

# Microwave Communication Systems

LOW-CAPACITY VHF systems have been the mainstay of many communication networks for many years but the increasing demand for high-capacity multi-channel telephone circuits, wide-band television and high-speed data channels is gradually relegating the VHF systems to the low-capacity feeder and junction circuits, whilst the main trunk routes are being equipped with wide-band radio relay systems in the UHF and SHF bands. The Marconi Company produces both low-capacity systems and also wide-band high-capacity systems which meet accepted international and CCIR performance standards.

## APPLICATION

The term 'microwave' has been applied rather loosely to cover the range 300 to 50,000 Mc/s, which includes the UHF, the SHF and higher frequency bands. The spectrum is shared mainly between radar and communications services, the latter being sub-divided between civil and military users. The allocation of frequency bands covering several hundreds of Mc/s for fixed-station use enables radio links to be engineered which will provide the large traffic capacity demanded of national and international trunk networks. This traffic includes groups of hundreds of telephone channels, television and sound broadcast channels, high-speed data, radar information and associated services such as telegraphy, facsimile and telemetry.

Because of the amount of traffic it carries, a microwave system must have complete reliability both in quality and continuity of performance. It is usual to duplicate equipment so that failures do not cause loss of traffic.

## AERIALS

The aerial system usually consists of highly directional parabolic or horn aerials. Alternate channels are cross-polarized and one aerial may accommodate several similarly polarized channels in one frequency band, or cross-polarized groups of channels in two or more frequency bands simultaneously.

One or more of the wide-band channels is normally nominated as a stand-by for several active channels. A supervisory system monitors the circuit quality and controls the necessary switching functions.

The directional aerials not only provide the high signal level necessary to meet the

performance standards but also, with a carefully selected frequency plan, minimize interference between other systems in the same area.

## SYSTEMS

The supervisory signals may, in simple systems, be carried with the traffic. Otherwise a separate low-capacity supervisory channel is included. This may use the same frequency band and aerial system, or operate quite independently. The system may be controlled from one station, or may be split into sections for convenience of maintenance, each with its control station.

The idealized trunk system often requires elaboration to meet the specific needs for internal traffic routing. A single route is sometimes controlled from two or more centres. Television and broadcast channels are often distributed along a route and, in the interests of economy, reversible channels for these essentially one-way transmissions are frequently provided.

The block diagram illustrates a typical microwave system with representative traffic requirements and the types of station required to provide these facilities. In practice, many more intermediate repeater stations could be included in the various sections of the system. The network consists essentially of a main trunk circuit, carrying telephony and television signals from the main terminal (1) to terminal (8). The intermediate terminal (4) provides a telephone trunk route to terminal (5) including further master groups of telephone channels. This section consists of two through channels and one additional channel sharing the common stand-by. The branching repeater (6) provides through telephony and television channels with a television spur link to terminal (11). The

repeaters (9) and (10) are reversible so that the main system may be served by programmes from terminal (11) or from repeater (10) at which outside-broadcast programmes can be inserted as either IF or video signals. Repeater (7) is an intermediate switching station (on the assumption that many repeaters are involved between stations (6) and (8)). At this point any RF channel has access to the stand-by channel in the event of a fault occurring between (6) and (7) or (7) and (8).

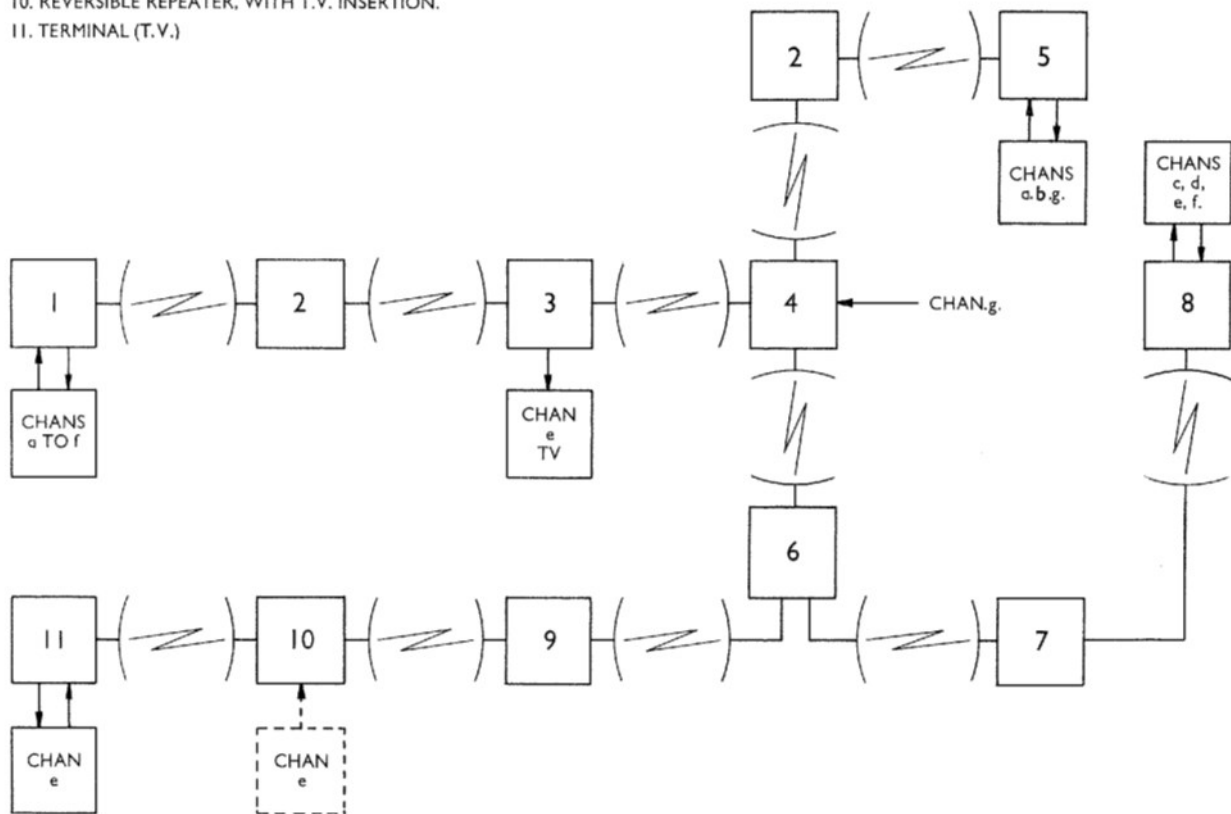
## PLANNING AND SURVEYING

The propagation characteristics of microwaves impose restrictions on their use. The requirement of a line-of-sight path between adjacent aerial systems implies a minimum clearance of any topographical obstructions or large buildings. Reflections from the ground, water surface and buildings may cause variations of signal level, or echoes, which can impair the performance of the system. The narrow beams radiated from the aerials require very rigid supporting towers. This may place an economic limit, while the transmission loss in the waveguide between the equipment and aerial may place a technical limit to the height of the tower. Many other factors affecting the cost and performance of the system require careful consideration before the most favourable engineering solution is found.

Correct siting of the station and determination of the tower heights are most important. It is expensive, if not impossible, to correct errors in this part of the system engineering and a radio survey to confirm calculations is often essential. Experience in surveying and operating systems in varied climatic conditions and over different types of terrain, such as Marconi's have

1. MAIN TERMINAL.
2. REPEATER, R.F. OR I.F.
3. DROP REPEATER. (T.V.)
4. INTERMEDIATE TERMINAL.  
(BRANCHING & SWITCHING.)
5. TERMINAL (TELEPHONY.)
6. BRANCHING REPEATER.
7. SWITCHING REPEATER.
8. TERMINAL (T.V. & T.P.)
9. REVERSIBLE REPEATER (T.V.)
10. REVERSIBLE REPEATER, WITH T.V. INSERTION.
11. TERMINAL (T.V.)

- CHANNEL (a) TELEPHONY, 2 OR 3 MASTER GROUPS. TERMINALS 1 TO 5.  
 (b) STANDBY FOR (a), (c) & (d).  
 (c) TELEPHONY AS (a). TERMINALS 1 TO 8.  
 (d) AS (c).  
 (e) TELEVISION WITH SOUND, TWO WAY. TERMINALS 1 TO 5, 8 & 11.  
 EXTRACTION AT REPEATER 3, INSERTION AT REPEATER 10.  
 (f) STANDBY FOR (e).  
 (g) TELEPHONY, AS (d) TERMINALS 4 & 5.



*A typical microwave system*

accumulated over many years, is invaluable in foreseeing difficulties and in interpreting the results of a limited survey.

#### TECHNIQUES

The term microwave was originally associated with a difference in technique from radio communication in other frequency bands. The essential difference in equipment design lies in the use of waveguide as a transmission line in place of the coaxial cable. The problems associated with the very wide bandwidth and very high frequencies involved have not only led to the development of new technical devices but have resulted in a quality of performance far superior to any previously possible.

Of the new designs, the travelling-wave

tube amplifier is outstanding. The RF repeater using three of these tubes can amplify a signal from a few micro-micro-watts to several watts without recourse to any low-frequency techniques. Transmitters, RF and IF repeaters almost invariably use one of these tubes as the power amplifier, with a gain of 40 dB or more over a bandwidth of tens of Mc/s.

The development of ferrite devices in the form of isolators and circulators has greatly simplified and improved the performance of microwave systems. The isolator permits almost loss-free transmission in a waveguide in one direction with a high degree of attenuation in the other. This feature virtually eliminates reflections from components, travelling-wave tubes, etc., and echoes in

long feeders with their attendant amplitude and phase distortion.

The circulator usually has three or four waveguide outlets with directional properties, enabling transmitters and receivers to be combined on to one feeder with very little interaction.

#### THE MARCONI SERVICE

The Marconi Company is able to undertake the planning, supply and installation of complete microwave and VHF systems. This service includes propagation surveys, provision of the radio links together with aerial supporting towers, channelling equipment, power generating plant and other ancillary services, maintenance, training and advice on operational and other problems.