RECEIVING EQUIPMENT FOR SATELLITE COMMUNICATIONS

4GHz Low-Noise Amplifier

This amplifier has been developed to cover the 4GHz satellite receiving band —3·7 to 4·2GHz, providing a gain over the band of 30±0·5dB. This may be augmented by a T.D.A or T.W.T before the mixer stage. The amplifier is cooled at about 18°K by a closed-cycle helium gas refrigerator giving an effective input noise temperature of 18°K.

This signal input is in WR 229 waveguide and incorporates a rejection filter for any power outside the receiving band. The input v.s.w.r is 1·3. Three identical stages are cascaded to give 30dB gain over more than the required band. This excess simplifies the setting up procedure. A single solid-state pump source is used, incorporating power stabilization. The amplifier requires 150mW of pump power at a nominal frequency of 21GHz. The system can be set up over a wide range of pump frequencies and is relatively insensitive to pump frequency or power.

The design includes facilities for remote control and monitoring of the equipment.

Data summary

Gain: 30dB (40dB with following amplifier).

Instantaneous bandwidth in excess of 500MHz: (To ±0·5dB.)

Noise temperature: 18°K.

Input v.s.w.r: 1·3.

Input guide: WR 229.

Cool-down time: 4 hours.

Approximate size: 61cm×30·5cm (2ft×1ft) (amplifier only).

Supply: 240V a.c.
100W (amplifier).
1700W (refrigerator).

Receiver Down-converters and I.F Equipment

Features

Flexibility of the design combined with 62 type modular construction permits a wide range of received carrier combinations to be achieved with the same basic equipment.

Full redundancy and automatic changeover configuration available.

Bandwidths required for the various carrier capacities (e.g T.V 132 channel telephones etc.) accurately defined by plug-in passive filters. All active amplifiers are wide band.

Plug-in group delay equalizers.

The cabinet-mounted waveguide branching equipment is followed by six cavity waveguide filters in the signal paths prior to the mixers.

The mixers employed are of the balanced diode type in waveguide No. 11 covering the frequency range 3·7–4·2GHz. The low-noise amplifier which follows the mixer is integral with it. Frequency-stable crystal-controlled sources provide local oscillators for each mixer. Separate down-conversion is provided for the beacon signals.

Group delay equalization is provided by plug-in cards giving a wide range of preset adjustment in each carrier path. The main i.f amplifiers are separately mounted and are of wide bandwidth. The required bandwidth for each particular carrier being accurately defined by passive plug-in filters.

All equipment is cabinet mounted.

Data summary

Input connection: Waveguide No. 11.

Input frequency: As required in the range 3·7–4·2GHz.

Input level: —77 to —42dBM as required.

Output impedance: 75Ω.

Output frequency: Centered on 70MHz.

Output level: 5dBm (per carrier).

Output Bandwidth: As required up to 32MHz.

Tracking Demodulators

In order to acquire and 'lock on' to the satellite, basic pointing commands generally operating from the satellite beacon signals, are required by the antenna servo equipment. The tracking demodulator converts the r.f signals, obtained for tracking purposes from the antenna feed via the beacon down-converters into d.c signals, which are fed to the servo system for correcting the antenna positioning error.

Features

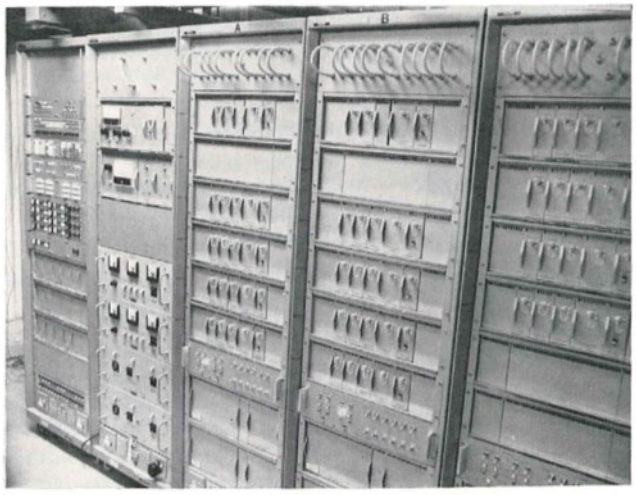
Beacon tracking demodulators for monopulse and mode conversion scan systems.

Tracking down-converter accepts preset beacon frequencies.

Scan rates up to 1000 r.p.m on mode conversion scan systems.

Two tracking demodulators (main/standby) can be fitted into one 183cm (6ft) cabinet.

Automatic changeover is available.



From right to left, receiver t.f rack, parametric amplifier monitory, equipment and local supervisory rack

Full remote operation.

Solid state with modular construction.

A.F.C (Automatic frequency control).

Full-lock facilities are provided on both the mode conversion scan and mono-pulse receivers. The dual main and standby equipment is mounted in one cabinet employing 62 type modular construction techniques.

Front panel indications and controls are presented locally on the cabinet and remoted to a panel mounted on the station control console. The equipment can be monitored or controlled from either locatian. A feature of the design is that the overall bandwidth is primarily determined by post detector filtering which is made possible by the special wide aperture phase sensitive detectors employed. This technique avoids the necessity for variable i.f bandwidths within the frequency acquisition and greatly simplifies receiver operation.

Data summary

Nominal input level: −100dBW.

Input i.f signal: 70MHz (other frequencies available on request).

Receiver effective noise bandwidth: 0·2 to 8Hz. This parameter is set by a simple modification according to tracking-loop system requirements.

Receiver error voltage outputs: 4V/min of arc.

Power requirements voltage: 100–125V or 200–250V a.c.

Power requirements frequency: 45–60Hz or 400Hz.

Supply voltage permissible variation: ±10%.

Modulators and Demodulators for Satellite Communications

The considerable experience of the Marconi Company in the design of multi-channel communication receivers has been applied to space communication systems now in operational use. Solid-state modulation, conventional and threshold extension demodulators have been designed to meet INTELSAT requirements. The threshold extension demodulator design is easily extended in practice to cater for an increasing traffic capacity should traffic growth justify it.

Features

Modulator suitable for 24 or 60 or 132 channel telephone and 525/625 line colour television.

Special wideband demodulator for colour television.

F.M.F.B demodulator for 24 or 60 or 132 channels.

62 type modular construction.

Main/standby configurations available.

Equipment

Modulator

This unit accepts the telephone or television baseband signal and converts it to highly linear wide-deviation frequency modulation. To produce the wide bandwidth required, the basic voltage controlled oscillator (v.c.o) is at u.h.f and is mixed down to 70MHz with the output of a second u.h.f oscillator. The output is raised in a linear amplifier and is corrected for group delay distortion. Included in the modulator is an a.f.c loop which incorporates a discriminator, the output of which is fed to a detector circuit, giving an alarm should the pilot fail or if the deviation is outside the prescribed limits.

Energy dispersal equipment to I.C.S.C requirements is included in the design.

Conventional Demodulator

This accepts the 70MHz output of the i.f amplifier system following the down-converter, and consists of a solid-state limiter, discriminator and line amplifier suitable for the wide bandwidth satellite television signal. The unit is in modular form for inclusion in a cabinet carrying many demodulators, and is followed by a plug-in de-emphasis network and attenuator unit.

Threshold extension demodulator

In this type of f.m demodulator design the threshold, defined as that value of carrier-to-noise where the output signal-to-noise ratio ceases to be directly proportional to the input carrier-to-noise ratio, is extended by changing the modulation index of the incoming signal before final demodulation.

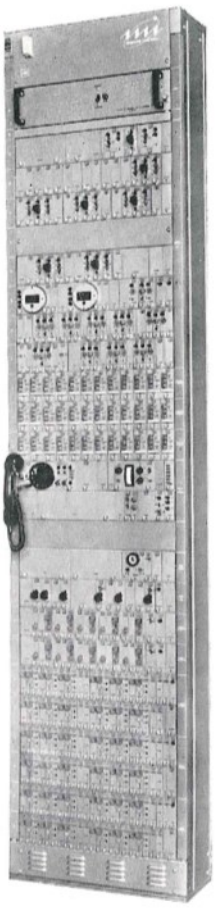
The unit accepts a 70MHz signal input from the down-convertor (following the low-noise amplifier) and passes first through a filter which passes the uncompressed signal. The signal is then up-converted by mixing with an a.f.c-controlled local oscillator, and a second filter selects the desired sideband and rejects the local oscillator and unwanted sideband. This signal is then down-converted to 70MHz by mixing the output of a linear v.c.o.

The 70MHz signal is amplified and passed through a single pole filter of a bandwidth suitable for the compressed deviation. This narrow-band signal is converted to baseband in a discriminator, and then fed back to the v.c.o as an error voltage via a low pass filter and a phase-controlling circuit. The baseband signals are also amplified and passed through the level-setting attenuator. An a.f.c circuit is included to counter any possible drift due to the transmitter oscillator, the satellite, the local receiver of doppler shift.

The unit is in modular form, and can be

132-Channel Multiplex Equipment for Satellite Communication Type MX214

Designed and produced by Marconi Italiana, Genoa, Italy



The MX214 is designed for assembling 132 speech circuits for transmission over a satellite communications network.

Transmit and receive circuits are packaged on separate functional racks to meet operational requirements specific to space communication. In designing the equipment special attention has been paid to the latest CCITT and COMSAT specifications.

Circuit

The assembly of 120 channels into the line frequency band 60–552kHz is in accordance with CCITT standards, namely:

(a) Twelve channels are first assembled into a basic group.
(b) Five basic groups are then assembled into a basic super-group.
(c) A final stage of modulation translates two basic super-groups into the line band.

An additional basic group is allocated in the band 12–60kHz bringing the capacity of the system up to 132 channels.

Data summary

4-Wire Audio Points

Frequency band: 300 to 3400Hz.

Input level: 0 to −15dBr.

Output level: +8 to −7dBr.

Impedence: 600Ω balanced.

Basic Group

Frequency band: 60 to 108kHz.

Sending side level (from channel modem to group modem): −37 to −47dBr.

Receiving side level (from group modem to channel modem): −5 to −30dBr.

Impedence: 150/130Ω balanced.

Basic Supergroup

Frequency band: 312 to 552kHz.

Sending side level (group to supergroup): −35dBr.

Receiving side level (supergroup to group): −30dBr.

Impedance: −75Ω unbalanced.

Multiplex Baseband of Satellite Link

Frequency band: 12 to 552kHz.

Sending side level (to radio): −10 to −45dBr.

Receiving side level (from radio): −15 to −45dBr.

Impedance: 75Ω unbalanced to 130Ω balanced or 150Ω balanced.

Multiplex Baseband of Terrestrial Link (960 ch.)

Frequency band: 60 to 4028kHz.

Sending side level: −20 to −45dBr.

Receiving side level: −20 to −45dBr.

Impedance: 75Ω unbalanced.

easily removed for maintenance. The adjustment for varying channel capacities in the case of the unit handling 24–132 channels is easily accomplished.

Data summary

Modulator-Typical specification

Output frequency: 70MHz ±70kHz.

Deviation per channel: 0·25 to 0·63 MHz r.m.s.

Normal television deviation:
525 line 9·4MHz peak-peak.
625 line 7·9MHz peak-peak.

Threshold Extension Demodulator

Input frequency: 70MHz nominal.

Highest baseband frequency: 552kHz.

Output level per channel: −15dBm.

Gain stability: 0·5dB per month.

Output impedance: 75Ω.

C/T Values for 8400pW phosometrically weighted

132 channels deviation: 0·63MHz r.m.s −148·5dBw/°K (typical).

60 channels deviation: 0·410MHz r.m.s −151·3dBw/°K (typical).

24 channels deviation: 0·25MHz r.m.s −154·8dBw°K (typical).

Conventional Demodulator

Input frequency: 70MHz.

Max. input deviation: 32MHz peak to peak.

Output bandwidth: 30MHz to 5·5MHz.

Output impedance: 75Ω.

Output return loss: 26dB.

Nominal output level: 1V peak to peak.