Marconi H.F Receiver 'Hydrus' Type 2001

The 'Hydrus' receiver is exceptionally compact and versatile, designed for operation in a wide range of transmission modes according to requirements. Extensive use of solid state circuitry throughout and careful circuit and mechanical design has resulted in a small, high quality equipment at a moderate price.

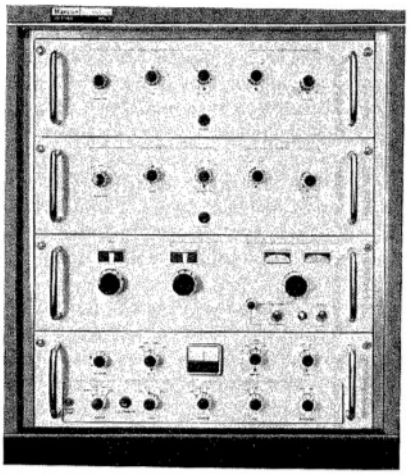
FEATURES

Inexpensive, high performance equipment.
Exceptional versatility, providing wide range of services.
Frequency range down to 1·5 MHz.
Very high reliability—solid state design.
The advantages of field effect transistors (F.E.T) exploited in the circuit design.
Temperature-stabilized crystal-controlled master oscillator incorporated.
Frequency synthesis to 0·1 MHz in steps and continuous coverage between steps.
Full transistorized Automatic Frequency Control.
Designed for fast re-tuning and change of operating mode.
Automatic Gain Control may be derived from carrier or either sideband as required.
A.G.C time constant variable manually.
For operation in a wide range of climatic environments.
Mains or battery operation (no external convertor necessary).

Field effect transistors (F.E.Ts) have been chosen for use in this receiver. These have the advantages of high input and output impedance, thus the effect on tuned circuits is considerably less than with conventional transistors. An exceptionally high gain is possible and in addition, the most significant advantage is the high order of linearity resulting in an exceptionally low level of intermodulation products. The well-known advantages of conventional solid state techniques are retained ensuring a very low power consumption, stability and space economy.

This receiver supercedes the well known 'H' Series, being capable of covering all double or single path 'main line' point-to-point services within the frequency range 1·5 to 30 MHz.

For short schedule working, fast re-tune is facilitated by decade switching in 0·1 MHz steps. An interpolating oscillator, covering 0·1 MHz between decade steps, is calibrated directly in signal frequency on the front panel. Three degrees of a.g.c time constant may be selected according to operational requirements and the a.f monitor on the front panel may be switched to monitor u.s.b



H1092

or l.s.b demodulator output. The automatic frequency control system follows frequency drifts up to ±250 Hz. Automatic gain control operates over 90 dB variation of signal strength, controlling output to within 6 dB.

Construction

A single path 'Hydrus' receiver comprises three basic units:
(a) Receiver Unit
(b) Synthesizer Unit.
(c) Telephony/Telegraphy Unit.
These units are based on a standard 5¼ in. front panel height and may be accommodated in bench mounted cabinets for a single receiver installation or in a free standing cabinet when one or two receivers are required. The units may be withdrawn by means of double extension runners, providing easy access for servicing.

The units can also be fitted in standard B.P.O type 19 in. racks.

Circuit

Receiver Unit:
The receiver unit includes the signal frequency amplifiers, intermediate frequency amplifiers, demodulators and audio frequency amplifiers. The received signal is converted to the r.f amplifier via a switched attenuator and a coupled circuit with bandpass characteristics to provide extremely good skirt selectivity. The frequency range 1·5 to 30 MHz is covered in four bands, switched and tuned by controls on the front panel. The first oscillator injection to the mixer is obtained from the synthesizer unit and covers the range 41·5 to 69·5 MHz in 1 MHz steps. Thus the signal frequency is converted to the band 39·5 to 40·5 MHz. The 40 MHz i.f amplifier and second mixer incorporates field effect transistors and a bandpass filter accepting 39·5 to 40·5 MHz with very high rejection to out of band signals. The second mixer is similar to the first, except that the oscillator injection derived from the synthesizer unit lies in the band 34·5 to 35·5 MHz to produce a second i.f of 5 MHz .The derivation of the first oscillator injection into the first mixer and the injection into the second mixer is such that a drift cancelling loop circuit is formed.

The input to the 5 MHz i.f amplifier and third mixer is preceded by a 5 MHz crystal filter with a 12 kHz passband which is sufficient to pass two 6 kHz sidebands of an i.s.b signal. The oscillator injection for the third mixer is obtained from a crystal oscillator in the Telegraphy/Telephony Unit and for telephony working (e.g. i.s.b, etc) may be 5·1 or 4·9 MHz to yield the third i.f of 100 kHz. In the case of telegraphy working (f.s.k) the frequency is 5·102 MHz which will give an i.f of 102 kHz.

The sideband demodulator crystal filters determine the passband for the sideband circuits. For i.s.b or s.s.b working these filters may be of nominally 3 or 6 kHz passband for both upper and lower sidebands.

For the reception of i.s.b and s.s.b signals, when a pilot carrier is radiated, the nominal 100 kHz third i.f is fed to a crystal filter having a passband of 100 Hz. The output of the filter is applied to an amplifier which provides two outputs at 100 kHz. These outputs are used for a.f.c and a.g.c purposes the circuits of which are contained in the Telephony/Telegraphy unit.

Synthesizer Unit

This unit contains the following major subassemblies:
(a) 1 MHz decade unit.
(b) 0·1 MHz decade unit.
(c) Interpolation oscillator.
(d) Power supplies and frequency dividers.

The equipment can be operated from a battery of 24 V (positive earth) or from 45–65 Hz single phase mains.

The 1 MHz decade unit includes the first oscillator and two bridge ring mixers. The oscillator covers the range 41·5–69·5 MHz in 1 MHz steps. The output of the first bridge ring mixer is 37·5 MHz. This 37·5 MHz signal is fed to the second bridge ring mixer which also has an input of 2–3 MHz from the 0·1 MHz decade. This results in an output in the range 34·5–35·5 MHz which is injected into

the second mixer of the receiver.

Thus it can be seen that as the first oscillator frequency from the 1 MHz decade has been injected into the first mixer of the receiver above the incoming frequency and into the second mixer below the incoming frequency a drift cancelling loop will result.

The 0·1 MHz decade unit contains a complete drift cancelling loop with an oscillator having an output in steps of 0·1 MHz from 6·05 MHz to 6·95 MHz controlled by a switch on the front panel.

The interpolation oscillator is a continuously tunable free running oscillator operating at 200 kHz to 300 kHz, controlled from the front panel, which allows an operator to set up any frequency within limits of 100 Hz—well within the a.f.c capture range.

The Telephony/Telegraph unit is available in several editions to suit customer requirements. A switch on the front panel selects the required system:

(a) Telegraphy (f.s.k) only.
(b) Telephony (i.s.b/s.s.b) only.
(c) Telephony/Telegraphy (i.s.b/s.s.b/f.s.k).

To operate telegraph recording apparatus an extenal supply (80–0–80 V) is required. This external supply is protected by guard lamps within the equipment and a jack is supplied on the front panel meter.

DATA SUMMARY

Frequency coverage: 1·5 to 30 MHz in 4 bands.

Services: i.s.b, s.s.b, d.s.b, f.s.k, c.w.

Aerial input: Suitable for connection to 50 Ω or 75 Ω impedances.

Output:

Telegraphy—Electronic relay capable of polar or neutral keying up to 60 MA from an external 80–0–80 telegraphy supply.

Telephony—10 dBm max in 600 Ω.

Sensitivity: *Telegraphy*—Using a 1 kHz passband the maximum input required for recording 400 Hz shift at a speed of 100 bauds is 0·35 μV in series with 75 Ω for one element per 1000 exceeding a bias distortion of 20%.

Telephony—Not less than 17 dB signal to noise ratio in a 3 kHz bandwidth at the output, for a sideband input of 1 μV in series with 75 Ω.

Automatic gain control: Less than 6 dB change in output for a 90 dB change in aerial input. A.G.C may be derived from either sideband or carrier.

Stability: Temperature controlled crystal oscillator 1 part in 10^8–0 to 50°C.
Third Oscillator—2 Hz per °C. This oscillator is controlled by a.f.c.
Interpolating Oscillator—10 Hz per °C.
Worst case condition at extreme ends of variable capacitor.

Frequency setting accuracy: ±100 Hz with scale check at 10 kHz intervals.

Overall frequency response: (3 kHz filters).
Variation in output is less than 4 dB for constant input signals corresponding to audio tones from 200 Hz to 3000 Hz when the residual mistune is less than ±3 Hz.

Sideband amplifier noise: At least 45 dB below the maximum a.f output.

Power supplies: 100 to 125 V and 200 to 250 V, 45 Hz to 65 Hz, single phase a.c ±6%. Battery break-in is provided to allow operation from a −24 V supply.

Environmental: The equipment is capable of continuous operation in all climates where the temperature is in the range 0°C to 40°C with a relative humidity of 90% or 0°C to 50°C dry heat.

Distortion:

(a) *Crosstalk:* Intelligible crosstalk between sidebands is lower than −60 dB. Non-intelligible crosstalk due to third order intermodulation products is lower than −50 dB.

(b) **Intermodulation:** At an a.f output level of +6 dBm the intermodulation products are better than 40 dB's down.

(c) **Harmonic:** At an a.f output level of +6 dBm the total harmonic distortion does not exceed 2%.

Automatic frequency control:

(a) *Telegraphy:* Electronic system which will follow, with a residual mistune of less than 10% of the shift, frequency drifts of up to ±250 Hz.

(b) *Telephony:* Electronic system which will follow, with a residual mistune of less than 3 Hz, frequency drifts of up to ±250 Hz.

Frequency selection: A system of decade tuning to 0·1 MHz steps and an interpolating oscillator covering 100 kHz.

Cross modulation: (C.C.I.R Rec 332 1963). The level of an undesired carrier sinusoidally modulated 30% at 400 Hz and located not less than 10 kHz from the wanted carrier frequency, which produces total crossmodulation products −20 dB relative to the desired output is not less than +35 dB relative to the desired sideband input level when this is less than +60 dB relative to 1 μV in series with 75 Ω. When the desired sideband level is between +60 dB and +80 dB relative to 1 μV in series with 75 Ω, the undesired carrier level to produce the same level of cross-modulation exceeds the desired signal input level by not less than 20 dB.

A.G.C time constant: Three degrees of time constant.
Fast—100 μsecs. Medium—5 secs.
Slow—25 secs.

Manual gain control: Adjustable to give up to 90 dB gain reduction.

Aerial attenuator: Provides up to 30 dB attenuation in 10 dB steps.

Selectivity:

First intermediate frequency: 40 MHz ±0·6 MHz at −3 dB.

Second intermediate frequency: 5 MHz ±6 kHz at −2 dB and ±10 kHz at −25 dB.

Third intermediate frequency: Telegraphy—The filters are centred on 102 kHz and have the following responses:

(a) or (b) fitted to order:	Bandwidth at −6 dB	−60 dB
(a)	1 kHz	3 kHz
(b)	0·5 kHz	1·6 kHz

Telephony—All frequencies are referred to 100 kHz.

	−2 dB Points	−60 dB Points
Upper sideband (3 kHz)	+200 Hz and +3100 Hz	−350 Hz and +3900 Hz
Lower sideband (3 kHz)	−200 Hz and −3100 Hz	+350 Hz and −3900 Hz
Upper sideband (6 kHz)	+200 Hz and +5900 Hz	−350 Hz and +7500 Hz
Lower sideband (6 kHz)	−200 Hz and −5900 Hz	+350 Hz and −7500 Hz
	−3 dB Points	**−60 dB Points**
Carrier Filter	±50 Hz	±300 Hz

Image response ratio: Greater than 80 dB.
I.F response ratio: Greater than 80 dB.

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