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A VERSATILE U.H.F TRANSMITTER

INTRODUCTION

The new B7319/7320 t.v transmitter combination covers Bands IV and V and is suitable for NTSC, PAL or SECAM signals using systems I, G or M. The B7320 provides a 10kW peak-vision output and 2kW (or 1kW for the 10:1 vision/sound requirement) sound output, and has separate sound and vision channels. The B7319 employs the combined vision and sound 'multiplex' system, the vision and sound signals being combined at intermediate frequency, providing a 4kW peak-sync power level with an 800W sound output level. The 7319 incorporates pre-correction in the i.f stages to reduce the intermodulation products (I/P) within the transmission channel.

The power amplifiers use 4-cavity klystron amplifiers, either the external-cavity type, (English Electric K370C/371C/372C series), or the integral-cavity type, (ITT Z153/163/173/50Z series). These klystrons are driven by all solid-state drive units.[1]

The transmitter signal processing and driving sections comprise solid-state modular units to provide the modulated r.f input at radiated frequency to the klystron amplifiers. Control and protection are effected by solid-state logic units and the klystron beam voltage h.t supply also uses solid-state devices, encapsulated in stacks.

The main/reserve configuration supplied to the I.B.A (Fig.1) comprised two complete transmitters. One, the main B7320 transmitter, was capable of 11kW peak-sync output, with derating to 6kW possible by h.t transformer tap adjustment, and appropriate sound output at 10:1 or 5:1 vision/sound ratios. The second B7319 reserve transmitter

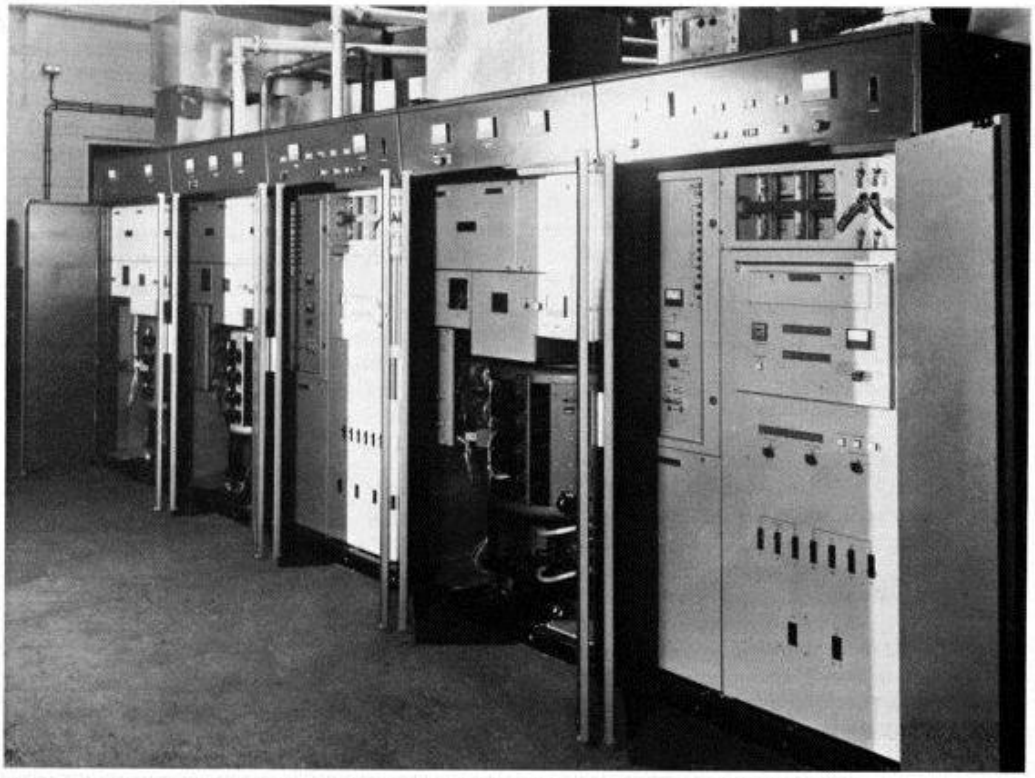


Fig.1 The I.B.A main/reserve configuration. B7320 u.h.f transmitter at the left and the B7319 to the right.

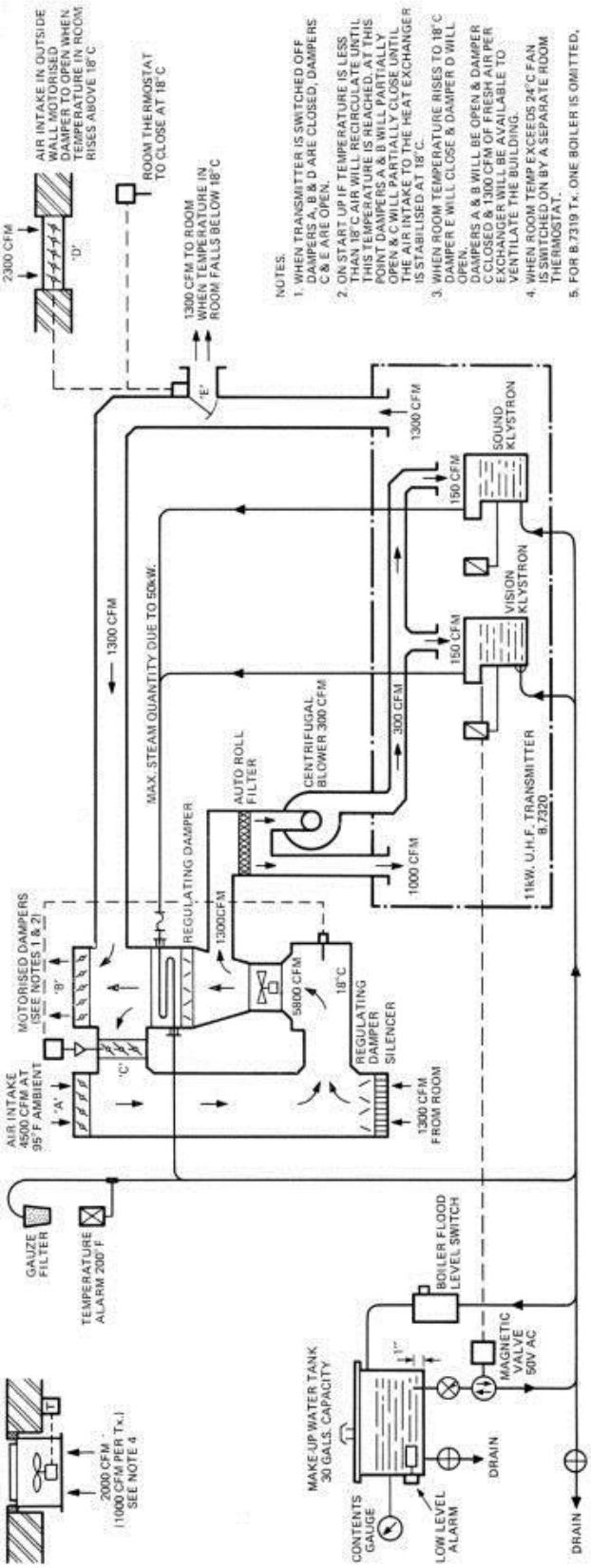


Fig.2 Cooling system functional diagram.

included the facility of power derating from 4kW to 2kW or 1kW peak-sync output, again with the multiplex sound output at the appropriate level.

The standard versions of these transmitters may also be separately installed, i.e, 2 × 10kW transmitters for main and standby or 2 × 4kW multiplex transmitters for main and standby.

MECHANICAL DESIGN

B7320 Transmitter

This consists of three identical in-line cabinets. Two of these house identical sound and vision klystron amplifiers, the third containing the power distribution components, control unit and beam supply for vision and sound klystrons. At the top of each cabinet are angled panels carrying meters and operational controls. The cabinets are designed to suit container transportation methods, each being mounted on a welded steel plinth for ease of transport and installation; (no separate plinths are needed to overcome floor irregularities). The complete transmitter measures 2,050mm high by 3,683mm wide by 1,321mm deep.

B7319 Transmitter

This consists of two cabinets, each identical to those of the B7320 transmitter. The klystron cabinet uses the same klystron while the layout is also similar. The control and power supply cabinet is the same layout as the B7320, the sole difference being the addition of control switches and indications for operating either transmitter in a local or remote mode for manual or automatic changeover.

The cabinet front doors are magnetically fastened and are not interlocked, so giving access to the klystron tuning controls, solid-state driver and status indicating units. The external finish is durable two-tone grey stove hammer paint, except for the azure-blue meter panel.

Cooler Unit

A separate cooler unit is supplied with each transmitter and provides steam cooling for the klystron amplifier collectors, high pressure air-cooling for the klystron cavities, and low pressure air-cooling for the cabinets (Fig.2). This unit is in the form of a cabinet which is acoustically lagged to reduce noise to a minimum. Two such cabinets with the associated air ducting, steam pipes, etc are required for the B7320/7319 transmitting system.

DESIGN FEATURES

Klystron Amplifiers

The power metering supplied measures the peak sync power of the transmitter, and hence does not vary with picture content. These meters are situated on the fascia panel, switches being provided to measure forward and reflected power and klystron cavity indicated power levels.

The klystrons for both sound and vision are vapour-cooled and no water pumps are used. Klystron boilers are gravity fed through a magnetic control valve which is operated by a water level sensing switch attached to the klystron trolley.

This switch can be adjusted to operate when the klystron water level falls below precise limits; if this magnetic valve should fail to close a boiler flooded indication gives warning.

The klystron focus current supply is electronically stabilized to within ±2% of its nominal operating value. This prevents any change in focus current as the focus coil heats up to its normal operating temperature and consequently maintains a good 'start' performance.

Both the B7320 and 7319 provide an interlock system ensuring that all doors permitting access to dangerous voltages must be locked by means of a key before the equipment can be switched on. The earthing switch must be operated after the mains power switch to remove any interlocked keys. This switch earths the three phases on the secondary of the beam voltage transformer, all smoothing capacitors and h.t links above 72V.

There are no fuses in any part of the transmitter, circuit breakers being used throughout and mounted behind the front panel of the cabinet such that they can be operated from the front.

The beam voltage rectifier supply uses solid-state rectifier stacks which are flame resistant and are capable of withstanding direct short-circuit conditions.

A monitoring panel on the front of the vision klystron cabinet enables r.f monitoring of the vision and sound outputs prior to the combining unit; also the output of the combining unit prior to the test load or antenna. This panel has a double sideband monitor fitted behind it so that any of the three r.f outputs may be linked in. The d.s.b monitor unit also has its output on this panel, a useful facility when setting up the transmitter performance.

LOGIC CONTROL

Beam Power Supplies and Logic Control are all situated in the third cabinet with comprehensive protection and earthing arrangements. A window is provided to ensure that the operator can see correct operation of the earthing contacts, which can be a most reassuring factor from the operating point of view.

The controlling and run-up procedure for the transmitter is fully automatic, operating from plug-in logic boards (Fig.3). The three operational states of the transmitter –

A.c on Indicating that mains has been connected to the transmitter.

Standby This condition is obtained by operating an **on** and **off** press-button on the fascia panel. This standby condition is preceded by a transient state which lasts as long as the transmitter requires for certain warming-up periods. Should any condition fail to be established, then the transmitter will not achieve 'standby' and the indicating lamp will not light.

H.t on which is the transmitting ON state brought about by pressing the **h.t on** button after the **standby** state has been established.

The transmitter can be brought to the fully *ON* state by one contact operated from a remote site, provided both **standby** and **h.t** buttons have been operated.

All control and indication circuits use solid-state components with the following exceptions:

Beam contactor and pilot relay
Filament contactor
Focus contactor
Contactors to actuate the feeder switch motor.

All the above contactors are driven by logic-contactor driver modules using triacs.

The logic control unit comprising plug-in modules is designed to provide the logical sequence of operations. Heater delays and turning off delays are solid-state while a fully automated solid-state, 3-shot recycling system protects against intermittent faults.

The indicator lamps mounted on the hinged front panel of the logic 'basket' provides status information of the service being monitored and include:

Delay complete	Cooling normal
Interlocks	Isolators
Vision focus	Lockout
Sound focus	Vision modulation, anode
Cabinet temperature	Sound modulation, anode
Air	Body current
Heaters	Vision s.w.r
Water level	Sound s.w.r
Boiler flooded	Combined s.w.r

All the above services and indications must be alight before h.t can be switched on. The absence of any auxiliary service will cause a fault indication (extinguished lamp) and will arrest the progressive control. Certain of the lamps are operated by memory circuits and will provide an indefinite record of the occurrence of a transient fault. A reset control will restore the lamps to their normal no-fault condition. The action of switching on the transmitter will also reset the lamps.

The faults that cause removal of h.t may either be – non-recycling producing a lockout which will hold off the h.t indefinitely until the fault is remedied, these are trip circuits, or recycling faults producing an overload. The h.t will restore for a 3-shot recycling programme, producing a lockout if the fault persists beyond three restorations. These are overloads.

A hold-on over-ride circuit allows the h.t to be restored immediately the heaters supply is restored in the event of a mains failure lasting less than 15 seconds.

The logic modules fit into 24-way edge connectors and may be easily withdrawn. Each module has test points accessible from the front, enabling logic inputs to be monitored without removing the module. A conventional edge connector key and slot mechanical interlock prevents an incorrect type of module being inserted in a socket.

One operational control is mounted on the front panel of the control unit 'Overload memory reset' (push to operate). It is necessary to operate this switch to reset any indicated fault lamp that has been extinguished due to an intermittent overload condition.

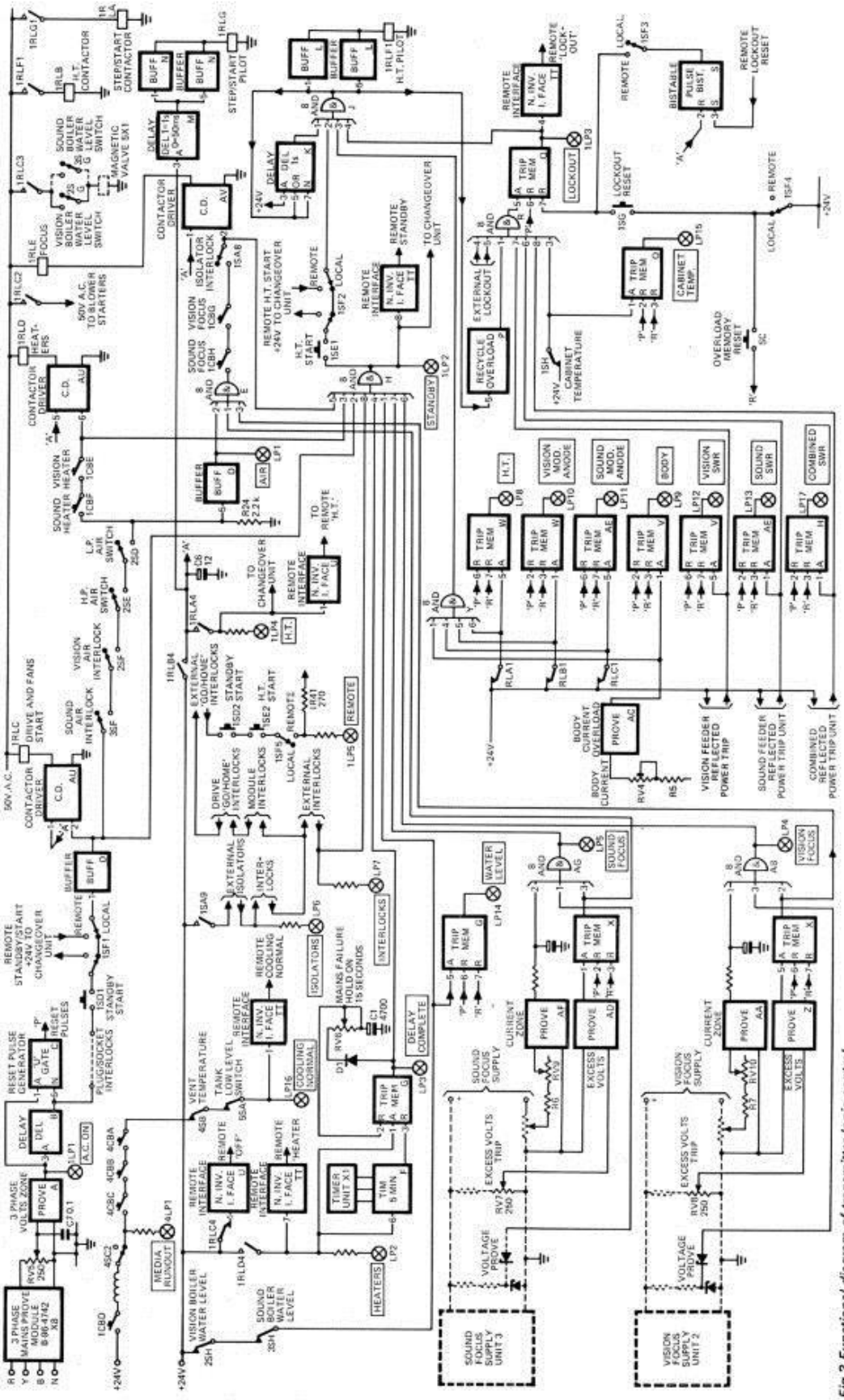


Fig.3 Functional diagram of transmitter logic control.

Operation of the auxiliary circuit breaker supplies 3-phase mains to the **Mains Prove** module; provided these voltages are meeting the range required a suitable logic signal will operate the **A.c on** lamp via a **prove** module. When the **Standby Start** switch on the fascia panel is depressed, subject to the plug and socket interlock on certain modules and the Local/Remote switch, a buffer module will actuate a contactor driver module to operate the relay supplying mains and 50V a.c to the starters of the fans in the cooler unit. Subject to the air interlocks and heater circuit breakers, the buffer module will also cause the heater contactor drive to operate the relay supplying the heaters and the heater timers. A second section of the buffer module also dependent upon the air interlocks and switches will light the **air** lamp.

This second buffer module also feeds into an *8 AND* gate module (E). Two other inputs are required to enable this gate and come from the sound and vision focus supplies. As there is no excess voltage to trip off the module monitoring excess volts on the sound and vision focus supplies, the *TRIP MEMO* module will be receiving an input on its 'A' terminal and will have been reset by a 'P' pulse at switch-on. The outputs of these modules, therefore at logic 1 will enable the 8 AND gate (E). Subject to the sound and vision circuit breakers and isolator interlock being made, the contactor driver (AV) will operate 1RLE, the **focus** supply relay, and switch on the vision and sound focus supplies.

When the focus supplies establish (voltage prove and current zone prove are satisfactory) and there is an absence of any excess volts trip on them, the 8 AND gates in the outputs of each (AB and AG) will provide an output. This lights the supply lamps and gives two inputs to the *STANDBY 8 AND* gate (H).

The other logic inputs of the *STANDBY 8 AND* gate are provided by:

Satisfactory klystron boiler water levels.

Main isolator, external isolator, internal and external interlocks made (**interlocks** lamp will light)

LOGIC 1 input from three contact drivers inputs; CD(AU) two inputs driving the fan and drive start relay and the heater relay; CD(AV) driving the focus supply relay.

(These inputs verify that all conditions preceding these contactor drivers are satisfactory.)

At the expiry of the heater delay timer (F) the trip memory module (G) receives its required input to provide an output. (The **delay complete** lamp is also lit.)

With the completion of the delay and all other logic inputs at 1, the *STANDBY 8 AND* gate provides a logic 1 output, and the STANDBY lamp is lit.

When the **H.t start** switch (SE) on the fascia panel is depressed, subject to the **local/ remote** switch, a logic 1 is applied to one input of the h.t pilot *8 AND* gate (J). The other three operative inputs to this gate will all be at logic 1. The trip inputs must be at logic 1, as all the trips depend upon the application of h.t so, up to this point, none of these trips can have operated. The DELAY mode (K) provides a delayed logic 1 output if it receives an input. If its input goes to logic O, the output also goes to zero, but, at the expiry of its delay, reverts to the logic 1 output state whether the input is restored or not. The inputs of the 8 AND gate which are not operative are strapped to the +24V rail.

Serious damage to the klystrons would occur if the h.t supply remained on as the result of a fault whilst the auxiliary klystron supplies were turned off by the control logic. To prevent this from happening, the 1–24V supply is routed via a contact pair on the h.t contactor to provide a secondary hold-on input to the contactor drivers for auxiliary services.

The drive is also situated in this cabinet, the power supplies for the drive being housed behind the fascia panel. The complete drive unit may be pulled out on runners when all units are accessible whilst the transmitter is running and no interruption to service is necessary to make minor adjustments to drive unit modules.

In the event of a fault on the main transmitter, the logic system will switch it off and bring the reserve transmitter into service. Both transmitters are designed such that either may be used as a single transmitter without changeover and standby facilities.

COOLING UNIT

Each transmitter is cooled independently, and both the circulating air and the room temperature are thermostatically controlled.

Combining the functions of heat exchanger, air blower and air filter, the cooler unit includes the following main items:

Steam condenser
Mini-roll filter
Air vent pipe thermostat
Low-pressure centrifugal fan
High-pressure fan
Damper motor
24V transformer
Proportional temperature controller.

Cooling air is blown over the condenser through which steam is passed from the klystron boilers, the condensed water then being returned to the water circulating system. Each transmitter is also air-cooled, the cooling air being filtered and thermostatically controlled. The amount of fresh air added to the circulating air depends on the damper settings, and these are determined by the thermostats.

The mini-roll filter is an automatic, roll-type unit which presents a large rectangular area of filter medium across the input air flow. A heavy type of Fibroceta is used and, as air passes through the media, contaminant is arrested and collects on one side of the filter. As this builds up the air pressure across the filter increases, such that an associated differential switch operates and completes a motor circuit and winds on a clean section of filter.

When the filter roll is almost exhausted, a mechanical arrangement operates a microswitch which removes power from the motor and extinguishes an indication light on the front of the transmitter labelled **filter media run out.**

The *COOLING NORMAL* indication will only indicate if the following contacts are closed:

Roll filter motor
Vent damper motor
Recirculation damper motor
Vent temperature
Low level switch in water tank.

Failure of any of the above services will extinguish the *COOLING NORMAL* lamp and remove the h.t.

Main/Reserve Combining Unit Frame and Logic Changeover Unit

The above unit (Fig.4) provides the following facilities:

Combining sound and vision (**main** transmitter) outputs, with a flexible method of linking r.f paths to the antenna feeder system
Power monitoring of r.f output levels
Automatic changeover from **main** to **reserve** transmissions in the event of a failure or degradation of performance with the complete system controlled by logic modules
Automatic level control units for both **main** and **reserve** transmitters

Fig.4 Changeover frame.

A 40dB coupler for accurate measurement of transmitter output power levels.

The combining unit is a conventional bridge coaxial type design and combines sound and vision signals. The unit also has colour sub-carrier notches for attenuating f_v – 4·3MHz. The motor-driven coaxial changeover switch is operated by the logic control unit and transfers the combined signals in the main path to the test load in the event of a failure. Changeover is then effected automatically to the reserve transmitter, operating in the multiplex mode, the output of which is then fed to the antenna.

The link panel facilitates bypassing the coaxial switch if required, either for maintenance purposes or if a fault should occur in the automatic changeover. The selected output is fed via a diplexer to the antenna.

Matching sections are installed in various locations in the feeder runs, their purpose being to decrease mismatches caused by coaxial switches, links and bends.

POWER-MONITORING

Power-monitoring facilities at various points in the r.f chain are provided in the form of power-monitoring modules. These modules are fed from peak envelope detector units which feed the analogue to digital converters for changeover logic to be fed to the necessary logic module.

The power metering monitors the following power levels which can be read on meters on the front fascia panel of the transmitter, or on portable power meters which may be plugged into the power monitoring module.

Vision Forward Power
Vision Backward Power
Sound Forward Power
Sound Backward Power
} Main Transmitter
Combined Output Power
Balancing Load Power
Reserve Forward Power
Reserve Backward Power

All power levels are peak reading, correspond to peak sync level and are independent of picture level. Reflected power levels are also connected to trip circuits at the combining unit input and the antenna input, such that if the reflected power rises above – 15dB relative to the forward power, a trip circuit is operated to remove the h.t from the klystron.

AUTOMATIC/MANUAL OPERATION

The transmitter control panel (Fig.5) enables the transmitter to be operated locally manually, or completely automatically from a remote position.

The standby transmitter has a changeover control panel which allows either transmitter to be operated locally from this panel, provided the transmitter controls are set to **Remote.**

If the logic control switch is also set to Remote, the transmitters, i.e **Main** and **Reserve** may be operated to the standby or fully powered condition by external control signal. A pulses ON condition

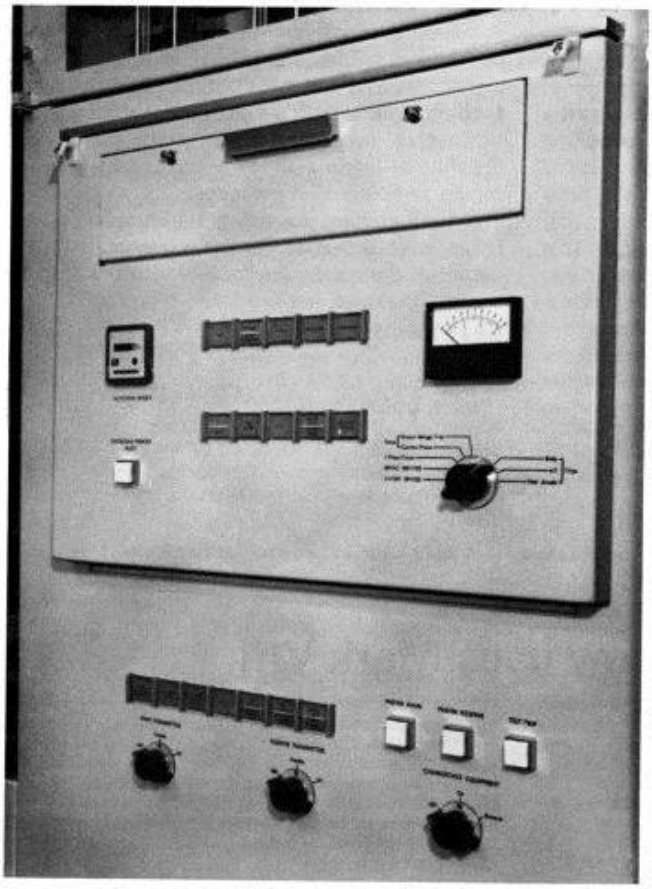
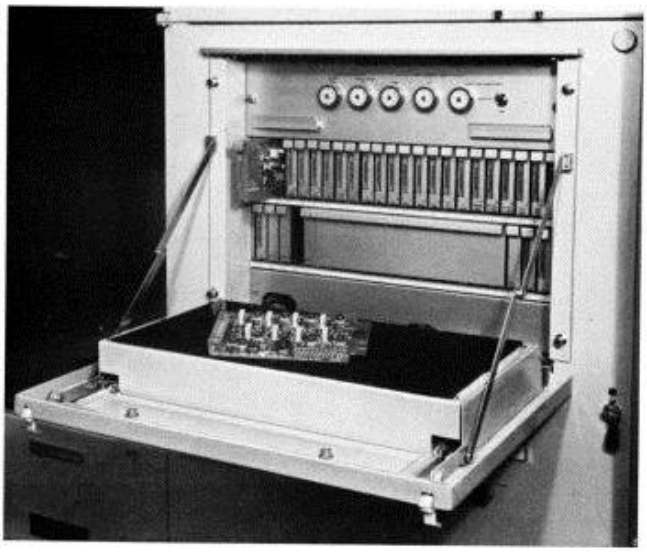


Fig. 5 Main control panel (above) and logic changeover unit (below).



to the **Standby** or **h.t input** will bring the relevant transmitter up to the standby or **h.t on** status. A further pulse to the corresponding cancel input will restore the original status. Control is effected by a change of state of a transistor between conducting and non-conducting, the latter condition being effectively an open circuit at the logic unit input.

With the logic control switch at the **on** position and the main transmitter switched to antenna, the fall of the main transmitter vision or sound power levels below a predetermined level, say 2dB, will, presuming the initial fault delay has elapsed, cause a changeover to the **Reserve** transmitter. If this reserve transmitter was previously cold, the first action of the changeover will be to bring it up to the standby status, and a further delay will be inserted by the internal tuning sequence of the transmitter before a changeover of the coaxial feeder switch is allowed to take place. If the reserve transmitter was already at **Standby** status then the extra delay will be bypassed.

The action of switching the non-preferred transmitter to local control will automatically inhibit the automatic changeover, so allowing switching to be carried out on the non-preferred transmitter.

The changeover control panel provides the following indication lamps:

Logic remote available – lamps light to indicate that the logic control switch has been operated to the **remote** position

Feeder frame lamp indicates that the antenna links are correctly positioned and the coaxial feeder switch motor isolator switch is at the **auto** position

Station remote ready lamp lights to indicate that all REMOTE READY circuits have been completed and that the transmitter is ready for remote operation

Initial delay lamp lights to indicate that the delay period has elapsed for filament warm-up time

Main normal indicates that the carrier and **h.t on** commands are both present and the transmitter is connected to the antenna

Reserve normal lamp indicates that the carrier and **h.t on** commands are both present and that the Reserve transmitter is connected to the antenna.

Main to antenna and reserve to antenna lamps light to indicate the operating mode to the antenna

The prefer main or prefer reserve lamp lights to indicate the transmitter preferred for service.

All the lamps mentioned above are duplicated for remote use.

Three analogue to digital converters monitor the output power levels of the main vision and sound transmitter and also the reserve combined power levels and provide logic signals to the automatic changeover unit. The monitoring signals are derived from the associated peak envelope detectors which are in turn fed from directional r.f probes in the appropriate feeder run.

Should a power level fall below a predetermined level, the output of the relevant A/D converter to the logic control unit triggers this control into taking executive action to initiate a changeover to the non-preferred transmitter.

All three units are identical and are of modular

plug-in construction, with a front panel light indicating that the levels being monitored are normal.

The automatic level control units mounted on the frame assembly are both fed from peak envelope detectors and produce a d.c potential which is fed back to the electronic attenuator unit in the drive unit, so automatically maintaining the blanking level constant on the transmitter output. This control improves both 50Hz and 300Hz asynchronous noise on both main vision and reserve transmitters. On the reserve transmitter the sound signal is removed by a T stub assembly prior to the detector unit. Any 6MHz due to the sound signal that may not have been removed by the r.f process is filtered by a network after the detector, and the ALC unit monitors the blanking level of the vision signal inlet. The automatic control of this level also facilitates the setting up procedure of the various parameters such as frequency response and linearity, as levels are maintained constant during tuning and correction procedures.

A 40dB coupler, accurately set up at low power levels, is used to measure the power levels at the output of the combining unit prior to the antenna on the Test Load.

REFERENCE

1 D. T. Richmond and K. Dews: A New I.F Modulated U.H.F Drive, Sound and Vision broadcasting, Vol. 14, No. 2, Summer 1973.