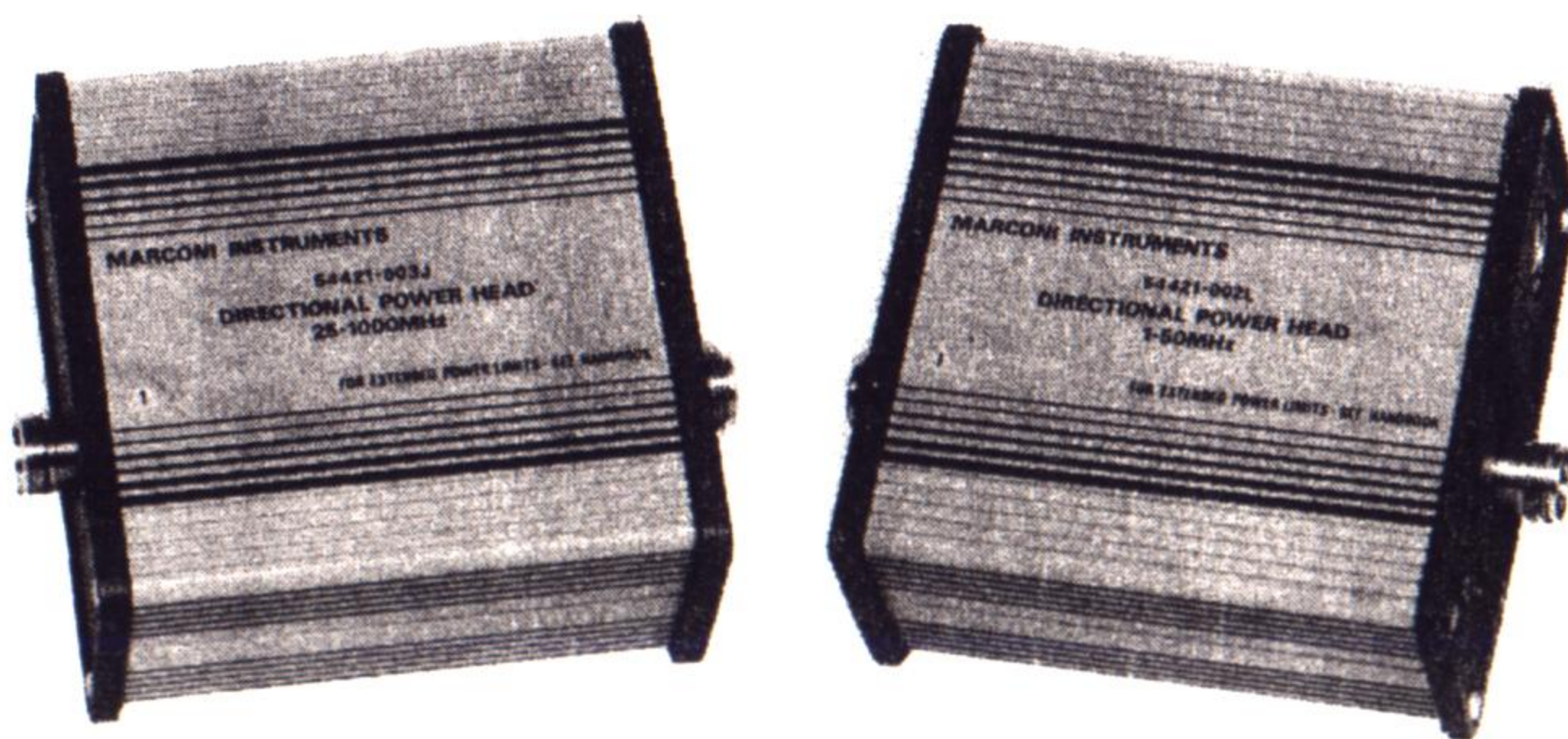


DIRECTIONAL POWER HEADS
for
Radio Communications Test Set
2955 series



Operating Manual

DIRECTIONAL POWER HEADS

for Radio Communications Test Set 2955 series

Part no. 54421-002L (1 MHz to 50 MHz)
54421-003J (25 MHz to 1000 MHz)

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PREFACE

WARNINGS, CAUTIONS AND NOTES

These terms have specific meanings in this manual:-

WARNINGS contain information to prevent personal injury.
CAUTIONS contain information to prevent damage to the equipment.
Notes contain important general information.

HAZARD SYMBOLS

The meaning of hazard symbols appearing on the equipment is as follows:-

Symbol	Nature of hazard	Reference in manual
	Static sensitive components	Page iv

MANUAL AMENDMENT STATUS

Each page in this manual bears the date of its original issue or, if it has been amended, the date and status number of the amendment. Any changes subsequent to the latest amendment status are included on Manual Change sheets coded C1, C2 etc. at front of the manual.

OPERATING PRECAUTIONS

This product has been designed and tested in accordance with IEC Publication 348 - 'Safety Requirements for Electronic Measuring Apparatus'. To keep it in a safe condition and avoid risk of injury, the precautions detailed in the WARNINGS below should be observed. To avoid damage to the equipment the precautions detailed in the CAUTIONS should also be observed.

WARNING – RF AND STANDING WAVE HAZARDS

Under certain operational conditions, high RF potentials may exist and contact with them could result in shock and burns. The power head should NEVER be used with the covers removed; if removal of the covers is necessary, the power head must first be disconnected from any source of RF power. Failure to correctly terminate the RF line under test will cause standing waves to be set up and hazardous voltages may be present.

WARNING – OTHER HAZARDS

Parts of this equipment are made from metal pressings, therefore it should be handled with due care to avoid the risk of cuts or scratches.

Some of the components used in this equipment may include resins and other materials which give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

CAUTION – STATIC SENSITIVE COMPONENTS

This equipment contains static sensitive components which may be damaged by handling – refer to the Service Manual for handling precautions.

Chapter 1

GENERAL INFORMATION

FEATURES

This accessory for the Radio Communications Test Set 2955 series is used to measure forward power, reverse power and VSWR in coaxial RF transmission lines and antenna systems. There are two versions as follows:-

Frequency range	Part no.
1 to 50 MHz (HF)	54421-002L
25 to 1000 MHz (UHF)	54421-003J

There are no controls fitted to the Directional Power Head. There are RF line input and output connectors and a DIN socket for the lead to the 2955. A 3 m Lead Assembly is supplied for connecting to the 2955. A 1 m Lead Assembly is available as an optional accessory. As the Directional Power Head is bi-directional, it can be connected either way round in the RF line.

The Directional Power Head is able to measure CW power or give an indication of peak envelope power (PEP) for AM and SSB. Selection between CW or PEP mode is made by a 2955 front panel key. A very wide measurement range is available, from 10 mW to 400 W under certain conditions, for both forward and reverse power. Range selection is automatic under software control, so no range switching is required of the operator.

A system of compensated peak responding detectors is employed to ensure fast response times and a wide dynamic range. It should be noted that the instrument is accurately calibrated for signals with low harmonic content and noise.

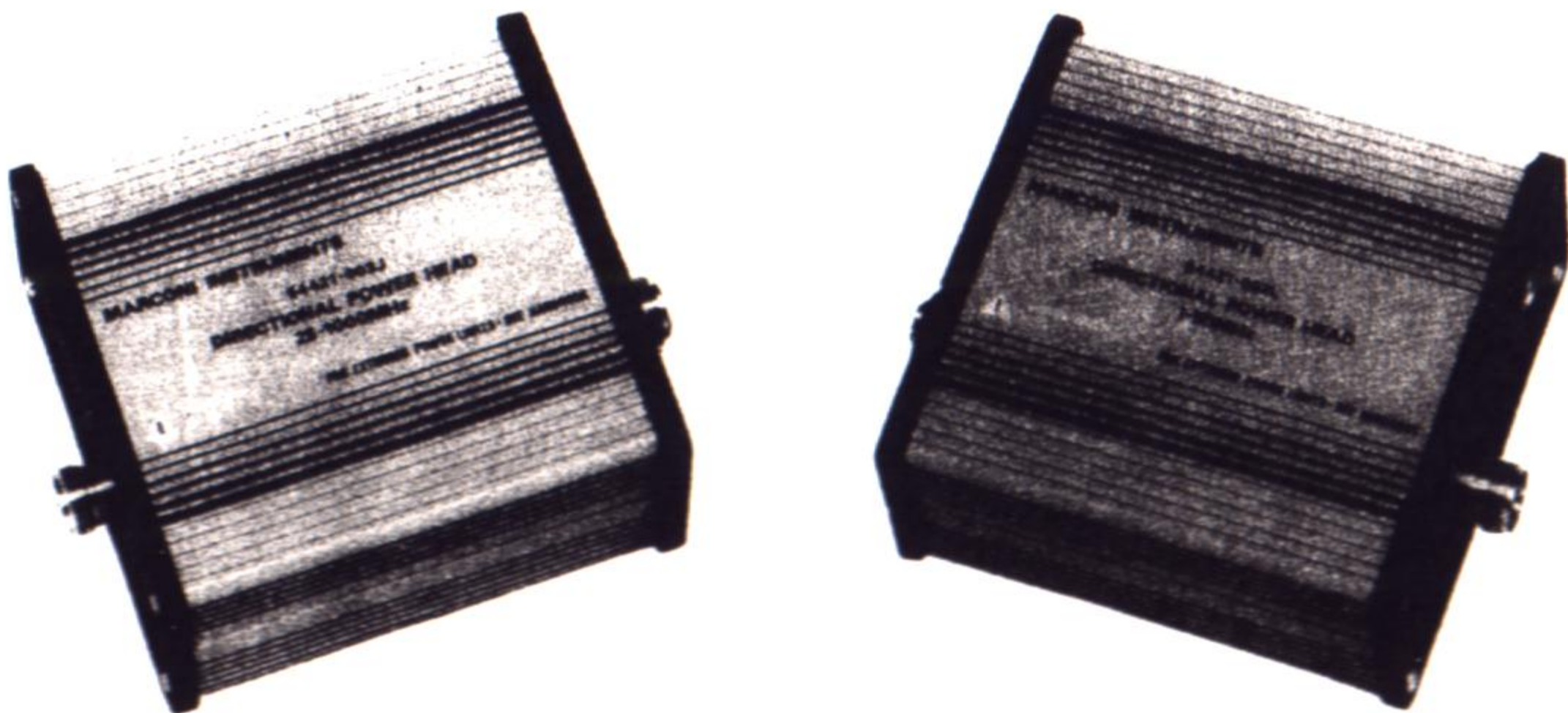


Fig 1-1 HF and UHF Directional Power Heads

PERFORMANCE DATA – POWER HEAD ONLY

	HF version	UHF version
Frequency range:	1 MHz to 50 MHz.	25 MHz to 1000 MHz.
Power measurement (either direction)	See Fig. 1-2.	See Fig. 1-3.
Indication range for CW:	5 mW to 400 W.	5 mW to 400 W at 25 to 520 MHz, 5 mW to 200 W at 1000 MHz.
Indication range for PEP:	1 to 400 W.	1 to 400 W at 25 to 520 MHz, 1 to 200 W at 1000 MHz.
Maximum applied PEP:	1 kW.	1 kW at 25 to 100 MHz, 200 W at 1000 MHz.
CW power accuracy	The quoted figures apply when the Power Head is terminated by a load which has a VSWR of 1.1:1 or better and within the temperature range 18 to 26°C.	
Calibration at 1 W (with harmonics <-50 dBc):	±4.7% (±0.2 dB) at 30 MHz.	±4.7% (±0.2 dB) at 100 MHz.
Flatness:	±3.6% (±0.155 dB) at 1 to 50 MHz.	±5.9% (±0.25 dB) at below 520 MHz, ±9.6% (±0.4 dB) at 520 to 1000 MHz.
Linearity, relative to 1 W:	±3.5% (±0.15 dB) ±0.003% of maximum power of Head, at 10 mW to 400 W.	3.5% (±0.15 dB) ±0.01% of maximum power of Head.

	HF version	UHF version
Calibration, flatness and linearity combined (root of sum of squares):	$\pm 7\%$ (± 0.29 dB) $\pm 0.003\%$ of maximum power of Head.	$\pm 8\%$ (± 0.35 dB) $\pm 0.01\%$ of maximum power of Head, at 25 to 520 MHz, $\pm 11\%$ (± 0.5 dB) $\pm 0.01\%$ of maximum power of Head, at 520 to 1000 MHz.
Effect of temperature outside 18 to 26 °C on calibration, flatness and linearity:	$< \pm 0.2\%/^{\circ}\text{C}$ (± 0.008 dB/ $^{\circ}\text{C}$).	$< \pm 0.3\%/^{\circ}\text{C}$ (± 0.015 dB/ $^{\circ}\text{C}$) at below 520 MHz, $< \pm 0.5\%/^{\circ}\text{C}$ (± 0.02 dB/ $^{\circ}\text{C}$) at 520 to 1000 MHz.
VSWR measurement	See Fig. 1-4.	See Fig. 1-4.
VSWR indication:	1.0 to 99.9.	1.0 to 99.9.
VSWR accuracy at 18 to 26°C:	$\pm 12.5\%$ for 1.1:1 to 2:1 (typically 3%), $\pm 15\%$ for 2:1 to 3:1 (typically 4%).	$\pm 16\%$ for 1.1:1 to 2:1 (typically 5%), $\pm 20\%$ for 2:1 to 3:1 (typically 6%).
Effect of temperature outside 18 to 26°C:	$< \pm 0.4\%/^{\circ}\text{C}$ for 1.1:1 to 2:1, $< \pm 0.6\%/^{\circ}\text{C}$ for 2:1 to 3:1.	$< \pm 0.3\%/^{\circ}\text{C}$ for 1.1:1 to 2:1, $< \pm 0.6\%/^{\circ}\text{C}$ for 2:1 to 3:1.
RF connectors		
Type:	N sockets.	N sockets.
Characteristic impedance:	50 Ω nominal.	50 Ω nominal.
Insertion SWR:	$< 1:1$ (return loss > 26.4 dB) at 1 to 50 MHz.	$< 1:1$ (return loss > 26.4 dB) at 25 to 1000 MHz.
Insertion loss:	< 0.05 dB.	< 0.35 dB at up to 520 MHz, < 0.65 dB at 520 to 1000 MHz.
Output connector		
Type:	DIN 7-pin socket, standard Lead Assembly (3 m) to ACCESSORY socket on 2955.	

	HF version	UHF version
Dimensions and weight		
Height:	52 mm.	52 mm.
Width:	108 mm.	108 mm.
Depth:	114 mm.	114 mm.
Weight:	645 g.	850 g.
Radio frequency interference:	Complies with the requirements of EEC Directive 76/889 as to limits of RF interference.	
Safety:	Complies with IEC 348.	
Environmental		
Rated range of use:	0 to 50°C.	
Limit range of operation:	0 to 55°C.	
Conditions of storage and transport		
Temperature:	-40 to +70°C.	
Humidity:	Up to 90% RH.	
Altitude:	Up to 2500 m (pressurized freight at 27 kPa differential (i.e. 3.9 lbf/in ²)).	

PERFORMANCE DATA – IN CONJUNCTION WITH 2955

When the Power Head is used in conjunction with the Radio Communications Test Set 2955 series, the performance is identical to that of the Power Head alone with the exceptions and additions given below.

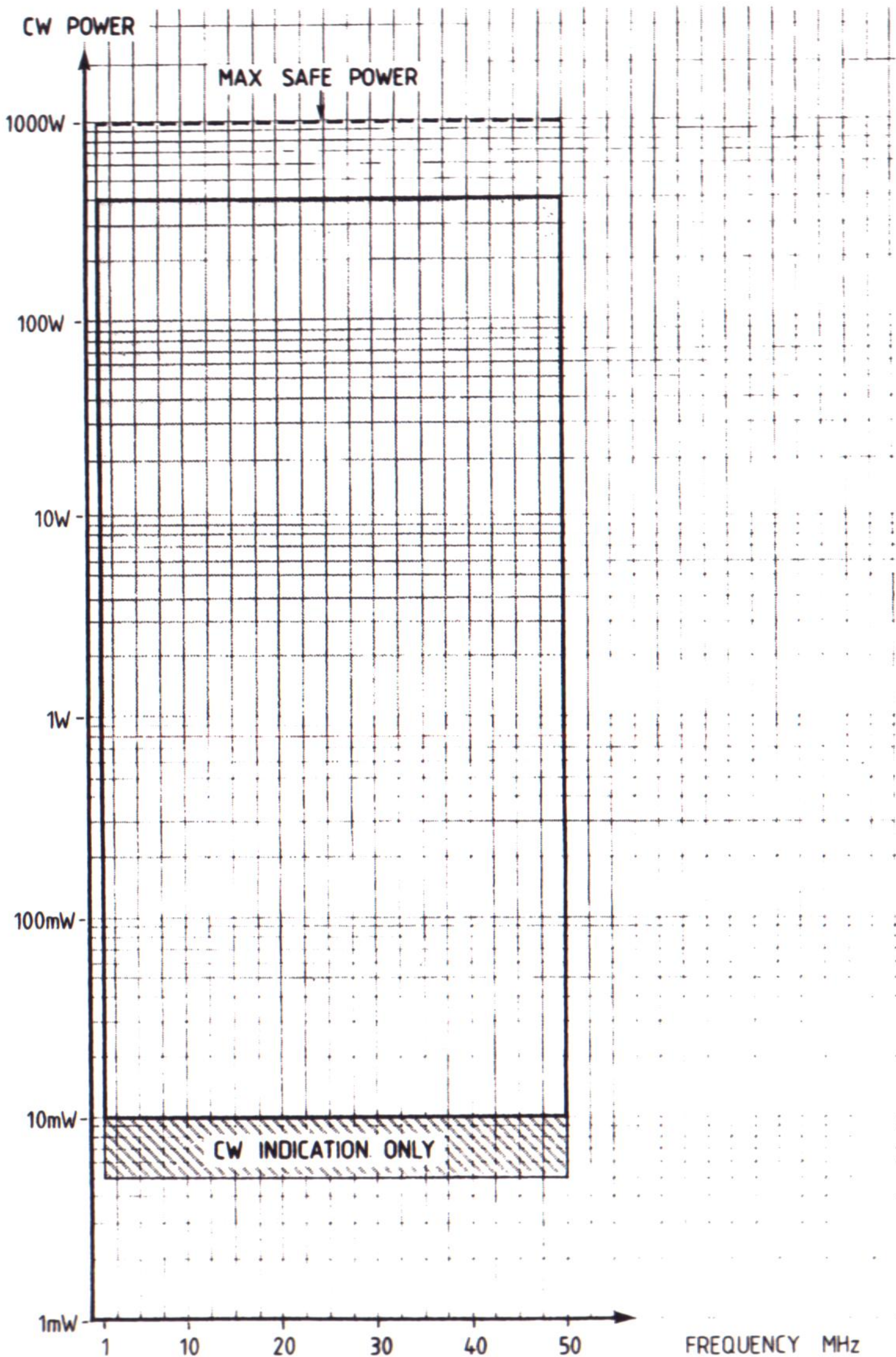
Power measurement

Resolution:	0.02 on 1 to 2.5 scales, 0.05 on 2.5 to 5.0 scales, 0.10 on 5.0 to 10.0 scales except for 1 mW on 5 to 100 mW range.
Indication:	1 to 3 digits and analogue display.
Setting:	Automatic ranging using 0 to 1, 0 to 3 and 0 to 10 scales.

	HF version	UHF version
Accuracy (including errors due to frequency response, linearity and calibration uncertainties combined (root of sum of squares)):	$\pm 8\%$ ($\pm 0.003\%$ of maximum power of Head).	$\pm 9\%$ ($\pm 0.01\%$ of maximum power of Head) at 25 to 520 MHz, $\pm 12\%$ ($\pm 0.01\%$ of maximum power of Head) at 520 to 1000 MHz.
Effect of temperature outside 18 to 26°C:	$< \pm 0.2\%/^{\circ}\text{C}$.	$< \pm 0.3\%/^{\circ}\text{C}$ at 25 to 520 MHz, $< \pm 0.5\%/^{\circ}\text{C}$ at 520 to 1000 MHz.

VSWR measurements

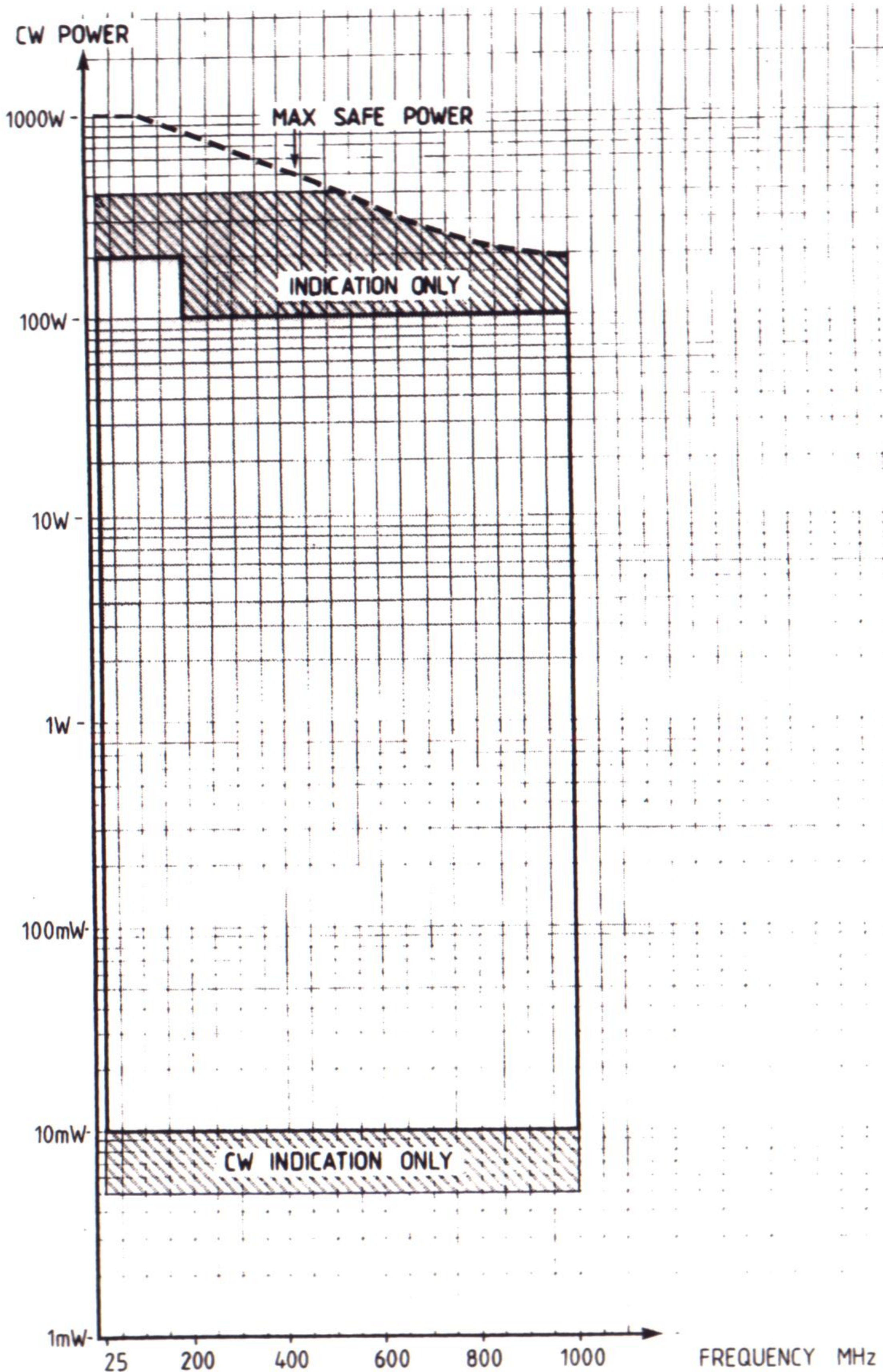
Resolution:	≤ 0.1 for ≤ 100 mW forward power, ≤ 0.05 for > 100 mW forward power (typically 0.01).
Indication:	3 digits and analogue display.
Setting:	Automatic ranging, analogue scales 1 to 2, 1 to 4 and 1 to 11.



— = PEP INDICATION RANGE
- - - = CW FULL SPEC. RANGE

TPB 5871

Fig. 1-2 Power range of HF Directional Power Head



— = PEP INDICATION RANGE
 — = CW FULL SPEC. RANGE

TPB 5872

Fig. 1-3 Power range of UHF Directional Power Head

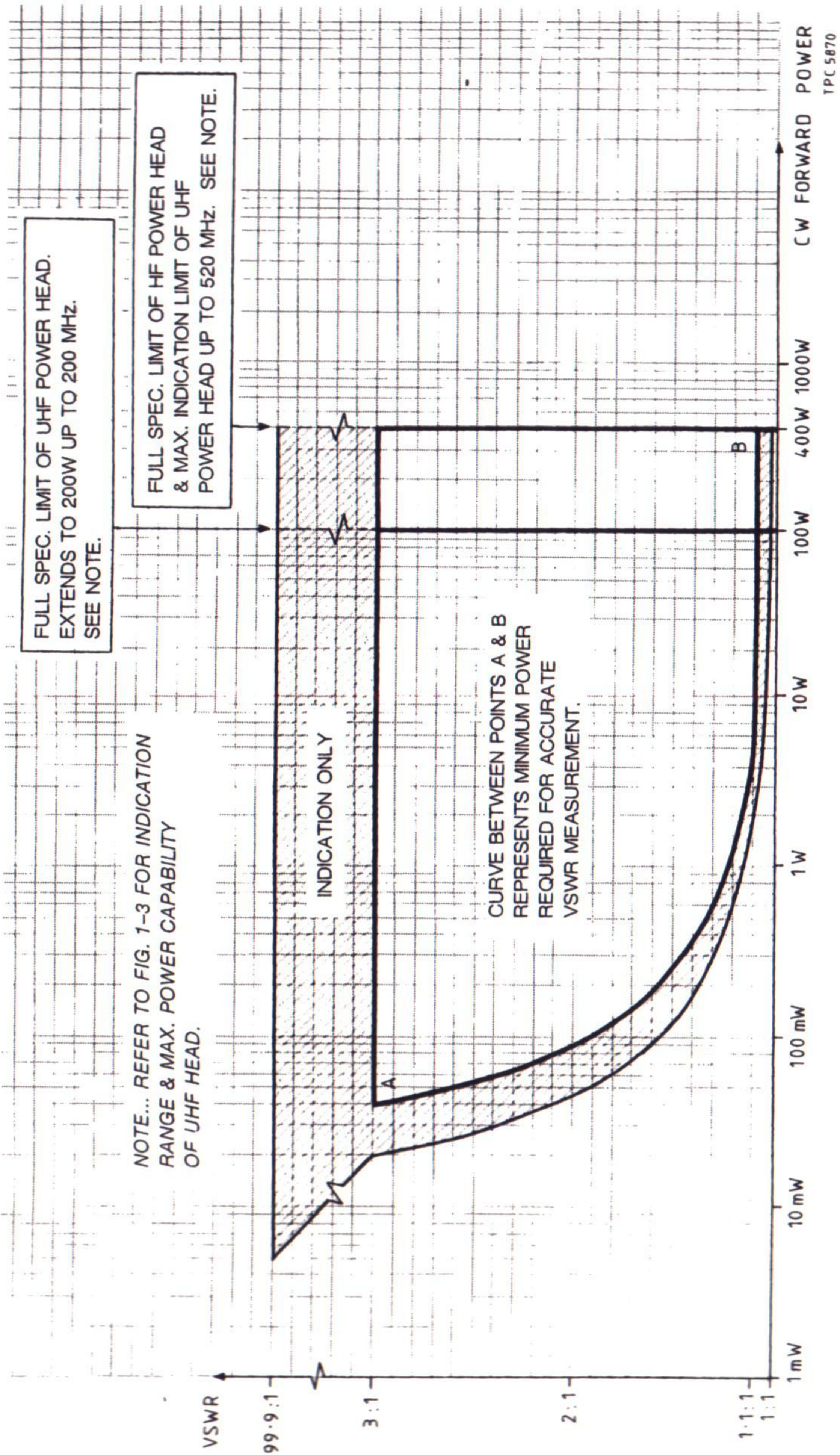


Fig. 1-4 VSWR range for HF and UHF Directional Power Heads

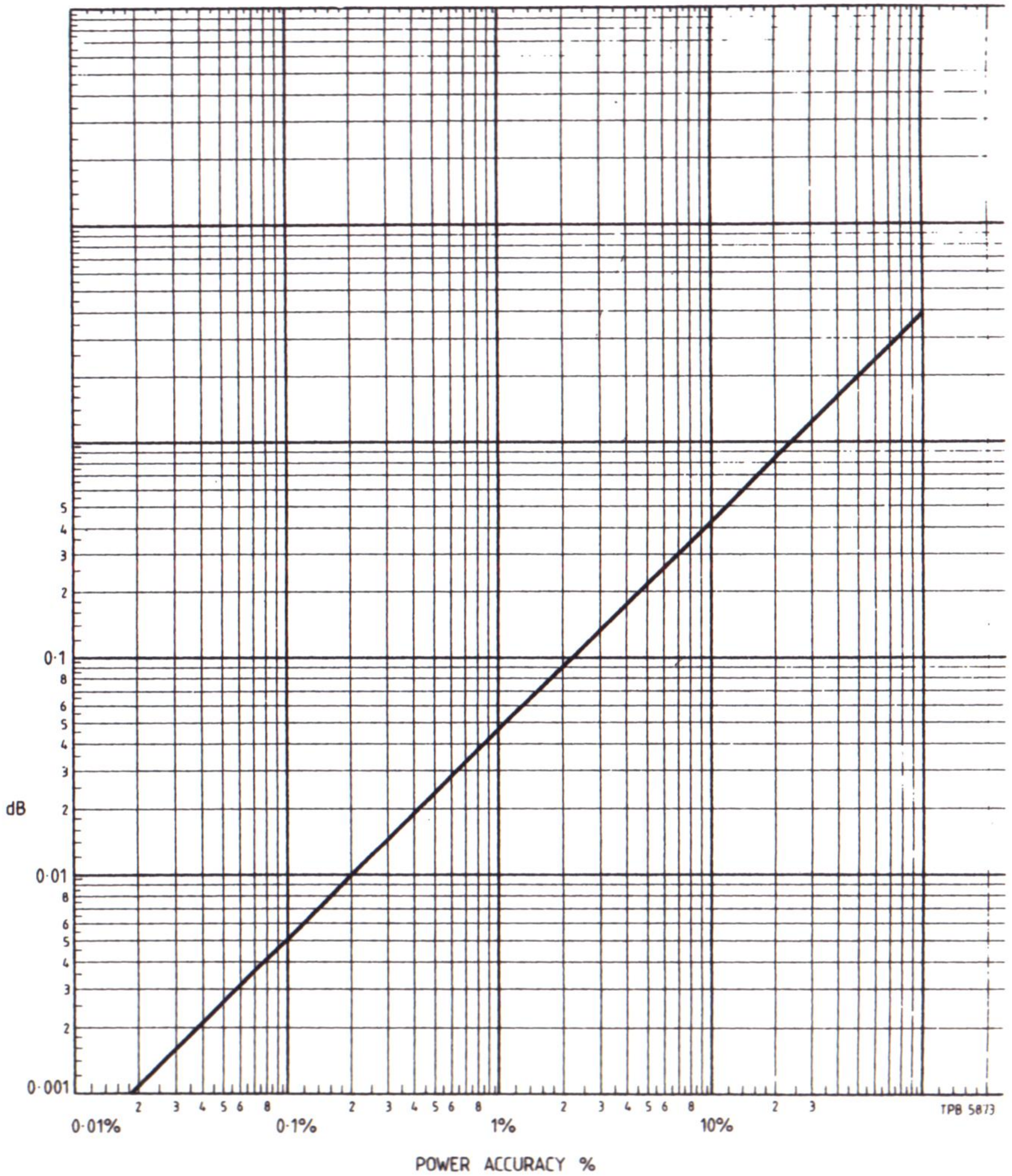


Fig. 1-5 Percentage to dB error conversion

TABLE 1-1 : CONVERSION OF VSWR TO RETURN LOSS

VSWR	Return loss (dB)	VSWR	Return loss (dB)
1.00	∞	1.54	13.4
1.01	46.1	1.56	13.2
1.02	40.1	1.58	13.0
1.03	36.6	1.60	12.7
1.04	34.2	1.62	12.5
1.05	32.3	1.64	12.3
1.06	30.7	1.66	12.1
1.07	29.4	1.68	11.9
1.08	28.3	1.70	11.7
1.09	27.3	1.72	11.5
1.10	26.4	1.74	11.4
1.11	25.7	1.76	11.2
1.12	24.9	1.78	11.0
1.13	24.3	1.80	10.9
1.14	23.7	1.82	10.7
1.15	23.1	1.84	10.6
1.16	22.6	1.86	10.4
1.17	22.1	1.88	10.3
1.18	21.7	1.90	10.2
1.19	21.2	1.92	10.0
1.20	20.8	1.94	9.9
1.21	20.4	1.96	9.8
1.22	20.1	1.98	9.7
1.23	19.7	2.00	9.5
1.24	19.4	2.50	7.4
1.25	19.1	3.00	6.0
1.26	18.8	3.50	5.1
1.27	18.5	4.00	4.4
1.28	18.2	4.50	3.9
1.29	17.9	5.00	3.5
1.30	17.7	5.50	3.2
1.32	17.2	6.00	2.9
1.34	16.8	6.50	2.7
1.36	16.3	7.00	2.5
1.38	15.9	7.50	2.3
1.40	15.6	8.00	2.2
1.42	15.2	8.50	2.1
1.44	14.9	9.00	1.9
1.46	14.6	9.50	1.8
1.48	14.3	10.00	1.7
1.50	14.0	11.00	1.6
1.52	13.7		

ACCESSORIES

Supplied

	Part no.
Lead Assembly with DIN plugs, 3 m	43130-591B
Carrying case HF version	46662-190V
Carrying case UHF version	46662-189W

Optional

Lead Assembly with DIN plugs, 1 m	43130-590R
Dual DIN Connector Assembly	44990-814K

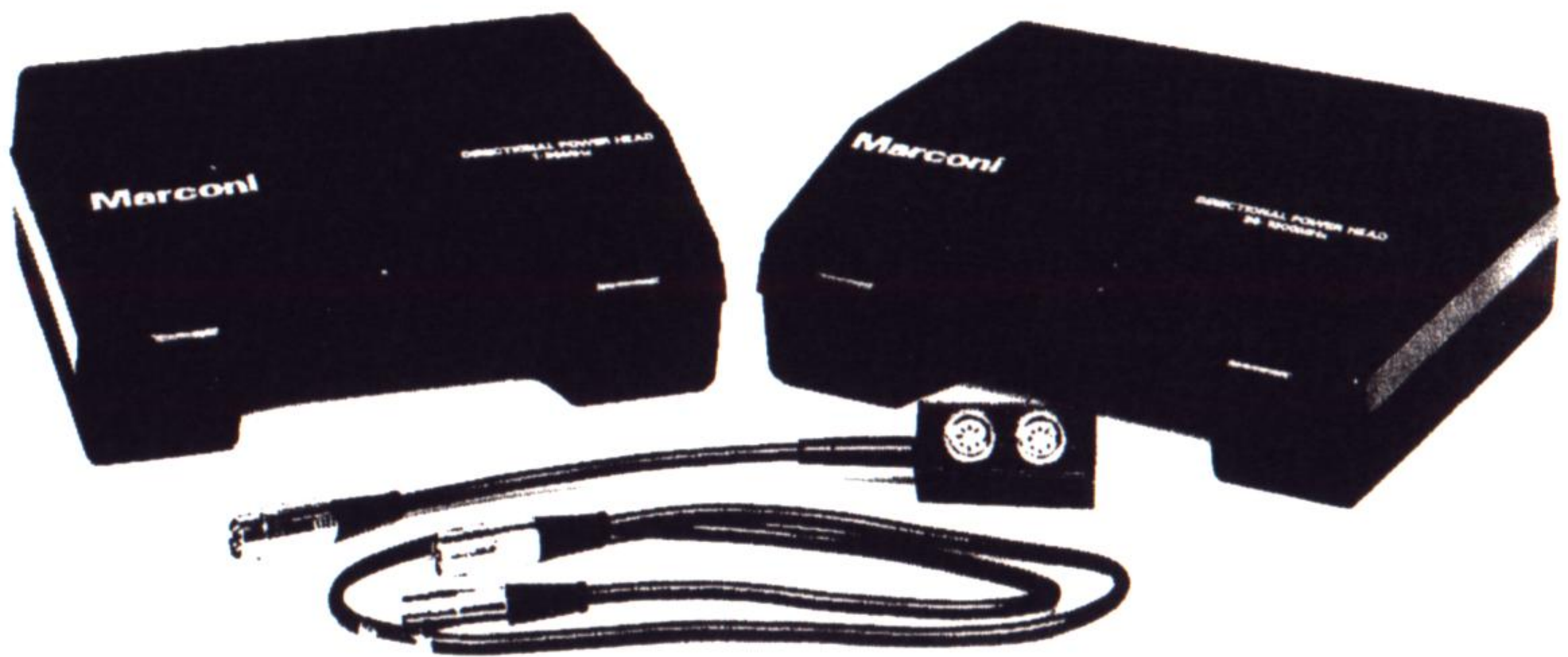


Fig. 1-6 Accessories

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Chapter 2

INSTALLATION

Unpacking and repacking

Retain the container, packing material and the packing instruction note (if included) in case it is necessary to reship the instrument.

If the instrument is to be returned for servicing:

- (1) Attach a label indicating the service required, type or model number and your return address and telephone number.
- (2) Place instrument within its container and secure.
- (3) Protect from transit damage by either shipping in strong "Jiffy" bag or wrap in foam rubber and secure with adhesive tape.
- (4) Mark the package "FRAGILE" to encourage careful handling.

Connection to 2955 Radio Communications Test Set

WARNING: RF HAZARD

No attempt should be made to connect the directional power head to an RF line until the "Operating Precautions" on page iv have been noted.

NOTE: Software issue 13 or later must be installed in the 2955 for correct operation. Earlier versions will not give accurate indications.

Switch on the 2955.

Connect the accessory cable between the seven pin ACCESSORY IN/OUT socket on the bottom right hand side of the 2955 front panel, and the seven pin DIN socket on the power head.

Immediately this connection is made the 2955 will detect the presence of the power head and the screen will change to directional power measurement format (Fig. 2-1).

The power head is now installed and the 2955 ready to make directional power measurements.

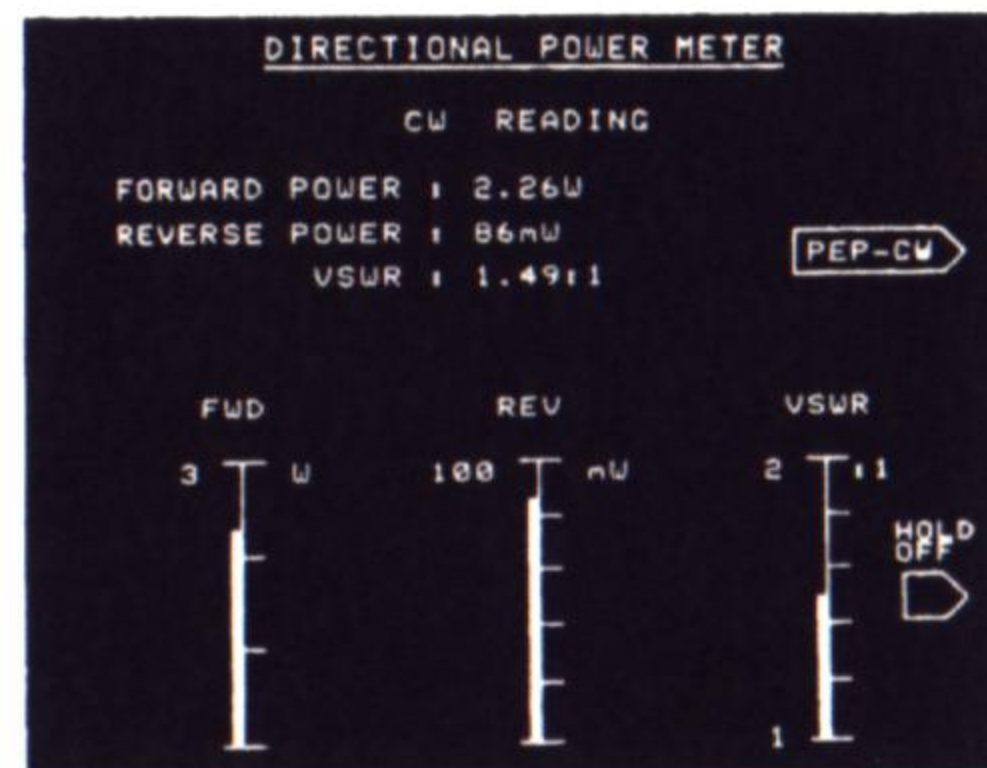
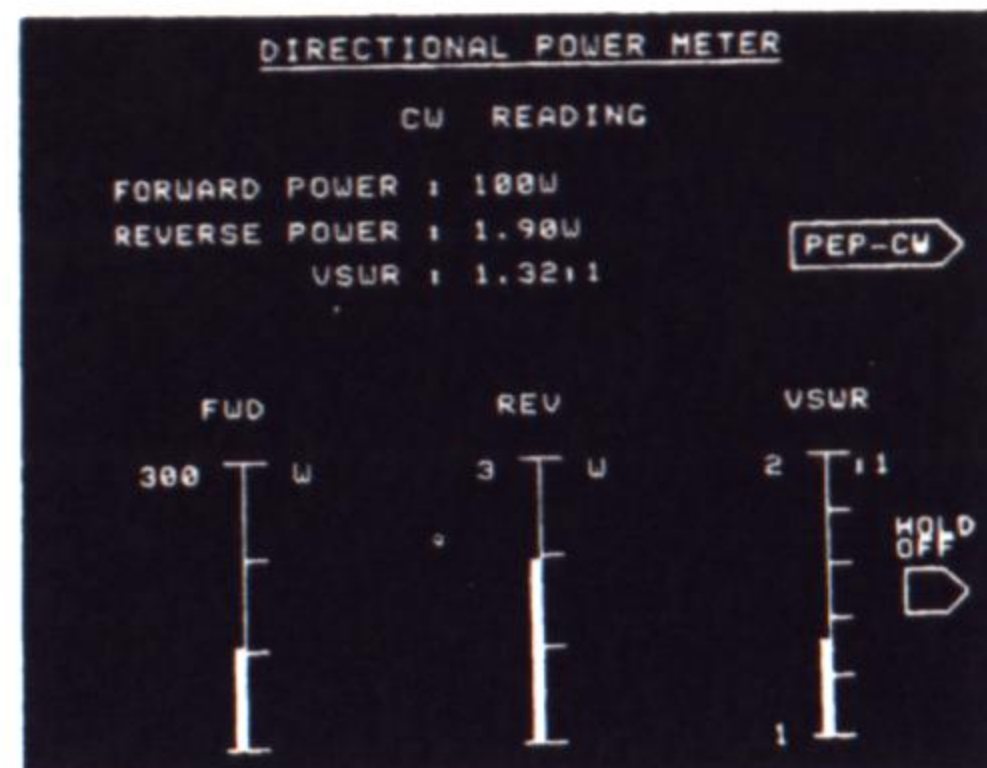


Fig. 2-1 Directional power measurement screen formats for HF or UHF power heads in CW mode

Chapter 3

OPERATION

General

The supplied equipment consists of the power head together with the 3 metre accessory cable.

Power supply

No internal or external power supplies are required; 12 V DC power is supplied to the power head from the 2955 via the accessory cable.

Operation

Connect the power head to the 2955 via the supplied accessory cable.

Ensure that transmitter power is OFF and an antenna or load is connected to the transmitter.

Connect the power head in series with transmitter output, using either N type socket for input or output.

The directional power head is able to operate in two modes, CW and PEP (when using AM or SSB). When the directional power head format first appears on the screen it is always in CW mode. The DUPLEX key acts as a soft key to switch from CW to PEP. Select CW or PEP as appropriate.

Switch on the transmitter under test and note that readings appear for forward power, reverse power and VSWR. The same values also appear on the three bar charts at the bottom of the screen.

The only other key that is active during a measurement is the HOLD key which freezes the screen until the key is depressed a second time.

Once the HOLD key has been depressed and the display frozen, a hard copy of the display may be obtained using the printer option, as described in the 2955 Operating Manual. The optional dual DIN connector is required to enable simultaneous use of the directional power meter and printer options.

Upon completion of measurements switch off the transmitter under test and then disconnect the power head from the 2955. The display screen will revert to the mode and parameters under which it was operating before the power head was connected, unless the HOLD function had been selected.

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GPIB operation

The 2955 has a general purpose interface bus capability. This enables the directional power head to be operated from an external controller, usually a computer, thereby facilitating its integration into ATE systems.

When operating under GPIB control the connection of the power head does not automatically cause the 2955 to change the screen to directional power format; to do this you must send the ET command from the controller. The DT command disables directional power mode and reverts the screen to the pre-vious mode and parameters in use.

Under GPIB control all 2955 front panel keys except one are redundant. The HELP key, which is now a soft key, is used to switch to local (i.e. front panel) control. The other keyed functions are enabled by commands from the controller, via the interface bus. When the power head is connected without GPIB only two front panel keys are operative; under GPIB operation these functions are performed by controller commands:

TABLE 3-1 : GPIB COMMANDS

Command	Function
PR	Select PEP
CR	Select CW
HDn	Freezes screen (off, on: n = 0,1)
ET	Enables directional power head mode
DT	Disables directional power head mode
RD11	Read forward power
RD12	Read reverse power
RD13	Read VSWR

Chapter 4

BRIEF TECHNICAL DESCRIPTION

Directional coupler assembly

The directional coupler is connected in series with the RF line under test and senses forward and reverse RF power. The coupler has two outputs, one for forward power and the other for reverse power. Because the coupler can be connected in either direction on the RF line, either output could represent forward or reverse power. Each output from the coupler is routed to an RF detector.

Channel circuit

There are two channel circuits, each comprising an integrator, AGC circuit and a peak buffer. Both channel circuits are identical to each other, therefore only channel 1 is described below.

CW operation (see Fig. 4-1)

The RF detector output is connected to one input of the integrator. The output from an LF detector is connected to the other input of the integrator. The integrator output controls the gain of the AGC circuit which controls the level of a 1 kHz signal to the LF detector.

When RF power is detected, an increased offset voltage exists at the integrator input which causes the AGC to compensate by increasing the level of LF voltage to the LF detector. The increase in LF level at the AGC circuit is routed to the test set and is directly proportional to the increase in RF sensed by the directional coupler.

The error correcting action of the AGC/LF detector loop circuit corrects for law variations in the RF detector, thereby extending its linear output range.

The RF and LF detector diodes for each channel have matched characteristics and are mounted close together to ensure thermal equilibrium. However, DC level differences due to temperature are compensated by a unique auto-nulling scheme (patent applied for) which further extends the detector dynamic range.

PEP operation

The integrator and AGC/LF loop circuit is not suitable for AM signals therefore for PEP operation they are switched out of circuit. The RF detector output is routed to a peak buffer which in channel 1 outputs a positive voltage and in channel 2 outputs a negative voltage proportional to the forward and reverse peak envelope voltage on the RF line under test.

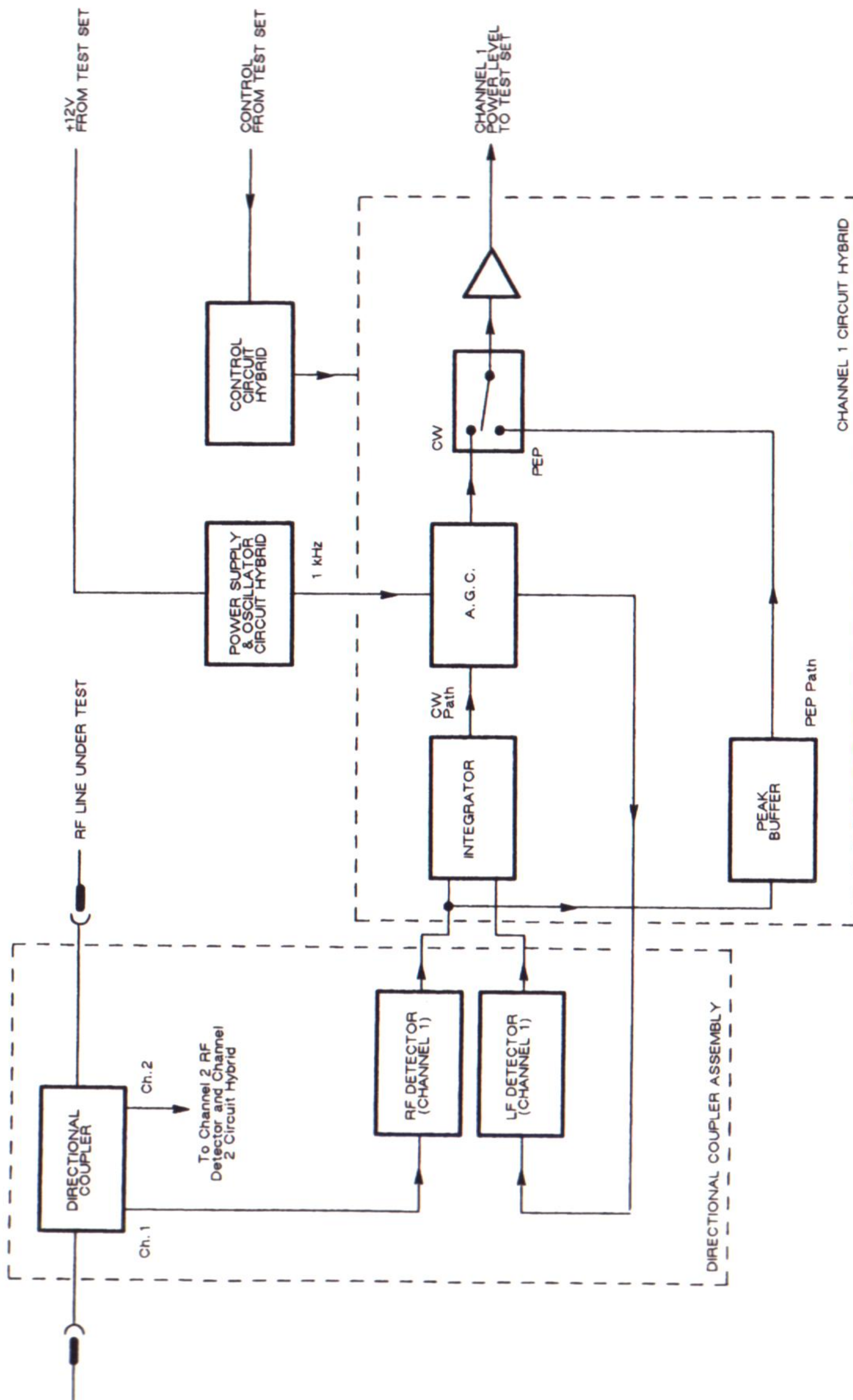


Fig. 4-1 Simplified block diagram of HF or UHF power head

Control circuit

Signal switching for CW/PEP signal paths is controlled by the test set via a control circuit hybrid in the power head. The control circuit directly controls the operation of the zero-loop circuit.

Power supply and oscillator

A power supply and oscillator circuit hybrid in the power head is powered by +12 V DC from the test set and provides the nominal 1 kHz signal to each channel AGC circuit and also ± 6.5 V DC supplies to the power head circuits.

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