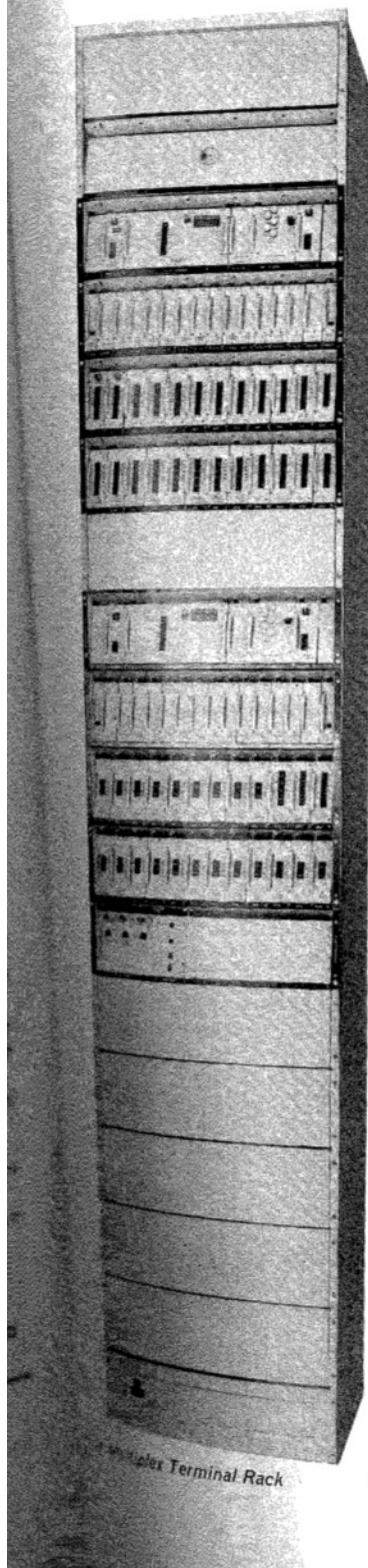


# Marconi 24-Channel Pulse Code Modulation Transmission System Equipment U 1310 Series



Multiplex Terminal Rack

U1000

The rapid and continuing growth in demand for inter-exchange circuits has resulted in extensive study of the economic provision of additional traffic capacity. The 24 channel PCM system has been developed to meet this demand by its application to new cable routes and to existing audio cable systems, both for simple point to point operation and more complex inter-exchange junction configurations. The equipment has been designed to anticipate application to integrated systems in the future. Whilst the principle of pulse code modulation has been established for some years the technique involved has only been capable of economic solution with the availability of modern micro-circuits and increasing experience in digital transmission.

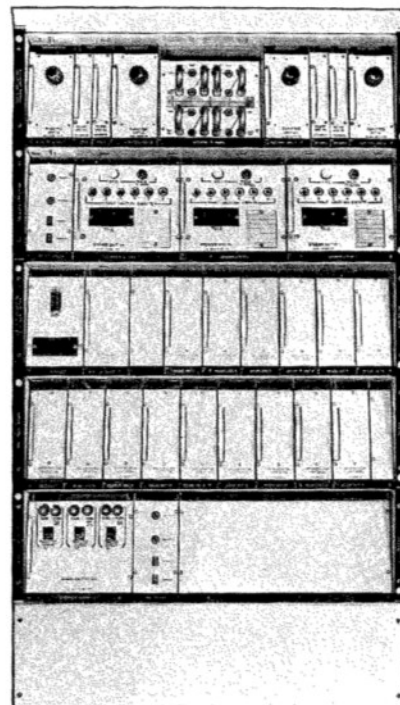
In 'short haul' applications, trials have proved such systems as FDM to be uneconomic compared to PCM. The PCM system will operate satisfactorily under adverse noise and cross-talk line conditions which would normally prevent the use of FDM. With a PCM system speech quality is not affected by the line length and the number of regenerative repeaters in circuit.

The basic specification for this PCM system and equipment has gained acceptance by more Telephone Administrations than any other current specification.

A compact design of exceptional reliability has been achieved by the extensive use of the latest and currently most advanced micro-circuits. The equipment uses diode transistor logic in dual-in-line packs. In the terminal equipment, the timing circuits have been reduced to the preferred size of 4 cards. The PCM multiplex terminal complete with all channel cards and signalling sets is accommodated in 4 shelves in the standard Post Office type 62 rack. This practice has evolved over many years of design and is proved and accepted in customer service.

The non-linear encoder-decoder uses a 13 segment companding law and digitally switched current, which gives extreme stability. The noise margin approaches the theoretical limit and is better than normal customer specifications. The quantization distortion ratio is within 3 dB of the theoretical over a 40 dB dynamic range using gaussian distributed band-limited noise input.

Up to three complete PCM Multiplex Terminals can be contained in a standard 9 ft high rack. A similar rack will also accommodate Line Terminal Equipment for 48 separate Multiplex Systems.



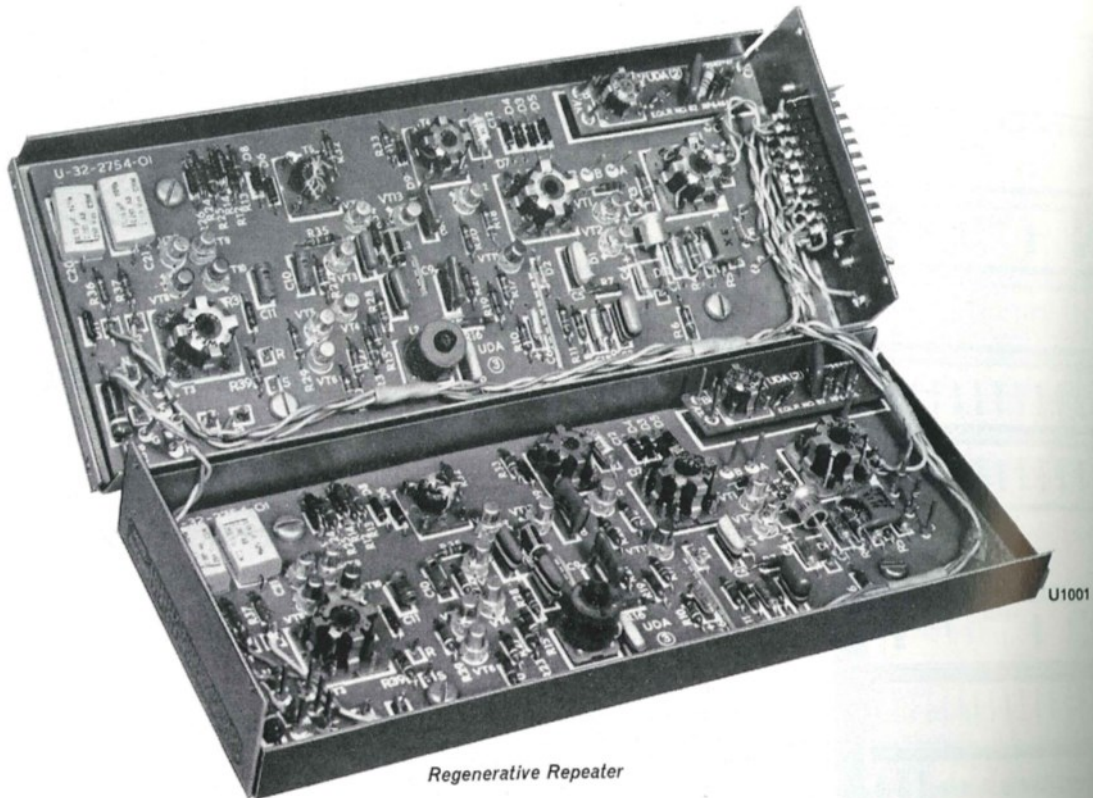
Line Terminal Rack

U1014

The regenerators used on the digital line system are housed in cast-iron repeater cases suitable for use in manholes or direct burial in the ground. Three sizes of repeater case are available. These house four, twelve or twenty four regenerator units respectively. The PCM transmission system is four wire, requiring one cable pair for the transmit direction and one cable pair in the receive direction. The line regenerators are power fed from the terminal equipment over the phantom circuits of the line cable pairs.

## FEATURES

- Microminiaturized circuitry with diode-transistor logic microcircuits.
- 24 channels transmitted simultaneously.
- High stability encoder decoder performance.
- Speech quality unaffected by repeaters.
- Low cost equipment, simple installation and maintenance.
- Exceptional reliability.
- Compact space saving design.
- Modular construction.
- Accurate fault location system.
- Comprehensive alarm facilities.
- Rationalized set of 15 cable equalizing networks.



Regenerative Repeater

Point to point or network operation.  
 Suitable for integrated systems.  
 Range of signalling sets for different  
 exchange conditions.  
 Teleprinter or 2k/bit data facility in addition  
 to speech circuits.

### System Principles

The Marconi U 1310 series equipment provides 24 speech channels in time division multiplex over normal junction cable pairs. Pulse coded speech is obtained by sequentially sampling 24 analogue speech signals, each at a rate of 8000 Hz, and then encoding the resultant amplitude modulated pulse train into digital form. A non linear encoding process combines compression of the analogue signal pulses, quantization of the pulse amplitudes to a discrete level and coding of the quantized pulses into a 7-bit binary code. The first bit of the binary code represents the polarity of the sample and the succeeding 6 bits the magnitude. Thus a total of  $2^7$  (=128) different amplitudes can be

represented, from peak positive to peak negative. To this 7-bit code is added a further bit which conveys signalling information appropriate to that particular speech channel, making an overall 8-bit code word. The signalling bit is also used, by a process of further time division multiplexing, to provide synchronizing information. Each 8-bit code word is transmitted to line in sequence for each channel.

24 code words, each containing 8 bits, are assembled together in time sequence to form a frame. A frame consists of 192 digits ( $8 \times 24$ ). Four frames are assembled in time sequence to form a multi-frame. The allocation of the signalling/synchronizing bit in each code word is related to the frames in the multi-frame thus: Frames 1 and 3—signalling. Frame 2—Not used (optional teleprinter). Frame 4—Synchronizing.

Signalling terminations are available for 2-wire and 4-wire audio circuits. The four wire signalling units provide a 4-wire audio

extension with or without gain in each path and digital to d.c conversion on the E and M wires. Multiple E and M facilities are also available. A range of two-wire signalling units provide normal signalling requirements on uni-directional junction circuits between typically Strowger step-by-step exchanges. Signalling units for other types of exchanges (e.g. crossbar) can be developed for individual requirements.

The digital signal from the multiplex equipment is in bipolar form (alternate marks inverted) and is 50% duty cycle. This produces a signal most suitable for line transmission. Regenerative line repeaters are spaced at nominal 2000 yard (1830 m) intervals.

At the receive terminal the digital line signal is decoded by the use of a non-linear weighting network similar to the one used in the encoder. The reconstructed analogue pulses are then distributed to their respective channel outputs and the 24 speech circuits restored.

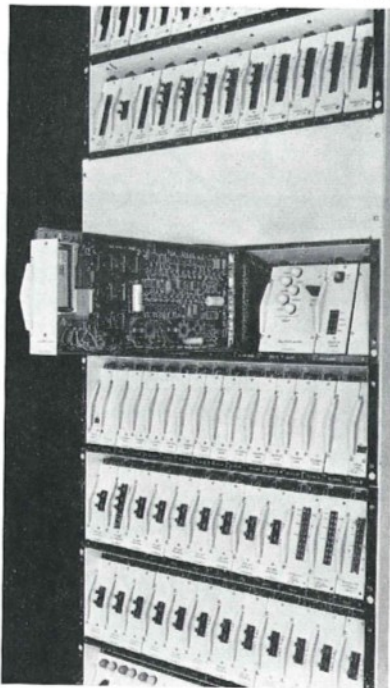
## DATA SUMMARY

**Number of channels:** 24.  
**Sampling rate:** 8000 Hz.  
**Coding:** 1 bit signalling or synch. plus 7 bit speech (symmetrical binary with alternate digit inversion).  
**Line terminations:** 120 ohms balanced.  
**Multipler interface:** 75 ohms unbalanced.  
**Synchronization:** Distributed pattern (every fourth frame).  
**Resynchronization time:** 7.5 milli-seconds  
**Gross digit rate:** 1.536 mega bits/second  $\pm 75$  bits/second.  
**Audio terminations:** 600 ohms balanced.  
**Peak Audio Signal T. Max:** +2 dBmO (CCITT Document WP33/XV No 9E).  
**Transmission loss:** 3 dB  $\pm 0.25$  dB (2 wire).  
**Amplitude/frequency response:**  
 300-3400 Hz at 0 dBm relative to 800 Hz.  

300 Hz	3400 Hz
1W to 2W, +0.5 to -3.0 dB	+0.5 to -2.0 dB
4W to 4W, +0.5 to -1.0 dB	+0.5 to -2.0 dB

**Line signal:** Bipolar  $\pm 3$  V (50% duty cycle).  
**Companding Law:** A=87.6 approximated by 13 segments with slope ratios of 2. (CCITT Document WP33/XV No 9E).  
**Companding advantage:** 24.1 dB.  
**Quiescent channel noise:** -63 dBm Op.  
**Quantization distortion:** Better than 25 dB (for the range -4 to -37 dBmO measured with gaussian test signal) and better than 30 dB for the range -10 to -30 dB.  
**Supply Voltage:** 24 V or 50 V d.c (Exchange battery).  
**Power required by a generator:** 48  $\pm$  2mA at 6.0 V max.

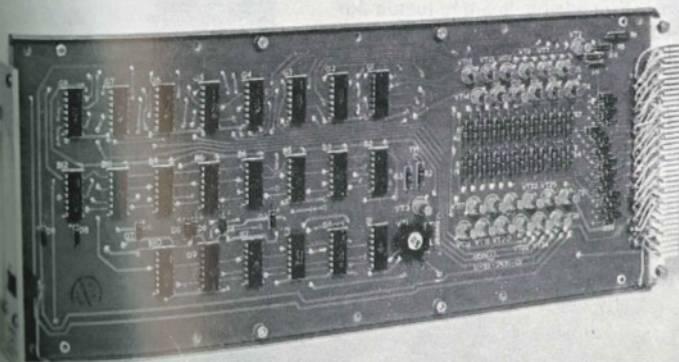
U1009



PCM Rack with Alarm Card on Outtrigger

### Temperature range:

*Exchange Equipment:* +2°C to +40°C.  
*Regenerator:* -5°C to +40°C.



Timing Card

U1004

## THE MARCONI COMPANY LIMITED Line Communications Division

Writtle, Essex  
 Telephone: Writtle 451. Telex: 99201  
 Telegrams: Expanse Chelmsford Telex