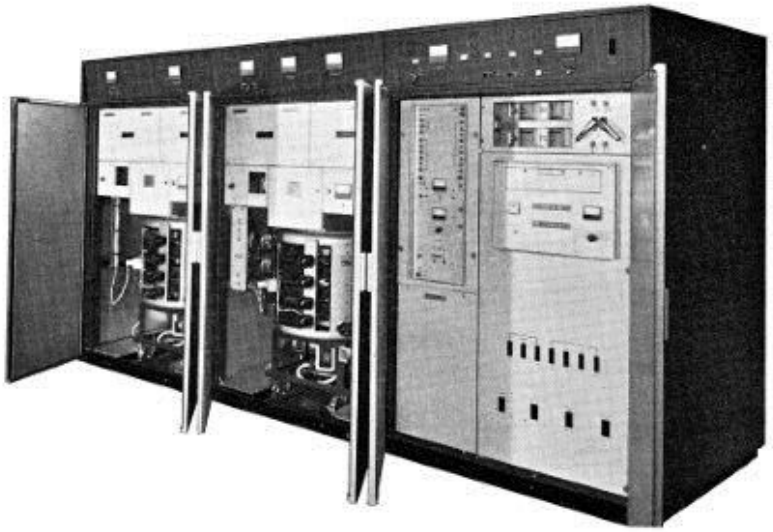
# Marconi Broadcasting Transmitter Systems

## 10kW U.H.F Television Transmitter B7320

### Features

- High gain four-cavity klystrons
- No other thermionic devices
- Full exploitation of integrated i.f drive
- Full colour performance on NTSC, PAL or SECAM standards
- Suitable for use on systems to CCIR classification G, K, I, M or N
- High stability of performance
- Simple installation
- No floor ducts required
- Can be installed against a wall
- Maximum in-operation access to drive units (unit can be completely withdrawn)
- Visible contacts earthing switch



### Introduction

The B7320 U.H.F Television Transmitter has an integral drive unit and two klystrons. The separate vision and sound outputs are combined in an external combining unit.

The English Electric K370 series klystrons have vapour-cooled collectors and air-cooled cavities and gun. No other thermionic devices are used. The centre cabinet houses the vision klystron. For cooling, an external unit houses the steam to air heat exchanger, high-pressure blower for the klystron cavity cooling, and air filters. The heat exchanger fan has a dual purpose, removing hot air from the transmitter cabinets and also cooling the heat exchanger block. The reservoir tank is mounted separately.

### Circuit Description

A detailed description of the solid state i.f drive is given later. The vision output from the drive passes via the circulator to the vision klystron. The drive sound output is also fed to the input of the sound klystron via a circulator.

The solid-state logic control circuit brings on the supplies in the correct sequence, including the necessary delays. The transmitter can be controlled locally by two controls, or from a remote point by operation of one or two controls, and telemetering outputs can be supplied for remote monitoring. (The Data Summary lists those available on the standard equipment.)

### Protection and Safety

Overload circuits protect the beam supply. Under fault conditions the supply is removed, but can be permitted to recycle three times before 'locking out' in order to prevent a transient fault condition taking the transmitter out of service. Supplies are also protected by circuit breakers on the a.c input.

Silicon rectifiers are used for all d.c supplies and the equipment is protected against mains borne surges of up to 2000V peak and against any internally generated surges.

A reflected power trip operates when the reflected wave in the klystron output line exceeds a safe value, and is included in the recycling circuit.

A mains isolator switch, interlocked with an earthing switch having visible earthing contacts, is built into the transmitter. Access to high-voltage points can only be obtained by using a key which is trapped in the lock until the isolator is 'off' and the points earthed. The transmitter is designed to comply with IEC safety regulations.

### Installation

The transmitter is delivered as a complete set of cabinets but with the heavy components removed for transport. Klystrons are inserted into the circuit assemblies supplied, which are mounted on wheeled carriages for ease of removal from the cabinet. Quick release connectors are used for air, steam and water pipes, the water connector incorporating a self-sealing device which avoids the need to turn off the water supply. Electrical connexions are also easily released and access to all points is excellent. All heavy iron cored components are fitted with wheels so that they can be rolled into or out of the cabinet.

### Combining Unit Assembly

An external B8152 Rotamode combining unit is used to combine vision and sound at the output of the klystron amplifier. This includes a notch filter which attenuates the colour sub-carrier lower sideband. The standard assembly includes harmonic filters and power monitoring devices, but a water cooled test load and 80mm (3⅛in) coaxial changeover switch are optional items

### I.F Drive

#### Input Signal Processing

HUM STRIPPING

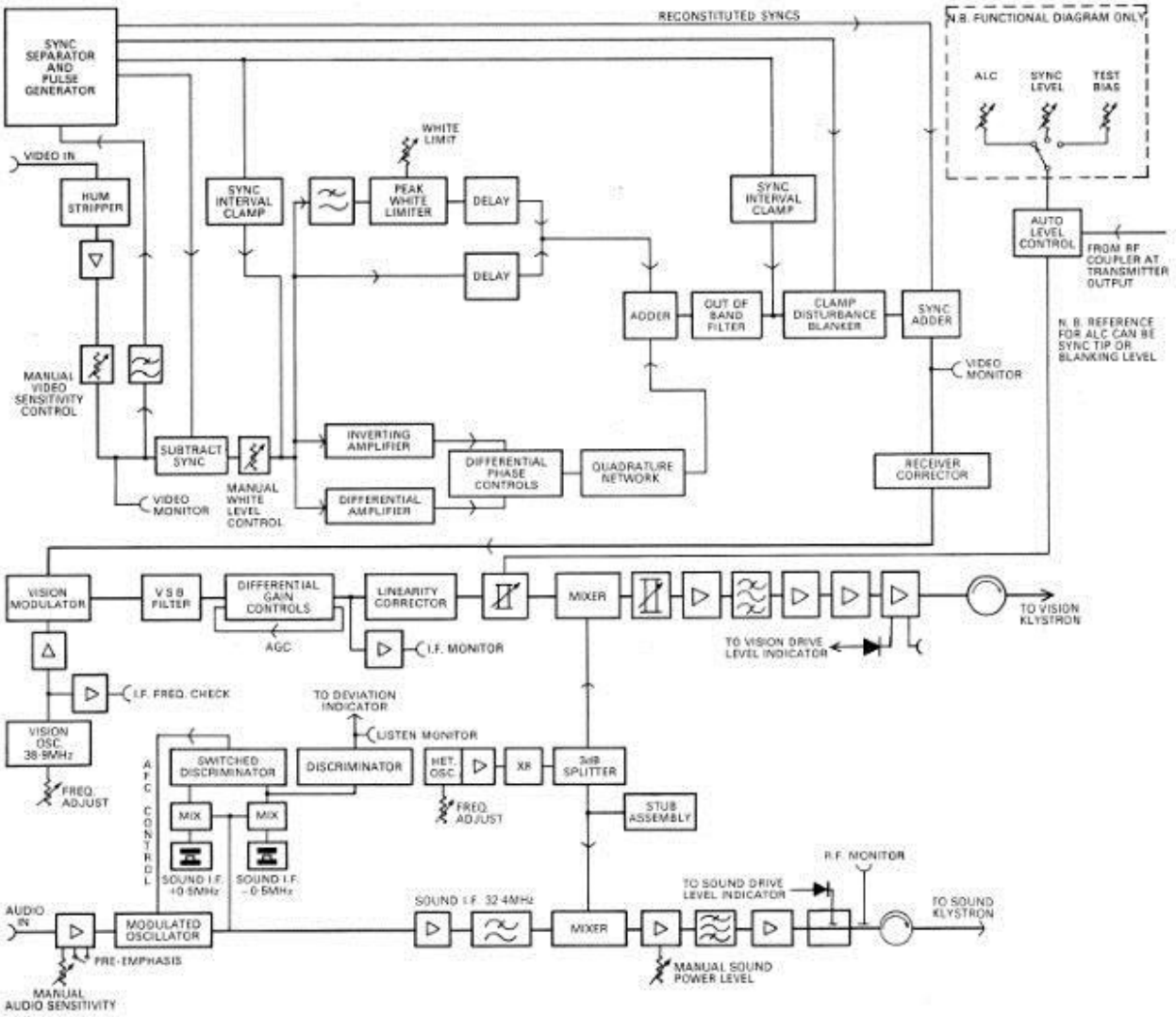
Induced hum on the input line is attenuated by a hum stripper at the input.

RECONSTITUTED SYNC PULSES

The sync pulses finally added to the picture waveform are produced by a pulse generator circuit which is triggered on and off at the half-amplitude points of the incoming sync pulses. In this way the sync pulse duration remains the same as that incoming, but the regenerated pulse has carefully controlled rise and fall times and has a constant amplitude for a variation of incoming sync amplitude of +3, —6dB relative to the nominal level. The reconstituted pulses are added following the clamp disturbance blanker.

SYNC INTERVAL CLAMPING

Back porch clamping in the signal path is minimized in order to reduce distortion in the colour burst area. The block diagram shows how the video path is divided. After




chrominance filtering, one signal is used to drive the clamp and blanking-pulse generating circuitry, while another is back-porch clamped and sync separated. The separated sync pulses are carefully matched in timing and amplitude and subtracted from the signal in the main path.

The resulting video signal without sync pulses is passed to the differential phase correction circuits, which require a clamped signal. This is achieved by clamping at blanking level during the sync interval period. A blanker follows later in the circuit which removes the hard sync interval clamp 'prints' before the signal is fed to the sync adder.

### PEAK WHITE LIMITER

The block diagram shows how, in the section of the video processing circuitry where only the picture portion of the signal is present, the signal route is split into four parallel paths, two of which are concerned with peak white limiting. One path is chrominance filtered and the remaining luminance signal processed to provide a signal which is zero up to a preset value, and beyond this provides a signal equal in value but opposite in sign to the main signal. The second path carries the main signal, suitably delayed. The two signals are then added and the resulting signal is peak white limited but with chrominance information unaffected.

**Out of band radiation** is restricted by a filter inserted after the differential phase corrector and peak white limiter, to suppress video frequencies which might cause modulation products outside the authorized channel.

## Vision Signal Pre-corrections

### GROUP DELAY CORRECTION

is included for distortion caused by the sound notch in the vision and sound combining unit and the out-of-band radiation filter described above. Since this distortion is in the single-sideband portion of the r.f spectrum it is conveniently corrected at video frequencies, the components being integrated with the out-of-band filter. Group delay distortion is also caused by the vestigial sideband filter. If correction is applied at video it introduces undesired effects in the corresponding portion of the wanted sideband. Correction is therefore applied at i.f, the components being integrated with the v.s.b filter.

### RECEIVER GROUP DELAY CORRECTOR (User's option)

To correct for the group (or envelope) delay introduced by a typical receiver many authorities specify a particular group delay characteristic for the transmitted signal. The B7320 transmitter provides a position for this to be inserted. Because of the variations in this requirement it is necessary to specify the characteristic wanted when enquiring about the equipment. When fitted, it can be bypassed, for testing purposes, by a switch.

### DIFFERENTIAL PHASE CORRECTION

is only required in the region of the chrominance subcarrier and its sideband. In the r.f spectrum this is entirely within the single sideband area and correction circuits operating at video frequencies will be entirely satisfactory. Correction is applied in the part of the circuit where only the picture portion of the signal is present, using the two other paths parallel to the peak white limiter. In each path the signal passes through an amplifier. One amplifier inverts the signal. The gain of the other can be changed at adjustable onset levels. The two amplifier outputs are added, resulting in a small difference signal with an amplitude which is dependent upon the instantaneous amplitude of the main signal. This difference signal is then passed through a quadrature network and added to the peak white limited signal. The result of the quadrature addition of the small difference signal is to produce a resultant negligibly different in amplitude from the main signal, but altered slightly in phase, this alteration being picture-level dependent. The potentiometers which determine the variable gain onset levels therefore function as differential phase controls.

### DIFFERENTIAL GAIN CORRECTION

is in the i.f section, immediately following the v.s.b filter. A single transistor amplifier is used, with emitter degeneration which is modified by diodes which begin conduction at adjustable threshold levels. A total of eight

diodes with separate onset controls is provided. Since the signal at this point is a modulated envelope, and the diode circuits change the gain on one side of the envelope, an asymmetrical waveform is produced. This amounts to distortion of the r.f cycles of the envelope and is remedied by passing the signal through a lowpass filter to remove the r.f harmonics.

To simplify the operational adjustment of the differential gain corrector the circuit employs a gain control loop. This maintains a constant sync pulse level at the output of the corrector and obviates the need to monitor and continually reset the unit gain as the correction is applied.

A separate unit follows, the linearity corrector, the function of which is to correct the power dependent linearity deficiencies of the vision klystron amplifier which occur towards blanking level. At the output of this unit a fully processed vision signal at a level of approximately 800mV peak-to-peak is supplied, via the electronic attenuator, to the mixer unit.

## Modulator and R.F Stages

### Vision modulator

After the addition of reconstituted syncs and processed video the signal is applied to the ring modulator operating at 38·9MHz.

### Frequency modulator

F.M sound is generated at the sound i.f in a modulator governed by an a.f.c circuit in which special care has been taken to avoid the phenomenon known as 'lock out' which occurs on some modulators as a result of overmodulation.

The output frequency is mixed with two crystal-controlled frequencies at 0·5MHz above and below carrier. The resultant 0·5MHz products are detected in a discriminator and the outputs compared to produce the a.f.c correction voltage. By using a single discriminator which is switched at a sub-audible rate between the two paths, and a storage comparator, inaccuracies resulting from discriminator drift are eliminated.

## Mixers and Solid-State R.F Amplifiers

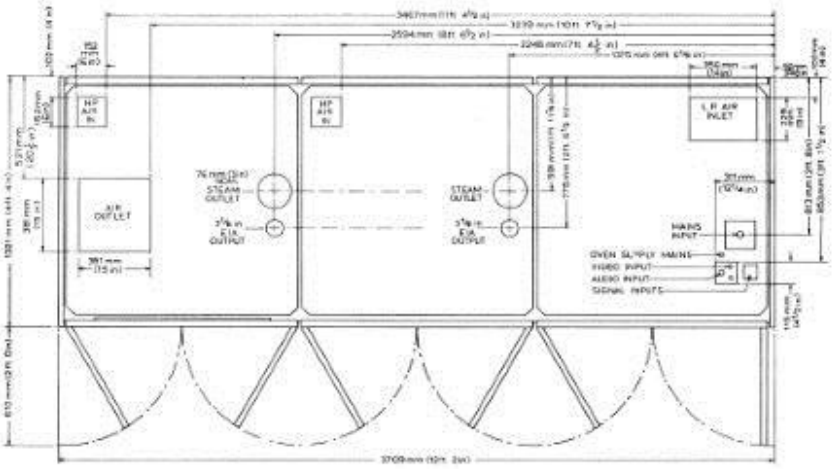
Vision and sound, at i.f, feed into similar mixer stages. A single heterodyne oscillator followed by a multiplier and 3dB splitter provides the local oscillator signals. The mixers are of the balanced diode type reproducing both sum and difference of i.f and heterodyne frequencies at the output. A two-element Butterworth comb line filter is also incorporated in the stage to give approximately 20dB rejection of the sum component. The difference frequency is coupled to the next stage. In the case of the sound mixer a stub assembly is connected in the line between its input and the 3dB splitter output to prevent undesirable cross modulation between the vision and sound drive chains.

The vision mixer is followed by a switched variable attenuator having 1dB steps. This is followed by a wideband amplifier having approximately 10dB gain. With some klystrons this gain may not be required at all frequencies and the amplifier can then be by-passed. Next in the chain is a band-pass filter to remove the unwanted products of the mixing process. An approximately 30dB wideband amplifier follows, and is succeeded by two untuned, balanced, amplifiers, having typical gains of 8dB and 6dB respectively, before the output circulator.

Fewer components are involved in the sound chain, the mixer being followed by only the 10dB amplifier, filter and 30dB amplifier before the output circulator.

All the amplifiers referred to above are wideband, solid state types and have well-matched input characteristics. This, together with the output circulator, permits ready replacement of faulty units with minimum degradation of performance.

Level indicators are driven from detector probes in the vision output amplifier, and in the sound output line.




## Control of Output Levels

An important design feature of the drive is the operational simplicity of the controls governing the three basic output r.f levels i.e 'SYNC LEVEL', 'BLANKING LEVEL' and 'WHITE LEVEL'. These three controls are adjacent and situated on the front panels. The sequence of control adjustment, prior to switching the transmitter into the automatic level control mode is also clear and logical.

1 Initially the automatic level control switch (on the i.f unit) is set to 'MANUAL'.
2 The 'SYNC LEVEL' control is adjusted to provide the correct r.f power level at the peak of the synchronizing pulse. The action of this control is to adjust the d.c control voltage for the electronic attenuator preceding the mixer stage.
3 The 'BLANKING LEVEL' control is then adjusted to set the correct r.f level at blanking. The control is in fact a gain control determining the amplitude of the reconstituted sync pulses.
4 White level in the r.f envelope, corresponding to peak white in the video waveform, is set by adjusting the 'WHITE LEVEL' control. In practice this adjusts the amplitude of the 'picture only' signal after sync stripping in the video processing circuits.
5 The adjustments described above provide the correct relative levels in the r.f envelope. Finally the automatic level control switch is set to 'A.L.C'. Usually the r.f levels will then alter slightly, while retaining the correct relative values, and the a.l.c is adjusted to restore the correct peak power level. The r.f output level selected as a reference is then maintained automatically. A choice of reference level is provided, the operator choosing either sync tip or blanking level by the position of an internal coaxial connector. Feed-back for operation of the a.l.c unit is obtained from a d.s.b detector in the vision transmission line to the combining unit.

Motorized control of sync, blanking and white levels is available as an option.

## Ordering Information

One 10kW installation comprising :
1 – UHF transmitter type B7320 supplied complete with two klystron assemblies, working klystrons and working crystals.
1 – Rotamode System Assembly.
1 – Heat exchanger.
1 Set Installation equipment, including transmission line, steam piping and water piping.
1 Set technical manuals.
Optional equipment :
1 – Water cooled test load complete with water flow meter and thermometers.
1 – 80mm (3⅛in) coaxial switch fitted in output line of combining unit.

If required, motorized level controls should be specified.

The receiver group delay corrector is only included for System M and should, if required, be separately specified and ordered for other systems.

Additional equipment, such as automatic voltage regulators, output transmission line, installation materials (e.g air ducting, test load water pipework etc) is readily available and can be supplied to order.

When ordering, or inquiring, about this equipment, the following details will enable requirements to be dealt with promptly.

Transmission standard to be used (CCIR classification G, K, I, M or N).

Working frequencies (including offset, if any).

Power supply system available, giving voltage, regulation and frequency and stating whether three- or four-wire.

Altitude of site above sea level and expected ambient temperatures.

## Data Summary

**Power output :** Vision 10kW, Sound 1kW or 2kW.

**Working frequency :** Supplied adjusted to specified channel, in the range 470 to 800MHz.

**Modulation standards :** Vision : A5C. Negative modulation, NTSC, PAL or SECAM Standards. Sound : F3.

**R.F output load impedance :** 50Ω unbalanced. Performance measurements are made using a dummy load having an input v.s.w.r in the passband of 1·04 or better.

**Maximum v.s.w.r :** 1·5 :1.

**Output connector:** 3⅛in. EIA.
**Carrier frequency stability** over a temperature range of ±10°C:
Vision Carrier: 500Hz/month
Sound Carrier: 500Hz/month
**R.F harmonics and spurious radiations:** The mean power of any spurious emission to the output transmission line will not exceed a level of 60dB below the peak sync vision power.
**Video input voltage:** 0·5V to 2·0V peak-to-peak composite with a picture to sync pulse ratio of 70/30.
**Video input impedance:** 75Ω with a return loss of not less than 30dB up to 6MHz.
**Video input connector:** TNC
**Vision amplitude/frequency response:** Measured at the combining unit output.
a) For a 625-line system (CCIR classification 'G')

| *Freq. rel. to carrier (MHz)* | *Limits (dB) Max* | *Min* |
|---|---|---|
| −4·43 | −30 | — |
| −1·25 and below | −20 | — |
| −0·75 | +0·5 | −4 |
| −0·5 | +0·5 | −1·5 |
| 0 to +1·5 | +0·5 | −0·5 |
| +4·0 | +0·5 | −1·0 |
| +4·43 | +0·5 | −1·5 |
| +5 | +0·5 | −2·5 |
| +5·5 | −20 | — |

b) For a 525-line system (CCIR classification 'M')

| | | |
|---|---|---|
| −3·58 | −42 | — |
| −1·25 and below | −20 | — |
| −0·75 | +0·5 | −3·0 |
| −0·5 | +0·5 | −1·5 |
| +0·2 | Reference | |
| +0·5 to 3·58 | +0·5 | −1·0 |
| +4·18 | +0·5 | −2·5 |
| +4·75 to 7·75 | −20 | — |

Equivalent responses can be given for other systems.
**Group delay/frequency characteristic:** Adjustable to user's requirements by the addition of a receiver group delay precorrector if required. Without this the characteristic is basically flat within the following tolerance graticule: 0·1 to 3·0MHz, ±40ns; decreasing linearly to 4·43MHz, ±20ns; increasing linearly to 4·8MHz, ±80ns. (For System M a receiver group delay precorrector for the specified FCC characteristic is standard supply.) Precorrector can be switched out.
**Sync level voltage variation:**
a) For variation in picture from black to white, not more than 2·5%
b) For variation in input sync amplitude of up to +3, −6dB from nominal value, not more than ±2% (sync=100%).
**Blanking level voltage variation:**
a) For variation in picture from black to white, not more than 2% (sync=100%)
b) For variation in input sync amplitude of up to +3, −6dB from nominal value, not more than ±1% (sync=100%).
**Modulation capability:** The transmitter can be modulated to 3% (sync=100%) but is equipped with a white limiter, effective only at frequencies below 1MHz.
**Noise and hum:** Not worse than −50dB peak-to-peak (or −59dB r.m.s) relative to sync tip level voltage.
**Field frequency square-wave tilt:** Not more than 2% of the black-to-white interval, excluding first and last 250μs of bar, using CCIR Rec. 421–2, Test signal No. 1.
**2T Pulse and Bar response:** Pulse K factor not more than 2%. Bar K factor not more than 1%.
**Spurious phase modulation:** With full picture amplitude sine wave modulation between 30Hz and 15kHz, sound noise (measured on a 50μs de-emph. intercarrier demodulator with a line freq. filter) will not be worse than −46dB relative to a ±50kHz deviation at 400Hz.
**Line time linearity:** Using a composite test signal consisting of a 10 riser staircase waveform between blanking level and white, the ratio of the minimum to maximum step amplitude will not be less than 0·9.
**Differential gain:** The test is made using a composite signal consisting of a 10 riser staircase waveform, the amplitude of which is adjusted to give modulation levels between 75% (sync=100%) and 20%. On this is superimposed a colour subcarrier sinewave signal with a peak-to-peak amplitude of up to 40% of the staircase amplitude. Under these conditions, the differential gain, being defined as the ratio of the minimum to maximum amplitude of the sinewave, will not be less than 0·95.
**Differential phase:** Using the same test signal as for differential gain, the phase of the colour subcarrier on any step will not differ by more than ±3° from that of the subcarrier burst.
**Audio input level at 400Hz:**
−10dBm to +12dBm for ±25kHz deviation.
−4dBm to +18dBm for ±50kHz deviation.
**Front panel input level adjustment:** ±5dB, continuously variable, within the range given above.
**Audio input impedance:** 600Ω balanced.
**Audio input connexion:** Terminals.
**Pre-emphasis:** 50μs or 75μs (preset at factory). Can be switched out for test purposes.
**Change of sound centre frequency with mod.:** Less than ±200Hz for deviation up to ±50kHz.
**Audio frequency response:** 30Hz to 15kHz, within ±1dB relative to the appropriate pre-emphasis curve.
**Audio harmonic distortion:** 30Hz to 15kHz, less than 1%.
**F.M noise:** Better than −60dB (unweighted) relative to ±50kHz deviation.
**A.M noise:** Better than −50dB, r.m.s noise relative to carrier level.
**Synchronous amplitude modulation:** Better than −40dB, r.m.s relative to carrier level when deviating ±50kHz at 400Hz.
**Cooling system:** Klystron collectors vapour phase cooled using demineralized water; the steam to air heat exchanger is external. Forced air cooling is used on the klystron cavities and gun. Provision is made to remove cabinet heat by an external fan.
**Ambient temperature range:** Operational between +1°C and +40°C at sea level, performance specification maintained over approximately ±10°C within this range. (Transmitter only, does not apply to heat exchanger. This must be specified for prevalent climatic conditions.)
**Maximum altitude:** 1800m (6000ft) above sea level (approx.) (transmitter only).
**Maximum relative humidity:** 95%.
**Warm-up time:** 5 mins.
**Power supply:** 380V or 415V, 50Hz or 60Hz 3-phase 4-wire. (Oven supplies can be connected internally or to an external 220V or 240V single-phase supply.) Internal protection is provided against mains-borne surges of short duration and up to 2000V peak. Where higher level surges are probable external surge limiting devices should be fitted.
**Automatic restoration after mains failure:** Occurs if mains supply fails for not more than 15 secs.
**Variation of supply voltage:** ±2% with max. ±0·5% phase imbalance.
**Variation of supply frequency:** ±2Hz.
**Typical power consumption:** (including an allowance of 9kW for heat exchanger and cabinet cooling fans) with black picture and 1kW sound: approx 56kW at 0·9 power factor.
**Finish:** Cabinet, light and dark grey.
Meter panel, blue.
**Legend:** English.
**Controls and indications:** On top panel of right hand cabinet: Pushbuttons with associated status indicators for STANDBY–ON and H.T ON. A rotary switch for LOCAL/REMOTE control. An AC ON lamp is associated with the three-phase prove circuit.
**Fault indication:** (lamps extinguished to indicate fault). Behind doors (diagnostic): Individual overload indication.
Front panel: Lock-out lamp, with adjacent reset button.
**Remote control:** External equipment should provide one (for direct-on utilizing built-in delays) or two (for 'standby/h.t on' sequence) make/break contacts rated for 2A at 24V d.c
'Make' brings transmitter on and 'break', off.
Motorized control of sync blanking and white level controls is available as an option.
**Remote indications:** A logic '1' (5V d.c nominal)
is generated for each of the following conditions:
Control available remotely
Transmitter off
Heaters on
Cooling normal
H.T on
Lock-out unoperated.
(The lock-out indication can be cancelled remotely by externally applying a logic '1' and this does not cancel the individual local trip indicator.) Analogue outputs are provided to indicate vision and sound power. Most of the remaining status indications can be repeated remotely and important analogue parameters can be telemetered to special order.
**Dimensions:**
Transmitter (B7320)
Height: 2·05m (6ft. 9in) (page 3 shows plan dimensions)
Weight: 3200kg (7 000lb) approx.
Combining Unit (Rotamode).
Height: 1·32m (4ft 4in)
Width: 1·25m (4ft 1in)
Depth: 1·25m (4ft 1in)
Weight: approx 120kg (264lb).



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