WE 6) for its support. The instrument is capable of an accuracy of 1 part in 10,000.
- (ii) **REFERENCE CAVITY**: This cavity is used in frequency-stabilizing systems and consists of a cylindrical cavity 0.500 in. (12.7 mm) in diameter in an Invar body. A single-hole feed gives an approximate match to the resonant cavity, and modes other than H_{01} are largely suppressed by a non-contact plunger backed by lossy material. The plunger is actuated by a micrometer divided to 0.01 mm.
- (iii) **GENERAL-PURPOSE WAVEMETER**: This H_{01} -rectangular-mode avoids all spurious modes and resonances. It can be used as a reaction or as a transmission instrument, and is fitted with a choke-type plunger which is actuated by a micrometer divided to 0.01 mm.

Cat. No.	Old No.	Description	Q	Resonant mode	Accuracy	Resolution
WQ 708	W 871	Standard wavemeter	unloaded 30,000	H_{10} cylindrical	1 in 10^4	0.4 Mc/s per micrometer div.
WQ 714	W 868	General-purpose wavemeter	unloaded 4,000	H_{01} rectangular	—	—
WQ 706	W 866	Reference cavity	loaded 15,000	H_{01} cylindrical	—	—

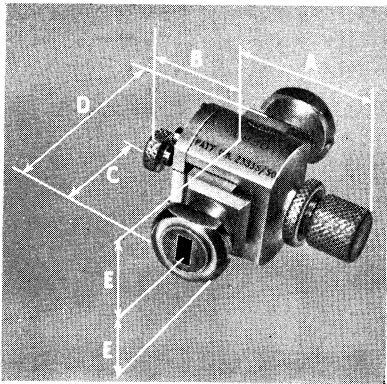
Matching units

Matching units are of three types :

- (i) SINGLE-PROBE : A matching unit of this type has a non-rotating metal probe adjustable in depth and position. It may be used to match any impedance having a voltage-standing-wave ratio better than 0·1. A concentric choke is used to avoid the troubles that might arise from contact between the probe and the waveguide.
- (ii) CALIBRATED MATCHING UNIT: This is a single-probe unit, similar to the WQ 820 but with the addition of scales for reading the depth of penetration and the longitudinal position of the probe. Probe depth is indicated on a micrometer scale divided to 0·1 mm, and probe position on an 0·1 mm vernier scale.
- (iii) E-H STUB TUNER : This is a hybrid tee with its E- and H-plane arms terminated by short-circuiting plungers actuated by standard micrometers graduated to 0·01 mm. The component can be used to introduce a reflection coefficient of any desired phase and amplitude.

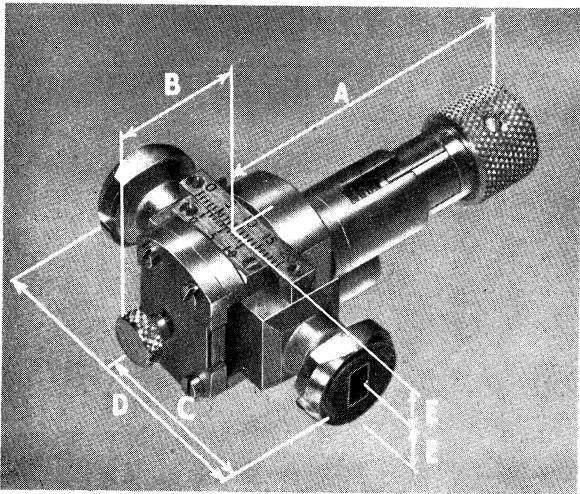
WQ 820

- A 1·3125 in. (33·3 mm) max.
- B 0·875 in. (22·2 mm) max.
- C 1·3125 in. (33·3 mm) max.
- D 0·9375 in. (23·8 mm) min.
- E 2·250 in. (57·1 mm)
- F 0·5625 in. (14·3 mm)
- Net weight 5½ oz (156 g)



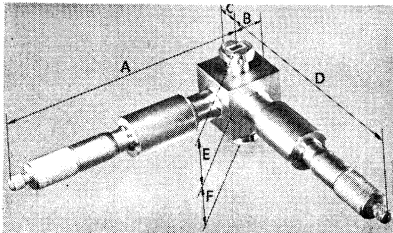
WQ 822

- A 2·375 in. (60·3 mm) max.
- B 0·875 in. (22·2 mm) max.
- C 1·3125 in. (33·3 mm) max.
- D 0·9375 in. (23·8 mm) min.
- E 2·250 in. (57·1 mm)
- F 0·5625 in. (14·3 mm)
- Net weight 7½ oz (212 g)

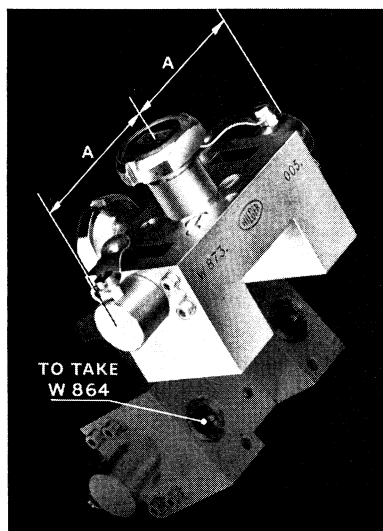
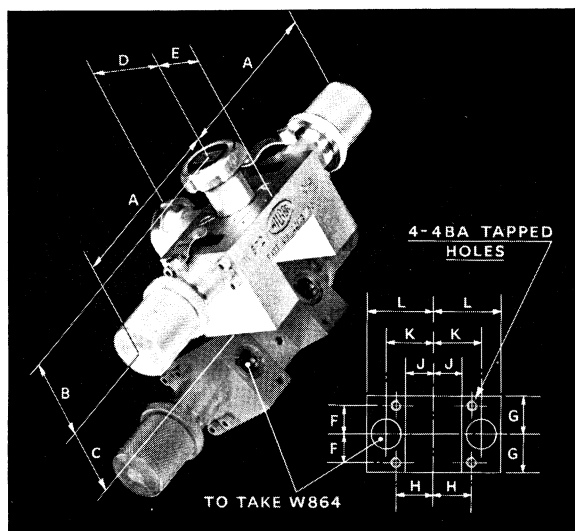


WQ 824

- A 6·0625 in. (154·0 mm) max.
- B 0·625 in. (15·9 mm)
- C 0·625 in. (15·9 mm)
- D 6·125 in. (155·6 mm) max.
- E 1·18 in. (30·0 mm)
- F 1·07 in. (27·2 mm)
- Net weight 2¾ oz (659 g)



Cat. No.	Old No.	Description
WQ 820	W 850	Single probe matching unit
WQ 822	W 859	Calibrated matching unit
WQ 824	W 858	E-H stub tuner



Note: WQ 952 and WQ 954 were photographed on a mirror

WQ 952 (top)

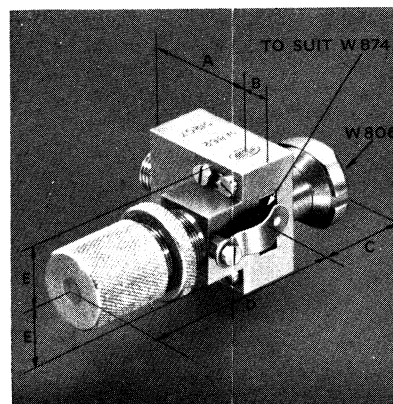
A 2.3125 in. (58.7 mm) max.
 B 0.870 in. (22.1 mm)
 C 0.780 in. (19.8 mm)
 D 1.125 in. (28.6 mm)
 E 0.500 in. (12.7 mm)
 F 0.375 in. (9.5 mm) centres
 G 0.500 in. (12.7 mm)
 H 0.507 in. (12.9 mm) centres
 J 0.382 in. (9.7 mm)
 K 0.632 in. (16.0 mm)
 L 0.882 in. (22.4 mm)
 Net weight 9½ oz (276 g)

WQ 954

A 1.257 in. (31.9 mm)
 Net weight 7¼ oz (206 g)
 Other dimensions as for WQ 952

WQ 948 (right)

A 0.977 in. (24.3 mm)
 B 0.250 in. (6.3 mm)
 C 0.750 in. (19.0 mm)
 D 1.880 in. (47.7 mm) max.
 E 0.50 in. (12.7 mm)
 Net weight 4 oz (113 g)



Crystal holders and balanced mixers

The following types are available.

- (i) **TUNABLE CRYSTAL HOLDER:** This is specially designed to take the waveguide type of crystal. It has a movable backing plunger so that it can be adjusted at each specific wavelength. Chokes are provided at the discontinuities where the waveguide crystal faces are inserted, and the D.C. or I.F. output is taken through a choke filter to a miniature cable plug.
- (ii) **FIXED-TUNING CRYSTAL HOLDER:** This is for use with wavemeters, or for monitoring power. It is not adjustable, the tuning being fixed to give a good wideband performance with an average crystal.
- (iii) **BALANCED MIXERS:** Each of these consists of a matched hybrid tee and two integral crystal holders. They are used, for example, as mixer units in super-heterodyne receivers when it is necessary to reduce local oscillator noise in order to obtain the best possible noise factor. They can be bolted to a standard 45-Mc/s I.F. chassis, with the outputs connected by leads to the input coil. The incorporated crystal-holders can be of either the tunable or the fixed-tuning type.

Output connectors are needed with all these instruments. The crystal holders need one each, and the balanced mixers (unless bolted to standard I.F. chassis) two each.

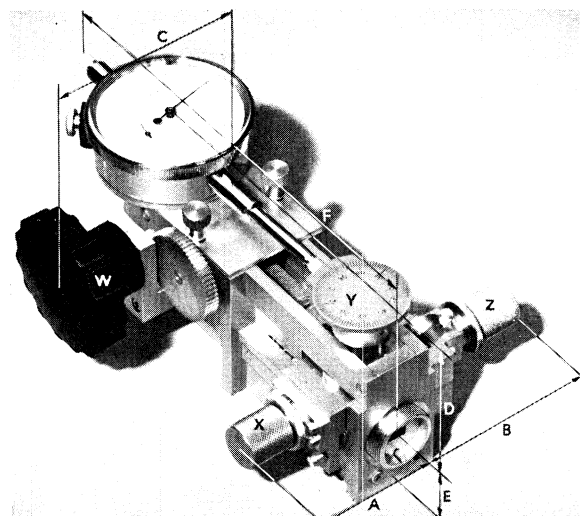
Cat. No.	Old No.	Description	Function
WQ 944	W 863	Crystal holder	Monitor detector, fixed tuning
WQ 948	W 862	Crystal holder	Monitor detector, tunable
WQ 952	W 872	Crystal mixer	Mixer, hybrid tee, tunable (type A)
WQ 954	W 873	Crystal mixer	Mixer, hybrid tee, fixed tuning (type B)
WE 74	W 874	Crystal G.E.C. pattern, type SIM 8	
WE 75	W 875	Crystal G.E.C. pattern, reverse polarity, type SIM 9	
WE 76	W 876	Crystal G.E.C. pattern, type GEM 8	
WE 77	W 877	Crystal G.E.C. pattern, reverse polarity, type GEM 9	
WE 64	W 864	Output connector	
WQ 956	W 865	Harmonic generator	
WQ 386	W 824	Taper section 8-4 mm	

Q 12

MICROWAVE INSTRUMENTS LTD.
 C 1962

Standing-wave indicator

This indicator incorporates a probe carriage located with respect to the optically worked surfaces of a fabricated slotted guide. The carriage supports a tongue which shields a probe 0.006 in. in diameter, a choke system being introduced on either side of the tongue. The probe penetration is adjustable up to 2.0 mm, and is indicated on a dial divided at intervals of 0.01 mm. The carriage has a tunable crystal holder and a backing plunger for matching the transition from probe to auxiliary waveguide. A slow-motion drive moves the carriage via a floating drive shaft; this ensures that no variable forces are applied to the constraints which determine the rectilinear motion of the carriage. The total travel is 23 mm, and the carriage position is indicated on a dial gauge reading to 0.01 mm. This instrument normally requires a pillar support WQ 16 and is fitted with fixing holes for mounting. With a matched load the instrument will measure voltage-standing-wave ratios accurately to within 1 per cent. The bandwidth of the indicator is 26.5 to 42 Gc s.



WQ 802

A 2.375 in. (60.3 mm) max.
B 2.75 in. (69.8 mm) max.
C 2.60 in. (66.0 mm)
D 2.4375 in. (61.9 mm)
E 0.930 in. (23.6 mm)
F 7.875 in. (200 mm) max.

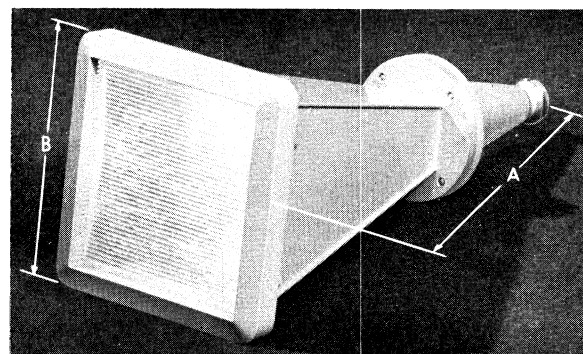
W Drive knob
X Transition backing plunger
Y Probe depth adjustment
Z Crystal-holder backing plunger
Length of main waveguide 5.50 in. (139.7 mm)
Net weight 59½ oz (1.7 kg)

Cat. No.	Old No.	Description	Accuracy of measuring
WQ 802	W 870	Standing-wave indicator	0.1%
WE 74	W 874	Crystal, G.E.C. type SIM 8	—
WE 64	W 864	Output connector with 36-in. (91 cm) coaxial cable	—

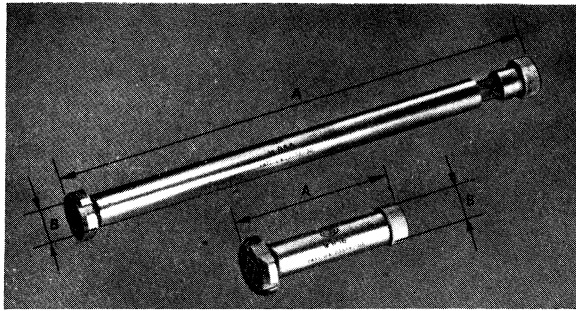
Horn radiators

The WQ 962 horn radiator has an electro-formed taper section feeding a square pyramidal horn, whose aperture is phase-corrected by an aspherical dielectric lens with its equi-phase surface bloomed to minimize reflection. The radiated beam is linearly polarized and has a width between half-power points of about 6 degrees in the electric plane and about 8 degrees in the magnetic plane.

The simple horn radiator (WQ 964) has a thin-walled electro-formed taper section similar to that used in the WQ 962.



Cat. No.	Old No.	Description	V.S.W.R.	Wavelength	Gain dB	A	B	Net weight
WQ 962	W 885	Phase-corrected	better than 0.85	8-10 mm	about 27.5	9.250 in. 234.95 mm	3.750 in. 92.25 mm	37 oz 1050 g
WQ 964	W 886	Simple	about 0.94	8.6 mm	about 19	3.00 in. 76.2 mm	0.875 in. 22.2 mm	1½ oz 42 g



WQ 900 (upper)

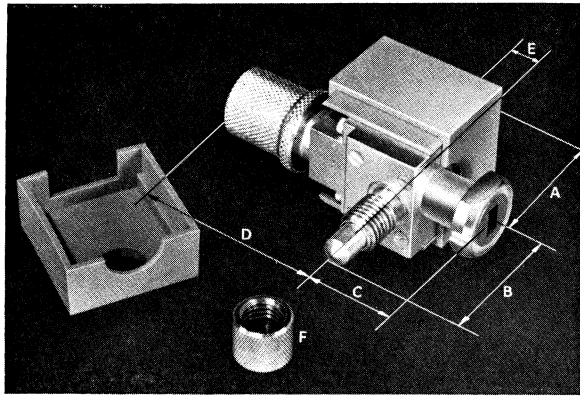
WQ 908 (lower)

Terminations

Terminations are made in two varieties.

- (i) **MATCHED TERMINATION** : This is used in low-power applications as a matched load. It consists of a length of waveguide that has a tapered insert of lossy material, which is variable in position.
- (ii) **SHORT TERMINATION** : This is a short dummy load used in conjunction with directional couplers, hybrid tees, rings, etc., to absorb power. It contains a fixed metallized glass vane.

Cat. No.	Old No.	Description	Wavelength	V.S.W.R.	Reflection coefficient	A	B	Net weight
WQ 900	W 855	Matched	8.6 mm 8-10 mm	—	0.001 0.005	6.562 in. min. 166.7 mm	0.4375 in. 11.1 mm	4½ oz 120 g
WQ 908	W 856	Short matched	—	~0.96	—	2.0625 in. 52.4 mm	0.4375 in. 11.1 mm	1½ oz 43 g



WQ 922

A 1.375 in. (34.9 mm) to output plug
B 1.033 in. (26.2 mm) max. over adjusting-screw F.

C 0.8125 in. (20.6 mm)
D 2.1875 in. (55.6 mm) max.
E 0.340 in. (8.6 mm)
Net weight 7 oz (198 g)

Thermistor

A thermistor consists of a small bead of metallic oxides with a large negative temperature coefficient of resistance. It is supplied in a waveguide mount which uses a miniature cable plug for the D.C. connections. It is used to measure low powers in the range from 10 microwatts to 10 milliwatts, and can be placed in an ordinary balanced or unbalanced bridge circuit. Usually the thermistor is operated under conditions in which its resistance is between 100 and 400 ohms, corresponding to a current of about 6 milliamps in the absence of microwave power. The unit has an insulating case shielding it from draughts, which would affect its temperature and upset its accuracy. It is matched at different wavelengths by means of a backing plunger and non-contact probe—both of which are adjustable. For absolute measurements a correction factor has to be applied, and the absolute accuracy is then within 0.5 dB. The instrument needs an output connector.

Cat. No.	Old No.	Description	Power	Operating resistance	Absolute accuracy after correction
WQ 922	W 860	Thermistor in mount	10 μ -watts to 10 m-watts	100 to 400 ohms	0.5 dB
WQ 926	W 861	Replacement of thermistor and calibration	—	—	—
WE 64	W 864	Output connector with 36-in. (91 cm) coaxial cable			

Klystrons

The E.M.I. range of Q-band reflex klystrons works at a resonator voltage of 2000 and a current of 8–15 milliamps. They give at least 15 milliwatts power output (30 milliwatts in the case of WQ 190) over their mechanical tuning ranges, which extend in all from 7.0 to 12.5 mm free-space wavelength. A typical power output is 60 milliwatts. The heaters require about 0.8 amp at 6.3 volts.

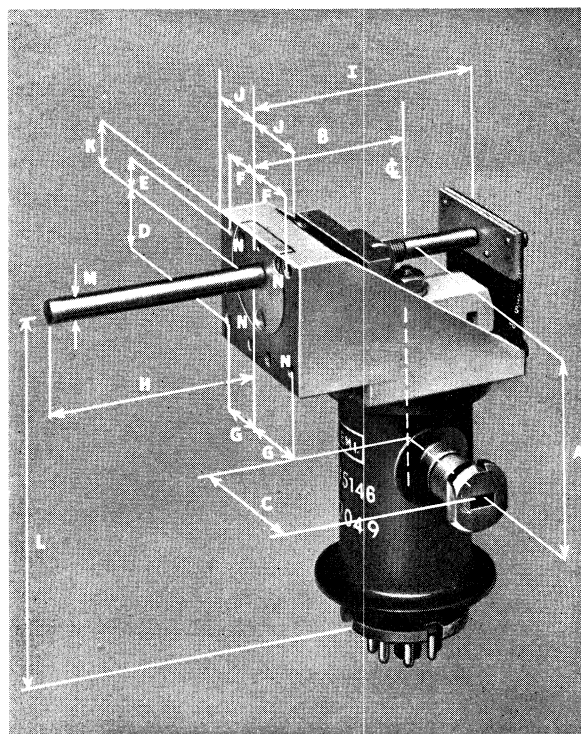
Reflector voltages range from 100 to 500 volts negative with respect to the cathode, and an average change of 30 volts covers the typical electronic tuning range of 60 Mc/s between half-power points.

All types are similar externally and are fitted with flange WQ 106 (J.S.C. No. 5985-99-083-1553). The temperature of the klystron envelope should not be allowed to exceed 150 °C and a cooling fan is recommended.

These klystrons may all be used with the klystron power supply WE 80.

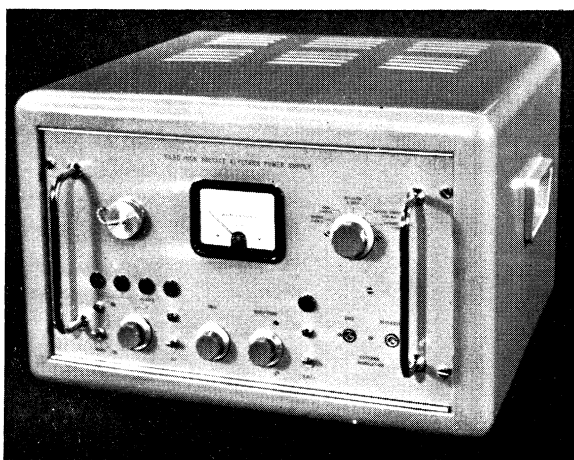
WQ 190–WQ 195

A	2.105 in. (53.35 mm)
B	1.625 in. (41.3 mm)
C	1.563 in. (39.7 mm) ± 0.02 in. (0.508 mm)
D	0.750 in. (19.1 mm)
E	0.275 in. (7 mm)
F	0.625 in. (15.9 mm) ± 0.01 in. (0.254 mm)
G	0.6875 in. (17.5 mm)
H	2½ in. (63.5 mm) max. 2 in. (50.8 mm) min.
I	2½ in. (71.4 mm) overall
J	5/8 in. (22.6 mm) max.
K	1/8 in. (11.1 mm) max.
L	4¼ in. (108 mm) max.
M	0.250 in. (6.4 mm) dia.
N	4 B.A.Thd.
Net weight 0½ oz (580 g)	



Cat. No.	Old No.	Klystron	Bandwidth mm
WQ 190	W 890	R 5146	8.43– 8.77
WQ 191	W 891	R 9555	7.0 – 8.0
WQ 192	W 892	R 9521	7.5 – 9.5
WQ 193	W 893	R 9546	8.0 – 9.3
WQ 194	W 894	R 9518	9.3 –10.8
WQ 195	W 895	R 9547	10.8 –12.5

Note : Hilger waveguide components are made in co-operation with the Royal Radar Establishment, Malvern, and by permission of the Ministry of Aviation. Some of the components are covered by patents owned by H.M. Government. The following patents have been applied for: British patents 689197, 683246, 691128, etc. and foreign patents.



Overall size: 22 $\frac{1}{4}$ in. wide \times 20 $\frac{1}{4}$ in. deep \times 14 in. high
(565 \times 514 \times 355 mm).

Weight with case approximately 100 lb (45 kg).

WE 80 (FA 80) HIGH-VOLTAGE KLYSTRON POWER-UNIT.

High-voltage klystron power unit

The klystron power-unit is designed to feed E.M.I. high-voltage reflex klystrons, including WQ 190 to WQ 195 listed on Q15. The unit operates from 50-cycle A.C. mains, 200–250 volts. The grid and reflector voltages are derived from an independent highly stabilized supply, and are applied to the valve before the cathode voltage is switched on. The D.C. heater supply is derived from a constant-voltage transformer, and is well smoothed. Heater voltage, cathode current, and all electrode voltages are monitored by a single 3 $\frac{1}{2}$ in. scale meter. There is provision for external modulation of the grid and reflector. If no external modulation is used, short circuit coaxial plugs will reduce ripple on the grid and reflector by approximately 50 per cent. The 19-in. front panel is suitable for standard rack mounting, and the unit is fitted in a case for normal bench use.

RESONATOR

Cathode voltage range: 1.85 to 2.25 kilovolts negative with respect to resonator (preset adjustment).

Cathode current rating: 15 milliamps maximum.

Voltage stabilization: About 100 millivolts change for mains variation of ± 5 , ± 10 per cent.

Ripple voltage: 8 millivolts peak to peak.

Output impedance: Less than 100 ohms at 2kV, 15 mA.

REFLECTOR SUPPLY

Voltage range: 100 to 500 volts negative with respect to cathode (front panel adjustment).

Stabilization: About 10 millivolts maximum change for mains variation of ± 5 , ± 10 per cent.

Output impedance: Not greater than 75 kilohms.

Ripple voltage: 12 millivolts peak to peak.

HEATER SUPPLY

Rating: 6.3 volts D.C. at 1 amp (front panel voltage adjustment).

Voltage stabilization: ± 1 per cent mains voltage variation 200–250.

Ripple voltage: Approximately 150 millivolts peak to peak.

GRID SUPPLY

Voltage range: 0 to 200 volts negative with respect to cathode (front panel adjustment).

Stabilization: About 5 millivolts maximum change for mains variation of ± 5 , ± 10 per cent.

Output impedance: Not greater than 150 kilohms.

Ripple voltage: 6 millivolts peak to peak.

Q 16

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