Communications

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COMMUNICATIONS

THE INCREASING REQUIREMENTS in the communications field call for a wide range of equipment built to give a high standard of performance. The frequencies employed extend from the LF to the SHF bands and so a variety of techniques are used.

Significant technical advances are being made, an example of which is a system of Ionospheric Forward Scatter transmission. Frequencies of between 30 and 60 Mc/s are used for direct communication over distances of the order of 600 to 1200 miles (1000 to 2000 km). Carefully engineered systems facilitate telegraph communication of exceptional reliability. In the realm of microwave links other examples are to be found, the use of travelling wave tubes alone resulting in the development of wide-band equipment giving up to 240 speech channels.

The facilities of the Marconi Company enable complete projects to be planned, engineered, installed and operated and the technical training of personnel carried out. Collaboration with the Automatic Telephone and Electric Company, whose reputation and experience in telecommunications is world-renowned, enables a completely comprehensive service to be offered. The massive combined resources of the two companies are at the disposal of authorities everywhere.

Table of Communication Transmitters and Associated Equipment

	Type of Service	*Type and Power of Transmitter*	*Drive and Modulation Equipment*	*Other Associated Equipment*
VHF SCATTER	FSK	HS201 (*p.279*) 40 kW	Type HD65 (*p.331*)	
HIGH-GRADE HF POINT-TO-POINT TRANS-MITTERS	ISB	HS51, (*p.281*) 30 kW PEP HS41, (*p.285*) 10–12 kW PEP HS71, 72 (*p.287*) 9–10 kW PEP HS31, 32 (*p.289*) 3·5 kW PEP	*ISB drive:* Type HD51 (*p.317*) or Type SSD2 (*p.315*) *Primary drive:* Type HD21 (*p.321*) or Type HD26 (*p.323*) *Standby:* Variable Oscillator Type HD28 (*p.323*) *DSB Modulator;* Type HD56 (*p.322*)	A Channel Displacer Type HW41 (*p.385*) will be required for each sideband carrying more than one channel. Radio Telephone Terminal Equipment Type HW21 (*p.379*) will be needed on each speech circuit. For privacy, Type HW11 (*p.375*) or HW12 (*p.377*) equipment is necessary.
		HS61, (*p.283*) 30 kW PEP	Type HS31 Transmitter (*p.289*)	
	Telegraphy: CW and FSK	HS51, (*p.281*) 20 kW HS71, 72 (*p.287*) 7 kW HS31, 32 (*p.289*) 3·5 kW	*Telegraph drive:* Type HD22 (*p.322*) *Primary drive:* Type HD21 (*p.321*) or Type HD26 (*p.323*) *Standby:* Variable Oscillator Type HD28 (*p.323*) *DSB Modulator:* Type HD56 (*p.322*)	Telegraph Monitoring Unit Type HD 23 or HD24 (*p.322*)
		HS61, (*p.283*) 20 kW	Type HS31 Transmitter (*p.289*)	
	Telegraphy: FSK Diplex	FSK Diplex service (*i.e.* two-channel FSK) can be obtained with any of the above transmitters by using the Type HK12 diplex keying unit (*p.323*)		
GENERAL PURPOSE HF TRANS-MITTERS	DSB Telephony and Telegraphy (CW and FSK)	HC200 (*p.293*) Up to 4 channels, 2 kW per channel telephony, 2·5 kW per channel telegraphy.	Incorporated in transmitter.	
		HS101, (*p.297*) 1·5 kW	Incorporated in transmitter.	

continued overleaf

	Type of Service	*Type and Power of Transmitter*	*Drive and Modulation Equipment*	*Other Associated Equipment*
GENERAL PURPOSE HF TRANS-MITTERS	DSB Telephony and Telegraphy (CW and FSK)	HC100 Up to 4 channels, *p.295* (400 W per channel)	Incorporated in transmitter.	
	DSB Telephony and Telegraphy (CW and MCW)	TGS541B 200 W (*p.301*)	Incorporated in transmitter. FSK only, Type HD63 (*p.329*)	
		TGS501 100 W (*p.303*)	Incorporated in transmitter. FSK only, Type HD63 (*p.329*)	
	ISB (and FSK telegraphy optional)	HS21 500 W PEP (*p.291*) per channel.	Incorporated in transmitter.	Radio Telephone Terminal Equipment Type HW22 (*p.381*) would normally be used per speech circuit. For privacy Type HW12 (*p.377*) would be used.
	FSK	HS92 400W (*p.299*)	Incorporated in transmitter.	
GENERAL PURPOSE MF TRANS-MITTERS	DSB Telephony and Telegraphy (CW and MCW)	TGM651 3 kW (*p.309*)	Incorporated in transmitter.	
		TGM541 200 W (*p.311*)	Incorporated in transmitter.	
GENERAL PURPOSE LF TRANS-MITTER	Telegraphy (CW and FSK)	HS81 40 kW (*p.313*)	Type HD64 (*p.313*)	
GENERAL PURPOSE TRANSMITTER-RECEIVER	Telegraphy (CW) and Telephony	HSR11 50 W (*p.307*)	Incorporated in transmitter.	
	SSB	HSR 21 60 W PEP (*p.305*)	Incorporated in transmitter.	

High Power Matching Transformers Types HA111 and HA112 (p.387) are also available for installation at HF transmitting stations.

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

20 kW VHF Amplifier
Type HS 201

An ionospheric scatter transmitter employing Type HS 201 amplifiers.

7271

TRANSMITTERS for point-to-point communication service using ionospheric forward-scatter transmission employ the Type HS 201 high-power VHF amplifier. This air-cooled amplifier unit is closely related in design to established television transmitters of proved reliability.

The equipment for a VHF forward-scatter transmitter consists of a pair of Type HS 201 amplifiers driven by the twin outputs of a Type HD 65 FSK Drive and Phasing Equipment (described on page 331). The amplifiers normally operate in parallel, each of them feeding directly into one half of a symmetrical aerial array, to give a total output power of 40 kW. The coupling between the two sets of feeder and aerials is so low that the amplifiers can be operated independently and switches can be provided so that, if necessary, both halves of the aerial can be fed from one amplifier. An alternative arrangement is available whereby the two outputs from the amplifiers are paralleled in a bridge-type combining unit and are fed *via* a single feeder to the aerial.

GENERAL

A Type HS 201 amplifier comprises a power control unit, a rectifier unit, an auxiliary rectifier

unit and an RF unit. These units are housed in cabinets with doors front and rear and are mounted in line, with an air-duct running transversely along the top. All stages of the equipment are air-cooled.

A control panel mounted on the front of the auxiliary rectifier unit carries the push-buttons for starting up and stopping together with supply and fault indication lamps. The oil-filled HT transformers and smoothing equipment are normally mounted externally in a fire-proof room.

CIRCUITS

The amplifier requires an input of 5 W at the radiated frequency. This is obtained from the associated drive equipment over a 75 Ω coaxial feeder. Three Class C push-pull stages are employed, with capacitive inter-stage coupling. The final stage utilises a pair of high-power tetrode valves with cross-neutralisation. This stage is inductively coupled to an unbalanced feeder.

All valve filaments in the amplifier are AC heated, the supplies for the second and third stages being taken from Scott-connected transformers to minimise hum. The HT DC power supplies are obtained from six 'English Electric' excitrons. These are high tension single-anode pool-cathode glass bulb mercury-arc rectifier tubes. They are used with a simplified form of grid control arranged to give complete arc suppression and restoration up to three times, in the event of a fault, before finally locking out. The amplifier circuits are fully protected by overload relays.

In the normal arrangement employing two amplifiers a reflectometer is incorporated in each feeder to indicate the output power and the reflection coefficient. A DC output from each reflectometer operates overload trip relays in the corresponding amplifier should a fault develop on a feeder.

DATA SUMMARY

Power output: 20 kW from one amplifier, 40 kW from two arranged in parallel, on FSK Telegraphy (F1).

Frequency range: 35–55 Mc/s.

Drive requirement: 5 W in 75 Ω at radiated frequency.

Output impedance: 50 Ω

Harmonic radiation: Less than 200 mW.

Noise level: Better than 50 dB below carrier level.

Operating conditions: The amplifier will operate at temperatures up to 45°C with low humidity and up to 40°C with high humidity.

Power supply: 380–440 V, 50 c/s three-phase four-wire AC mains. Voltage regulation +6% to −10%, frequency tolerance ±2½%.

Dimensions:

	Height	Width	Depth
Type HS 201 amplifier	8 ft (2·43 m)	10 ft (3·04 m)	3 ft 9 in. (1·14 m)

In conjunction with Type HD 65 drive and phasing equipment the following performance can be attained:

Frequency stability: 5 parts in 10^6 for a temperature change of 10°C within the range 10–40°C, ambient.

Frequency shift: 4–9 kc/s total shift.

Stability of frequency shift: 1% of max. shift.

Keying speed: Normally 200 bauds, but speeds up to 400 bauds can be accommodated.

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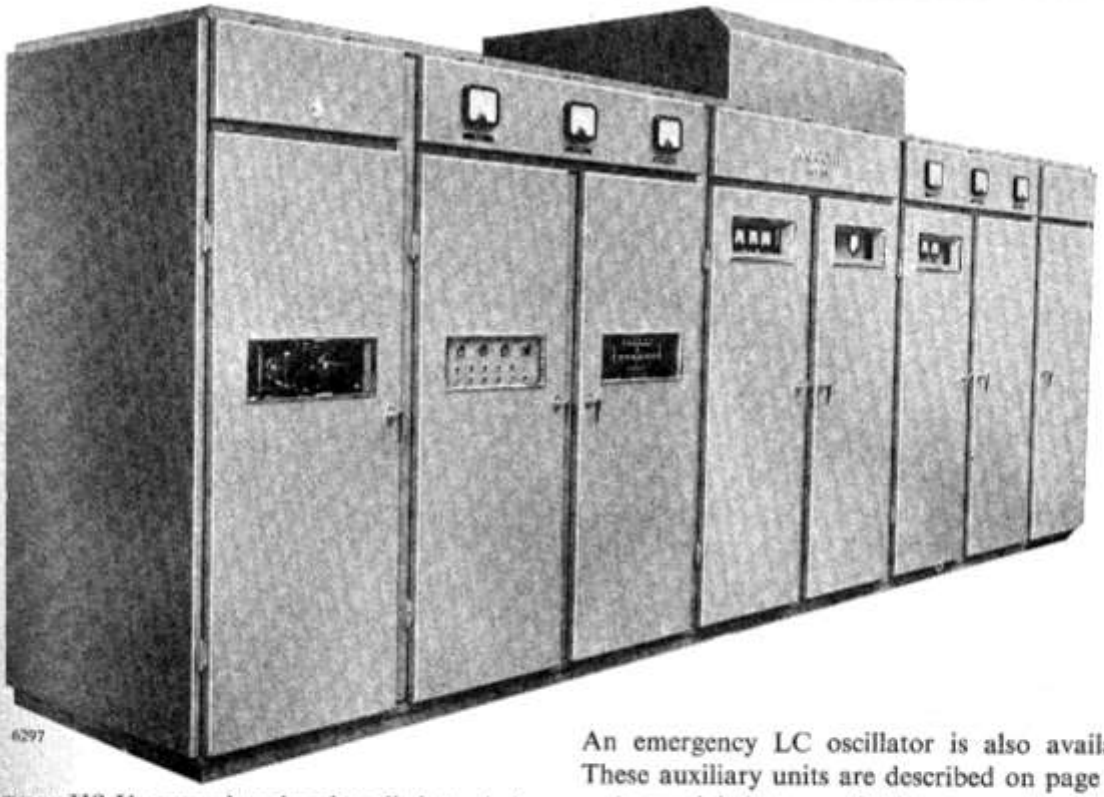
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

30 kW HF ISB Transmitter
Type HS51



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THE TYPE HS 51 transmitter is primarily intended for operation on independent sideband telephone or frequency shift and on/off telegraph services and, when used in its independent-sideband condition, is driven by separate ISB generating and monitoring equipment. This unit (see pages 315 and 317), accepts two separate AF inputs and converts them to two sidebands about a low-level 3·1 Mc/s pilot carrier. For DSB operation a suitable modulator is available.

A separate RF crystal drive source is used to generate one of six predetermined frequencies for the transmitter. A keying unit is available which provides electronic keying on CW, FMCW and FSK, the desired service being switch-selected. An emergency LC oscillator is also available. These auxiliary units are described on page 321.

A special feature of this transmitter is the design of the last three stages, each of which comprises continuously variable inductance and capacitor units, which, with the valve mounting, form a complete tuning unit. These main power stages are built as enclosed units, and are still further screened by the main enclosure. Both unwanted radiation and any noise from the air cooling system is thus kept to a minimum.

The tuning of the earlier stages is effected by variable inductance and capacity combined, thus giving complete frequency coverage with one control. The mixers and harmonic generators consist of six switch-selected sub-units, each of which can be pre-set to any frequency.

FEATURES

Continuous tuning of power stages over the entire frequency range without change of components.

Automatic selection of any one of six pre-set frequencies is provided for.

Easy access to all parts of the transmitter, low-power stages being retractable.

Grounded-grid technique used on high power stages.

RF feedback to reduce distortion.

Air-cooling throughout, with dust filtering.

Control from central panel, with switching operations shown on mimic diagram.

DC filament heating in high-power stages to improve performance.

Low power consumption on standby.

Comprehensive interlock system ensures safety of personnel; ample overload protection provided.

DATA SUMMARY

Nominal power output (to aerial feeder):
30 kW peak envelope power on ISB (A3b).
20 kW on CW on/off telegraphy (A1 and F2).
20 kW on FSK telegraphy (F1).
7·5 kW carrier modulated 95% on DSB telephony (A3).

Frequency range: 4·0–27·5 Mc/s.

Output impedance: 190 Ω or 600 Ω balanced, or 75 Ω unbalanced with 2:1 SWR.

Harmonic radiation: Less than 20 mW.

Noise level: Better than −60 dB (relative to PEP on ISB).

Non-linear distortion (ISB): Third order intermodulation product not greater than −36 dB relative to either of two equal testing tones for any power level up to full peak envelope power.

Input level: Nominal 0·1 W from primary drive and 0·25 W from ISB or keyed telegraph drive (3·1 Mc/s).

Carrier compression: Less than 1·5 dB for any level of single-frequency signal up to −6 dB relative to peak sideband power.

Power supply: 380–415 V, three phase, 50 c/s AC mains, normally four-wire. Voltage regulation +5 to −15%, frequency tolerance ±2½%. Arrangements can be made for operation from 60 c/s supply.

Power consumption (approximate):
ISB 52 kW with 2-tone modulation (full power), 17 kW for pilot carrier only.
CW 'mark' 60 kW
CW 'space' 10 kW
FSK 60 kW
Power factor, 0·9.

Dimensions:	Height	Width	Depth
Main transmitter enclosure (including access area).	9 ft 4 in. (2·84 m)	20 ft (6·1 m)	4 ft 4 in. (1·32 m)
Space for oil-filled units.	9 ft 9 in. (2·97 m)	9 ft 6 in. (2·9 m)	8 ft (2·44 m)
Space for air fan equipment.	9 ft 9 in. (2·97 m)	9 ft 3 in. (2·83 m)	8 ft (2·44 m)

Overall performance on ISB telephony using Type HD 51 and Type HD 21 drive equipment:

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Frequency response: Level within ±2 dB from 100–6000 c/s.

Overall performance on telegraphy using HD 20 series drive equipment:

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Keying speed: Normally 200 bauds, but higher speeds can be catered for.

Keying potentials: ±10 V into 2000 Ω.

Frequency shift: 200–1000 c/s.

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

30 kW HF Amplifier *Type HS 61*

ON PARTICULAR round-the-clock telephone and telegraph services there are periods of transmission when the power required for satisfactory communication exceeds that in normal use. The Type HS 61 30 kW linear HF amplifier has been designed to operate in conjunction with a 3½ kW transmitter Type HS 31 for providing this additional power. Special facilities can be included to permit the switching of a Type HS 61 Amplifier to any one of a number of Type HS 31 Transmitters and its output to any one of a number of aerials.

FEATURES

Tuning over the whole frequency range, with no change of components.

Forced-air cooling throughout, with associated dust filtering.

Double screening of power stages, resulting in reduction of indirect radiation and of noise due to air cooling.

Grounded grid technique used in both amplifier stages.

Instantaneous changeover from ISB to CW without power switching or retuning.

Compact construction and easy servicing.

Full protection of both personnel and equipment by safety interlocks and overload devices, including a 'three-shot' HT restoration system.

CONSTRUCTION

The amplifier assembly is housed in an enclosure formed of five unit sections and the design allows for access to all parts, with doors at front and rear.

Air ducting conveys cooling air to and from a separate fan room situated at the rear. The fan supplies 3000 cu.ft. of cooling air per minute. Control of the fan is exercised from the front of the amplifier, and the equipment is arranged to shut down in the event of a failure in the supply of cooling air.

In addition to the fan room, a fireproof room or compartment should also be provided for the accommodation of the oil-filled components.

The minimum recommended ceiling height for the transmitter hall is 10 ft. No cabling trenches are necessary.

CIRCUIT

Both of the high-power valve circuits are similar in design, each consisting of a grounded grid amplifier using an air-cooled triode working under class B2 conditions. Capacity coupling is employed between the two amplifier stages and the second stage is inductively coupled to a balanced feeder circuit terminated in a matching unit to suit the particular type of feeder required.

DATA SUMMARY

Used in association with Transmitter Type HS 31:

Nominal output (to aerial feeder):
- (*a*) ISB working – 30 kW peak envelope power.
- (*b*) CW on/off or FSK – 20 kW.
- (*c*) DSB working – 7·5 kW.

Frequency range: 4–27·5 Mc/s (75–10·9 metres) on all services.

Output impedance: 600 Ω for balanced twin-wire feeder; 200 Ω for twin coaxial feeder.

Harmonic radiation: Below 200 mW (Atlantic City Standards).

Noise level: Not greater than −50 dB for individual frequency components relative to peak envelope power for the overall system on ISB, or −40 dB relative to 95% modulation on DSB.

Power supply: 380–440 V (line) 3-phase 50 c/s AC (normally 4 wire). Regulation to be within ±2½% in frequency. Arrangements can be made for operation from 60 c/s supply.

Power consumption: (at 0·9 p.f.)

ISB	48 kW with two-tone modulation
	16 kW pilot carrier only
CW	56 kW on 'mark'
	14 kW on 'space'
FSK	56 kW.

Overall performance on ISB service using Types HD 51 and HD 21 Drive Equipment:

Frequency tolerance: Within 1 part in 10^5.

Frequency response: Level within 2 dB from 100–6000 c/s.

Non-linear distortion: Third order intermodulation product is not greater than −36 dB relative to either of two equal testing tones for any power level up to peak envelope power.

Pilot carrier compression: Less than 1 dB for any level of single frequency signal up to −6 dB relative to peak sideband power.

Overall performance on telegraphy using Type HD 20 series drive equipment:

Frequency tolerance: Within 10 parts in 10^6, over the temperature range 10–40°C, ambient.

Keying speed: 200 bauds (250 w.p.m. morse). Provision for low-pass filter to meet CCIR requirements. Higher speeds can be catered for.

Keying potentials: Electronic keying, approx. ±10 V into 2000 Ω input load.

FSK operation: Frequency shift from ±100 to ±500 c/s about mean frequency.

Dimensions (approx.):

Height	Width	Depth
7 ft 6 in.*	12 ft 6 in.	4 ft
(2·28 m)	(3·81 m)	(1·22 m)

**9 ft (2·74 m) over air ducting.*

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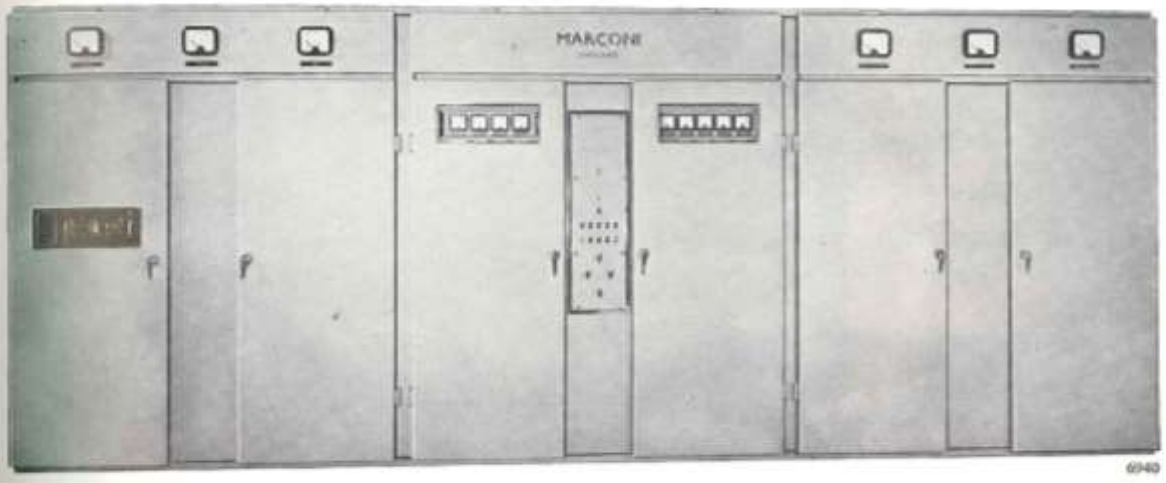
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

10 kW HF ISB Transmitter
Type HS41



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INTENDED FOR OPERATION on fixed services the Type HS 41 transmitter provides facilities for independent sideband and VF telegraph operation, or for telegraphy with CW on-off keying or frequency-shift keying. The equipment embodies many advanced design features and gives a high standard of performance whilst providing extensive control facilities.

A separate RF crystal drive source providing one of six predetermined frequencies (see page 321) is used with this transmitter.

The ISB drive equipment is separate from the transmitter proper and thus can be mounted in any convenient position. Facilities for monitoring the signal at various points in the transmitter may be provided in the ISB drive equipment. Suitable drive units are described on pages 315 and 317.

FEATURES

Continuous tuning of power stages over the entire frequency range without change of components.

Automatic selection of any one of six pre-set frequencies is provided for.

Tuning may be effected either locally or by remote control.

Air cooling throughout, with dust filtering.

Envelope feedback reduces distortion to minimum.

Double screening of power stages, resulting in reduction of indirect radiation and attendant decrease in noise due to cooling air.

Compact assembly with ready access for servicing and fully comprehensive safety interlocking.

CIRCUITS

Drive is obtained from an external crystal oscillator and applied, *via* two harmonic generator stages, to a balanced mixer stage. The balanced mixer also accepts a 3·1 Mc/s modulated signal from the ISB drive equipment, or a 3·1 Mc/s keyed signal from the drive keying unit, and converts this to the radiated frequency. The mixer is followed by three stages of RF amplification.

The output from the low-power stages is amplified by a tetrode stage comprising two valves in parallel, followed by a conventional tetrode stage. The final stage consists of a grounded-grid Class B linear amplifier. The final amplifier may be inductively coupled to a balanced feeder circuit or to an unbalanced coaxial feeder.

DATA SUMMARY

Nominal power output (to aerial feeder):
10–12 kW peak envelope power on ISB (A3b).
8–10 kW on CW on/off telegraphy (A1 and F2).
8–10 kW on FSK telegraphy (F1).
2·5–3 kW on DSB telephony (A3).

Frequency range: 4·0–27·5 Mc/s.

Output impedance: 190 Ω or 600 Ω balanced, or 75 Ω unbalanced, with 2:1 standing wave ratio.

Harmonic radiation: Less than 20 mW.

Noise level: Better than −60 dB relative to peak envelope power on ISB.

Non-linear distortion (ISB): Third order intermodulation product not greater than −36 dB relative to either of two equal testing zones for any power level up to full PEP.

Input level: Nominal 0·1 W from primary drive and 0·25 W from ISB or keyed telegraph drive (3·1 Mc/s).

Carrier compression: Less than 1·5 dB for any level of single-frequency signal up to −6 dB relative to peak sideband power.

Power supply: 380–415 V, three phase, 50 c/s AC mains, normally four-wire. Voltage regulation ±6%, frequency tolerance ±2½%. 60 c/s supply can be catered for.

Power consumption (at 0·95 power factor):
CW mark 30 kW, space 16 kW.
FSK 30 kW.
ISB 25 kW with two-tone modulation.

Dimensions (overall):

Height	Width	Depth
8 ft 6 in.	17 ft 2¾ in.	3 ft 8¾ in.
(2·59 m)	(5·25 m)	(1·14 m)

Overall performance on ISB telephony using Type HD 51 and Type HD 21 drive equipment:

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Frequency response: Level within ±2 dB from 100–6000 c/s.

Overall performance on telegraphy using HD 20 Series drive equipment:

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Keying speed: 200 bauds.

Keying potentials: ±10 V into 2000 Ω.

Frequency shift: 200–1000 c/s.

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Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

10 kW HF ISB Transmitters

Types HS71 and HS72

THESE TRANSMITTERS, which exemplify the most advanced practice in transmitter design, provide the following services:

a. Telegraphy on CW and FSK (A1 and F1).

b. Independent Sideband Operation (A3b).

The drive equipment is external and provides either independent sideband modulation or telegraph keying at 3·1 Mc/s and suitable RF oscillator signals for frequency changing in the transmitter.

A suitable modulator is available if DSB operation is required.

The Type HS 71 is manually operated whereas the Type HS 72 provides fully automatic tuning and selection of any one of six pre-set frequencies. In all other respects the two transmitters are identical.

FEATURES

Tuning over the whole range without change of components.

Air cooling throughout, with dust filtering.

Envelope feedback to reduce distortion.

Double screening of power stages, resulting in reduction of indirect radiation and of cooling air noise.

Compact assembly with good access for servicing and full safety interlocking.

CONSTRUCTION

Housed in an enclosure formed of unit sections with accessibility through front and rear doors, the transmitter assembly presents a pleasing symmetrical appearance. There are four bays, the left-hand two containing the rectifiers and power

control equipments while the two right-hand bays house the low power and auxiliary transmitting circuits and main output stage. The cooling blower is external to the transmitter. The external ISB drive equipments available for use with these transmitters are described on pages 315 and 317. For details of the primary RF drive equipment, keying unit, monitor unit, etc., see page 321. These 7-ft cabinet equipments may be situated in any convenient position near the transmitter. The equipment is designed for tropical use within an ambient temperature up to 40°C (high humidity) or 45°C (dry heat).

CIRCUIT

Drive is obtained from an external crystal oscillator and applied *via* a harmonic generator to a balanced mixer stage. The balanced mixer also accepts a 3·1 Mc/s modulated signal from the ISB drive equipment or a 3·1 Mc/s keyed signal from the drive keying unit and converts this to the radiated frequency. The mixer is followed by two stages of RF amplification.

The output from the low-power stages is amplified by two tetrode stages, each comprising two valves in parallel, followed by the penultimate stage which utilises a single triode connected as a grounded-grid amplifier. The final stage is two parallel-connected grounded-grid triodes inductively coupled to a balanced 600 Ω output circuit.

The main power stages are enclosed units and are further screened by the transmitter enclosure.

DATA SUMMARY

Nominal power output (to aerial feeder):
9–10 kW min. peak envelope power on ISB (A3b).
7 kW on CW on/off telegraphy (A1 and F2).
7 kW on FSK telegraphy (F1).
3·5 kW on DSB telephony (A3).

Frequency range: 4–27·5 Mc/s.
Alternative version 2·5–20 Mc/s.

Output impedance:
600 Ω balanced with 2:1 standing wave ratio. Special edition also available to provide 50 Ω unbalanced.

Harmonic radiation: Less than 20 mW.

Noise level: Better than −50 dB relative to peak envelope power on ISB.

Non-linear distortion (ISB): Third order intermodulation product not greater than −36 dB relative to either of two equal testing tones for any power level up to full PEP.

Input level: Nominal 0·1 W from primary drive and 0·25 W from ISB or keyed telegraph drive (3·1 Mc/s).

Carrier compression: Less than 1·5 dB for any level of single-frequency signal up to −6 dB relative to peak sideband power.

Power supply: 380–420 V three-phase 50 c/s AC mains, normally four-wire. Voltage regulation ±6%, frequency tolerance ±2½%. Arrangements can be made for operation from 60 c/s.

Power consumption: CW mark 21 kW, space 10 kW. FSK 21 kW. ISB 18 kW PEP with 0·9 power factor.

Dimensions:	Height	Width	Depth
	7 ft 6 in.	10 ft 7 in.	3 ft 9 in.
	(2·28 m)	(3·2 m)	(1·13 m)

Overall performance on ISB telephony using Type HD 51 and Type HD 21 drive equipment:

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Frequency response: Level within 2 dB from 100–6000 c/s.

Overall performance on telegraphy using HD 20 series drive equipment:

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Maximum keying speed: 200 bauds.

Keying potentials: ±10 V into 2000 Ω.

Frequency shift: 200–1000 c/s.

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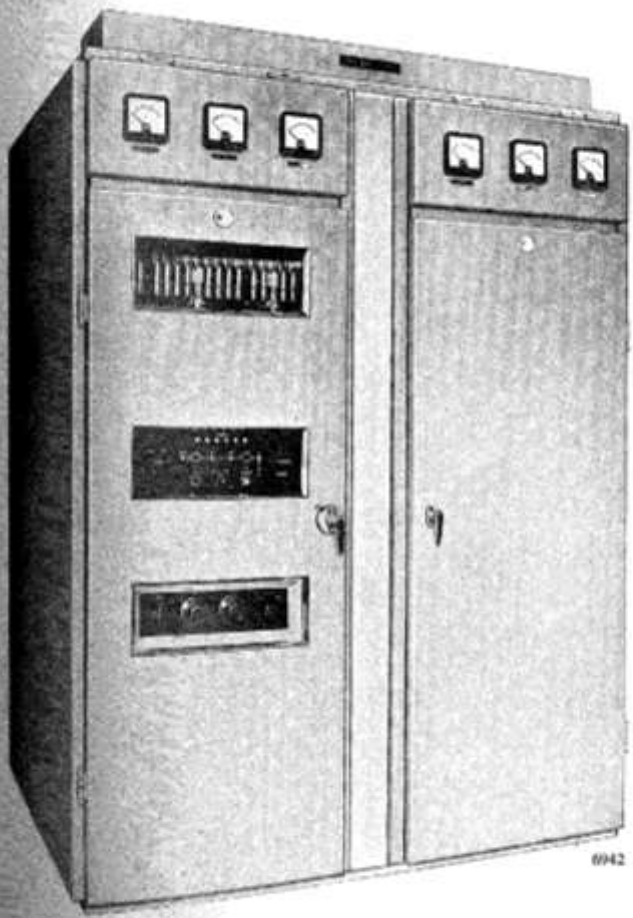
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

3·5 kW HF ISB Transmitters

Types HS 31 and HS 32

THESE MEDIUM-POWER HF transmitters are intended for independent sideband and VF telegraph operation, or for telegraphy with CW on/off keying or frequency-shift keying. The equipment embodies many advanced design features and combines a high standard of performance with modest overall dimensions.



The transmitter stages may be continuously tuned over the entire frequency range without change of components beyond padding capacitor switching in the final stage. This is made possible by the special design of the final stage anode tuning circuit which includes a continuously variable inductance coil mounted on the valve anode assembly.

Although the transmitter itself has continuous tuning it will usually be operated from a separate RF crystal drive source providing one of six predetermined frequencies (see page 321). Manual frequency selection is employed in the Type HS 31, whereas the Type HS 32 has automatic control and automatic 6-way frequency selection.

The transmitter assembly is housed in an enclosure formed of two unit sections, one containing the compact transmitting equipment, the other enclosing the rectifier and control gear. Air cooling is employed for all valves, the air-cooling suction fan being normally mounted in the base of the RF unit. Provision is made for mounting the fan externally if required. Double screening of the power stages serves to minimise indirect RF radiation. All stages of the transmitter are readily accessible with front and rear doors on each unit and withdrawable sub-units forming the low-power stages. Doors giving access to the interior are interlocked with the supply circuits for safety. The filaments of all valves except the penultimate stage are heated with alternating current.

The ISB drive equipment is separate from the transmitter proper and thus can be mounted in any convenient position. Facilities for monitoring the signal at various points in the transmitter may be provided in the ISB drive equipment. (See pages 315 and 317.) A modulator is available for DSB operation.

The FSK drive unit is also external to the transmitter and provides a 3·1 Mc/s keyed signal (see page 323).

By the addition of suitable amplifier units this transmitter can be up-rated to 10 kW when it is known as the Type HS 71 (see page 287).

CIRCUITS

Drive is obtained from an external crystal oscillator and applied, *via* a harmonic generator to a balanced mixer stage. The balanced mixer also accepts a 3·1 Mc/s modulated signal from the ISB drive equipment, or a 3·1 Mc/s keyed signal from the drive keying unit, and converts this to the radiated frequency. The mixer is followed by two stages of RF amplification.

The output from the low-power stages is amplified by two tetrode stages, each comprising two valves in parallel followed by the final stage which utilises a single triode valve connected as a grounded-grid amplifier. The final stage is inductively coupled to a balanced feeder circuit or may be matched to a coaxial feeder if required via a suitable external wideband transformer.

DATA SUMMARY

Nominal power output (to aerial feeder):
On ISB, FSK and CW service:
3·5 kW from 4–21 Mc/s.
2·5 kW from 21–27·5 Mc/s.
On DSB telephony:
1·5 kW carrier from 4–21 Mc/s.
1·0 kW carrier from 2–27·5 Mc/s.

Frequency range: 4·0–27·5 Mc/s.

Alternative version: 2·5–20 Mc/s.

Output impedance: Normally 600 Ω balanced twin wire. 190 Ω balanced or 75 Ω unbalanced, using external transformer.

Harmonic radiation: Less than 20 mW.

Noise level: Better than −50 dB (relative to peak envelope power on ISB).

Non-linear distortion (ISB): Third order intermodulation product not greater than −36 dB relative to either of two equal testing tones for any power level up to full PEP.

Input level: Nominal 0·1 W from primary drive and 0·25 W from ISB or keyed telegraph drive (3·1 Mc/s).

Carrier compression: Less than 1·5 dB for any level of single-frequency signal up to −6 dB relative to peak sideband power.

Power supply: 380–440 V, three-phase, 50 c/s AC mains, normally four-wire. Voltage regulation ±6%, frequency tolerance ±2½%. Arrangements can be made for operation from 60 c/s.

Power consumption (at 0·9 power factor):
CW mark 9 kW, space 3·6 kW.
FSK 9 kW.
ISB 7 kW with two-tone modulation.

Dimensions (overall):

Height	Width	Depth
7 ft 6 in.	5 ft 6 in.	3 ft 9 in.
(2·28 m)	(1·68 m)	(1·14 m)

Overall performance on ISB telephony using Type HD 51 and Type HD 21 drive equipment:

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Frequency response: Level within 2 dB from 100–6000 c/s.

Overall performance on telegraphy using HD 20 series drive equipment:

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Maximum keying speed: 200 bauds.

Keying potentials: ±10 V into 2000 Ω.

Frequency shift: 200–1000 c/s.

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

500-Watt HF ISB Transmitter
Type HS21

THE TYPE HS 21 HF TRANSMITTER has been developed in order to meet the general need for a low-power independent-sideband transmitter capable of giving a wide selection of transmission frequencies and suitable for operation over intermediate distances.

FEATURES

Twin-channel ISB operation on any one of up to four pre-selected frequencies.

Provision may be made for simultaneous operation of FSK telegraphy on channels not used for ISB transmission or, alternatively, a second twin channel ISB transmission may be radiated.

Local or remote control with complete operating facilities.

Built-in oscilloscope and monitor unit for setting-up purposes.

GENERAL DESCRIPTION

The complete transmitter consists of a single cabinet in which selected RF units, ISB drive units, FSK units and monitor units are mounted. Power supplies are permanently installed in the lower half of the cabinet.

The transmitter permits operation on one of four frequencies for independent-sideband transmission. It is possible to transmit up to two frequency shift signals simultaneously with the independent-sideband transmission.

Where remote control is desired, the various switching operations are performed on small remote control units, one for each operator. Each of these permits LT, HT and channel contactors to be operated as well as providing the keying or modulation inputs. Full metering facilities are provided throughout.

6570

ISB Drive Unit

The two speech input signals are fed separately to amplifiers whose outputs are taken to balanced 100 kc/s modulators. These produce upper and lower sidebands corresponding to the input

channels, the carrier being balanced out. Crystal filters stop the unwanted sidebands, the required signals being combined and fed with a pilot carrier to a further balanced modulator, which shifts the centre frequency to 2·15 Mc/s. This output is fed through a selective amplifier to the appropriate RF unit. A built-in valve voltmeter monitors the output level.

RF unit

A crystal oscillator, followed by a harmonic generator and buffer amplifier, produces the carrier frequency ±2·15 Mc/s, which is mixed with the output of the ISB drive unit in a balanced modulator to produce the final radiated frequency. This signal is fed to a tuned amplifier designed to eliminate unwanted modulation products. These stages are followed by a push-pull penultimate amplifier which feeds a push-pull output stage. On ISB, the grids of this stage, as well as being fed from a low-impedance source, are heavily damped in order to avoid signal distortion.

FSK unit

The shift circuit in the FSK unit employs the 'FMQ' principle, whereby a crystal working in series resonance is transformed by a quarter wave network to appear as a parallel impedance. A simple reactance modulator is then used to shift the frequency in a definite and controlled manner. The oscillator operates at 2·15 Mc/s, the shift being controllable between 200 and 1000 c/s, and is followed by amplifiers which feed the RF unit mixer as in the ISB condition.

Monitor unit

This unit consists of two sub-units, an oscilloscope and an acceptor unit. By means of these units and two audio test oscillators contained in the ISB drive unit the 'two-tone' waveform may be checked at the output during the setting-up procedure.

Power supply units

The transformers are mounted on wheels running on rails in the lower half of the cabinet. Smoothing equipment and rectifiers are mounted in trays above. Comprehensive fusing and overload protection are provided. Sufficient power is available to permit four channels to radiate simultaneously.

DATA SUMMARY

Power rating (to aerial feeder): ISB–500 W PEP. FSK–450 W (3–20 Mc/s), 400 W (20–27·5 Mc/s).

Frequency range: 3–27·5 Mc/s.

Feeder system: 600 Ω balanced or 75 Ω unbalanced.

Frequency tolerance: 10 parts in 10^6 over the temperature range 10–40°C, ambient.

Harmonic radiation: Less than 45 mW, complying with Atlantic City Standards.

Frequency response: Within ±1·5 dB from 250 to 6000 c/s.

Non-linear distortion: Third order intermodulation product not greater than −28 dB relative to either of two equal testing tones.

Pilot carrier noise level: Less than 40 dB rel. to PEP.

Speech input level: −20 dBm from 600 Ω lines.

FSK: Frequency shift: 200–1000 c/s.
Keying speed: 150 bauds max.

Power supply: 200–250 V single-phase, 50 or 60 c/s AC mains. Voltage regulation ±6%, frequency tolerance ±2½%.

Maximum power consumption: 7·5 kW max. at 0·8 PF.

Dimensions:

Height	Width	Depth	Weight
7 ft 2 in. (217 cm)	4 ft (122 cm)	3 ft 9 in. (113 cm)	30 cwt (approx.) (1524 kg)

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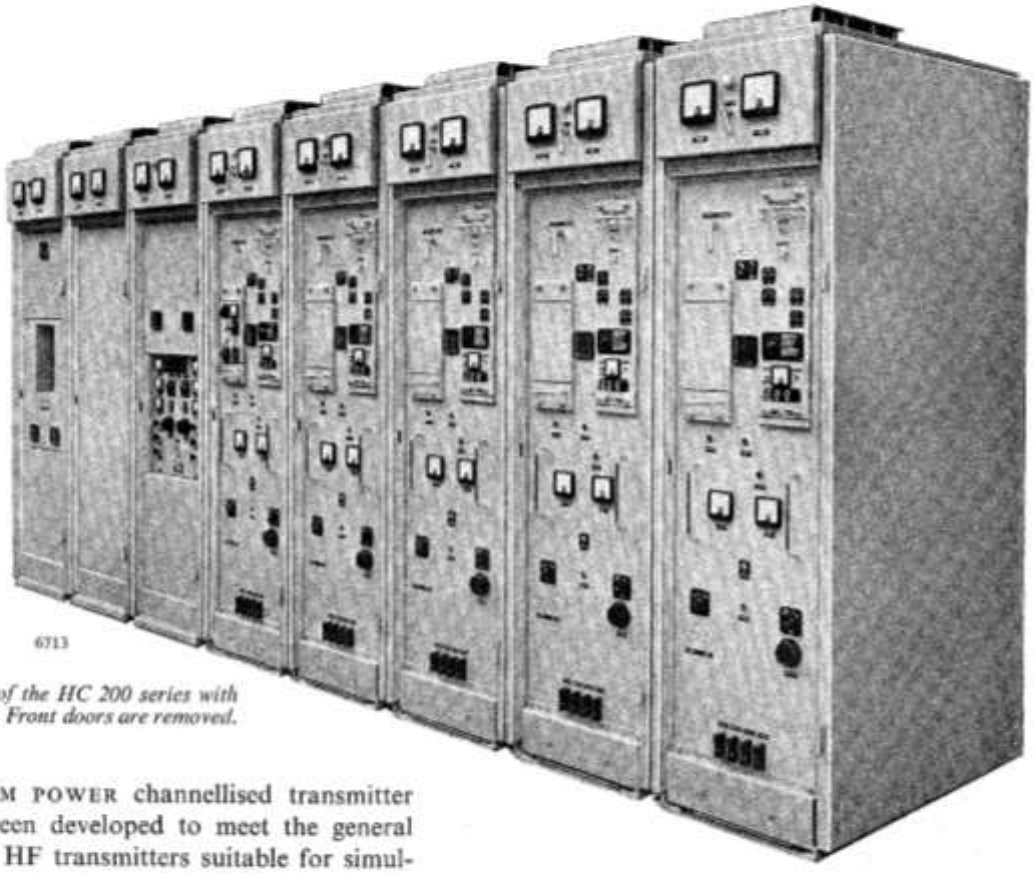
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

2·5 kW HF Channellised Transmitters
HC 200 Series



6713

A transmitter of the HC 200 series with spare RF units. Front doors are removed.

THE MEDIUM POWER channellised transmitter series has been developed to meet the general demand for HF transmitters suitable for simultaneous operation on up to four pre-set spot frequencies and at the same time providing facilities for various types of transmission.

The equipment is built on unit fashion so that it is possible to have different arrangements to provide the required facilities. It is also possible to expand the installation as station requirements grow, so giving maximum flexibility. The limits are determined by the power units, of which two types are available: the standard unit, Type HC 212, caters for four RF units or two RF units and two modulator units, whereas the half-power unit, Type HC 211 is for installations of half this size.

Facilities include CW, tone, ESK telegraphy and telephony, but for FSK operation an external drive is necessary.

GENERAL DESCRIPTION

A complete transmitter consists of several cabinets housing the required RF units, modulators, and power unit. Each RF unit can be tuned

to any spot frequency in the band 2–27·5 Mc/s.

Control may be either local or remote. The switching operations are performed on small units, one per RF channel, with keys or microphones provided in accordance with the service requirements. Instant channel selection is possible.

The various units comprising the complete transmitter are each divided into sub-units to form circuit chains depending upon the function of each whole unit, and are basically the same as those of the Type HC 100 series described on page 295.

DATA SUMMARY

Power rating (to aerial feeder):
Telephony 2 kW per channel (carrier).
Telegraphy 2·5 kW per channel.

Frequency range: 2–27·5 Mc/s. Simultaneous operation on four spot frequencies. (Lower limit 2·5 Mc/s on FSK and FMCW.)

Frequency tolerance: 5 parts in 10^6 over the temperature range 10–40°C, ambient.

RF harmonics:
Less than 200 mW, complying with Atlantic City Standards.

Modulation:
Up to 95% for Tone Telegraphy and Telephony.

Scintillation:
To comply with Atlantic City standards.

AF input level:
−20 dBm from 600 Ω line for full modulation.

Frequency response (telephony):
±2 dB from 250 to 3400 c/s.

Amplitude distortion (telephony): Not exceeding 6% for 80% modulation from 250 to 3400 c/s.

Noise level (telephony):
−40 dB with reference to full modulation.

Telegraph keying: Up to 160 bauds. Tone telegraphy, hand speed.

Power supply: 360–440 V (±5%), 50–60 c/s (±2½%), three-phase, four-wire AC mains.

Total power consumption (maximum): 24 kVA at 0·9 PF for four simultaneous FSK channels.

Overall dimensions:
(for four RF units, power supply unit and modulator unit).

Height	Width	Depth	Weight
7 ft 2 in. (218 cm)	11 ft 9½ in. (359 cm)	3 ft 9 in. (114 cm)	36 cwt. (1070 kg)

Possible channel arrangements:

Facility	*CW*	*Telephony or Tone Telegraphy*	*FSK or FMCW*
Number of channels	4	–	–
	–	2	–
	–	–	4
	3	–	1
	2	1	–
	2	–	2
	1	1	1
	1	–	3
	–	1	2

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

400-Watt HF Channellised Transmitters *HC 100 Series*

THE LOW-POWER SERIES of channellised transmitters combine in one cabinet facilities for various types of transmission with simultaneous operation on more than one channel. For stations operating on several services simultaneously, such as airports, ships and headquarters main offices, where installation compactness is an important factor, the HC 100 series is unexcelled.

FEATURES

Simultaneous operation on up to four crystal-controlled pre-set channels.

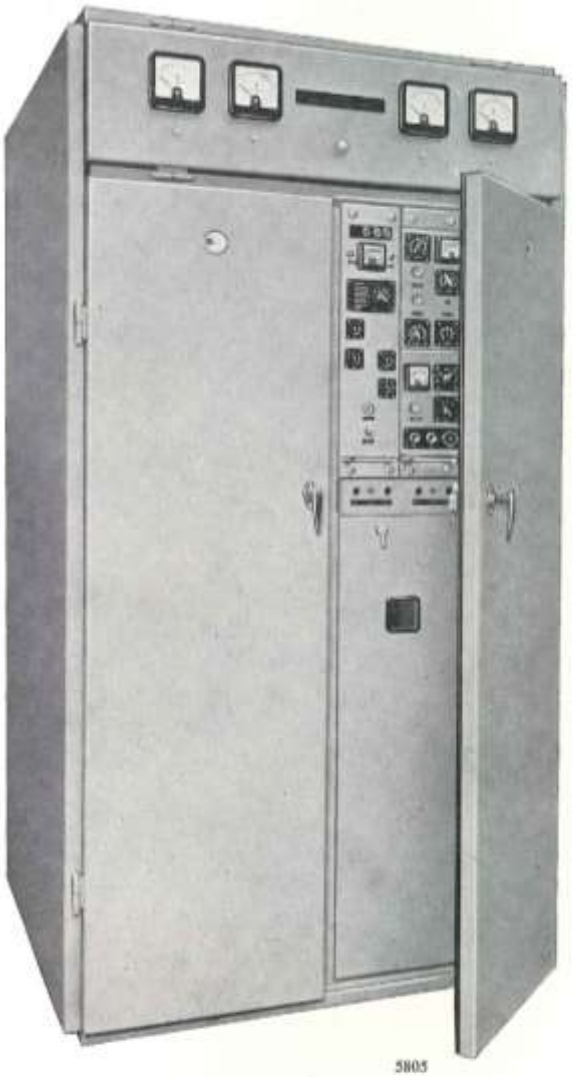
Facilities are provided for the following types of transmission:
- Continuous wave telegraphy.
- Tone telegraphy.
- Frequency shift telegraphy.
- Frequency modulated telegraphy.
- Phase modulated telegraphy.
- Telephony (high level modulation).

Unit construction employed. Selected RF, modulator or FSK units may simply be slid into the main cabinet to provide the desired transmission facilities.

Operation may be either local or remote.

Instant selection at the operating point of any of the working channels.

Spare RF units may be carried to give a wider selection of operating frequencies.



5805

GENERAL DESCRIPTION

The complete transmitter consists of a single cabinet in which selected RF units, modulators, phase modulators, or FSK units may be accommodated to provide the desired transmission facilities. Each RF unit is set up to operate on one predetermined spot frequency.

The switching operations are performed on small

remote control units, one per RF channel, with provision for either key or microphone according to the service required.

The various units comprising a complete transmitter are each divided into sub-units to form circuit chains depending upon the function of each whole unit.

RF units. These consist of a crystal master oscillator followed by an isolator, two harmonic amplifier stages, a penultimate stage and a final amplifier working into the aerial circuit.

Modulator unit. A modulator unit comprises the AF amplifying chain, the final stage working in Class B conditions and arranged for anode modulation of an RF stage. The modulator input may consist of a telephony input from microphone or telephone line at 600 Ω impedance or, alternatively, keyed tone can be obtained from an internal oscillator having a frequency of 1000 c/s to give tone telegraphy transmission.

FSK unit. FSK is obtained by a separate FSK drive unit, the output of which is fed into the harmonic amplifier stages of the transmitter. The FSK drive consists of several sub-units; a fixed frequency crystal oscillator with a mixer or frequency changer unit and amplifier stages. It also incorporates a 300 c/s test oscillator for setting up and this oscillator can be used to produce anti-fading frequency modulated CW when working into the FSK unit through the reactance valve.

When keying is changed from FSK to CW the same oscillator and mixer are used as in the case of FSK, but a steady oscillator frequency is maintained, and the keying input is transferred to the FSK output amplifier to give ON/OFF CW operation. Where FSK is not fitted Ph.MCW may be produced by means of a separate phase modulator.

Power supply units. The power supply units include components and circuits for the production of anode, grid and filament voltages for all stages considered above. Switches, fuses, relays and circuits are incorporated for control of the various units and of the single-phase AC mains.

DATA SUMMARY

Power rating (to aerial feeder): 400 W for all transmissions.

Frequency range: 1·6*–27·5 Mc/s. Simultaneous operation on four spot frequencies.

Frequency tolerance: 5 parts in 10^6 over the temperature range 10–40°C, ambient.

RF harmonics: Less than 40 mW complying with Atlantic City Standards.

Modulation: Up to 95% for tone telegraphy and telephony.

Scintillation: To comply with Atlantic City Standards.

AF input level: −20 dBm from 600 Ω line for full modulation.

Frequency response (telephony): ±2 dB from 250–3000 c/s.

Amplitude distortion (telephony): Not exceeding 6% for 80% modulation from 250–3000 c/s.

Noise level (telephony): −40 dB with reference to full modulation.

Telegraph keying: Up to 160 bauds. Tone telegraphy, hand speeds.

Power supply: 200–250 V (±5%), 50–60 c/s (±2½%), single-phase AC mains.

Power consumption (maximum): 8 kVA at 0·9 PF for 4 simultaneous FSK channels.

Overall dimensions:
Height 7 ft 2 in. (217 cm). Width 4 ft (122 cm). Depth 3 ft 9 in. (114 cm). Weight 2600 lb (1180 kg).

Transmitter types (channel arrangement):

Type	*CW*	*Telephony or tone telegraphy*	*FSK or FMCW*
HC 101	4	–	–
102	–	2	–
103	–	–	4
104	3	–	1
105	2	1	–
106	2	–	2
107	1	1	1
108	1	–	3
109	–	1	2

** 2·5 Mc/s for FSK.*

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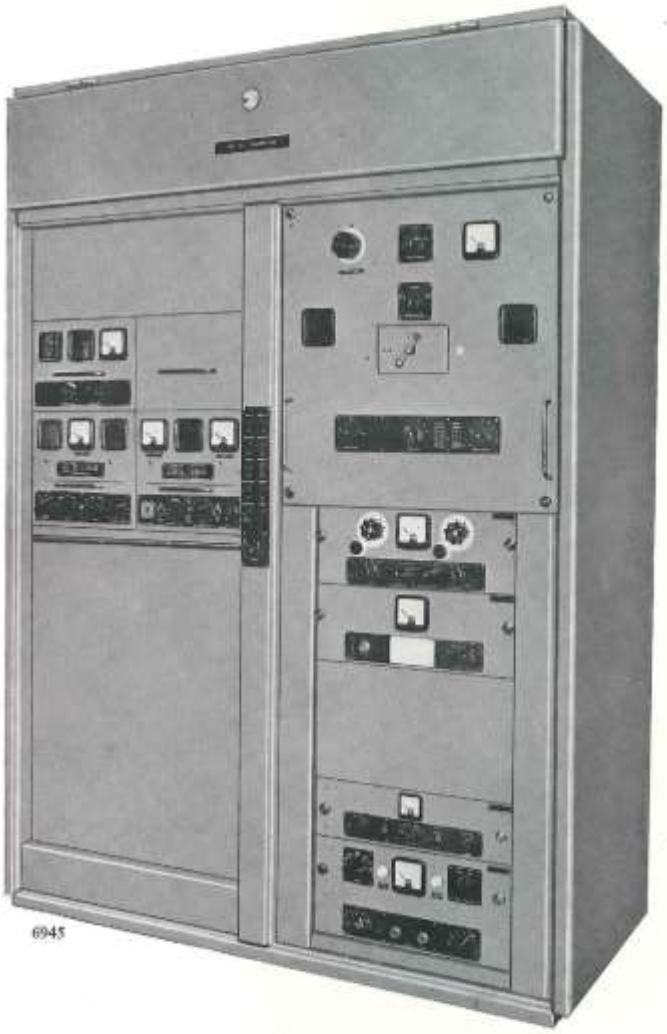
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

1·5 kW HF Telegraph/Telephone Transmitter *Type HS 101*

THIS VERSATILE self-contained equipment is intended mainly for fixed point-to-point telegraph and telephone links carrying public traffic, and for aeronautical, police or other security services. The Type HS 101 Transmitter has, however, a very wide field of application, as it is available in a number of editions, offering a wide selection of facilities and its performance is well within the requirements of the international regulations.


6945

FACILITIES

Editions are available giving various combinations of the following types of transmission:

Continuous wave telegraphy.
Phase- or frequency-modulated CW telegraphy.
Frequency-shift keyed telegraphy.
Frequency-modulated frequency-shift telegraphy.
Telephony.

All editions have crystal control and an auxiliary variable-frequency oscillator (VFO) can be incorporated.

A two-wire remote control system and a multi-wire extended control system are available. All editions can be equipped either for single-phase or three-phase power supplies.

GENERAL

The transmitter is housed in a twin-bay cabinet. The left-hand bay contains, in the lower part, the power supply components and, on the appropriate editions, the modulation transformer. In the upper portion of the bay are mounted the local control panel, absorber unit, relay and bias supply units and, when fitted, the modulator unit.

The final RF stage is assembled in a single withdrawable unit mounted in the upper section of the right-hand bay. In the lower half of the bay is housed the selection of runner-mounted auxiliary units appropriate to the transmitter

edition. The range of auxiliary units includes FSK and mixer units, telegraph monitor, modulator and variable-frequency oscillator. A blower is mounted behind the auxiliary units.

Electronic keying with partial absorption and signal curbing is a standard feature which serves to reduce spurious emissions, while low harmonic radiation is ensured by completely screening the final RF amplifier.

External auxiliary units are available for extended or remote control of the transmitter. The facilities offered by these units are:

(*a*) Stand-by/On/Off switching.

(*b*) Speech.

(*c*) Telegraph keying.

On speech the carrier is switched by means of the telephone pressel switch.

If required all services can be operated directly at the transmitter itself, from the local control panel.

CIRCUIT

On those editions of the transmitter which include CW and phase-modulated CW service the crystal oscillator or VFO is followed by a harmonic generator chain whose output is fed to the final RF stage. This stage employs two air-cooled tetrodes connected in push-pull. The keying signal from the auxiliary units is applied to one of the harmonic generator stages *via* the absorber.

On those editions of the transmitter which include FSK service the output of the crystal oscillator (or VFO) is taken, together with the output of the keying unit to a mixer stage. After amplification the signal from the mixer is applied to the push-pull tetrode final RF amplifier.

High-level modulation is employed on all editions that offer telephony service. The final RF amplifier is modulated by the output of an AF amplifier chain that includes a volume limiter.

The main HT DC rectifier employs xenon-filled rectifier valves.

DATA SUMMARY

Nominal power output (to aerial feeder): CW On/Off and FSK 1·25–1·5 kW; Telephony (carrier) 850 W.

Frequency range: 2·5–20 Mc/s. Six crystal-controlled frequencies within this range. A variable-frequency oscillator is also available.

Frequency tolerance: 15 parts in 10^6.

Output impedance: 600 Ω balanced. Maximum standing wave ratio 2 : 1 (a transformer is available for matching into coaxial feeders).

Harmonic radiation: Less than 150 mW complying with Atlantic City standards.

Telegraph keying: Single or double current, at speeds up to 100 bauds.

Modulation: Up to 100%.

AF input level: −20 dBm for full modulation.

AF response: ±2 dB from 300 to 3400 c/s.

AF distortion: Less than 5% at 80% modulation.

Hum level: −40 dB relative to 100% modulation.

Power supply: Either 200–250 V single-phase or 360–440 V three-phase four-wire AC mains, 50–60 c/s. Permissible variation, voltage ±6% frequency ±2½%.

Power consumption: 5 kW max. at 0·9 PF.

Dimensions (overall):

Height	Width	Depth	Weight
7 ft 3 in.	5 ft	2 ft. 6 in.	2500 lb (approx.)
(220 cm)	(152 cm)	(76 cm)	(1130 kg)

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

400-500 Watt HF FSK Transmitter *Type HS92*

THIS is a low-power transmitter developed for FSK operation on four spot-frequencies. In the design, emphasis has been placed on low initial cost, reliability and simplicity of operation. These features make the equipment especially suitable for middle-distance teleprinter operation.

FEATURES

Any one of four spot-frequencies may be rapidly selected.

Rapid wavechange may be undertaken by semi-skilled operators, with lamp indication of correct functions.

Four separate 50 Ω coaxial outputs, the required output selected automatically during wave changing.

Built-in FSK drive unit with direct indication of frequency-shift on panel mounted meter.

Suitable for tropical conditions – sealed against entry of dust or insects.

Fully protected by interlock and trip system.

CONSTRUCTION

The transmitter is housed in a 6 ft metal cabinet and comprises three main units as follows: RF unit, FSK drive unit and power supply unit. The RF and FSK units are runner-mounted for easy access, and full metering facilities are provided on the front panels. The cabinet is dust proof and the equipment is suitable for tropical use.

CIRCUIT

A 3·1 Mc/s crystal oscillator in the FSK unit is frequency-shifted by a reactance modulator stage controlled by an electronic relay circuit. The

oscillator output is fed to a balanced mixer stage and mixed with the output from a four spot-frequency crystal drive oscillator. The final radiated frequency is selected by the mixer anode circuit, amplified and fed to the RF Unit.

This unit contains a low-power amplifier stage coupled to the output tetrode which is matched to the aerial feeder by a π circuit.

Throughout the transmitter the number of controls has been reduced to a minimum.

DATA SUMMARY

Frequency range: Four spot-frequencies in the range 2–20 Mc/s.

Service: FSK (F.1).

Power output (nominal to aerial feeder):
500 W (2–10 Mc/s).
400 W (10–20 Mc/s).

Output impedance: 50 Ω unbalanced.

Maximum SWR: 2:1

Note: An external matching transformer can be supplied for converting the 50 ohms unbalanced output to 600 ohms balanced, when required.

Frequency stability: ±15 parts in 10^6 over a 10°C range between 10°–40°C ambient.

Harmonic radiation: Below 200 mW (complies with International Regulations).

Keying speeds: 200 bauds max.

Frequency shift: Variable between 200–1000 c/s.

Power supply: 200–250 V, 50–60 c/s, single phase.

Power consumption: Standby: 425 W.
Total: 1800 W.

Dimensions:

Height	Width	Depth	Weight
6 ft (185 cm)	2 ft (61 cm)	2 ft 6 in. (76 cm)	1470 lb (670 kg)

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

200-Watt HF Telegraph/Telephone Transmitter *Type TGS 541B*

PARTICULARLY SUITABLE for fixed stations working point-to-point, this HF transmitter also offers facilities for headquarters stations operating to mobile services.

The transmitter is designed for local control and employs hand selection of frequency. If specially required the transmitter can be provided with extended multi-wire control for use from a nearby position.

FEATURES

Rapid selection of any of six predetermined spot frequencies.

Facilities for CW, MCW and telephony, and provision for phase modulation of the carrier as an anti-fading device. FSK can be provided by the use of an external drive unit Type HD 63.

Keying at speeds up to 100 bauds with full absorption.

A voice-operated carrier switching unit can be employed in addition.

Provision for power reduction in three steps down to 5 W output.

All units are mounted on extension runners thereby providing complete accessibility and facilitating servicing.

Visual and aural monitoring of all services at both local and remote control points is provided.

'Listening through' facilities are incorporated.

The normal output circuits provide for both 600 Ω balanced and single-wire unbalanced conditions.

5528

CIRCUITS

The crystal oscillator drives into a phase splitter stage, the output of which is applied to the grids of two cathode followers working in push-pull and constituting the phase modulation driver stage. The output of this stage is fed to the grids of two pentode valves *via* an RC network. A phase difference in the grid signals of 90° is thereby introduced and the anode currents, which feed into a common load, vary correspondingly in phase. The combined output is then fed to the aperiodic amplifiers which raise the signal level so that sufficient drive to the harmonic generators is ensured.

Phase modulation of the carrier is effected by superimposing an LF voltage on the steady DC voltage applied to the suppressor grids of the pentode valves in a differential manner (*i.e.*, the voltage of one grid is a maximum when the other is a minimum and *vice versa*). This results in the current in the load varying in phase by ±45° with respect to its mean value. The LF voltage is obtained from a local tone oscillator.

Two harmonic generator stages are incorporated and are switched to give the necessary frequency multiplication to cover the range, their output being automatically maintained constant throughout. The output circuits of these two stages are pre-tuned to the six spot frequencies of the transmitter.

The final stage consists of six tetrode valves, working in parallel push-pull. Anode modulation is applied for MCW and telephony working. The transmitter can be operated either at full power or in one of three reduced power conditions with a minimum value of 5 W.

AERIALS

The normal output circuits are designed to provide both a balanced output, working into 600 Ω impedance (assuming the standing-wave ratio is not greater than two), and also an unbalanced output such as is required for use with a harmonic aerial of not less than a quarter-wave in length. The balanced output is not used for frequencies below 3 Mc/s.

DATA SUMMARY

Power rating (to aerial feeder):
CW 200 W.
MCW 180 W (when modulated 95%).
Telephony 125 W carrier (modulation up to 95%).

Frequency range: 1·5–23 Mc/s.

Frequency tolerance: 100 parts in 10^6.

Service: CW, Ph.MCW, MCW, telephony. FSK using external drive unit Type HD 63.

AF harmonics: AF harmonic content on full-power telephony does not exceed 6% at 80% modulation between 200 and 3000 c/s.

Keying: Up to 100 bauds.

Modulation: 95% max. on MCW and telephony.

AF input level: Transmitter is fully modulated by a speech level of 15 dB below 1 mW.

AF response: Level within ±2 dB from 200–7000 c/s at the transmitter.

Noise level: At least −45 dB with reference to 95% modulation at full power.

Power supply: 200–250 V, 50–60 c/s single-phase AC mains. Voltage regulation ±6%, frequency tolerance ±2½%.

Power consumption: 1·5 kVA at 0·85 PF on full power.

Dimensions:

Height	Width	Depth	Weight
6 ft 2 in. (188 cm)	1 ft 11 in. (58 cm)	2 ft 1 in. (64 cm)	664 lb (301 kg)

Ventilator fittings add approximately 8 in. (20 cm) to the above height.

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

100-Watt HF Telegraph/Telephone Transmitter *Type TGS501*

SUITABLE for fixed and land stations on relatively short and secondary links, the Type TGS 501 transmitter is of small dimensions and low weight.

The transmitter is built up in two units, both assembled in the main structure.

Unit A contains the aerial circuits, RF stages and modulators. The voice-operated carrier switching unit, if required, is also fitted in this section.

Unit B contains the power supplies for the whole transmitter.

Unit A is hinged at the bottom of its front panel and the unit may be pivoted on this hinge clear of the transmitter structure. Unit B is assembled beneath unit A in the main cabinet and hence full access is provided to the components of units A and B. Safety switching arrangements prohibit access to live circuits, thus ensuring protection of personnel, but, although the power is automatically cut off when unit A is swung out, it can be re-applied deliberately for testing purposes.

FEATURES

Service selection of CW, MCW and telephony, keying being confined to hand speeds. FSK can be provided by the use of an external drive unit Type HD 63.

Immediate choice of any one of seven pre-selected crystal-controlled spot frequencies.

Simple tuning arrangements assisted by the use of multi-colour indicators.

A voice-operated carrier switching unit (VOCSU) may be fitted as an optional feature. Common-frequency duplex operation is thus possible when employing an associated receiver fitted with desensitising facilities.

'Listening through' facilities are provided for telegraphy operation.

Access for servicing made easy by hinged front panel construction.

The normal aerial termination provides for two alternative conditions.

Full operational metering facilities are provided.

All controls are mounted on the front panels and the transmitter may be operated by relatively unskilled personnel.

Either a table stand microphone or a telephone handset is used for telephony working. Sidetone is provided.

CIRCUIT

The transmitter circuit design has been simplified as far as possible. The crystal oscillator is controlled by a limiter and followed by a buffer stage and a frequency multiplier which drives four valves in parallel push-pull.

By controlling the gain of the doubler stage, the power output from the transmitter is maintained substantially level over the whole frequency range.

Freedom from keying 'chirp' is achieved by running the crystal oscillator continuously and keying the buffer and doubler stages. To prevent spurious radiation on space the crystal oscillator is enclosed in a cast aluminium box and all leads to it are filtered.

Anode and screen modulation of the final stage is effected up to a depth of 80% by means of Class AB 2 modulators which are driven by a three-stage speech amplifier entirely resistance-capacity coupled. Full modulation is attained with an input of less than 1 mW. The input may be by 600 Ω line, and remote on/off switching in this case would be confined to the use of VOCSU. The carrier switching in normal telephony operation is by means of a switch on the microphone.

AERIALS

The normal aerial termination will provide for the following alternative conditions:

(*a*) Unbalanced output suitable for a harmonic aerial not less than one quarter-wave in length.

(*b*) Balanced 600 Ω feeder coupling for frequencies above 3 Mc/s. If a number of aerials are required for different frequencies, each with a 600 Ω feeder, switching facilities can be provided.

DATA SUMMARY

Power rating (to aerial circuit):
CW: 80–100 W.
MCW: 90–120 W (80% mod.)
Telephony: 70–90 W carrier (max. mod. 80%).

Frequency range: 1·5 to 13 Mc/s (selection of 7 spot frequencies).

Frequency tolerance: 100 parts in 10^6.

Modulation: Up to 80% for both MCW and telephony.

AF input level: −15 dB rel. to 1 mW for 80% modulation.

AF response: Within ±2 dB from 275 to 4000 cycles per second.

Noise level: 40 dB down at 80% modulation on full power telephony.

Harmonic performance:
(*a*) AF harmonic content on full power telephony will not exceed 8% at 80% mod.
(*b*) RF harmonics less than 8 mW, in full conformity with Atlantic City Standards.

Power supply: 100–125 V and 200–250 V, 50–60 c/s, single-phase AC mains.

Power consumption: 0·8 kVA. (max.) at 0·9 PF.

Dimensions:

Height	Width	Depth	Weight
3 ft 7¾ in. (111·1 cm)	2 ft 1 in. (64 cm)	1 ft 10¾ in. (56·8 cm)	316 lb (144 kg)

Marconi

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

60 Watt HF SSB Transmitter/Receiver

Type HSR21

THE TYPE HSR 21 HF transmitter/receiver has been designed to provide communication over medium distances in under-developed and similar areas where reliable and easily installed HF radio communication facilities are essential. By the use of single-sideband transmission and reception a performance equivalent to that provided by conventional amplitude-modulated (AM) equipment of many times the power output may be obtained simply and at low cost. Other advantages resulting from SSB operation are much improved intelligibility during reception of signals subject to selective fading, and reduction in interference from other transmissions due to a narrower and more sharply defined receiver passband.

The equipment permits simplex operation on any one of four crystal-controlled spot frequencies. Channel selection is effected by one knob and the remaining controls can be operated by unskilled operators once the equipment has been set up on the working frequencies. The frequency stability is such that automatic frequency control is unnecessary, the lower sideband and no carrier being radiated when communication with existing AM stations is required. There is also provision for manually keyed CW or MCW transmission and reception.

A switch is provided to enable speech operation from any one of three remote desk sets, located up to approximately 100 yards away. For communication under difficult conditions speech clipping may be switched in which results in a greater average power output. The aerial system employed is a single quarter-wave wire.

CONSTRUCTION

The equipment comprises two units mounted one above the other in a steel cabinet. Both units may be drawn forward and access to the RF unit for setting up the working frequencies is provided by a removeable top panel. A meter is included in the RF unit for monitoring and setting up.

CIRCUIT

The transmitter follows normal SSB design but has been simplified as far as possible. Speech signals pass through the microphone amplifier to the 100 kc/s balanced modulator. The lower sideband product is selected by a crystal filter and then shifted to 1·6 Mc/s in the second modulator.

After amplification at this frequency the signal is shifted to the radiated frequency in the third modulator. Two linear amplifiers follow and the output stage feeds *via* a π network to the aerial.

The receiver is a double superheterodyne using the same intermediate frequencies as the transmitter. A tuned RF stage is included and a crystal sideband filter identical with the transmitter filter is used to select the wanted sideband.

The 100 kc/s, 1·7 Mc/s and RF oscillators are crystal controlled and common to transmitter and receiver. Four switched crystals are used in the RF oscillator for channel selection and these, together with the 1·7 Mc/s crystal, are mounted in a thermostatically controlled oven in order to achieve sufficient frequency stability.

The power supply circuits are conventional and provide HT, LT and bias supplies for the equipment.

DATA SUMMARY

GENERAL

Frequency range: 3–15 Mc/s. Choice of four crystal controlled spot frequencies located as follows:

Channels 1 and 2, 3·0–6·7 Mc/s.
Channels 3 and 4, 6·7–15 Mc/s.

Service:

Telephony:

Single sideband, suppressed carrier, or single sideband with full carrier.

Telegraphy:

CW, ON/OFF Telegraphy (A1) or single sideband keyed tone.

DSB and MCW signals can also be received.

Power supply: 110–115 or 200–250 V, single phase, 50–60 c/s AC.

Power consumption: Receive: 130 W.
Transmit: 330 W.

Dimensions:

Height	Width	Depth	Weight
23 in. (90 cm)	22 in. (87 cm)	20 in. (79 cm)	160 lb (75 kg)

TRANSMITTER

Frequency tolerance: 3 parts in 10^6.

Power output: 60 W PEP.

Non-linear distortion: Third order intermodulation products less than −26 dB relative to either of two equal testing tones.

Frequency response: Level within 3 dB from 350–3000 c/s.

RECEIVER

Signal/noise ratio: 12 dB minimum for 1 μV sideband signal.

Frequency response: Level within 3 dB from 350–3000 c/s.

Selectivity: Attenuation at 700 c/s outside 350–3000 c/s passband is greater than 60 dB.

AF output: 1·5 watt maximum into built-in loudspeaker.
Provision for headphones.

Marconi

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

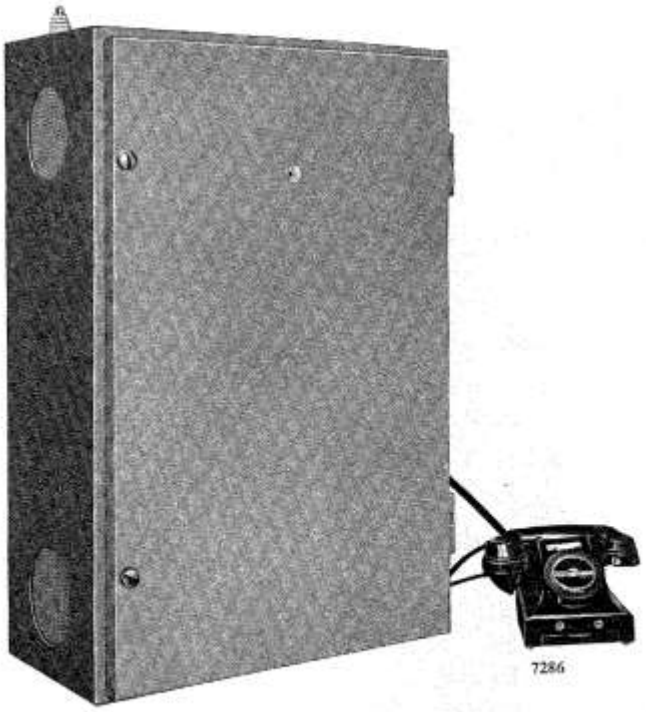
50-Watt HF Transmitter/Receiver
Type HSR 11

IN THE DESIGN of the Type HSR 11 HF Transmitter/Receiver emphasis has been placed on low initial cost, reliability and simplicity of operation. These characteristics, together with the robust manner of construction make this equipment particularly suitable for basic communication over medium distances in underdeveloped areas.

The Type HSR 11 transmitter/receiver is a pretuned equipment for telephone or hand-speed CW telegraph service. The transmitter gives 50 W power to the aerial on either of two spot frequencies. The receiver also operates on either of two spot frequencies, which may differ from those of the transmitter. When working telephony only the set is controlled from a desk telephone control unit, which may be placed up to 100 yards approximately from the main equipment. On/off switching and frequency changeover can be effected at the desk telephone control unit. For telegraph working the desk unit is not required, the headset and key being plugged directly into jacks on the front panel of the main equipment. This panel carries all operating controls needed, including a frequency changeover switch.

The facility of listening-through is provided so that, except for the case of common-frequency working, 'break-in' CW can be worked where separate receiving and transmitting aerials are installed.

Where both telephone and telegraph service are required the telephone desk unit is plugged directly into a socket on the main cabinet and the equipment is operated from that point.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CONSTRUCTION

The main equipment comprises four units mounted in a heavy-gauge steel cabinet having a removable hinged door. These units are: the transmitter RF unit, receiver unit, transmitter modulator unit and power supply unit. Each of these is supported on angle brackets fixed to the sides of the cabinet. They are easily removable, multi-pin plugs and sockets being used on the inter-unit cabling. A switched meter is included on the transmitter RF unit for taking measurements at all important parts of the circuit.

CIRCUIT

In the transmitter a crystal-controlled oscillator drives two power tetrodes connected in parallel.

A loading coil and a range of series capacitors enable the transmitter coupling to be adjusted to deal with the wide range of load impedance presented by a single-wire aerial. The taps are preset to suit the two spot frequencies to be used.

The modulation chain comprises a line amplifier, phase splitter, push-pull triode driver stage and push-pull tetrode modulator. A limiter and limiter amplifier are also incorporated.

A tone oscillator is provided to generate AF sidetone on CW working.

The receiver is of the superheterodyne type with a crystal-controlled local oscillator. One stage of signal-frequency amplification is employed. The circuits are pre-tuned for either of two spot frequencies not necessarily those of the transmitter. A beat frequency oscillator, with variable control, may be switched into use for telegraph reception.

Conventional power supply circuits are used to provide the necessary HT, bias and filament heating supplies for the transmitter and receiver.

DATA SUMMARY

Frequency range: Choice of two crystal-controlled spot frequencies located anywhere within the range 2–12 Mc/s.

Nominal power output (to aerial feeder): 50 W on CW On/Off Telegraphy (A1) and Telephony (A3).

Frequency tolerance: 100 parts in 10^6.

RF harmonic distortion: Less than 6% at 90% modulation.

Frequency response (telephony): ±2 dB from 300–3,400 c/s.

Aerial system: Single-wire 'vertical' or inverted 'L' aerial approx. 60 ft (18 m) long.

Receiver adjacent channel selectivity:
Bandwidth at −6 dB not less than 8 kc/s.
Bandwidth at −30 dB not greater than 36 kc/s.

Receiver signal/noise ratio: With a signal modulated 30% at 400 c/s connected *via* 230 Ω to the aerial terminal, a 10 dB signal/noise ratio is obtained for an input of 10 dB relative 1 μV.

Receiver AF output: 2 W max. in 3 Ω at 1 kc/s. The total harmonic distortion under these conditions is less than 5%.

Power supply: 100–115 V or 200–250 V, 50–60 c/s single-phase AC mains.

Power consumption: 350 W on telephony (full modulation) 280 W on CW telegraphy (key down).

Dimensions:

Height*	Width	Depth	Weight
3 ft (91 cm)	1 ft 10½ in. (57 cm)	1 ft 1 in. (33 cm)	90 lb (41 kg)

* *Including aerial insulators.*

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

3 kW MF Telegraph/Telephone Transmitter *Type TGM 651*

THE Type TGM 651 TRANSMITTER is a medium-power equipment designed to give a high performance combined with ease of operation. It is especially suitable for land stations operating to ships. Although the standard frequency range is 550–275 kc/s, the lower limit can be extended to 100 kc/s. The transmitter is then known as the Type TGZ 651.

The set is housed in a four-bay cabinet. Each unit can be withdrawn on runners from the cabinet, giving complete accessibility to any part of the transmitter for servicing. In order to protect operating personnel, safety switches are fitted which ensure that no unit can be withdrawn until the power is cut off. When required, covers can be supplied which completely enclose the

equipment with the exception of the aerial ammeter and final stage anode current meter dials.

The technique of enclosing all units in a single cabinet enables inter-wiring to be in factory-made cable-forms, thus reducing the 'on site' installation wiring to a minimum. The cabinet splits into four bays for easy handling during transport and installation, each bay being approximately 6 ft 10 in. high by 2 ft square.

FEATURES

Immediate switching to any one of six preselected crystal-controlled spot frequencies.

Simple and rapid frequency changing in approximately 15 seconds.

Control may be either local or remote, all controls being centralised into one unit in both cases.

Service selection of CW, MCW, and telephony.

A voice-operated carrier-switching unit can be fitted internally to the transmitter for telephony operation.

'Listening through' facilities are provided.

Both visual and aural monitoring are possible at local and remote points.

CIRCUIT

A crystal oscillator provides the drive which is fed to a pentode valve operating as a harmonic generator. This is followed by an isolator and RF amplifier operating under class A conditions, and the output is capacity coupled to the intermediate amplifier. This stage consists of two beam tetrodes in parallel suitably arranged so as to be kept in the safe dead-loss condition when no drive is applied. Two parallel-connected pentode valves comprise the final stage which is suppressor modulated for MCW and telephony operation.

DATA SUMMARY

Power rating (to aerial circuit):

CW: 2·5–3·0 kW
MCW: 1·0–1·2 kW
Telephony: 730–880 W (carrier)

} With provision for ½ or 1/16 full-power working.

Modulation: Up to 85% by suppressor-grid modulation of final stage.

Frequency range: 550–275 kc/s.

Frequency tolerance: 200 parts in 10^6.

Keying: Hand speed.

RF harmonics: Less than 200 mW radiated with either low or high-power output.

AF response: Within ±1 dB from 200–4000 c/s. (*Note*—These figures do not include sideband cutting due to the characteristics of the aerial circuit.)

Speech input level: Modulated to a depth of 85% by a level 15 dB below 1 mW.

AF harmonics: Less than 10% at 85% modulation.

Power supply: 340–430 V, 3-phase 4-wire 50 c/s AC mains.

Power consumption: 7 kVA at 0·85 PF on CW 'mark'.

Dimensions (overall):

Height	Width	Depth	Weight
6 ft 10 in. (208 cm)	7 ft 1½ in. (218 cm)	2 ft 2 in. (66 cm)	2200 lb (998 kg)

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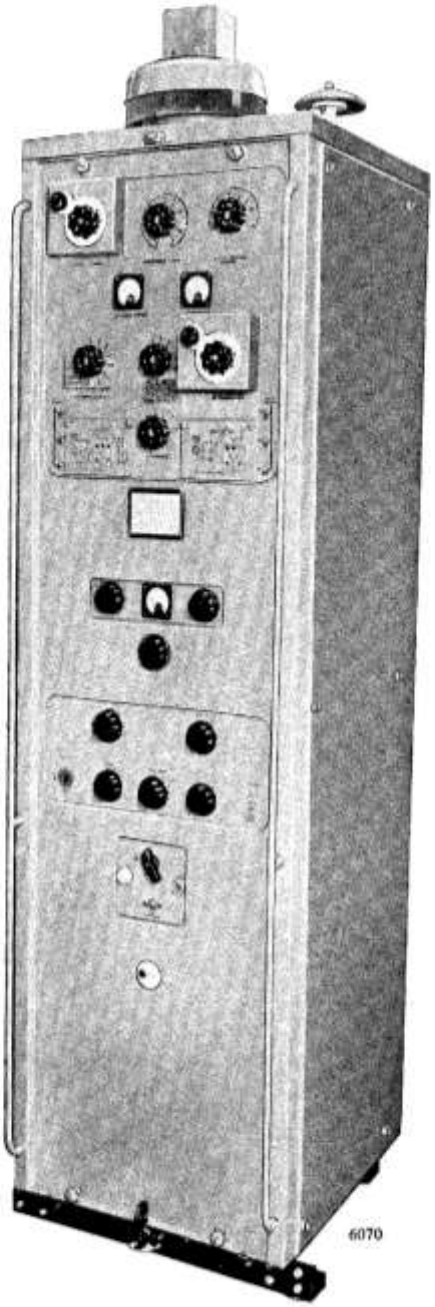
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

200-Watt MF Telegraph/Telephone Transmitter *Type TGM 541*

THE TYPE TGM 541 transmitter is suitable for both fixed stations working on point-to-point services and coastal stations operating mobile services. It has all the advantages of modern design in both its mechanical and electrical aspects, which, together with sound construction throughout, ensure a high standard of performance and reliability of operation.



FEATURES

Service selection of CW, MCW or telephony.

Manual selection of any one of six predetermined crystal-controlled spot frequencies.

A voice-operated carrier switching unit can be provided. Common-frequency duplex telephony is thus possible using an associated receiver fitted with desensitising circuits.

Full or reduced power operation.

Withdrawable unit construction gives full accessibility for servicing.

Interlocks ensure safety of personnel.

Aural monitoring of all services.

'Listening through' facilities are incorporated.

GENERAL DESCRIPTION

The equipment is made up of six units housed in a substantial single-bay metal cabinet. Each unit can be withdrawn from the front and fitted on extension runners, giving complete accessibility to all parts. Connections are made to each unit by self-aligning, self-cleaning contacts. All inter-unit wiring is carried in a space at the back of the transmitter and is enclosed by the back

panel. The power transformer is located at the base of the cabinet. A safety gate switch prevents removal of the front cover whilst power supplies are connected.

The output circuits are designed to give an unbalanced output, as required for use with a harmonic aerial. The RF output is monitored by means of a small diode rectifier, the demodulated signal being fed back to the operator's headphones. A keyed audio oscillator provides sidetone for CW monitoring.

The transmitter is primarily designed for local control and provides rapid hand-selection of up to six pre-set frequencies. If specially required provision can be made for remote operation from a nearby position, in which case the multi-wire extended control requires eleven pairs of conductors, including three screened pairs. The loop resistance of each pair should not exceed 30 Ω to ensure satisfactory operation of the relays. This provides full remote control with the exception of frequency changing.

DATA SUMMARY

Power rating (to aerial feeder):

CW	200 W.
MCW	180 W (when modulated 95%).
Telephony	125 W carrier.

Frequency range: 275–550 kc/s.
1·6–3·4 Mc/s.
(Selection of 6 spot frequencies).

Frequency tolerance:
200 parts in 10^6 from 275–550 kc/s.
100 parts in 10^6 from 1·6–3·4 Mc/s.

Service: CW, MCW, telephony.

AF harmonics: AF harmonic content on full-power telephony does not exceed 6% at 80% modulation between 200 and 3000 c/s.

Telegraph keying: Hand speed.

Modulation: Up to 95% for both MCW and telephony.

AF input level: Transmitter is fully modulated by a speech level of 15 dB below 1 mW.

AF response: Level within ±2 dB from 200–7000 c/s at the transmitter.

Noise level: 45 dB below 95% modulation.

Power supply: 200–250 V, 50–60 c/s single-phase AC mains.

Power consumption: 1·5 kVA at 0·85 PF.

Dimensions:

Height	Width	Depth
6 ft 2 in. (188 cm)	1 ft 11 in. (58 cm)	2 ft 1 in. (63 cm)

(Ventilator fittings add approximately 8 in. (20 cm) to the height.)

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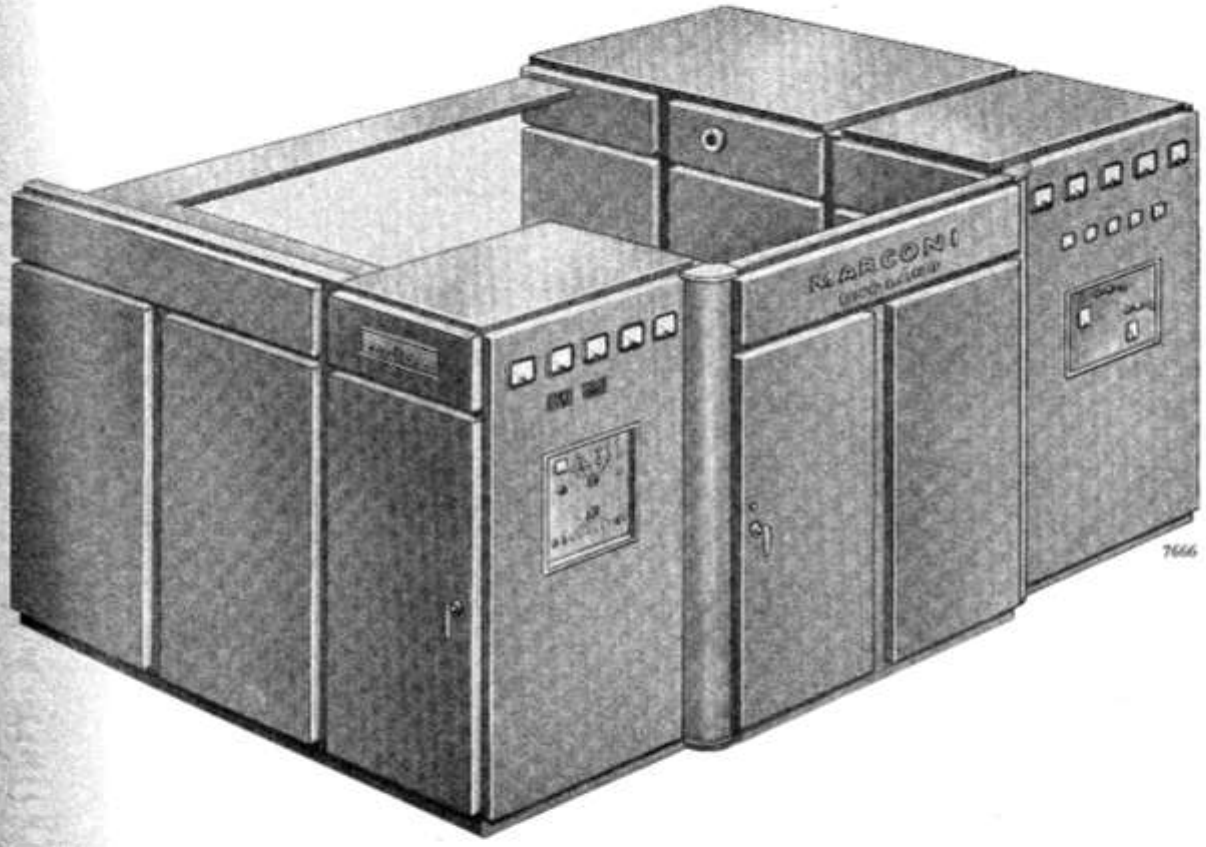
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

40 kW LF Transmitter
Type HS81



TYPE HS 81 is a high-power long-wave transmitter of compact design and robust construction. It is capable of providing a service of great reliability.

The associated drive, Type HD 64, provides a stable carrier frequency which may be either frequency-shift or on-off keyed at speeds up to 160 bauds (limited only by the aerial characteristics). One of six crystals is normally selected to provide a final radiated frequency in the band 75–160 kc/s. A variable-frequency LC oscillator is also usually provided, capable of covering the entire frequency range, for use on AC on-off services when required.

Monitoring facilities are provided for checking shift and monitoring waveforms on a built-in cathode ray oscilloscope.

FEATURES

Rapid selection of any one of six crystal-controlled spot frequences.

Variable-frequency LC oscillator available for emergency operation on CW on-off services.

Visual and aural monitoring of circuits in the drive and the transmitter output with direct display of waveforms on built-in CRO.

Modern transmitting valves operated under very conservative conditions ensure reliability.

Compact transmitter layout requires small plan area and minimises ducts and conduit required.

CIRCUIT

For FSK operation the frequency of a 3·1 Mc/s crystal oscillator is shifted a precise amount by means of a reactance modulator controlled by the keying circuits. The oscillator is followed by a buffer stage and frequency divider. A separate oscillator provides an output at one of the six crystal-controlled frequencies, which is frequency divided and mixed with the output from the modulated oscillator to produce an output in the range 75–160 kc/s.

The transmitter employs two air-cooled RF stages to raise the drive input power of 5 watts to an output of 40 kW.

For CW on-off operation the buffer stage of the 3·1 Mc/s oscillator is keyed, thus interrupting the radiated carrier.

DATA SUMMARY

Frequency range: 75–160 kc/s (1875–4000 m).

Power output: 40 kW on CW and FSK.

Transmission:

Using crystals: CW on-off (A.1), FSK (F.1).
Using VFO: CW on-off (A.1).

Frequency stability: To meet International Regulations

Using crystals: ±0·01%.
Using VFO: Within ±0·1%.

Keying speeds: Hand keying, or electronic keying up to 160 bauds (200 w.p.m. Morse).

Power supply:

Transmitter: 3 phase, 380, 400 or 420 V, 4 wire 50 c/s AC with a voltage variation within ±6%.
Drive: 200–250 V, 50–60 c/s AC.

Dimensions:

	Height	Width	Depth
Transmitter (excluding fan chamber):	7 ft (214 cm)	12 ft 6 in. (380 cm)	8 ft (240 cm)
Drive:	7 ft (214 cm)	2 ft (61 cm)	1 ft 10 in. (56 cm)

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MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
Marconi House, Chelmsford
Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

ISB Generating and Monitoring Equipment *Type SSD 2*

THE TYPE SSD2 EQUIPMENT supplies low-power excitation at 3·1 Mc/s, which, *via* an intermediate modulator, drives an HF transmitter giving the desired frequency and power output for radiating SSB telephony transmission on two independent sidebands.

The units of the equipment are all mounted in a sturdy cabinet of attractive design. The more important units are built on chassis with front panels on which are mounted meters and controls. These units slide on runners which permit complete withdrawal from the cabinet, and, in addition, the units may be tilted to give complete access to the under-chassis.

CIRCUITS

ISB generating circuits. Each of the two audio inputs passes through a line amplifier (fitted with a volume indicator for level measurement), to a balanced first modulator, and there combines with the output of a 100 kc/s oscillator to produce the usual upper and lower sidebands. Special crystal band-pass filters select the upper sideband of channel A and the lower sideband of channel B, and pass them, through a combining hybrid, carrier-stop filter and hybrid input circuit, to the second modulator. The carrier-stop filter eliminates any small residue of the 100 kc/s carrier that may have been passed from the channel filters. The pilot carrier is fed from the first oscillator (100 kc/s) *via* a level control to the hybrid input circuit of a balanced second modulator.

A second oscillator generates a 3 Mc/s signal which is combined with the two 100 kc/s sidebands and the 100 kc/s pilot carrier in the second modulator to produce sidebands in the 3·1 Mc/s

region and a pilot carrier of 3·1 Mc/s. An IF amplifier provides the necessary discrimination against unwanted products and its output consists of the 3·1 Mc/s pilot carrier and the wanted upper and lower sidebands carrying channels A and B respectively. The IF amplifier is fitted with a peak voltmeter for measuring the sideband and pilot-carrier levels.

Two AF oscillators (1605 c/s and 1015 c/s) are provided for setting-up purposes, and special care has been taken to obtain high stability in these oscillators. The setting up of the individual tones, or both tones together, at their correct levels, is done simply by the operation of a switch.

Monitoring circuits. The monitoring circuits provide means for demodulating down to audio frequencies the outputs from selected monitor points in either the transmitter, the 3·1 Mc/s IF amplifier, or the 100 kc/s stage, aural monitoring either by headphones or by small loudspeaker being provided.

The main part of the monitoring equipment is the monitor receiver, which comprises two frequency-changers, a demodulator, and an AF stage. The control for monitoring either at RF, 3·1 Mc/s, or 100 kc/s, consists simply of a switch. Channel filters are provided so as to enable either channel to be selected for monitoring purposes. A 425 c/s bandpass filter is provided to select the $(2f_1-f_2)$ inter-modulation component when measuring distortion. Special care has been taken to obtain a very high degree of discrimination against unwanted products, and this, combined with the good frequency stability of the AF test oscillators, ensures a high degree of accuracy in making distortion measurements. Provision is made for enabling the carrier level to be checked, even when signals are being transmitted. The AF output from the monitor receiver is amplified by the monitor receiver amplifier, which is provided with a volume indicator for the purpose of measuring levels.

Double-sideband operation. It might happen that the need would arise to work with a receiver suitable only for normal DSB operation, and to cater for this need it has been arranged that the simple operation of one switch converts the equipment from ISB to DSB in an instant. In DSB operation only channel A is used. The DSB output level is ¼ W PEP and the carrier level is −6 dB relative to ¼ W. The same monitoring equipment is used in the DSB condition of working.

DATA SUMMARY

AF input:

Impedance: 600 Ω (two inputs).

Level: −22 dBm to +24 dBm, *i.e.*, −30 dB to +16 dB relative to reference telephonic power. Frequency range: 100–6000 c/s.

Output:

Impedance: 75 Ω (coaxial feeder).

Level: Each AF input produces maximum output of −6 dB relative to ¼ W, *i.e.*, the total peak sideband power is ¼ W.

Pilot carrier: Level is set to:

(*a*) −16 dB reference to ¼ W for single-channel operation.

(*b*) −26 dB reference to ¼ W for two-channel operation.

Frequency range: 3·094–3·106 Mc/s.

Non-linear distortion: The third-order inter-modulation product $(2f_1-f_2)$ is at least 48 dB down relative to the level of one of the two equal level testing tones f_1 and f_2.

Carrier compression:

Less than 1 dB at ¼ W output.

Pilot-carrier stability:

5 parts in 10^8 over the temperature range 10–40°C, ambient.

Power supply: From 110 V or 210–250 V, 50–60 c/s (±2 c/s) AC mains.

Power consumption: 200 W approx.

Dimensions:

Height	Width	Depth	Weight
72 in.	22 in.	18¾ in.	576 lb
(183 cm)	(57 cm)	(50 cm)	(261 kg)

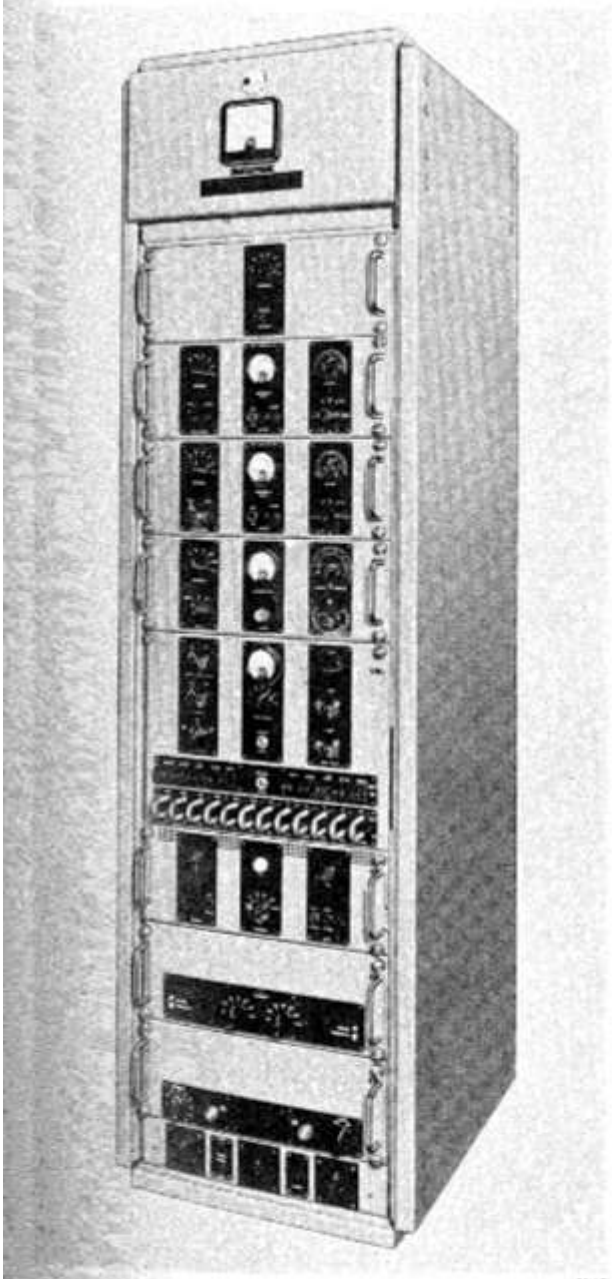
Marconi

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

ISB Generating and Monitoring Equipment *Type HD 51*



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POINT-TO-POINT COMMUNICATION in the HF band utilising independent sideband transmission has been greatly extended in recent years, and performance of a very high order is required of the equipment providing the drive for ISB transmitters. The Type HD 51 ISB Drive Equipment has been designed to a standard that meets the latest specifications of the British Post Office and the Services. When supplied with two audio inputs (100 c/s to 6000 c/s) this equipment provides an output of two independent sidebands (corresponding to the two audio inputs) centred around a controlled low-level pilot carrier of 3·1 Mc/s. If used in conjunction with channel displacing equipment (see page 385) and a suitable transmitter, *four* telephone speech channels (300–3000 c/s) may be radiated. The output can be changed over instantly to low-level DSB for emergency use by the operation of two switches. The gain throughout the equipment has been stabilised by extensive use of negative feedback, and limiters are incorporated to prevent overloading on either sideband which would cause distortion on the other. These features, coupled with the inclusion of circuits providing automatic remote warning of any significant change of carrier level, make the equipment eminently suitable for unattended operation.

The equipment is assembled in a cabinet 7 ft high, and unit construction is employed throughout. The majority of units are runner mounted allowing for speedy removal and complete access. Special attention has been given to the monitoring arrangements, to accessibility of controls, and to simplification in the operations of setting up and measuring distortion.

DATA SUMMARY

AF inputs: 2 balanced or unbalanced 600 Ω lines. Levels: +10 dB to −10 dB relative to 1 mW.

3·1 Mc/s output: Peak sideband power: 250 mW total. Carrier level: Adjustment from −32 dB to 0 dB relative to 250 mW. Normally −26 dB relative to 250 mW. Impedance 72 Ω coaxial feeder. This may be terminated *via* a 10 dB pad by *any* impedance.

Frequency tolerance: Better than 2 parts in 10^6 per week for ambient temperature changes of 10°C–40°C.

Frequency bandwidth: 3·094–3·106 Mc/s.

Spurious and harmonic outputs: All (including 3 Mc/s) are more than 60 dB below 250 mW.

Frequency response:
Within 1 dB from 200 to 5800 c/s.
Within 2 dB from 100 to 6000 c/s.
50 c/s rejected by more than 25 dB.
7 kc/s rejected by more than 5 dB.
9 kc/s and above rejected by more than 25 dB.

Gain constancy: ±0·5 dB over any 6 hours of unattended operation for ±1% mains variation. ±1 dB over any 6 hours of unattended operation for ±6% mains variation.

Limiters: No effect on performance up to full level on each sideband, less than 2 dB rise of sideband output for any further increase of input level.

Non-linear distortion:
3rd order ($2f_1$–f_2), lower than −50 dB.
2nd order (f_2–f_1), lower than −50 dB.
Both measured by standard two-tone test with 250 mW PSP.

Carrier regulation: Less than 0·5 dB total variation of −26 dB pilot carrier for any signal level up to 250 mW.

Transient distortion:
Overshoot: less than 1%. Rise and decay: less than 750 μs. Delay: less than 1 ms. Measured with a pulse-modulated audio input.

Crosstalk: Less than −60 dB (excluding inter-modulation products).

Monitor receiver:
Inputs:
(*a*) From pick-up points in transmitter either at radiated frequency or at 3·1 Mc/s.
(*b*) From drive unit at 3·1 Mc/s or 94–106 kc/s.
Outputs:
Two independent audio outputs (corresponding to the two sidebands) at +10 dBm in 600 Ω. Distortion less than 1%.

Carrier monitoring (simultaneous with above outputs):
Range: As for drive pilot carrier.
Alarm: A change of carrier level of more than 3 dB for more than 1 second closes contacts for a local and a remote alarm.

Distortion monitoring:
In conjunction with built-in audio oscillators both 2nd and 3rd order inter-modulation products may be measured down to −60 dB below one of the two equal testing tones. The distortion introduced by the monitor receiver does not exceed −66 dB below one of the two test tones.

Double sideband: 3·1 Mc/s output PEP at 100% modulation is 250 mW. Carrier power is −6 dB below 250 mW. Distortion is less than 1% at 100% modulation.

Power supply: 110–120 or 200–250 V, 45–65 c/s single-phase AC. Voltage regulation ±6%.

Power consumption: 500 W at 0·9 PF.

Dimensions:

Height	Width	Depth	Weight
7 ft (213 cm)	2 ft (61 cm)	2 ft 6 in. (76 cm)	594 lb (270 kg)

Marconi

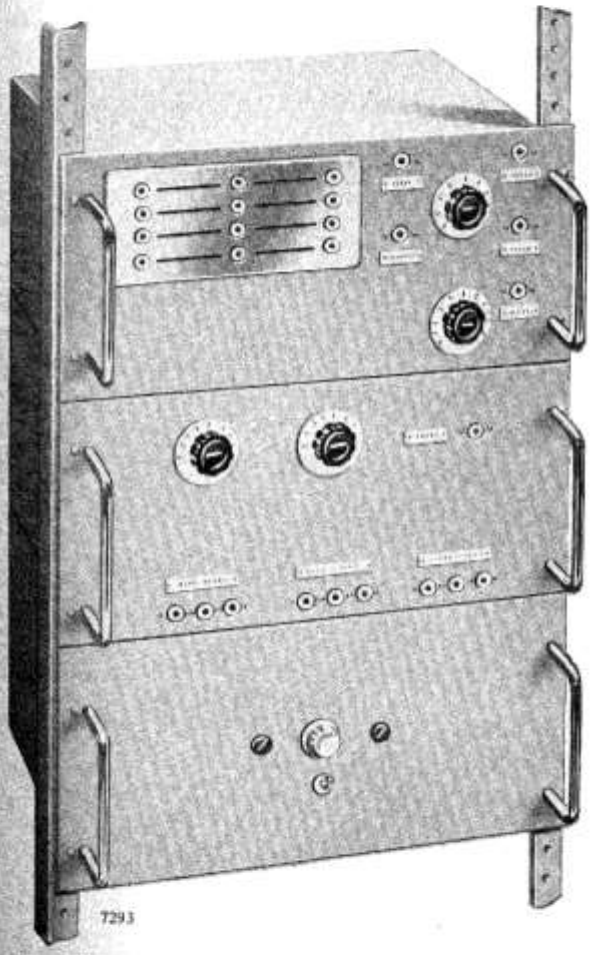
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, Chelmsford

Telephone: Chelmsford 3221. Telex: 1953. Telegrams: Expanse Chelmsford Telex

FM VF Telegraph Equipment

Type HL 11/12



THIS EQUIPMENT provides a means of combining three frequency-modulated voice-frequency telegraph channels within a 3 kc/s speech band for ISB transmission, and for reception of such signals on three channels by means of a FM VF double-diversity terminal in conjunction with an ISB diversity receiver.

CONSTRUCTION

The transmitting and receiving circuits are contained in withdrawable units mounted in standard 19 in. rack assemblies. The transmitter, known as the Type HL 11, consists of three panel units—an amplifier and filter unit, a tone oscillator unit and a power supply unit—mounted in a rack, usually with the associated drive equipment. The receiver, known as the Type HL 12, comprises eight units—a receiver unit and a power unit for each channel and two filter units. These units are mounted together in a standard rack, with or without other apparatus as desired. They are robust in nature, generously rated and designed to operate in tropical climates, housed in normally protected buildings.

Test points from all important parts of the circuit are brought out to the front panels of the equipment. These enable rapid checking of the operation of the apparatus to be carried out without interference with the service.

CIRCUIT

Each telegraph channel consists of a tone, frequency-shifted ± 100 c/s to produce the 'mark' and 'space' signals. The system is sometimes referred to as frequency shift tone (FST). The tone frequencies are 780 c/s, 1620 c/s and 2580 c/s, so chosen to ensure a minimum of harmonic relationship. They are generated by resistance-capacitance oscillators the outputs of which are controllable over a range of 10 dB.

Keying and output filters are incorporated to limit the frequency spectrum to that necessary for the highest keying speed, and the three channels are then combined in a common amplifier having a gain of 25 dB variable in 1 dB steps.

The combined signal modulates the transmitter through the usual ISB drive equipment.

For reception, the three tone outputs from an ISB receiver are separated by means of filters and fed via a conventional chain of limiter, discriminator and signal shaping circuits to a DC output stage. Path selection is provided by gating circuits which follow the discriminators and are controlled by the signal strengths before limiting.

A polar DC output of 30–0–30 mA, suitable for teleprinter or undulator operation, is provided.

If, in the interests of operational flexibility it is desirable to dispense with the FM VF receiving equipment, each telegraph signal can be treated as an independent narrow-band FSK signal, using a highly selective specialised receiver. A version of the Type HR 11 double-diversity receiver is available, suitable for this purpose.

DATA SUMMARY

Tone frequencies: 780 c/s ±100 c/s
1620 c/s ,, ,,
2580 c/s ,, ,,

Tone stability: 2 parts in 10^3 for temperature variations between 10° and 50°C and ±10% variation of mains voltage.

Keying speed: 100 bauds max., all channels.

Keying potential: ±10 V to ±80 V DC.

Output to radio transmitter: 0 dBm to −20 dBm, into 600 Ω.

Input from radio receiver: 0 dBm to −30 dBm, into 600 Ω.

Output from receiver: 30–0–30 mA max. into 2000 Ω earthed load.

Fading ratios: Inter-channel level difference 30 dB max.

Power supply: 200–250 V 50–60 c/s AC.

Power consumption:
Transmitter Type HL 11: 100 W.
Receiver Type HL 12: 240 W.

Dimensions:

	Height	Width	Depth	Weight
Type HL 11	21 in. (53·4 cm)	19 in (48·3 cm)	13 in. (33 cm)	78 lb (35·3 kg)
Type HL 12	49 in. (125 cm)	19 in. (48·3 cm)	13 in. (33 cm)	225 lb (102·2 kg)

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Crystal Drive and Auxiliary Units

TO EXPLOIT FULLY the capabilities of communication transmitters such as the Types HS 31, HS 51 and HS 61, particularly where a number of these are operated on one station and centralised drive equipment is desirable, a flexible drive arrangement is necessary. A series of crystal drive and auxiliary units has therefore been developed to provide RF drive of high stability on several frequencies (normally up to six) with on-off keying or frequency-shift keying (FSK). On-off CW keying with anti-fading frequency modulation is also available.

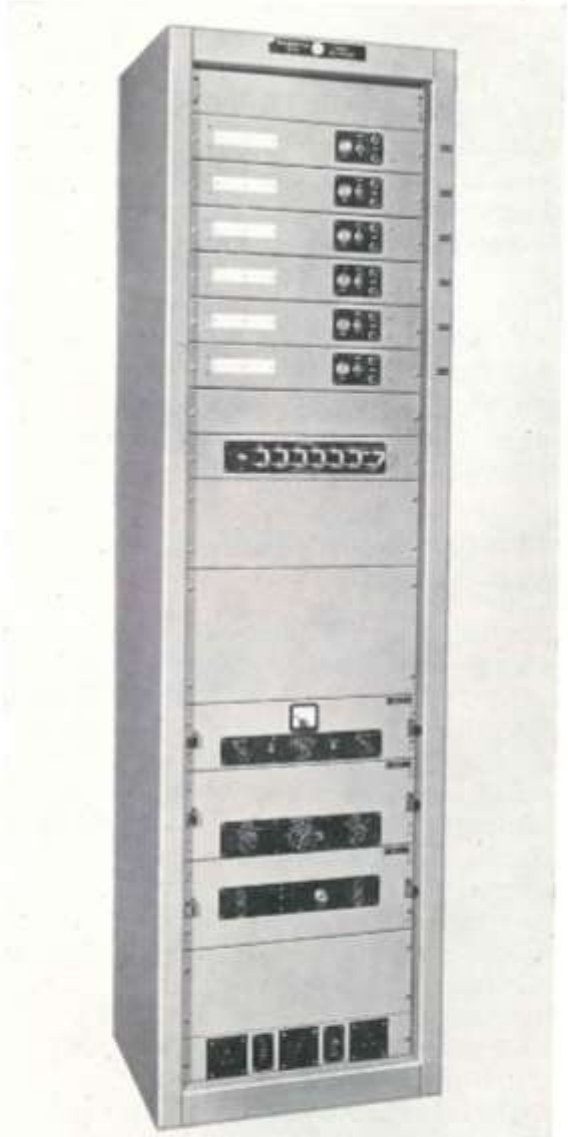
A typical drive equipment is made up from a selection of the units described below, the quantities depending on requirements. Each item in the series consists of one or two units of 19 in. (48 cm) width suitable for mounting in a standard rack or cabinet. Operating controls are on the front panel. The metering of cabinet-mounted equipment is effected by a general-purpose meter in the cabinet which can be connected to any of the units by a test cord and plug.

	Height	Width	Depth
Overall cabinet dimensions:	7 ft 0¼ in. (214 cm)	23½ in. (60 cm)	19⅛ in. (48 cm)

Single Frequency Crystal Drive Unit *Type HD 21*

This unit consists of an oscillator and compact crystal oven, an amplifier and power supply components. These are mounted on a strip-type panel 3½ in. high and 19 in. wide. All components are readily accessible and the entire unit is easily removable from the cabinet in which it is normally mounted.

The crystal is arranged to operate in the parallel resonant condition in a tritet circuit. There



Typical assembly of crystal drive and auxiliary units. 6568

are no tuned circuits in the oscillator, which is designed to operate with a suitable crystal in the range 2–8 Mc/s with provision for fine frequency adjustment in service.

Auto RF Switching Panel

By means of this panel any one of up to six inputs from external oscillators (*e.g.* Type HD 21 drives) can be selected for feeding to a transmitter. The panel may be manually operated by the knob on the front or it may be remotely controlled by the Ledex switch unit incorporated.

Keying Unit *Type HD 22*

This unit provides an output at 3·1 Mc/s which is keyed in accordance with the input double- or single-current keying signal. The output may be frequency-shift keyed or keyed on-off, with or without anti-fading frequency modulation.

The keying unit consists of two panels. The first contains an electronic relay stage, reactance modulator, crystal oscillator and oven, buffer amplifier and output amplifier. The second houses a power supply unit. The main operational controls are on the front of the unit.

Telegraph Monitoring Unit *Type HD 23*

The telegraph monitoring unit comprises a 3·1 Mc/s crystal oscillator, 3·1 Mc/s tuned amplifier, audio frequency oscillator and discriminator. The unit enables the frequency shifts produced by a keying unit, Type HD 22, to be checked aurally on headphones or visually on a built-in beat-indicator meter. It also provides an output monitor signal suitable for applying to an external cathode-ray oscilloscope for visual examination of waveforms. The frequency shifts may, if desired, be checked against an external beat frequency oscillator.

There is also provision for aural monitoring or, using an external oscilloscope, visual monitoring of CW signals.

The heater and HT DC supplies are normally obtained from the power unit forming part of the keying unit, Type HD 22.

Monitor Unit *Type HD 24*

This unit is intended for monitoring FSK and CW on-off telegraph keying signals. It will monitor input signals at 3·1 Mc/s and, as it incorporates an RF mixer stage, it can also deal with input signals in the band 4 to 27·5 Mc/s providing that the appropriate conversion frequency is also available to convert the signal back to 3·1 Mc/s. It is therefore possible to monitor the keying signals at all stages of a transmitter, except where frequency multiplication is effected after the mixer stage in the transmitter.

The monitor unit incorporates a compact 2¾-in. oscilloscope upon which the frequency shifts and keying waveforms can be checked.

Crystal Drive Unit *Type HD 26*

This unit provides an output on any one of six crystal-controlled frequencies in the range 1·4 to 8 Mc/s. Provision is also made for connecting a signal from an external LC oscillator which may be switched through to the output of the unit when required. There is a built-in power supply.

Variable LC Drive *Type HD 28*

This equipment comprises a high-stability variable-frequency oscillator with frequency multipliers and a power supply unit. The tuning mechanism of the oscillator incorporates precision gearing to enable a high order of setting accuracy to be attained. The equipment is suitable for use as a transmitter drive or as a frequency standard. The master oscillator has a range of 2 to 4 Mc/s. The temperature-sensitive elements are mounted in a simple thermally-controlled oven. The master oscillator is coupled to a harmonic amplifier which extends the frequency range to 32 Mc/s.

Crystal Calibrator *Type HD 29*

Designed for use as a reference frequency source to check variable-frequency oscillators such as the Type HD 28, this unit provides crystal-controlled calibration signals at 10 kc/s intervals in the range 2 to 4 Mc/s. A mixer stage is incorporated into which the crystal-controlled signal and a signal from the variable oscillator may be fed.

The resulting beat note may be aurally monitored. The unit has a built-in power supply.

Double Sideband Modulator *Type HD 56*

This unit is a low-power DSB equipment producing a modulated output at either 3·1 Mc/s or 6·2 Mc/s, and is suitable for use with transmitters such as the Type HS 31 or HS 71.

It has a built-in power supply and is provided with metering facilities for setting-up and measuring valve feeds.

A compressor circuit is incorporated, which may be used to avoid overmodulation when required. The percentage modulation is indicated directly on the front panel meter.

Frequency Shift Diplex Keying Unit *Type HK 12*

This equipment is designed primarily for keying telegraph transmitters by the two-channel frequency shift diplex system which enables the transmitter to handle simultaneously two independent signals. When using this system an FS diplex receiving unit must be fitted at the receiver.

The unit provides for single or two-channel FSK, CW On-off, MCW On-off or Fascimile operation, with an output at 3·1 Mc/s.

Anti-fading frequency modulation may be applied on single-channel FSK or CW.

HF Master Oscillator *Type NM 103*

The Type NM 103 master oscillator covers the frequency range 2 to 32 Mc/s. The equipment comprises LC-oscillator, frequency multiplier/amplifier and power supply unit.

All controls are mounted on the front panel. Two separate high-discrimination setting scales are provided on this panel, one being for the LC-oscillator and one for the multiplier/amplifier. The oscillator scale is calibrated to read the fundamental frequency directly in kilocycles per second. It is possible to set the frequency of the oscillator directly and without charts, to an accuracy of better than ±1 kc/s at the fundamental frequency. The scale of the amplifier tuning control is marked with the fundamental frequencies of the LC-oscillator and the actual output frequency is given by a multiplying factor depending on the position of the range switch.

A series of adjustable cams, geared to the spindle of the main tuning capacitor operate a small trimmer to correct any deviation in the straight-line frequency law of the main tuning control.

DATA SUMMARY

Unit type:	HD 21	HD 26	HD 28	NM 103	HD 29	HD 22	HK 12
Frequency:	2–8 Mc/s 1 spot freq.	2–8 Mc/s 6 spot freq.	2–32 Mc/s variable	2–32 Mc/s variable	2–4 Mc/s at 10 kc/s intervals	3·1 Mc/s	3·1 Mc/s
Overall stability (temp. range 10–40°C, ambient):	5 parts in 10^6	10 parts in 10^6	40 parts in 10^6	400 parts in 10^6	40 parts in 10^6	15 parts in 10^6	15 parts in 10^6
Output impedance:	75 Ω	75 Ω	75 Ω	75 Ω	75 Ω	75 Ω	75 Ω
Output power:	100 mW	100 mW	100 mW	10 mW	+12 dBm	250 mW	250 mW
Frequency shift:	—	—	—	—	—	0–1200 c/s	2-channel 50–1200 c/s single channel 50–1000 c/s
Keying speed:	—	—	—	—	—	200 bauds	2-channel 100 bauds, single channel 400 bauds.

Unit type:	HD 21	HD 26	HD 28		NM 103	HD 29	HD 22		HK 12
Power supply (50 to 60 c/s AC):	200–250 V	210–250 V	110, 120 and 200–250 V		230 V	110, 120 and 200–250 V	200–250 V		200–250 V
Power consumption:	20 VA	22 W	300 W		50 W	45 W	80 VA		
Dimensions:			*Oscillator panel*	*Supply panel*			*Keying panel*	*Supply panel*	
Height	3½ in. (9 cm)	7 in. (18 cm)	10½ in. (27 cm)	7 in. (18 cm)	10 in. (25 cm)	7 in. (18 cm)	7 in. (18 cm)	7 in. (18 cm)	8¾ in. (22 cm)
Width	19 in. (48 cm)	19 in. (48 cm)	19 in. (48 cm)	19 in. (48 cm)	19 in. (48 cm)	19 in. (48 cm)	19 in. (48 cm)	19 in. (48 cm)	19 in. (48 cm)
Depth	6½ in. (17 cm)	10 in. (25 cm)	19½ in. (49·5 cm)	16 in. (41 cm)	17 in. (43 cm)	16 in. (41 cm)	12 in. (31 cm)	12 in. (31 cm)	15 in. (38 cm)
Weight	5¾ lb (6·8 kg)	19 lb (8·6 kg)	80 lb (36·3 kg)	35 lb (15·9 kg)	55 lb (25 kg)	27 lb (12·3 kg)	16¾ lb (7·6 kg)	27½ lb (12·5 kg)	36 lb (16·3 kg)

Auto RF switching panel

Inputs: Up to six, 75 Ω coaxial.

Output: One, 75 Ω coaxial.

Motor power requirements: 50 V DC 2 A intermittent.

Dimensions:

Height	Width	Depth	Weight
3½ in. (9 cm)	19 in. (48 cm)	6½ in. (17 cm)	5¾ lb (2·6 kg)

Telegraph monitoring unit – Type HD 23

Service: (*a*) CW on-off keying.
(*b*) Frequency-shift keying.

Output signal: AF voltage to external 'phones. Waveform voltage to external oscilloscope.

Audio oscillator stability: ±2%.

Power supplies: 6·3 V AC heater supply 1·5 A) and 200–250 V DC supply (30 mA).
Normally obtained from Type HD 22 unit.

Dimensions:

Height	Width	Depth	Weight
5¼ in. (13 cm)	19 in. (48 cm)	7⅛ in. (18 cm)	10 lb (4·5 kg)

Monitor unit – Type HD 24

Service: Single- and two-channel FSK.
Single-channel FSK with anti-fading FM.
Facsimile.
CW on-off keying with or without anti-fading FM.

Input signal: Approx. 1 V into 75 Ω at 3·1 Mc/s *or* approx. 0·5 V into 75 Ω in the band 4–27·5 Mc/s together with 4 V of conversion frequency from transmitter HG or from an external oscillator.

Telegraph keying speed: 400 bauds max.

AF oscillator stability: ±2%.

Power supply: Details as Type HD 21 unit. Consumption 120 W approx.

Dimensions:

Height	Width	Depth	Weight
7 in. (18 cm)	19 in. (48 cm)	15 in. (38 cm)	35 lb (15·9 kg)

Double sideband modulator – Type HD 56

Input level: −20 dBm min.

Output frequency: 3·1 Mc/s or 6·2 Mc/s.

Output power: 0·25 W carrier into 75 Ω.

Distortion: Not greater than 2% at 80% modulation (with compressor circuit inoperative).

Noise: 50 dB below 100% mod. level.

Frequency response: ±2 dB from 200–3500 c/s.

Frequency stability: Less than ±10 parts in 10^6 per month for changes in temperature of 20°C to 50°C.

Input impedance: 600 Ω balanced or unbalanced.

Output impedance: 75 Ω unbalanced.

Power consumption: 40 W.

Power supply: 110 or 200–250 V, 50–60 c/s AC.

Dimensions:

Height	Width	Depth	Weight
8¾ in. (22 cm)	19 in. (48 cm)	10 in. (25 cm)	26 lb (11·8 kg)

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