



D. B. MANNING and M. HAZLE

THE MARK VIII COMMUNICATION SYSTEM

INTRODUCTION

A television camera is rarely operated in isolation. It is normally part of a complex production system involving many people all of whom may need to be in communication with each other at various times before or during a programme.

With the introduction of the sophisticated Mark VIII Colour Camera it was decided a new, forward-looking design of communication system, uncompromised by the restriction of compatibility with previous equipment, was needed.

GENERAL PRINCIPLES

The prime requirement is for good quality sound, free from crosstalk, noise and overloading to minimize operator fatigue. Each user should have adequate control of the many circuits so that each can be adjusted to suit the various listening conditions.

The system design must be flexible and cater economically for varying requirements from the small, simple studio to the major studio complex. It must be capable of ready integration into inter-area talkback systems. Above all it must be reliable when operated continuously, possibly under adverse conditions.

DESIGN PARAMETERS

The following system design parameters were thus established:

- (a) The Camera and Camera Control Unit (CCU) to have the option of an omnibus (American) system or switched (British) system
- (b) Moving coil microphones to be used throughout
- (c) All inter-unit wiring to be at OdBm level (0.775V), with balanced circuits and low output impedance feeding high input impedances
- (d) Production area microphone amplifiers to incorporate fully automatic limiting circuits
- (e) All production positions to have a choice of open microphone/loudspeaker working or of headset working
- (f) A relay matrix for engineering talkback with flexibility in the choice of crosspoints and switch positions

- (g) A maximum of six cameras to work with one communication unit, but with the possibility of combining units for larger installations
- (h) Amplifiers to be plug-in, with separate printed wiring boards for the distribution of Producer's Talkback, Programme Audio, Camera Talkback, and Camera Control Unit Talkback
- (j) An auxiliary connector giving access to all important circuits for integration into other systems.

SYSTEM CHOICE

There are two alternative systems available; the two-wire American or the four-wire British. The change between the two is made by replacing one printed board in both the camera and camera control unit.

The two-wire version employs an interphone system compatible with the omnibus ring used in American television studios. The facility for private camera to camera control unit communication is provided for line-up or single-channel working. By closing a Conference switch the camera and control unit are brought into the omnibus ring. A floor manager position is provided at the camera, being permanently connected to the two-wire ring inlet at the camera control unit. Programme Audio (Audio Cue) is present at the camera, floor manager and camera control unit positions. The 'Call' and 'Cue' (Tally) facilities are the same as those described later for the four-wire system.

With the four-wire system Programme Audio, Production Talkback and Engineering Talkback can be fed into the camera channel. Outputs of Camera Talkback and CCU Talkback can be either fed out to the communication unit, or looped directly back into the camera channel for private camera/camera control unit communication. All inputs and outputs are floating balanced, and OdBm (0.775V) is the standard level throughout.

CAMERA CONTROL UNIT

The camera control unit operator's headset is fed with Programme Audio, Production Talkback and Camera Talkback; up to +20dBV can be delivered to high-impedance headphones. A speak/off/call

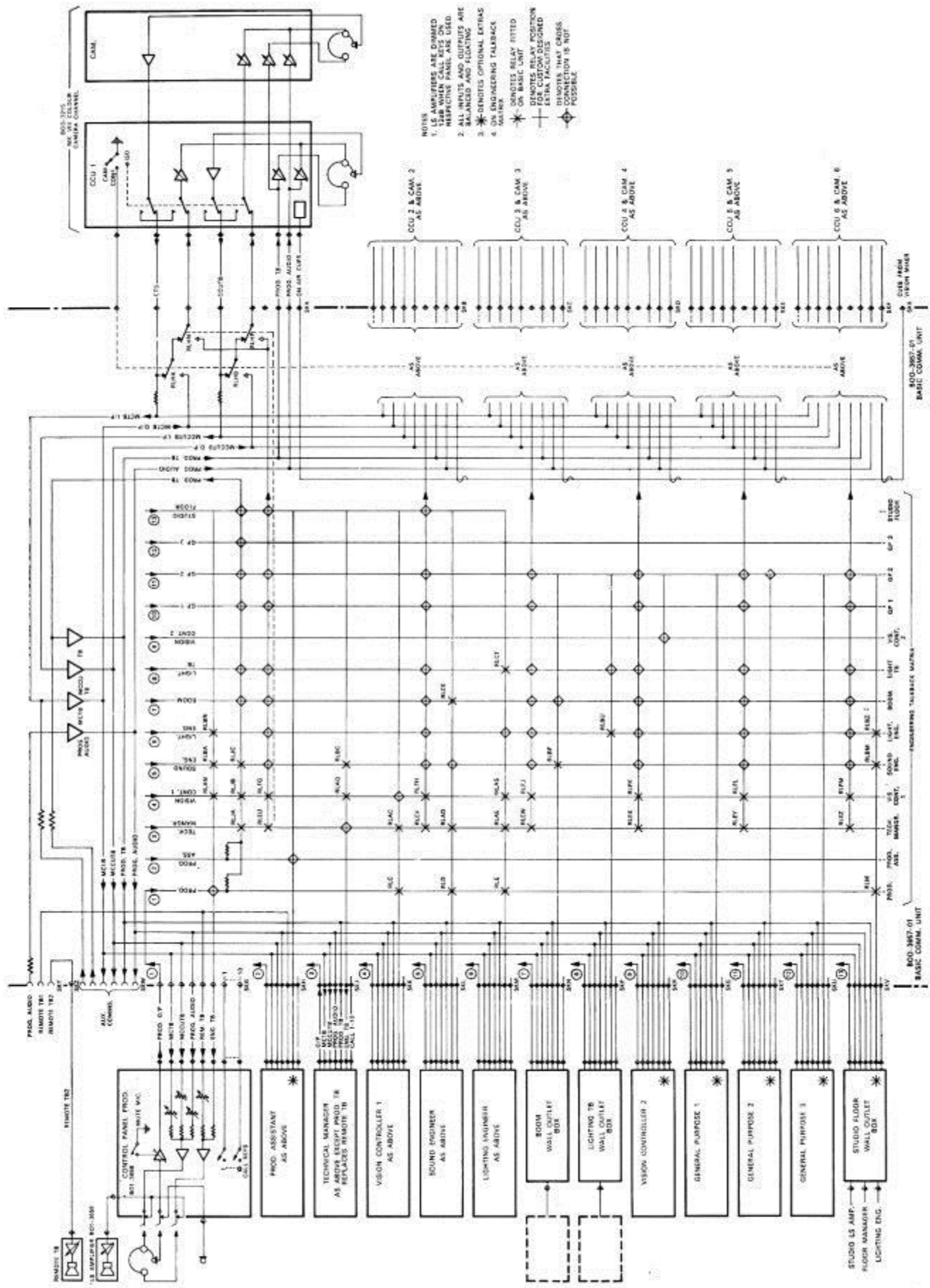


Fig.1 Facilities diagram, Mark VIII communication system.



key for the operator is provided on the Camera Control Panel, together with three volume controls and a three-position switch giving:

1 Camera

Is the normal mode of operation when the channel is part of a multi-camera system which is being used with a communication unit.

2 ISO

Provides private communication between camera and CCU for line-up or single channel working, and dispenses with the need for any communication unit shorting plugs at the channel outlet.

3 Conference

Enables the CCU operator to make contact with other cameras, via the mixed camera talkback and mixed CCU talkback lines in the communications unit. One pair of contacts in this position is used for the conference facility described in the two-wire system.

CAMERA

A talkback panel at the rear of the camera mounts two headset outlets, wired in parallel, for the cameraman and floor manager, and fed with Programme Audio, Production Talkback and Engineering/Camera Control Unit Talkback. This panel includes volume controls for the three feeds plus a speak/call key.

Two headphone outlets for floor personnel are provided next to the camera cable connector, and are fed with Programme Audio and Production Talkback. The levels at these two outputs are set by the volume controls on the talkback panel. Again, up to +20dBV can be supplied to each headset and headphone outlet.

Cues

The camera channel is cued by shorting a pair of contacts in the communications plug at the rear of the camera control unit. These are normally wired with one of the pair earthed — but links are provided on the camera control unit talkback board to facilitate alternative arrangements.

'On-Air' lamps are provided on top of the camera,

on the viewfinder and the front of the camera control panel. The camera lamp may be switched off when required and a brightness control is provided for viewfinder lamps.

Call Camera

The camera control panel speak/call switch enables the operator to call the camera by flashing the camera 'on-air' lamps. When a camera is on air its 'on-air' lamp cannot be dowsed by this speak/call switch.

Call CCU

When the call/speak key at the camera is pressed, an audible warning is sounded at the CCU. The 'on-air' lamps on the front of the CCP are flashed on if the camera is not on air, or off if they are already on. The audible warning and cue lamp illumination are only operated while the call key at the camera is depressed. Therefore, a small 'hold call' lamp on the front of the CCP is also illuminated. This remains on until the call is answered by the CCU operator moving his key to the 'speak' position.

Standby Talkback

A +24V supply is available in the Camera Control Unit (for ovens and relays) and remains on when the main channel power supplies are off. This is used to provide power for talkback when the channel is being first set up (e.g. at an O.B site).

The +24V is passed up two of the talkback wires in the camera cable to power the camera talkback board. The changeover from the +24V to the normal rails in the camera and CCU is carried out by a relay on the CCU talkback board. After the channel is switched on there is a short delay (10 seconds approx), before the changeover occurs so that the camera power supply has time to come on and provide the normal rail for the talkback.

COMMUNICATION UNIT

The communication unit is wired to accept up to six camera channels, and to provide each with Programme Audio and Production Talkback (Fig.1). With the Camera Control Unit set for CAMERA (normal) operation, it permits each channel to communicate with itself, while tapping off CCU Talkback and Camera Talkback for distribution to the relevant production positions.

When the CCU is set to 'Conference', the changeover relays in the Communication Unit switch all cameras to receive Mixed Camera Control Unit Talkback, and all camera control units to receive Mixed Camera Talkback, enabling one engineer to control all channels from one camera control unit.

The communication unit also accepts d.c ON-AIR cues from an external source, such as a vision mixer, and distributes these to each camera channel.

A maximum of thirteen production and engineering positions are catered for, all with very similar facilities. In general, they work from B3658 Talkback Control Panels, but certain areas, such as Studio Floor, Booms and Lighting Grid have their own specific panels with reduced calling facilities.

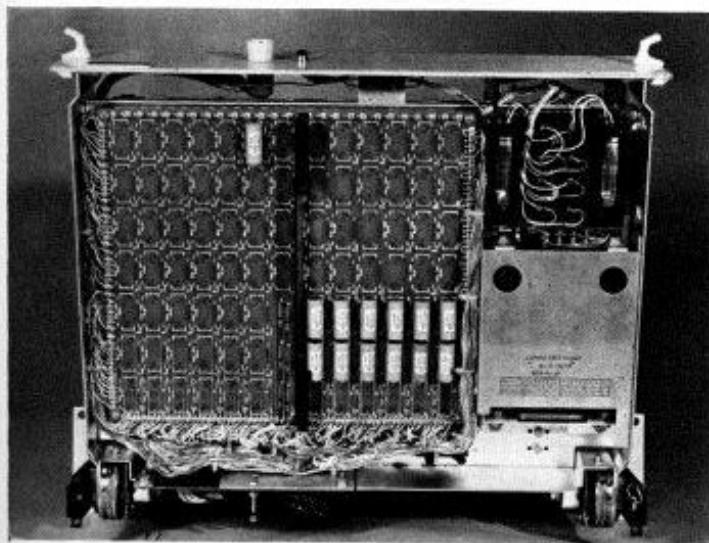


Fig.2 View of Engineering Talkback Matrix.



Every position receives Programme Audio, Mixed Camera Talkback (MCTB) and Mixed Camera Control Unit Talkback (MCCUTB), together with switched Engineering Talkback from predetermined circuits on a relay matrix. The slight difference between these 13 outlets are:

- (a) The Producer and Producer's Assistant positions provide permanent talkback to all other outlets and can receive an external (REMOTE) talkback signal from another unit.
- (b) The Technical Manager, Vision Controllers 1 and 2 and General Purpose 3 (GP3), have access to individual CALL CAM circuits and these can be programmed for any number of cameras up to the maximum of six.
- (c) The GP3 and Studio Floor positions have restricted access to the Engineering Talkback matrix. Only five circuits are available.

Engineering Talkback Matrix

A unique design of matrix provides great flexibility in covering customers varying requirements. It consists of two double-sided printed boards, laid out such that the balanced input pairs proceed from left to right on one side, and the output pairs from top to bottom on the other side (Fig.2).

A diaphragm relay (giving high reliability) can be fitted at any crosspoint. Figure 1 shows the relays fitted to provide basic facilities while additional relays can be added as required. Wire links on the matrix board determine which key is controlling any given crosspoint.

Distribution Amplifiers

Four identical distribution amplifiers plug into sockets near the front panel with their gain controls readily accessible. To minimize crosstalk individual voltage regulators are fitted in the supply rail of each amplifier. The circuit utilizes a pair of TAA300 integrated circuits, fed from a balanced input transformer with alternative $600\ \Omega$ or high-impedance inputs. A transformerless, a.c. coupled output is employed having an impedance of less than $1\ \Omega$.

Power supply

An integral supply unit powers the Distribution Amplifiers, Remote Talkback Control Panels, Loud-

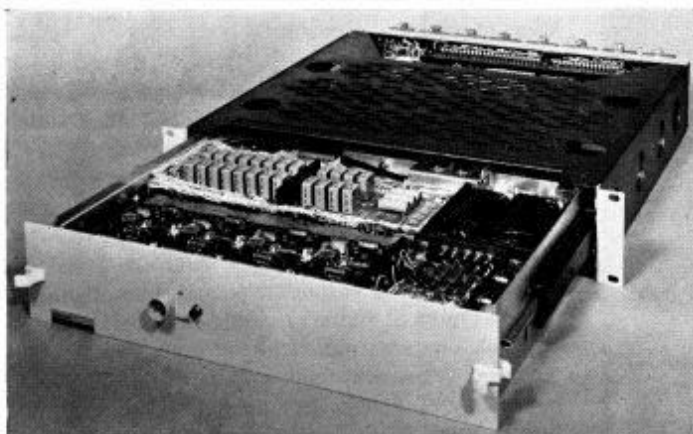


Fig.3 The Communication Unit.

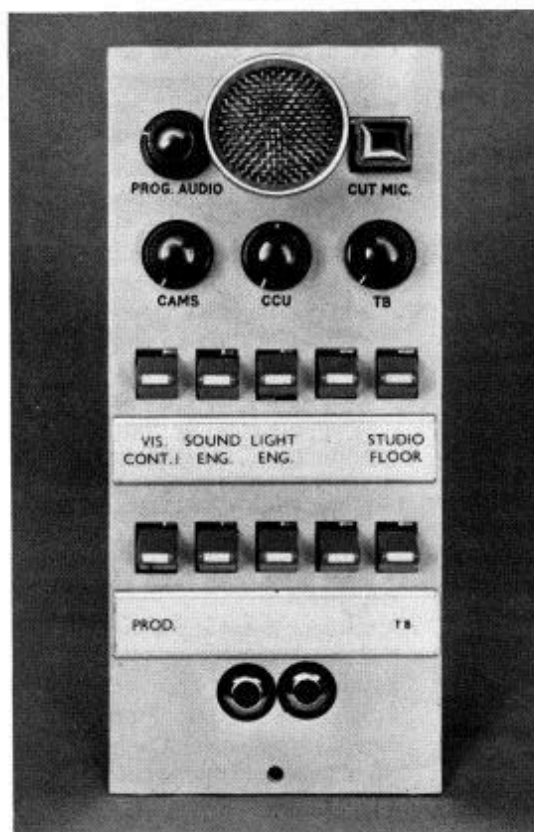


Fig.4 Talkback Amplifier Panel.

speaker Amplifiers Panels and relays. The supply provides +15V and -15V rails, is current regulated and protected against short circuits.

The mechanical construction of the Communication Unit, which occupies $3\frac{1}{2}$ in of 19in rack space, is shown in figure 3. Apart from the Distribution Amplifiers all boards are wired in — but may be easily hinged up for access and maintenance. All cable connectors are on the rear panel and are multi-pin MRAC types, except for the standard EP4 mains connector.

TALKBACK AMPLIFIER PANEL

Due to the advent of reliable linear integrated circuits and associated miniaturized components, it has proved possible to meet all the specified design parameters by fitting amplifiers on the control panels. This panel (Fig.4) incorporates a moving-coil microphone which can be plugged directly into the panel, or used with a flexible stalk. There are four separate gain controls to permit the balance of the incoming circuits, and ten calling keys, non-locking down and locking up, for operating the engineering talkback circuits. As each key can be programmed to any available circuit, and these will vary at each control position, a large selection of film strip designations are supplied with every panel. These can be cut up and slid into the label holders as required.

All panels are fitted with twin jack sockets so that a plug-in headset can be used instead of the stalk microphone. As with the camera and camera control unit, a d.c. voltage is supplied giving the choice of

using an amplified moving-coil microphone headset, or the older established carbon microphone headset.

A plug-in assembly includes a microphone amplifier and two earphone amplifiers. The high-gain microphone amplifier has an internal preset gain control and a sophisticated two-stage limiter amplifier. This gives exceptionally good control of the varying voice levels found in production control areas, preventing annoying distortions from shouted commands which would normally overload the system. There is a preset limiting control which is normally set up to prevent the peak output rising above +8dBm, but it can be adjusted from limiting peaks to 0dBm out to the other extreme of no limiting at all. Thus, if there are any circumstances where the limiting is not required, it can be turned off.

For maximum intelligibility a shaped frequency response has been chosen, with symmetrical roll-off at high and low frequencies. The response is designed to be approximately -6dB at 100Hz and 8kHz. The transistor input stage is followed by a gain control stage utilizing a field-effect transistor controlled by amplified a.g.c.

The output stage is an SL630C integrated circuit feeding a balanced output transformer. This package also has automatic gain and muting controls. A push button on the front panel is available to kill the output of the microphone amplifier, providing privacy when required.

Two CA3033 integrated circuits are used to provide high-level drive to the separate earphones. A maximum level of +20dBV is available to overcome the worst ambient noise conditions. Mixed camera talkback (MCTB), mixed camera control unit talkback (MCCUTB) and Programme Audio are mixed to one earpiece with a high degree of isolation between each circuit. Production Talkback and Engineering Talkback are mixed to the other earpiece. The engineering circuit has an internal gain control which is normally set to provide a slightly higher level than all the other circuits. This ensures the receipt of urgent commands.

For installations using loudspeaker listening it is possible either to combine the two headphone circuits to one loudspeaker amplifier panel, or have separate loudspeaker panels as desired.

It can be seen from figure 4 that the talkback amplifier panel is a very compact unit and the amplifier board is fully screened, permitting it to be mounted in any position in control desks.



Fig.5 Loudspeaker Amplifier Panel.

Connection to the Communication Unit is by a standard 26-way screened cable. The audio conductors have been specially selected to provide good crosstalk performance and cable lengths of over 100 metres can be used without undue degradation of performance.

A separate 14-way cable from the talkback panel feeds the loudspeaker amplifier panel, both amplifiers receiving their d.c supply from the central Communication Unit.

LOUDSPEAKER AMPLIFIER PANEL

This compact unit (Fig.5) has been designed in alternative panel sizes. It can be mounted beside the Talkback Amplifier panel with similar $8\frac{1}{8}$ in height, or in a second version 4in high it can be mounted in a standard Marconi control desk. The amplifier includes a PA246 integrated circuit and can provide over two watts output into the 5in x 3in loudspeaker.

A front panel gain control is fitted and there is also an automatic 'dimming' circuit. Operating any call key on the TB Control Panel reduces the gain of the loudspeaker Amplifier Panel by 10dB. This value is chosen to prevent acoustic feedback, but is easily adjustable from 0dB to complete muting. Also, the keys on the TB Control Panel are wired in such a manner that loudspeaker muting on any call circuit can be disabled by simply cutting a link on the key.

ANCILLARY UNITS

To complete the range of units in the system, there is a comprehensive Studio Outlet Panel, a Studio Floor Loudspeaker Outlet Panel and a Boom Outlet Panel. All are designed to fit standard Marconi wall outlet boxes. The Studio Outlet Panel provides headset communication with the other areas. Five calling circuits and all the standard listening circuits are available. The amplifier is identical to that used in the Talkback Amplifier Panel. In addition there is an output socket for a high-quality Studio Address loudspeaker amplifier with in-built muting for control from Transmission Rehearsal circuits.

The alternative Floor Loudspeaker Outlet Panel simply provides the Studio Address loudspeaker socket and muting circuit. This is for smaller installations where no talkback amplifier is required.

The Boom Outlet Panel is a simple conversion unit from the 26-way MRAC connector to the more robust Amphenol type for use on the studio floor. The same panel is also suitable for lighting talkback.

These two panels are used in conjunction with the Boom Outlet Box. This again uses the standard talkback amplifier printed wiring board, but only two calling keys are provided, together with a headset jack, and relevant gain controls.

ACKNOWLEDGMENTS

The authors are indebted to Mr D. R. Sharp of The Marconi Operational Services Group, Broadcasting Division, for his assistance in the planning and design of this equipment.