Eddystone Broadcast

S7600 Series
S7610C 10kW
High Power
FM Transmitter

Installation
and
Operation

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SECTION ONE : INTRODUCTION

! CAUTION !

These Transmitters operate at **high RF power levels, internal supply energy levels and mains supply current levels**. They also incorporate devices containing **toxic BeO**. Installation, operation and maintenance of this unit must therefore, only be carried out by suitably qualified personnel, familiar with and fully utilising the safety procedures such equipment demands.

NO attempt at installation should be made without full reference to and compliance with SECTION TWO : INSTALLATION.

NO attempt at internal maintenance should be made without full reference to and compliance with the appropriate sections (apart from fuse changing which is detailed in INSTALLATION).

1.1 : GENERAL DESCRIPTION

S7610C High Power FM Transmitters provide output powers of up to and including 10kW (used singly) or 20kW (using combined pairs) in the standard Band ll frequency range of 87.5-108MHz. They are normally supplied with either one or two Exciters, capable of generating a standard mono or stereo FM signal from a variety of analogue or digital audio or data sources (including left/right audio, MPX, RDS, SCA, DARC etc.). It is important to note that the Exciter(s) supplied will depend on the user's actual requirements in this regard which, therefore, must be clearly specified at time of ordering.

The Transmitters are contained within a standard 19 inch rack of 43U height and 1000mm depth. All that is required is a connection to a three phase mains supply, to an antenna, to the Exciter/Drive(s) and to external forced air cooling via a 300mm exhaust connection (the inlet air is drawn in from the room via vents in the Transmitter module front panels). When used in pairs, to generate up to 20kW, an additional two-way splitter, combiner and approximately 4kW balance load is also required. In this situation, additional manual 'patching' or manual/automatic switching can be provided, as an option, to direct all of one Transmitter's power to the antenna.

The key feature of The S7600 series is its ability to remain 'on-air'. The use of multiple Amplifier and Power Supplies Modules and dual power supply and control circuitry means that if failures do occur, it normally only results in a reduction of output power. Furthermore, the lightweight, hot-pluggable Amplifier and Power Supply Modules can be easily replaced, in seconds, without having to go 'off-air'. Provision for dual Exciter/Drive automatic changeover and for connection to a second active/passive reserve S76XX or S79XX (i.e. 500W to 10kW) Transmitter is also made, further enhancing the ability to remain 'on-air'.

Each Transmitter consists of a number of modules described as follows (1.1.1 – 6 inc.). Front and rear views, block and circuit diagrams, showing these modules are bound at the rear of this manual (S7610C-01GA, S7610C-01BK and S7610C-01CT).

Workshop editions of this manual contain extra information, also bound at the rear, which gives detailed test procedures, circuit diagrams, assembly diagrams, layouts and parts lists.

1.1.1 : E2021 300W Amplifier Module

Thirty two of these are provided, each with their own independent control and monitoring circuitry. The circuitry in each amplifier provides reverse power, supply current and temperature monitoring to shut down and protect individual modules. Failures in a single Amplifier Module only tend to give a slight reduction in power, with the Transmitter still operating with several modules having failed.

Each Amplifier Module can be removed or replaced whilst the Transmitter is operating ('hot-pluggable'). This feature means that if failures do occur, modules can be replaced within seconds, without having to go 'off-air'. Red/green fault displays on the front of each module help indicate the faulty module to be replaced, this normally restoring the Transmitter's full output without any further immediate technical investigation being required. The relatively low weight and small size of each module assist their actual transport to site.

Each Amplifier also has its own front panel 'mute' switch, which is mechanically interlocked so that it has to be operated before the module can be removed. All other signal, 50V dc supply and control connectors are at the rear of the unit. The control connectors go to one of two independent internal Transmitter control buses.

Each control bus has its own RS485 data bus which is used to carry the monitored serial information from the amplifier to the E2023 Controller. Each bus also has its own power level control line, derived from the E2026 Drive Changeover/Output Monitor Unit, to set the power level of each amplifier module and thus the final Transmitter output power.

Two versions of the 300W Amplifier Module may be supplied (E2021-03 and -04). These versions have slightly different internal circuitry. They are however interchangeable, but to maximise output power, all modules should ideally be of the same version.

1.1.2 : E2088 Power Supply Module

Sixteen of these are provided, all fed from a single three phase mains input via a single front panel safety switch. This switch can be padlocked in the 'off' position to ensure that the Transmitter remains off whilst work is being carried out at the antenna etc.

All the modules are grouped into two supplies 'A' (lower horizontal supply bank, nine modules) and 'B' (upper horizontal bank, seven modules). These are sub-divided into a total of six sub-groups, each of two or three modules (two sub-groups per phase). The modules in each sub-group are current OR'd together. The 'B' supply provides a supply bus to the fourteen upper E2021 Amplifier Modules. The 'A' supply provides a supply bus to the eighteen lower Amplifier Modules. Single units such as the E2023 and E2026 are supplied from all sub-groups in both 'A' and 'B' supplies using diode 'OR'ing.

Each E2088 Power Supply Module has its own forced air cooling, output control and monitoring circuitry and generates a regulated 50-53V dc supply to specific number of the thirty two output Amplifier Modules. Removal of one or more Power Supply Modules causes a decrease in power output with some power being generated as long as all the modules remain in at least one sub-group. As with the Amplifier Modules, each Power Supply module can be removed or replaced, within seconds, whilst the Transmitter is operating. Red/green fault displays, relatively low weight and small size again feature.

50-53Vdc outputs for each Amplifier, for all the low power single units and mains supplies for each of two Exciters are provided via separate fuses at the rear of the Transmitter. The Power Supply monitor connectors go to one of two independent internal Transmitter control buses and hence to the E2023 Controller.

1.1.3 : E2023 Transmitter Controller Unit

This single unit provides comprehensive monitoring of the forward power, current and temperature of each E2021 Amplifier Module and of the final output forward power, reverse power and temperature via the E2026 Drive Changeover/Output Monitor. It also monitors the E2088 Power Supply Modules. In the situation where dual drive automatic changeover or automatic power level control is used, this unit provides the necessary control. Remote control and monitoring of the Transmitter can also be provided via this unit using parallel or serial data.

The Control Unit is microprocessor based with a back illuminated, high contrast 4 line by 20 character display and separate red/green 'System Normal' indicator. A robust, sealed membrane keypad is provided with a sounder to indicate correct key entry. The rear of the unit has separate connectors for the two independent internal Transmitter control buses, connectors to monitor and control one or two Exciters, a connector for power level control and a connector for parallel monitoring. An RS232 monitor/control port is provided on the front panel (E2023-01/02) with an additional TCP/IP monitor/control port on the rear (E2023-02 only). In the latter case, selection of RS232 or TCP/IP is done by internal links.

If a fault should occur within the E2023, a manually operated switch on the E2026 Drive Changeover/Output Monitor Unit can be used for basic control of the Transmitter. This enables it to be kept 'on-air' whilst the E2023 is replaced.

1.1.4 : E2026 Drive Changeover/Output Monitor (and Splitter) Unit

This single unit interfaces between the Exciter(s) and the multiple E2021 Amplifier Module inputs, via two 16 Way Splitter Units. The splitter section within the unit is a two way Wilkinson utilising standard coaxial cable and is thus easily repaired if any become damaged. All outputs are brought to TNC connectors at the rear of the unit. Phase length matched, 50Ω coax leads then connect these outputs to the main E2021 inputs via the 16 Way Splitters.

This unit also contains circuitry to measure the Transmitter's final output forward and reverse powers, via the output Directional Coupler, and the temperature of the final 32 Way Combiner's dumping load heatsink. Front panel red/green displays indicate any fault condition. Two multi-turn preset High or Low Power potentiometers are accessible via the front panel to enable independent setting of two Transmitter output powers. They are selected using various forms of local, external or remote control or via a link between connectors on the Control Bus Board 'A' (see section 3.4.2). A front panel connector is provided to give a harmonically filtered test sample of the Transmitter's output forward power.

As with the E2023, the rear of the E2026 has separate connectors for the two independent internal Transmitter control buses. As previously detailed, each control bus has its own RS485 data bus, one of which is used to carry the monitored serial information from the E2026 to the E2023 Control Unit. For these two buses, the E2026 also provides two equal but independent power level control voltages (derived from either the front panel High or Low Power potentiometers) to set the power level of the E2021 Amplifier Modules and thus the final Transmitter output power. One control voltage is used for the Amplifier Modules on the right hand side of the Transmitter and the other for the Amplifier Modules on the left hand side.

A front panel lockable toggle switch is provided to manually mute or start (i.e. demute) the Transmitter or can be set to enable the E2023 Control Unit to select high/low power or to mute/demute the Transmitter as part of an automatic control sequence. An interlock switch connector is also provided on the rear to enable the open-circuiting of external switches placed at safety points (e.g. at Antenna access gates) to automatically mute the Transmitter. The state of this circuit is displayed on a front panel indicator.

The E2026 can also provide manual or automatic dual drive changeover in conjunction with the E2023 Control Unit. Switching is performed by two coaxial RF relays within the E2026. These direct one of two Exciter's outputs to the 16 Way Splitters and the other to a dumping load. This dumping load has to be provided, externally to the E2026, whenever two Exciters are supplied and the Exciter not in use is required to remain 'active' or be tested. Three TNC connectors are provided at the rear of the unit to connect to Exciter(s) and dumping load. Front panel indicators show which Drive is selected.

1.1.5 : E2083-01 16 Way Splitter and E2084-01 32 Way Combiner Units

Two E2083-01 16 Way Splitters are provided within the Transmitter to split the power from the Exciter/Drive(s) to the E2021 Amplifier Module's inputs. A single E2084-01 32 Way Combiner is provided to combine the E2021 outputs and connect them to the Transmitter's final antenna output via an harmonic filter and directional coupler. Phase length matched, 50Ω coax leads connect the Splitter and Combiner to the E2021's inputs and outputs.

The Splitter uses a four way Wilkinson followed by matching sections providing a total of 16 50Ω matched outputs. A 50Ω coaxial cable is used for the splitting and matching sections. The unit has integral dumping loads for the Wilkinson section.

The Combiners use a patented multiple way 'rat-race' splitting/combining technique. Quarter-wave lengths of 50Ω and 95Ω coax are used in a physically compact 'bird-cage' construction, with an air-spaced, tri-axial quarter-wave output matching section. This technique offers high isolation and return loss over the whole bandwidth, with very low through loss. The Combiner's dumping loads are fitted on a separate heatsink, the temperature of which is monitored by the E2026 Drive Changeover/Output Monitor Unit.

1.1.6 : Output Low Pass Harmonic Filter and Directional Coupler

These are separate items fitted at the top of the rack. The Harmonic Filter is fed directly from the output of the 32 Way Combiner via rigid coaxial line. The Directional Coupler is fixed directly to the EIA flange connector output of the filter. Connections to the Antenna are then made directly to the flange connector output of the Coupler.

The Coupler forward and reverse power sensing outputs are connected to the E2026 Drive Changeover/Output Monitor Unit via low pass filtering and response levelling units. The E2026 contains circuitry to measure the forward/reverse powers and display them via the E2023 Control Unit.

1.2 : VARIANTS AND OPTIONS

The only variant and its constituent modules and units is as follows :-

	Amplifier Modules	Power Supplies	Transmitter Auto. Cont.	Output Monitor and Drive C/O	Splitter Unit	Combiner Unit	Harmonic Filter and Directional Coupler
S7610C-01	32 off E2021-03 or E2021-04	16 off E2088-01	Single E2023-01 or E2023-02 (/T Option)	Single E2026-04	2 off E2083-01 16 Way	Single E2084-01 32 Way	Single of each (both internal)

The option (identified by a letter suffix) is as follows :-

/T	Fitted with TCP/IP Remote Control (on E2023-02)

1.3 TECHNICAL SPECIFICATIONS

The S7600 range of FM Transmitters is designed to meet or exceed ETSI Standards:-

EN 301 489-01 : ERM/EMC for Radio Equipment, Part 1, Common Technical Requirements.
EN 301 489-11 : ERM/EMC for Radio Equipment, Part 11, Specific Conditions for FM Transmitters.
EN 302 018-02 : ERM (Spectral Occupancy) for the FM Radio Broadcast Services.
EN 60215:1989 : Safety Requirements for Radio Transmitting Equipment

Note that the following figures do not include any which principally depend on the Exciter/Drive being used (e.g. frequency stability). The figures given below may also be affected by the Exciter/Drive's performance. In both cases the relevant equipment's own manual should be consulted.

RF Interface Ports	50Ω nominal
Input Drive Power	RF Input from Exciter/Drive supplied :- 130-160W (200W absolute maximum)
Output Power Level	With any load with a return loss ≥ 14dB (1.5:1 VSWR) any angle. (though see note below in 'Output Power shutdown' section) Note two independent settings available for selection. Adjustable at least 3.2kW to 10kW (Power Low setting) Adjustable at least 5kW to 10kW (Power High setting)
Output Power Variation	Not more than ± 1dB under all specified operating conditions.
Output Power Shutdown	Output power is automatically reduced or shutdown to ensure that any load with return loss <10dB including open and short circuits, does not cause any damage to the transmitter. The return loss level at which shutdown starts can be set by an internal adjustment (see section 2.3.3). This level is normally set at the factory to be 16dB, the level at which excess reverse power first produces a warning indication.
Output Reverse Intermodulation	Reverse intermodulation products will be better than or equal to –10dB, relative to the interfering incident signal, this being offset over the range ±300kHz to ±20MHz (but remaining within 87.5MHz to 108MHz).
Frequency Range	87.5 -108MHz
Spurious Emissions	In the range 9kHz to 1000MHz : - Better than or equal to –84dBc
Out of Band (Adjacent Channel) Emissions	Better than or equal to –110dBc/Hz, at ±200kHz offsets, and 145dBc/Hz at ±2MHz. When measured in a 1kHz bandwidth, the limit figures become –80dBc at ±200kHz offsets and –115dBc at ±2MHz.
Incidental Amplitude Modulation	Synchronous (AM due to FM) :- Not greater than 2% with a peak deviation of ±40kHz at a modulation frequency of 500Hz. Asynchronous (residual AM due to hum and noise with no FM modulation) :- Not greater than 1% when measured unweighted in a 20Hz to 20kHz bandwidth.

Status Indications	Output forward and reverse power and combiner heatsink temperature. Output forward power, temperature and current of any selected Amplifier module. Power Supplies, Cooling fans/system and (when connected) Drives status. Red/green pass/fail led indicators on all modules.
Dimensions	Height :- 45U (plus ventilation and output connections) Width :- Standard 19in rack. Depth :- Standard 1000mm deep rack
Environmental	Ambient Temperature (operating) : -5 to +50 deg.C Ambient Temperature (storage) : -20 to +70 deg.C Relative Humidity (operating) : Less than or equal to 90%, non condensing with the transmitter at a higher temperature than the ambient. Altitude (operating) : Up to 3000 metres a.s.l.
Power Supply	Single three phase plus neutral (plus protective earth) input. 305 to 455V AC phase to phase (176 to 264V phase to neutral) 47- 63Hz. Apparent power factor 98%. Efficiency 88% (Power Supply units only) Supply currents (at 10kW RF output) typically :- 25A at 230V AC (phase to neutral) per phase Typical overall efficiency 55% at above power levels (AC in to RF out).

SECTION TWO : INSTALLATION

! CAUTION !

These Transmitters operate at **high RF power levels, internal supply energy levels and mains supply current levels**. They also incorporate devices containing **toxic BeO**. Before commencing installation, it is recommended that the complete INSTALLATION section is read and understood. **The instructions should then be strictly followed, by suitably qualified personnel, otherwise sub-standard or even dangerous operation may result.**

It is also **strongly recommended** that a **mechanical check** is made of the Transmitter, before it is installed and switched on. This is to ensure that no loosening of connectors or damage has occurred, during transit, which may lead to further damage being caused at switch-on. The principal items to check are : -

No obvious physical damage has occurred to the Transmitter frame, modules or internal wiring.

The internal rigid coaxial line connection between output combiner and filter is securely made **– a poor connection here may lead to overheating of the line, combiner and filter**.

All removable, internal RF coaxial connectors (SMA/B/C, BNC, TNC, N etc) are in place and tight.

All internal multi-way connectors (Ribbon, D Type, Molex etc) are in place and secure.

Each E2021 Amplifier Module is pushed fully into the Transmitter with its lock switch fully pushed down – **do not try to force these modules home** – if they appear difficult to insert fully, check that the locating 'harpoons' at the rear of each module (either side of its D connector) are not bent.

Each E2088 Power Supply Module is pushed fully into the Transmitter with its locking lever engaged– **do not try to force these modules home** – if they appear difficult to insert fully, check the connectors at the rear of the module.

2.1 : PHYSICAL DIMENSIONS AND FITTING

2.1.1 Installation Items

Various installation items are required. A list of these (including spare fuses) is given below. Actual requirements depend on the configuration of the equipment supplied (e.g. with or without Exciter/Drive(s), whether or not leads are supplied ready made etc.). Note that extra, unlisted parts may be required for connections to any Exciter/Drive(s) that are supplied (see manuals supplied with them).

Typical Quantity	Description	Function
Length as req'd	5 core, 10mm^2 per core, type SY, flexible steel armoured cable.	Mains supply lead
1	50A 'C' rated 4 pole miniature circuit breaker (MCB).	Fitted at mains supply distribution point to protect supply leads and mains input components in the Transmitter
1	EIA 1 5/8" free connector/bullet.	For connection to lead from Antenna or RF output load.
Length as req'd	Low loss 50Ω RF coaxial cable, rated in excess of Transmitter output power at maximum ambient temperature.	RF output lead.
1 - 3	TNC 50Ω RF coaxial free plug(s).	For connection to leads from Exciter/Drive(s) and their dummy load.

Typical Quantity	Description	Function
Length as req'd	Low loss 50Ω RF coaxial cable, rated in excess of Exciter/Drive output power at maximum ambient temperature.	RF input and dummy load leads.
1	Coaxial, 87.5 – 108MHz, 50Ω load with suitable free connector, rated in excess of Exciter/Drive output power at maximum ambient temperature.	Exciter/Drives' dummy load.
1-3	2 Way, 10A, 5.08mm pitch screw terminal block (c/w wire shorting link). (e.g. Weidmuller BL5.08/2)	External safety interlock and fan/external cooling system status inputs (shorting links are removed when inputs wired to safety/cooling circuits).
1 - 2	9 Way D plugs c/w covers.	For connection to leads from control/monitor inputs of Exciter/Drive(s).
1 - 2	9 Way D sockets c/w covers.	For connection to parallel and serial RS232 remote control/monitor links.
1	15 Way D plug c/w cover.	For connection to additional control/monitor input links
Length as req'd	Multi-core screened cable (number of cores as required).	Control/monitor leads.
Length as req'd	Heavy gauge grounding wire/strap.	For safety earth lead.
1-2	IEC 6A free plug to free socket mains leads (1 metre, 3 core each 0.75mm^2, EPR insulated, HOFR sheathed for high temperatures).	For fused and switched mains supply connections to Exciter/Drive(s).
33	500mA (F) Fuses (for smd holders, 'Littelfuse' R451.500)	For protection of control circuits within E2021 Amplifiers and E2026 Drive C/O/Output Monitor.
32	16A (T) HBC 5x32mm (¼ x1¼ in) Fuses	For protection of internal dc supply leads to and high current circuitry within E2021 Amplifiers.
4	6.3A (T) HBC 5x20mm Fuses	For protection of internal low current dc supply leads and of mains supply leads and circuitry intended for connection to Exciter/Drives(s).
As reg'd	300mm 'Elephant' ducting etc.	For external forced air cooling systems

2.1.2 Installation Procedure

The Transmitters are totally self-contained in a standard 19 inch, 43U rack with 1000mm depth. All that is required is a connection to a three phase mains supply, to an antenna, to the Exciter/Drive(s) and to an external forced air cooling system (see section 2.1.3).

When S7610C are used in pairs, to generate up to 16kW, an additional two way splitter, combiner and approximately 4kW balance load is also required. In this situation, additional manual 'patching' or manual/automatic switching can be fitted, as an option, to direct all of one Transmitter's power to the antenna. Information with regard to the additional units will normally be supplied in their own manuals or in manuals supplied with specific systems.

2.1.3 External Cooling Systems

! CAUTION !

The Transmitter should not be operated for any significant period of time without connection to an operating cooling system with sufficient air-flow capacity. Otherwise, the RF output power will be turned down automatically or may even be muted completely to protect the Transmitter itself.

The S7610C-01 requires an external cooling unit. Connection to the cooling system is via a single section of 300mm 'elephant' ducting to the rear exhaust. Inlet air is drawn from the area where the Transmitter is installed via vent holes in the front of the various Transmitter modules.

Negative pressure must be established within the Transmitter (i.e. air drawn through the exhaust by the external fans). To maintain low internal Transmitter temperatures, an airflow of approximately 1760 CFM (840 litres/sec) is required for inlet air temperatures of up to 25 deg.C.

The two E2026 'FANS' status inputs may also be connected to airflow detectors, within the external cooling system, to enable loss of flow to be signalled. These status inputs (two way connectors) are situated near the bottom of both right hand and left hand internal 'bus' distribution printed circuit boards. The detection device must present a short circuit when the airflow is present. If a connector is not used, it must be fitted with a shorting link (see section 2.2.10).

2.2 EXTERNAL CONECTIONS

2.2.1 Mains Supply Connection

The supply must be three phase plus neutral, 230V AC phase to neutral, 400V phase to phase (±20%) and 47-63Hz. Provision is made for a protective earth. The maximum current drawn from each phase (at 230/400V AC) is in the order of 25A.

! CAUTION !

The S7610C MUST NOT be operated at voltages significantly below the lower limits stated in section 1.3, as the supply current may exceed the rating of the mains supply connectors and associated wiring and components. Fitting of the specified MCB (see next sections) will ensure this cannot occur.

! CAUTION !

The mains supply lead to the Transmitter must consist of five core (3P+N+protective earth) insulated cable. **Each core must be at least 10mm^2** and the overall cable armoured (type SY flexible steel armoured cable preferred) **and not mounted in a conduit with other supply cables**.

A four pole, 50A (C rated) MCB must be provided at the supply distribution board to protect both lead and Transmitter supply input circuitry.

Alternatively (to give supply breaker redundancy) three separate single pole 50A C rated MCBs may be used, one in each phase line at the supply distribution board.

Also, since the supply input circuitry contains a filter, which passes current to the Transmitter chassis, **the Transmitter chassis must be connected to a safety ground**.

Also ensure whilst making any connections to the mains supply, that the Transmitter's front panel Supply Disconnector is switched to 'off' (i.e. at O) and is preferably padlocked in that position to prevent inadvertent operation of the Transmitter.

The supply lead is connected via screw terminals on the Transmitter's **mains supply filter input**. The filter is fitted at the bottom of the rack, just behind the rear fuse panel, underneath a protective cover. The terminal connections are as follows :-

Terminal	Connection
L1	Phase #1
L2	Phase #2
L3	Phase #3
N	Neutral
Earthing Stud	Prot. Earth
Chassis Stud	Cable Armour

The armouring of the cable should also be taken to ground at the supply distribution board.

An additional chassis earthing stud is provided adjacent to the mains supply input connector to allow the Transmitter chassis to be permanently bonded to nearby safety ground .

Note that the individual three phase input leads MUST NOT be connected, in parallel, to a single phase supply – this could result in damage to the Transmitter (caused by excessive neutral current).

2.2.2 RF Output Antenna Connector

! CAUTION !

When operating, high RF Voltages are present on this connector. Always ensure when making connections here, or working on any load connected, that the Transmitter's front panel Supply Disconnector is switched to 'off' (i.e. at O) and is preferably padlocked in that position.

This is a 50Ω 1 5/8" EIA flange coaxial connector at the top of the Transmitter. Care must be taken to use adequately rated (at maximum ambient temperature) low loss cable for the lead to the antenna or load

2.2.3 RF Input Exciter/Drive(s) Connectors

! CAUTION !

When operating, high RF Voltages may be present on these connectors. Always ensure when making connections here, or working on any load connected, that the drive source(s) to the Transmitter are switched off or safely muted.

These are three 50Ω TNC coaxial sockets at the centre rear of the E2026 Drive C/O /Output Monitor Unit. Socket SK08 (Drive A) is for connection a single Exciter/Drive's RF Output. When dual drive changeover is supplied, socket SK06 (Drive B) is used for connection to the second Exciter/Drive's RF Output. In this case, socket SK07 (Load) is used for connection a 50Ω Exciter/Drive dummy load, normally situated in the section of the rack where the Exciter/Drives are fitted.

2.2.4 Safety Interlock Connector

This is a removable, 2 Way, 5.08mm screw terminal block PL12 at the rear of the E2026 Drive C/O /Output Monitor Unit. A shorting link has to be made between the terminals to de-mute the Transmitter (the front panel INTERLOCK EXT. MUTE display goes from red to green when the terminals are linked). If there are no external safety interlock switches, a short direct link is made, this being the state in which the connector is normally supplied. If connections need to be made to external safety switches, this link is removed and the switches are wired in a series loop to the connector so that if any switch opens, the link is broken.

! CAUTION !

For the safety interlocks to work correctly, the external switches and link wiring must 'float' (i.e. must not be grounded at any point). The total loop resistance should not exceed approximately 100Ω. The external wiring may also be ferrite loaded for emc requirements. **No external voltages should be applied to this connector.**

2.2.5 RF Output Monitor Connector

This is a 50Ω BNC coaxial socket SK01 on the left-hand side of the E2026 Drive C/O /Output Monitor Unit front panel. This provides an harmonically filtered sample of the Transmitter's forward output power at a level, into 50Ω, approximately 72dB below the power being delivered into the load (e.g. approximately 0.5mW for 10kW being delivered). This connector is for test purpose only with the test equipment and lead being disconnected when not in use. **NOTE that the levels of any harmonics present are not necessarily equal to those at the antenna.**

2.2.6 Drive A/B Monitor and Control Connectors

These are two identical 9 Way D sockets SK03 and SK06 at the rear of the E2023 Control unit. These are used to enable one or two Exciter/Drive(s) to be monitored and controlled by the E2023 (with two Exciter/Drives this enables automatic dual Exciter/Drive changeover). Multi-core screened cable, not exceeding 3 metres in length, should be used for the interconnecting leads.

Each lead terminates in a separate 9 Way free D plug at the E2023 end which is wired as follows :-

Pin 1	RS232 Data from Drive (not enabled)
Pin 2	Ground
Pin 3	Prefer Drive from Rem. Control Momentary low > approx. 1sec
Pin 4	Slow Status Monitor from Drive Continuous low >2secs registers 'good' Continuous high >10secs registers 'fail'
Pin 5	Fast Status Monitor from Drive Continuous low >2secs registers 'good' Continuous high >2secs registers 'fail'
Pin 6	RS232 Data to Drive (not enabled)
Pin 7	Ground
Pin 8	Ground
Pin 9	Mute/demute to Drive Continuous low to mute

Each input (pins 3, 4, 5) is internally 'pulled up' to +5V through 12kΩ and must be fed from a voltage free source of less than 1kΩ to ground for a low state (open-circuit for a high state). These inputs are protected against constant application of up to ±12V dc directly applied.

The mute/demute output (pin 9) is an 'open collector' NPN, silicon low saturation switching transistor suitable for driving loads from +5V to +24V dc with maximum currents of 10mA. The low state output impedance is approximately 10Ω.

These connections are wired in accordance with the monitor and control requirements of the type of Exciter/Drive(s) supplied and normally, not all the pins will need to be connected. Pin 3, if used, is for connection to a remote control and monitoring system. This enables selection of a particular drive to be preferred (forced) remotely by momentarily pulling this line to ground.

If automatic dual Exciter/Drive changeover only requires one of the two status monitor inputs for operation, the other must be connected to ground.

2.2.7 Parallel (standard) or RS232 Serial Remote Control DTE Connector

This is a 9 Way D plug PL04 at the rear of the E2023 Control unit. It is used to enable various forms of remote control and monitoring, possibly requiring additional external units. Multi-core screened cable, not exceeding 3 metres in length, should be used for the interconnecting lead.

The lead terminates in a 9 Way free D socket at the E2023 end which is wired as follows :-

	Parallel (standard)	Serial RS232
Pin 1	Power Output Low (app.–2dB rel. set output)	Rec'd Signal Detect
Pin 2	Power Output Fail (app. –12dB rel. max o/p)	Received Data
Pin 3	Reverse Power High (app. 200W)	Transmit Data
Pin 4	Combiner Temp. High (app. +100deg.C)	Data Terminal Ready DTR
Pin 5	Ground	Ground
Pin 6	Fan/Cooling System Fail	Data Set Ready DSR
Pin 7	System Normal	Request to Send RTS
Pin 8	Drive A/B Selected	Clear to Send CTS
Pin 9	Drive Changeover on Auto	Ring Indicator RI

The parallel outputs are 'open collector' NPN, silicon low saturation switching transistors suitable for driving loads from +5V to +24V dc with maximum currents of 10mA. The low state output impedance is approximately 100Ω. Each output is protected against constant application of up to ±5V dc directly applied. A normal (non-faulty) condition is indicated by the output pin being pulled to ground (i.e. low state) by the switching transistor. Drive A selected and Drive C/O on Auto are similarly indicated. Note that the serial option requires an additional internal link lead, which re-directs the serial remote control from the front panel COM port to the rear panel DTE connector (pins 2, 3, 5 only).

2.2.8 Second Transmitter Remote Control Connector

This is a 15 Way D socket SK05 at the rear of the E2023 Control Unit. It is used to enable externally derived automatic control of Transmitter muting and high/low power level setting. Multi-core screened cable, not exceeding 3 metres in length, should be used for the interconnecting lead.

The lead terminates in a 15 Way free D plug at the E2023 end which is wired as follows :-

Pin 1	Select Low Power Input (continuous low to select)
Pin 2	Mute Transmitter Input (continuous low to mute)
Pin 3	Output Status A (continuous low state – not used)
Pin 4	Output Status B (continuous low state – not used)
Pin 5	RS485 Data (+) In (not used)
Pin 6	RS485 Data (-) In (not used)
Pin 7	RS485 Data (+) Out (not used)
Pin 8	RS485 Data (-) Out t used)
Pin 9	Not Connected
Pin 10	Ground
Pin 11	Ground
Pin 12	Ground
Pin 13	Ground
Pin 14	Not Connected
Pin 15	Not Connected

Each input (pins 1, 2) is internally 'pulled up' to +5V through 12kΩ and must be fed from a voltage free source of less than 1kΩ to ground for a low state (open-circuit for a high state). These inputs are protected against constant application of up to ±12V dc directly applied. Note that they are only active when the associated E2026 Auto-Mute-Start switch is in the Auto position and have delays in the order of 200mS. **Thus, they should not be used as part of a safety interlock system** (see 2.2.4).

Each output (pins 3, 4) is a relay contact to ground for a low state (open-circuit for a high state). The contacts are rated at 1mA (minimum at 5V dc) to 1A maximum switching current. The maximum voltage (including switching surges) must be limited to ±24V dc. These outputs (and pins 5-8 inc.) are not used and thus should not be externally connected.

2.2.9 Mains Supply Output Connectors

These are two single-phase mains supplies, provided inside the lower rear of the Transmitter, on 'flying' IEC connectors. Each one is connected, via the front panel SUPPLY DISCONNECTOR switch to different phases of the mains supply input. Thus equipment connected to these supplies can be arranged in two groups, both groups being switched off when the Transmitter itself is switched off using the front panel switch.

The continuous total load on output each should not exceed approximately three amps. Each output is protected by a 6.3A (T) HBC fuse, FS43 and FS44 allow for current surges at 'switch-on'

2.2.10 Fans/Cooling System Status Input Connectors

These are two, removable 2 Way, 5.08mm screw terminal blocks. They (CON03) are situated at the bottom of both right hand and left hand internal 'bus' distribution printed circuit boards. A shorting link has to be made between the terminals of both individual connectors to indicate that the fan/cooling system is good (i.e. both inputs at a low state). When this is done, front panel FANS display goes from red to green.

Each input is internally 'pulled up' to +5V through 24kΩ and must be fed from a voltage free source of less than 2kΩ to ground for a low state (open-circuit for a high state). **No external voltages should be applied to these inputs.** The external wiring may be ferrite loaded for emc requirements.

If there are no fan or external airflow detectors, short direct links are made (this being the state in which the connectors are normally supplied). If connections need to be made to external airflow

detectors, one or both links are removed and one or two detectors can be wired to them. If only one detector is used, the other connector must retain its short direct link.

2.2.11 RS232 Serial Control and Monitor (COM) Connector

This is a 9 Way D plug PL01 on the right hand side of the E2023 Control unit front panel. It is used to enable down loading of status and to enable simple control using a personal computer (PC) directly connected to this front panel COM port. Multi-core screened cable, not exceeding 30 metres in length, should be used for the interconnecting lead. The lead terminates in a 9 Way free D socket at the E2023 end which is wired as follows :-

Pin 1	Not connected
Pin 2	Received Data (to E2023)
Pin 3	Transmit Data (from E2023)
Pin 4	Not Connected
Pin 5	Ground
Pin 6	Not Connected
Pin 7	Not Connected
Pin 8	Not Connected
Pin 9	Not Connected

Note that the assigned pin numbers and their functions are for a standard 9 pin plug on 'Data Terminal Equipment' (DTE) such as computers. Standard crossover or 'null modem' leads may thus be used for connection to a personal computer or PC. The length of the interconnecting lead may be extended by use of compatible RS422/485 or fibre-optic line drivers.

Note that the internal connections to this connector may be re-directed to the rear panel DTE connector PL04 by the use of an optional internal link lead (see section 2.2.7).

Full details of serial remote control procedures via this connector are given in Section 2.4.

2.2.12 TCP/IP Control and Monitor Connector (/T option only)

This is a standard RJ45 connector SK08 mounted in an additional screened box fitted to the rear of the E2023-02 Control Unit. This enables all the control and monitoring detailed in Section 2.4 to be performed using TCP/IP (Transmission Control/Internet Protocol)

This arrangement requires the unit to be assigned a unique Internet Protocol address. When first connected to the network via its RJ-45 connector, the E2023's TCP/IP adapter will attempt to acquire an IP address automatically (it's quite common to have networks configured to use 'DHCP', which provides these addresses on demand). The address to which a device has been assigned can then be determined and, if required, be overridden with a desired fixed value, using Eddystone supplied software. Note that internal linking leads determine if control and monitoring is via this connector or the front panel RS232 COM port connector (both cannot be used together).

2.2.13 FWD/REV Output (Analogue Monitor) Connectors

These are two 50Ω SMC coaxial sockets PL10/11 at the left rear of the E2026 Drive Changeover/Output Monitor Unit. They provide DC analogue output voltages corresponding to the Transmitter output forward and reverse powers. Coaxial screened cable, not exceeding 3 metres in length, should be used for the interconnecting leads.

PL11 provides the forward power indication at a level of approximately 2.5V at 4kW to 3.5V at 10kW.
PL10 provides the reverse power indication at a level of approximately 1.4V at 200W.

Both outputs are from impedances of approximately 5kΩ.

2.3 SETTING UP PROCEDURES

2.3.1 Fuses

If any problems occur after the Transmitter has been installed and switched on, fuses may need to be checked and possibly replaced. However, a blown or open-circuit resettable fuse would generally indicate the presence of a fault, which would need correcting.

The type, function and access to fuses is as follows :

Type	Function	Access
500mA (F) Fuses (for smd holders, 'Littelfuse' R451.500) One per E2021.	For protection of control circuits within E2021 Amplifier modules. If fuse blows, all front panel displays on just the affected E2021 go out and its power level falls.	Remove Amplifier module from front, taking care to release the mechanical securing locks first. Smd fuseholder is at rear of unit under the screen cover.
500mA (F) Fuse (for smd holders, 'Littelfuse' R451.500) One only.	For protection of control circuits within E2026 Drive Changeover /Output Monitor Unit. If fuse blows, all front panel displays (except Drive A/B and Interlock) on just the E2026 go out and the overall output power level falls to zero. Note, if a spare fuse is not available, one may be transferred from one of the E2021 modules to enable operation at lower power.	Slide Drive Changeover/Output Monitor Unit forwards and out after removing front fixing screws and any leads connected to its rear. Smd fuseholder is accessible underneath the screen cover on the front printed circuit board, right hand side. **! CAUTION ! Ensure that the front panel Supply Disconnector is switched to 'off' (i.e. at O) and is preferably padlocked in that position.**
16A (T) HBC 5x32mm (¼ x1¼ in) Fuses One per E2021.	For protection of internal dc supply leads to and high current circuitry within E2021 Amplifier modules. If fuse blows, all front panel displays on just the affected E2021 go out and its power level falls to zero**.**	At the bottom rear of the Transmitter, the larger fuse-holders grouped on the left and right hand sides. Note FS number and position mirrors amplifier number and position. **! CAUTION ! these are high energy circuits and thus care must be taken if replacing the fuse with power on.**
6.3A (T) HBC 5x20mm Fuses Two only.	For protection of internal low current dc supply leads. Internal low current supplies are dual redundant, thus the loss of one fuse produces no failure (only E2023 display warning). If both blow, E2023 and E2026 front panel displays all go out and the overall output power level falls.	At the bottom rear of the Transmitter, the smaller fuseholders FS41/42. **! CAUTION ! these are high energy circuits and thus care must be taken if replacing the fuse with power on.**

Type	Function	Access
6.3A (T) HBC 5x20mm Fuses Two only	For protection of mains supply leads and circuitry intended for connection to Exciter/Drive(s).	At the bottom rear of the Transmitter, the smaller fuseholders, FS43/44. **! CAUTION ! these are high energy circuits and thus care must be taken if replacing the fuse with power on.**
3A Hold RUE 30V Resettable Fuse One only.	For internal protection of E2023 Control unit. If the fuse goes high impedance, the E2023 front panel displays will all go out and any automatic control will cease.	Inside E2023, on rear Interface Board. Note this fuse will automatically reset if the front panel Disconnector switch is temporarily set to 'off' (i.e. to 'O') or if the E2023 is temporarily disconnected from the Control Bus Boards at <u>both</u> sides of the rear of the Transmitter.

<u>2.3.2 Output Power Level and Frequency Adjustment</u>

If the Transmitter is not supplied with preset output power levels and frequency, its front panel HIGH POWER control and the Exciter/Drive(s)' power output and frequency will need to be set. The manuals for the type of Exciter/Drive(s) supplied or in use must be consulted for information on how the settings required of them are actually made.

The procedure is as follows :

1) Ensure the Transmitter has been installed as detailed in sections 2.1 and 2.2. and that the E2026 Drive Changeover/Output Monitor front panel switch is set to MUTE.

2) Disconnect all E2021 Amplifier modules by releasing their front mechanical locks and pulling them slightly forward.

3) Apply power to the Transmitter. Ensure supply distribution 50A MCB is on and the front panel Disconnector switch is at 'on' (i.e. at 'I') and ensure that the external cooling system is operative.

4) Ensure all displays are on red, green or amber (except disconnected E2021s) else follow fuse checking procedure as detailed in section 2.3.1 (fault finding may be required if this occurs). Check Exciter/Drive(s) are operating.

5) Check the E2026 INTERLOCK/EXT MUTE display is green (if red ensure the safety interlock link at the rear of this unit is made).

6) Set the Exciter/Drive(s) power output to minimum (which must be less than 200W) and frequency to that required.

7) Reconnect all E2021 Amplifier modules ensuring their mechanical locks are remade and ensuring all their displays come on at red, green or amber – if not, again check fuses.

8) Set the E2026 Drive C/O /Output Monitor front panel switch to START and use the E2023, in DRIVES mode, to select Drive A or Drive B to connect an Exciter/Drive to the Transmitter itself.

9) Set the E2026 Drive C/O /Output Monitor Unit's front panel HIGH POWER and LOW POWER <u>twenty</u> turn controls to fully clockwise (i.e. <u>maximum</u> power setting). Ensure that the HIGH POWER control display is on.

10) Slowly increase the selected Exciter/Drive(s) output power until 10kW is just obtained. To ensure complete accuracy, an external calibrated power meter should be used to measure this output power. Increase the input level by a further 1dB (approximately 20%). <u>In no case however must the input power exceed 200W</u>. The output power should rise above 10kW.

11) If a second Exciter/Drive is fitted, repeat step (10) with the E2023, in DRIVES mode, used to select the second Exciter/Drive.

12) With the Exciter/Drive power set as described, turn the HIGH POWER control anti-clockwise until the measured output power falls back to 10kW (or less if required). Check the same power is obtained by selecting the other Exciter/Drive if fitted (using the E2023 in DRIVES mode).

13) Similarly set the LOW POWER control by repeating step (12) but with the E2026 front panel switch set to AUTO (rather than START) and LOW POWER selected by grounding pin 1 of the E2023 rear panel Second Transmitter connector SK05 (see section 2.2.8).

14) Check that the output power displayed on the E2023 Control Unit also reads the set output power. This reading will not be as accurate as the external calibrated power meter but should be within about ±0.25dB (approx. 400W at 10kW).

15) If the reading is not within this range it may be adjusted by a preset control inside the E2026 Drive Changeover/Output Monitor Unit. To access this control, slide the E2026 forwards after removing its two front fixing screws, taking care not to strain any leads connected to its rear. The preset control (marked 'CAL FWD') is at the rear left hand side of the printed circuit board accessible through an aperture in the screen cover. Care must be taken that none of the other four preset controls on the board are altered. Adjust the control clockwise to increase reading or anti-clockwise to decrease reading.

The Transmitter will now be ready for operation with audio and or data sources applied to the Exciter/Drive(s). The manuals for the type of Exciter/Drive(s) supplied or in use must be again consulted for information on how such sources are applied and controlled.

The RF Monitor connector at the left-hand front of the E2026 Output Monitor/Drive C/O Unit may be used to check the close-in spectrum of the Transmitter output signal. Note that any harmonic levels shown will not necessarily indicate those present at the Transmitter output. Any test equipment should not however normally be left connected.

2.3.3 Reverse Power Trip Level Adjustment

If the REV led on the E2026 Drive Changeover/Output Monitor Unit is intermittently or permanently red, this indicates that the level of reverse power is greater than about 200W. This shows that the antenna system connected to the Transmitter is relatively poor. If the Transmitter's reverse power trip point is set too low, this may cause a reduction in the available output power. As long as the E2021 Amplifier's REV leds are not also red, the trip point setting can be increased to help maintain full output power (although the REV warning may still be displayed).

The reverse power trip point may be adjusted by a preset control inside the E2026 Drive Changeover/ Output Monitor Unit. To access this control, slide the E2026 forwards after removing its two front fixing screws, taking care not to strain any leads connected to its rear. The preset control (marked 'REV TRIP') is at the rear left hand side of the printed circuit board accessible through an aperture in the screen cover. Care must be taken that none of the other four preset controls on the board are altered. Adjust the control anti-clockwise until the output power reaches a maximum.

Note that if this preset control is ever advanced too far clockwise, this may cause a decrease in output power with less than 200W reverse power, i.e. with a relatively good antenna system and with the E2026 REV led still green.

2.3.4 Serial Remote Control Baud Rate Setting

The operating Baud rate and be viewed and changed if required, by pressing [MODE] on the E2023 Transmitter Control Unit continuously for about 3 seconds. The screen will then change to show the present rate and the four 'soft' keys below can be used to select 2400, 4800, 9600 or 19200 Baud. The screen will time out in about 3 seconds after entry or after the last press of one of the four soft keys. Timeout is 'counted' down on the display. The Baud rate is held in non-volatile RAM and is error checked at power-on-reset, defaulting to 9600 if any Baud rate store error found.

2.4 SERIAL REMOTE CONTROL AND MONITORING

2.4.1 Introduction

Serial control via the front panel COM PORT connector (section 2.2.11) uses asynchronous data (1 start, 8 data, 1 stop bit, no parity) at 2400, 4800, 9600 or 19200 Baud. Control commands and status monitor requests are detailed in section 2.4.2. The content of status monitor information reverted from the E2023 is detailed in section 2.4.3. The /T option also enables the same functions using TCP/IP via a rear panel RJ45 connector (section 2.2.12). Selection of front panel COM port or rear panel RJ45 is made using internal link leads. The rear panel DTE port, PL04, may also be used as the COM port in place of that on the front panel (section 2.2.7) again by using internal links.

The individual data bytes are defined in ASCII form, to enable basic control and monitoring using a PC running a terminal program. However, a PC program with a dedicated textual and/or graphical user interface is required for proper implementation of a remote control and monitoring system. Eddystone Broadcast should be contacted for further information regarding such programs and hardware implementations using the RS232 port directly or via USB or TCP/IP adaptors.

2.4.2 Control Commands and Status Monitor Requests

All command and status monitor requests are initiated by the remote control unit (PC) – the E2023 never outputs any serial data via the COM PORT connector unless requested to by that unit.

The remote control unit always sends a sequence of three bytes, waiting for each byte to be 'echoed' correctly before the next one is sent (which must be within 500mS of the previous one). A wait of 500mS is also recommended before the sequence is timed out and aborted. A new sequence of three bytes then can be attempted. Note that an echo will not be returned when an invalid sequence is detected by the E2023.

The three bytes are :-

First byte	'Handshake' (always ASCII #) – indicates start of sequence
Second byte	'Command' – indicates form of control or status monitoring
Third byte	'Status Requests' (after ASCII ? Command) - gives details of status monitoring required or 'Controls' (after ASCII % & , + Commands) - gives details of control required

Details of the Handshake, Command, Status Request and Control bytes are given in the following four tables. Typical examples of controller generated sequences are as follows :-

? 1 Request to revert the status of Amplifier #1
% A Sets auto drive to A
& P Sets drive mode to passive

Handshake (first byte sent from controller)			
Title	Function	Hex	ASCII
Async_Hshake	Remote input handshake	23	#

Remote Input Commands (second byte sent from controller)			
Title	Function	Hex	ASCII
Query_Status	Status query (request to revert)	3F	?
Drive_Prefer	Drive A or B	25	%
Drive_State	Drive state Active or Passive	26	&
Tx_Power	Tx power High or Low	2C	,
Tx_State	Tx state Mute or Start	2B	+

Remote Input Status Requests (third byte sent from controller after **?** command)			
Title	Function	Hex	ASCII
Op_Stat	Revert output status	30	0
Amp1_Stat	Revert amplifier 1 status	31	1
Amp2_Stat	Revert amplifier 2 status	32	2
Amp3_Stat	Revert amplifier 3 status	33	3
Amp4_Stat	Revert amplifier 4 status	34	4
Amp5_Stat	Revert amplifier 5 status	35	5
Amp6_Stat	Revert amplifier 6 status	36	6
Amp7_Stat	Revert amplifier 7 status	37	7
Amp8_Stat	Revert amplifier 8 status	38	8
Amp9_Stat	Revert amplifier 9 status	39	9
Amp10_Stat	Revert amplifier 10 status	3A	:
Amp11_Stat	Revert amplifier 11 status	3B	;
Amp12_Stat	Revert amplifier 12 status	3C	<
Amp13_Stat	Revert amplifier 13 status	3D	=
Amp14_Stat	Revert amplifier 14 status	3E	>
Amp15_Stat	Revert amplifier 15 status	3F	?
Amp16_Stat	Revert amplifier 16 status	40	@
Amp17_Stat	Revert amplifier 17 status	41	A
Amp18_Stat	Revert amplifier 18 status	42	C
Amp19_Stat	Revert amplifier 19 status	43	B
Amp20_Stat	Revert amplifier 20 status	44	D
Amp21_Stat	Revert amplifier 21 status	45	E
Amp22_Stat	Revert amplifier 22 status	46	F
Amp23_Stat	Revert amplifier 23 status	47	G
Amp24_Stat	Revert amplifier 24 status	48	H
Amp25_Stat	Revert amplifier 25 status	49	I
Amp26_Stat	Revert amplifier 26 status	4A	J
Amp27_Stat	Revert amplifier 27 status	4B	K
Amp28_Stat	Revert amplifier 28 status	4C	L
Amp29_Stat	Revert amplifier 29 status	4D	M
Amp30_Stat	Revert amplifier 30 status	4E	N
Amp31_Stat	Revert amplifier 31 status	4F	O
Amp32_Stat	Revert amplifier 32 status	50	P
Amp33_Stat	Revert amplifier 33 status	51	Q
Amp34_Stat	Revert amplifier 34 status	52	R
Amp35_Stat	Revert amplifier 35 status	53	S
Amp36_Stat	Revert amplifier 36 status	54	T
Amp37_Stat	Revert amplifier 37 status	55	U
Amp38_Stat	Revert amplifier 38 status	56	V
Amp39_Stat	Revert amplifier 39 status	57	W
Amp40_Stat	Revert amplifier 40 status	58	X
Sys_Stat	Revert system status	59	Y
Dri_Stat	Revert drive status	5A	Z

Remote Input Controls (third byte sent from controller after **% & , +** commands)			
Title	Function	Hex	ASCII
A_Drive	Set auto drive to A	41	A
B_Drive	Set auto drive to B	42	B
Passive	Set drive mode to passive	50	P
Active	Set drive mode to active/unmuted	55	U
Pwr_Hi	Set Tx power to high	48	H
Pwr_Lo	Set Tx power to low	4C	L
Mute	Set Tx to mute	4D	M
Unmute	Set Tx to start/unmute	53	S

2.4.3 Reverted Status Monitor Information

The status of the Transmitter is reverted in response to a ? command (see section 2.4.2). After the third byte is echoed back to the remote control unit, a further fifteen bytes are sent immediately from the E2023, with no delays between individual bytes (each 1 start, 8 data, 1stop, no parity). **NOTE that the E2023 must be left set on 'MAIN' mode for all the amplifier module status to be kept updated (section 3.3).**

The first fourteen of the fifteen bytes contains the specific status information requested. The last byte is an exclusive OR checksum of those fourteen bytes. This checksum can be used by the remote control unit to check that the information has not become corrupted.

The meanings of the various bytes in the information string are defined in the table below.

Reverted Status Information (meanings of bytes reverted in response to **?** command)			
Title	Meaning	Hex	ASCII
Norm	Status normal	4E	N
N_Norm	Status not normal	4F	O
Stat_Low	Status low	4C	L
Stat_High	Status high	48	H
Fail	Status fail	46	F
Fuse	Status fuse?	45	E
Auto	Tx/Drive on auto	54	T
Man	Tx/Drive on manual	59	Y
Drive_A	Drive preferred or on A	41	A
Drive_B	Drive preferred or on B	42	B
Drive_Pas	Drive passive	50	P
Drive_Act	Drive active/unmuted	55	U
Tx_Muted	Tx Muted	4D	M
Tx_Start	Tx Unmuted	53	S
N_Known	Not known	58	X
N_Applic	Not applicable	5A	Z
Direct Display	Numerical values	30-39	0-9
Direct Display	Sign	2B 2D	+ -
Direct Display	Decimal point	2E	.
Direct Display	Blank	00	NUL
Direct Display	Less than	3C	<

Most meanings are general. A string of fourteen information bytes would normally contain several 'N's, each one indicating that a particular status (forward power, reverse power etc.) is 'Normal'. Some are specific, 'A' and 'B' for example, only refer to Drives A and B.

Direct display bytes give an immediate numerical display of power, current and temperature etc., even when using a basic terminal program.

If the E2023 contains no known good information about a particular status, the 'X' byte is reverted. This occurs if the E2023 is unable to interrogate individual modules within the Transmitter and thus cannot determine their status. However, it should be noted that certain Transmitters do not have every amplifier or power supply module fitted - status of such modules is thus returned either as 'X's (amplifiers) or as 'F' (power supplies). The 'Revert Output Status Request' (ASCII 0) returns the Transmitter type and can be used by the Remote Control Unit to determine whether a particular module should, in fact, be missing and its status not known.

Note that the information returned may have a latentcy of two to four seconds, since the E2023 can take that amount of time to collect the status of all the individual amplifier modules.

The following four tables detail the contents of the various strings of reverted status information. The final column in each defines which ASCII values a particular byte can have. The table above defines the meanings of these values. The first byte in each table is the echo of the third byte sent from the remote control unit.

Reverted System Data Block (15 extra bytes reverted in response to **# ? Y** sequence)		
Title	Status	Possible Values (ASCII)
Tx_Data1	Tx data status request byte	third byte echo fixed at Y
Tx_Data2	Tx system normal status	N O
Tx_Data3	Tx forward power status	N L F X
Tx_Data4	Tx reverse power status	N H X
Tx_Data5	Tx combiner temp status	N H X
Tx_Data6	Tx fans/cooling status	N F X
Tx_Data7	Tx A 50V line status	N E F
Tx_Data8	Tx B 50V line status	N E F
Tx_Data9	Tx C 50V line status	N F
Tx_Data10	Tx D 50V line status	N F
Tx_Data11	Tx power auto/man status	T Y
Tx_Data12	Tx power (man) start/mute status	M S Z
Tx_Data13	Tx power (true) high/lo setting status	H L X
Tx_Data14	Tx power (auto) start/mute status	M S
Tx_Data15	Tx power (auto) high/lo setting status	H L
Tx_Data16	Tx status 8 bit EOR checksum (of 2-15 inc. only	

Reverted Drive Data Block (15 extra bytes reverted in response to **# ? Z** sequence)		
Title	Status	Possible Values (ASCII)
Dri_Data1	Drive data status request byte	third byte echo fixed at Z
Dri_Data2	Drive C/O auto/man status	T Y
Dri_Data3	Drive on A/B status	A B
Dri_Data4	Drive preferred A/B status	A B
Dri_Data5	Drive active/passive status	P U
Dri_Data6	Drive A slow status	N F
Dri_Data7	Drive A fast status	N F
Dri_Data8	Drive B slow status	N F
Dri_Data9	Drive B fast status	N F
Dri_Data10	Drive A pass/fail	N F
Dri_Data11	Drive B pass/fail	N F
Dri_Data12	Drive C/O count	0 1 2 3 4
Dri_Data13	Tx external mute status	M S
Dri_Data14	Tx external high/low status	H L
Dri_Data15	Tx external interlock status	M S
Dri_Data16	Drive status 8 bit EOR checksum (of 2-15 inc. only	

Reverted Output Data Block (15 extra bytes reverted in response to **# ? 0** sequence)		
Title	Status	Possible Values (ASCII)
Op_Data1	Output data status request byte	third byte echo fixed at ASCII 0
Op_Data2	Output Forward Power Level MSB (kW)	X or + (plus) - (minus) . (decimal point) Null (blank) 0 to 9 (inc)
Op_Data3	Output Forward Power Level MSB-1 (kW)	
Op_Data4	Output Forward Power Level LSB+1 (kW)	
Op_Data5	Output Forward Power Level LSB (kW)	
Op_Data6	Output Reverse Power Level MSB (W)	
Op_Data7	Output Reverse Power Level MSB-1 (W)	
Op_Data8	Output Reverse Power Level LSB (W)	
Op_Data9	Output Temperature Level MSB (deg.C)	
Op_Data10	Output Temperature Level MSB-1 (deg.C)	
Op_Data11	Output Temperature Level LSB (deg.C)	
Op_Data12	Output OS number MSB	
Op_Data13	Output OS number MSB-1	
Op_Data14	Output OS number LSB	
Op_Data15	Output Tx Type	0 (500W) 1-6 (1kW-6kW) 7 (5kW S7605C) 8-9 (10kW-9kW) : (10kW)
Op_Data16	Output data 8 bit EOR checksum (of 2-15 inc. only)	

Reverted Amplifier Data Block (15 extra bytes reverted in response to **# ? 1** to **# ? X** sequences)		
Title	Function	Possible Values (ASCII)
Amp_Data1	Amp number 1-40	third byte echo of ASCII 1-9 : ; < = >? @ A-X
Amp_Data2	Amp Forward Power Level MSB (W)	X or < (less than) + (plus) - (minus) . (decimal point) Null (blank), 0 t0 9 (inc.)
Amp_Data3	Amp Forward Power Level MSB-1 (W)	
Amp_Data4	Amp Forward Power Level LSB (W)	
Amp_Data5	Amp Current Level MSB (Amps)	
Amp_Data6	Amp Current Level MSB-1 (Amps)	
Amp_Data7	Amp Current Level LSB+1 (Amps)	
Amp_Data8	Amp Current Level LSB (Amps)	
Amp_Data9	Amp Temperature Level MSB (deg.C)	
Amp_Data10	Amp Temperature Level MSB-1 (deg.C)	
Amp_Data11	Amp Temperature Level LSB (deg.C)	
Amp_Data12	Amp Forward Power status	N F X
Amp_Data13	Amp Current status	N H X
Amp_Data14	Amp Temperature status	N H X
Amp_Data15	Amp Reverse Power status	N H X
Amp_Data16	Amp data 8 bit EOR checksum (of 2-15 inc. only)	

SECTION THREE : OPERATION

Once installed and set up as described in Section Two, manual operation is limited to the switch on the E2026 Drive C/O /Output Monitor Unit. Various forms of automatic control can be provided using the E2023 Control Unit. This unit also provides comprehensive monitoring of power, current and temperature levels etc. as well as being the 'gateway' for various extended and remote control and monitoring options.

NOTE that the Transmitter must not be operated for long periods without the external cooling fans in operation.

3.1 CONTROLS AND DISPLAYS

The controls and displays available for each module or unit and their functions are as follows :

3.1.1 E2021 Amplifier Module

Marked	Type	Function
LOCK	Opto Switch	To mute/demute and mechanically retain the module. Down position to demute and secure module. Up position to mute and enable module's removal.
FWD	LED Display	Red indicates forward power fail (module output power more than approximately 6dB below that required). Amber indicates forward power muted. Green indicates normal operation.
REV	LED Display	Red indicates reverse power to module in excess of approximately 30W (i.e. 10dB return loss relative to maximum module output). Green indicates normal operation.
TEMP	LED Display	Red indicates module heatsink temperature greater than approximately 85 deg.C. Green indicates normal operation
CURRENT	LED Display	Red indicates module current (to Amplifier Pallet) in excess of approximately 11A. Green indicates normal operation.
CPU	LED Display	Red indicates module CPU (microcontroller) failure, other LED displays will automatically be turned off. Green indicates normal CPU operation.

3.1.2 E2088 Power Supply Module

Marked	Type	Function
DC	LED Display	Green indicates that the supply output is above approximately 40V dc
DC	LED Display	Red indicates that the supply output is below approximately 40V dc
AC	LED Display	Green indicates that the input is above approximately 85V rms ac.

3.1.3 E2023 Transmitter Controller Unit

Marked	Type	Function
SYSTEM NORMAL	LED Display	Red indicates one or more system conditions are abnormal (and should be cleared). Green indicates all significant system conditions are normal. Amber indicates 'Power-on-Reset' period
CONTRAST	Adjustable Pot. (1T)	To set the contrast of Controller's liquid crystal display (LCD) for best contrast in the prevailing viewing and ambient temperature conditions.
MAIN	Membrane Switch	To directly select the main LCD screen showing the Transmitter's output forward power, reverse power state and combiner heatsink temperature.
MODE	Membrane Switch	To select other Controller functions ('modes') such as Amplifier module monitoring.
∧	Membrane Switch	To step upwards through choices offered in the mode selected.
∨	Membrane Switch	To step downwards through choices offered in the mode selected.
Unmarked 'Soft' keys	Membrane Switches	To select various choices offered in the mode selected.
Unmarked Display	20 Character by 4 line LCD (back illum-inated by LEDs)	Indicates present mode (middle of top line) with status, input parameters etc. and next key operation choices below.

Note an internal sounder indicates correct membrane switch key operation by a single beep or an invalid key input by a short series of beeps.

3.1.4 E2026 Drive Changeover/Output Monitor Unit

Marked	Type	Function
DRIVE A B	LED Displays	Green LED indicates which Exciter/Drive is connected to the Transmitter input. The other LED remains off.
AUTO, SELECT A B	Not Fitted	Operation Fixed in Automatic mode.
INTERLOCK, EXT MUTE	LED Display	Red indicates the safety interlock connector at the rear of the unit is open-circuit (i.e. link broken). Green indicates normal operation.
AUTO, MUTE and START	Lockable Toggle Switch (3 Way)	To manually mute or start (demute) the Transmitter or (in AUTO) to enable this, and LOW POWER selection, to be done directly by the E2023 Auto Controller
HIGH POWER	LED Display and Adjustable Pot. (20T)	Green LED indicates high power output setting selected and adjacent pot. can be used to directly set output power level. The LOW POWER LED will be off.
LOW POWER	LED Display and Adjustable Pot. (20T)	Green LED indicates low power output setting selected and adjacent pot. can be used to directly set output power level. The HIGH POWER LED will be off.
TEMP	LED Display	Red indicates combiner heatsink temperature greater than approximately 100 deg.C. Green indicates normal operation.
REV	LED Display	Red indicates reverse power to Transmitter in excess of approximately 200W (i.e. 16dB return loss relative to maximum Transmitter output of 10kW). Green indicates normal operation.
FWD	LED Display	Red indicates forward power fail with output power more than approximately 10dB below that required. Green indicates normal operation.
FANS	LED Display	Red indicates a cooling system fault (if sensor(s) connected) Green indicates normal fan operation.
CPU	LED Display	Red indicates unit CPU (microcontroller) failure, other LED displays will automatically be turned off (except HIGH and LOW POWER, INTERLOCK and DRIVE A/B). Green indicates normal CPU operation.

3.1.5 Supply Disconnector

Marked	Type	Function
'O' and 'I'	Switch (4 pole)	To switch all incoming mains supply on ('I') or off ('O'). For extra safety whist working on the Transmitter or its' antenna or load, this switch may be padlocked in the off position.

3.2 MANUAL CONTROL

Simple manual control of the Transmitter can be performed using the three way lockable toggle switch on the front of the E2026 Drive Changeover/Output Monitor unit.

The AUTO – MUTE – START switch can be used to manually mute or start (demute) the Transmitter.

The AUTO – SELECT A – SELECT B switch is not fitted, operation is fixed in Automatic mode.

Note that, to maximise the operating life of the changeover relays within the E2026 Drive Changeover/Output Monitor Unit, the AUTO – SELECT A – SELECT B switch is not fitted. Instead, Drive control is fixed in AUTO mode where, selecting Drive A or B from the E2023 front panel or remotely will automatically mute the Drives during the changeover period

The E2023 Controller can be removed without disabling Transmitter local operation (although no display of actual output power will be present). In this situation, individual modules and units will still display their own status on red/green LEDs.

3.3 MANUAL MONITORING

The E2023 Control Unit is primarily used to monitor the Transmitter's final output power etc. and to monitor the state of each individual E2021 Amplifier Module. Other functions are available which mainly relate to the automatic control optional features.

To display the Transmitter's final output forward and reflected powers, press [MAIN] on the E2023 Auto Controller front panel. No matter what state the Controller is in, pressing this key will always display the final output power. A short beep from the internal sounder indicates a valid key press. In this state, the E2023 will monitor the output power (via the E2026 Drive Changeover/Output Monitor Unit) several times per second. It also polls through the E2021 Amplifier Modules to internally record their power, temperature and current status. A complete poll of all E2021s takes approximately three to four seconds.

To display individual E2021 statuses, press [MODE] then the soft key on the horizontal row beneath 'Amps' on the LCD display. A short beep from the internal sounder indicates each time a valid key is pressed (if a non-valid key is pressed then several short beeps are sounded together). An individual E2021 status can be displayed by pressing the [∧] or [∨] keys on the left hand side of the LCD display to select that E2021's number. The E2021s are numbered left to right, bottom to top. Thus they start at number '1' on the left hand of the bottom row and end at number '32' at the right of the top row. When an individual E2021 is being monitored in this way, the output power continues to be monitored but not displayed. To display the output power again, just press [MAIN] as previously described. **NOTE that when Amplifier Module status is being interrogated via remote monitoring, the E2023 mode must be left in 'MAIN' to ensure that the Modules continue to be polled and their latest status recorded (section 2.4.3).**

If the forward power status (via the E2026 Drive Changeover/Output Monitor Unit) or the status of an individual E2021 Amplifier cannot be read by the E2023 over the internal RS485 buses, the LCD display will show 'Status not present' in place of the expected readings. This will happen if an Amplifier is not present or if a fault exists in the monitoring circuitry.

In all modes, if the Transmitter is muted by the front panel switch on the E2026 Drive Changeover/Output Monitor Unit, the amber 'FWD' led of the E2021 being monitored will flicker.

If any overall 'System Normal' status has failed, the front panel SYSTEM NORMAL led will change from green to red. To display individual overall 'System Normal' statuses, press [MODE] then the soft key on the horizontal row beneath 'System' on the LCD display. An individual status can then be monitored by pressing the [∧] or [∨] keys on the left hand side of the LCD display. To display the output power again, press [MAIN] as previously described.

3.4 AUTOMATIC CONTROL

The E2023 Control Unit also enables various forms of automatic control such as dual Exciter/Drive changeover, muted/reduced power operation etc. or any normal combination of them.

For muted/reduced power operation, the AUTO – MUTE – START switch must be set to AUTO.

3.4.1 Exciter/Drive Control and Monitoring

When dual Exciter/Drives are connected to the E2023, to enable monitoring and set-up, press [MODE] then the soft key on the horizontal row beneath 'Drives' on the LCD display. (note that a single Exciter/Drive can also be monitored or controlled in this way).

The LCD display will then indicate which Exciter/Drive is selected and will indicate whether it is 'normal' or 'fail'. If the other Exciter/Drive is passive (i.e. in a muted state) the display will show '????' By pressing the soft key beneath 'Act/Pas' the non-selected Exciter/Drive can be toggled between muted (passive) or demuted (active). This choice can also be made using remote control.

The top row of the display shows the number of automatic changeovers (0 to 4) since it was last reset. Exciter/Drive A or B can be preferred or forced by using the soft keys, the rear panel inputs or remote control.

Any such control action resets the automatic changeover counter to zero, the '0' flashing for approximately 30 seconds to indicate that no actual changeover can take place during this 'settling' period. An automatic changeover can then occur if the selected Exciter/Drive fails (by either a continuous 'fast' status failure for 2 seconds or a continuous 'slow' status failure for 10 seconds). If the non-selected Exciter/Drive is 'passive' the changeover will always take place. If the non-selected Exciter/drive is 'active' the changeover will only occur if it is registered as not failed. A changeover will increment the counter, the new displayed number again flashing for approximately 30 seconds to indicate that no further changeover can take place during this new 'settling' period. If the originally selected Exciter/Drive then becomes 'good' again (by both 'fast' status and 'slow' status being continuously 'good' for 2 seconds) it will not be automatically re-selected unless the newly selected drive itself fails. Note that the drives are briefly, automatically muted during the changeover sequence.

Changeovers can occur up to 4 times, after which any further changes are prohibited until the counter is automatically reset to zero after a period of about one hour after the final changeover (or sooner by manual local or remote intervention).

To display the output power again, press [MAIN] as previously described.

3.4.2 Muting and Reduced Power Operation

When muting or reduced power control is required, to enable monitoring and set-up, press [MODE] then the soft key on the horizontal row beneath 'Power' on the LCD display.

The LCD display will then indicate the various muting and high/low power settings available (automatic local/ remote, manual and external). The four soft keys below the LCD display allow local selection of the MUTE/START and HIGH/LOW (power) settings used when AUTO control is selected. These settings can also be made using remote control. To allow the system to settle, any such control action also resets the automatic Exciter/Drive changeover counter to zero and prevents any changeover for a period of 30 seconds (see section 3.4.1).

When the E2026 AUTO – MUTE – START switch is set to MUTE or START (i.e. manual control), the display shows the actual switch setting and the manual setting of high/low power ('Manual='). The latter can only be done by an internal link (i.e. this setting of high/low power cannot be done from the front panel). In this mode, the switch mute/start selection can only be over-ridden by the safety interlock opening and muting the Transmitter directly (the first part of the display then showing 'Manual=I-Lock'). The automatic settings are displayed as 'Auto=' and can be set as described in the previous paragraph.

When the E2026 AUTO – MUTE – START switch is set to AUTO, the display shows the automatic settings in operation. As before, the mute/start selection can be over-ridden by the safety interlock opening and muting the Transmitter directly (the first part of the display then showing 'I-Lock'). However, auto operation also allows the internal auto mute/start setting to be over-ridden by the rear panel 'Mute Transmitter Input' (see section 2.2.8) the first part of the display then showing '(ext)Mute'.

The order of priority is thus 'I-Lock' then '(ext)Mute' then 'Start/Mute' as selected internally. When 'I-Lock' or '(ext)Mute' are operative, the START/MUTE soft-keys are disabled, being shown as '(x)', though this selection can still be made using remote control.

Similarly with the E2026 AUTO – MUTE – START switch set to AUTO, the internal high/low power setting can be over-ridden by the rear panel 'Select Low Power Input' (see section 2.2.8) the second part of the display showing 'Low(ext)'. The order of priority is thus 'Low(ext)' then 'High/Low' as selected internally. When 'Low(ext)' is operative, the HIGH/LOW soft-keys are disabled, being shown as '(x)', though this selection can again still be made using remote control.

It should be noted that auto mode has to be selected by the E2026 AUTO – MUTE – START switch to enable low power to be selected remotely or via the front panel. The only manual mode provision for selecting low power is via an internal link, which then over-rides all other auto settings that might be made.

To display the output power again, press [MAIN] as previously described.

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