



**STA1000 Series
Antenna Mount Amplifier
Product Range**

Operation Manual

© 2004 e2v technologies limited

This work must not be copied in whole or in part without the prior written permission of e2v technologies limited.

This Operation Manual covers the following amplifier type numbers: **STA1140, STA1240, STA1340 and STA1427 Series (including all derivatives).**

SAFETY NOTES

The following warnings and precautions are for your safety and the prevention of injury. Please read them carefully and observe at all times when installing or operating a Stellar Travelling Wave Tube Amplifier. Hazard warning signs, as defined in BS5378 Safety Signs and Colours, are used on the equipment to highlight any possible hazards.



Earthing

The mains supply connection cable to the amplifier must include an electrical safety protective earth conductor correctly installed and connected to the local distribution system earthing point in conformance with local regulations. The electrical safety protective earth conductor must be capable of carrying 15 A and must be from an approved manufacturer (1.5 mm²/14 AWG).

An external protective earth, also providing protection against RF and transient currents, must be connected between the amplifier and an adjacent earth point before applying the mains supply and should only be removed after disconnecting the amplifier from the supply. The external protective earth conductor must be a flat copper strap, braided or plain, and must be capable of carrying 30 A. The length of external protective earth conductor must not exceed 400 mm.



Mains Supply

A mains supply disconnection device must be provided to isolate this amplifier from the mains supply source. Either a plug/socket outlet or a two-pole isolation switch must be used as the mains supply disconnection device, and it must be easily accessible. The connector on the amplifier is NOT suitable, and must not be used to disconnect the amplifier when powered.



Toxic Material

The Travelling Wave Tube (TWT) within the amplifier contains beryllium oxide. Dust created by breakage, or fumes from a beryllium oxide fire, are highly toxic if inhaled, or if particles enter the body via a cut or abrasion.

Consult e2v technologies and the appropriate national authorities for details regarding the disposal of damaged or old TWTs and amplifiers.



High Voltage

High voltages in excess of 9.2 kV are present within the amplifier. However, the equipment is designed so that personnel cannot come into contact with high voltage circuits unless the covers are removed.

Access inside the amplifier is restricted to suitably skilled engineers.



RF Radiation

Exposure of the human body to microwave radiation can constitute a hazard (ANSI/IEEE C95-1-1992). Personnel must be protected from microwave energy produced by the TWT.

All RF connectors must be correctly fitted before operation, so that there is no leakage of RF energy. The amplifier must not be operated unless the RF output connection is correctly terminated. It is particularly hazardous to look into open waveguides, coaxial feeders, or transmitter antennae when the amplifier is operating.



Input Drive

Damage to the amplifier may occur if the RF input drive level or the input frequency are outside the limits given in the specification for the model (see section 1.1).

Environmental

- Do not block, or poke objects through, the amplifier ventilation slots.
- Do not spray aerosol cleaners directly on to the amplifier surfaces when cleaning.
- Do not operate the amplifier on an unstable or unsafe surface.
- Ensure that all cables cannot be walked on, tripped over or damaged by furniture or movable equipment.
- Do not place objects inside the waveguide.
- Ensure exhaust air is not recirculated.

STANDARDS COMPLIANCE

Stellar amplifiers comply with the following requirements. Further details may be provided if necessary.

- EEC Directive 89/336/EEC Electromagnetic compatibility.
- EEC Directive 73/23/EEC Low voltage directive.

e2v technologies' quality management system is certificated to the requirements of ISO9001:2000.

CUSTOMER CARE

Stellar 24-Hour Hotline

In the event of a Stellar product operational problem or urgent application enquiry:

1. Complete a Product Service Report Form before calling the Hotline. A copy can be found at the back of this manual.
2. Contact the Stellar Hotline on **+44 (0)1245 355398**, where your enquiry will be dealt with.

Return Procedure

In the event of a Stellar product requiring return to e2v technologies:

1. Have as many of the following details as possible to hand before contacting e2v technologies. This will help us to respond promptly to your request.
 - Type number (found on the panel adjacent to the RF output).
 - Serial number (found on the panel adjacent to the RF output).
 - Has the product been damaged?
 - Description of any operational fault or problem.
 - Return address.
2. The Customer Service Team will issue you a Reference Number for the return.
3. Complete a Product Service Report Form (a copy can be found at the back of this manual), noting in particular any unusual occurrences before or at the time of failure. The form must be returned with the product.
4. If the original packaging is in good condition, use it to return the product. If the original packaging is damaged, e2v technologies can supply suitable replacement packaging for a small charge.
5. Clearly mark the outer packaging with the following information:
 - Reference number.
 - Type number.
 - Serial number.
 - Return address.

For further details, refer to the e2v technologies Standard Conditions of Warranty, a copy of which can be found at the back of this manual.

CONTENTS

SAFETY NOTES	2
STANDARDS COMPLIANCE	3
CUSTOMER CARE	4
Stellar 24-Hour Hotline	4
Return Procedure	4
CONTENTS	5
1 THANK YOU FOR BUYING STELLAR	6
1.1 Range of Options	6
2 CARE OF YOUR AMPLIFIER	7
2.1 Storage	7
2.2 Handling	7
2.3 Unpacking	7
2.4 Cleaning	7
2.5 Maintenance	7
3 INSTALLATION CONSIDERATIONS	8
3.1 Mounting	8
3.2 RF Connections	9
3.3 Cooling Considerations	10
3.4 Mains Supply Connection	12
3.5 User Interface Connections	14
3.6 Redundant Switch Configuration	14
4 BASIC OPERATION OF THE AMPLIFIER	16
4.1 Applying The Mains Supply	16
4.2 Mains Supply Interruptions	16
4.3 Functions	16
4.4 Upconverter Operation	17
4.5 RF Sample Port	18
5 USER INTERFACES	19
5.1 Pin Identification	19
5.2 User Interface Features	20
6 RS-485 SERIAL BUS	26
6.1 General Description and Features	26
6.2 Protocol	31
6.3 Summary Of Command Messages	33
6.4 Examples Of Command And Response Messages	34
6.5 Application Notes	38
7 RELATED DOCUMENTS	39
APPENDIX A	40
APPENDIX B	41
APPENDIX C	42
APPENDIX D	43
APPENDIX E	44

1 THANK YOU FOR BUYING STELLAR

Thank you for buying a Stellar TWTA. This e2v technologies antenna mount amplifier range provides RF power outputs up to 400 W and operates in the C, X, Ku and DBS bands. The amplifier is:

- Compact
- Lightweight
- Portable – can run off a wide range of mains input voltages and frequencies
- Designed for high reliability.

Before using your new amplifier, we recommend that you spend a little time to read this manual to familiarise yourself with its operation and features.

If you have any further questions, or recommendations about this manual, please contact your distributor.

In addition to this manual your amplifier should be supplied with:

- a mains connector and cable (pre-wired),
- a control connector plug,
- test results,
- air cowls (2 off),
- waveguide screws: 8 off 10-32 UNF-2B (for C- and X-band), 4 off 6-32 UNC-2B (for Ku- and DBS band).

1.1 Range of Options

The STA1000 series of antenna mount amplifiers includes the following RF system options (see figure 1):

- Low gain (no solid-state pre-amplifier).
- Integral solid-state pre-amplifier (fixed gain).
- Integral solid-state pre-amplifier (digitally variable gain) using serial bus.
- Integral lineariser.
- Internal L-band block upconverter.
- Breakout link (for use with internal upconverter).
- Four main frequency bands.
- Three sub-bands in Ku-band and two in C-band.

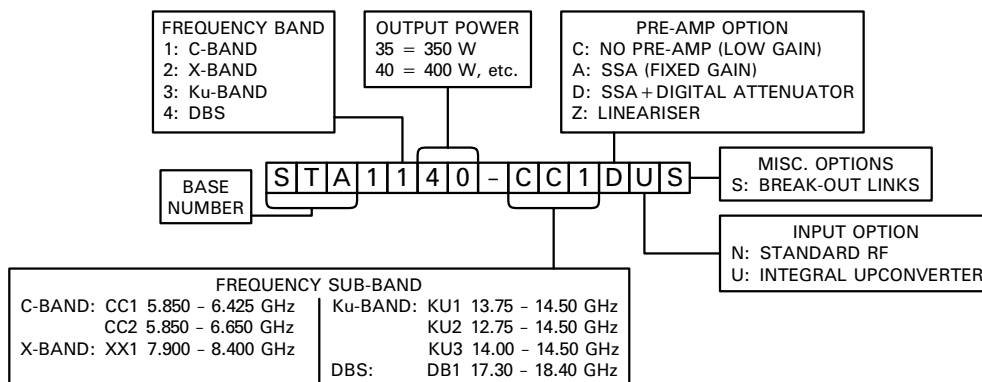


Figure 1 Example type number showing options available

2 CARE OF YOUR AMPLIFIER

2.1 Storage

- Store the amplifier in its normal horizontal orientation.
- Storage temperature is from -40 to $+80$ °C.
- Do not use amplifier boxes to support the weight of any other item.
- Retain the amplifier boxes for future use.
- Avoid severe shocks.

2.2 Handling

The amplifier nominally weighs 25 kg, so care must be taken when attempting to lift or carry it.

2.3 Unpacking

Only install and use the amplifier within the specified environmental limits.

2.4 Cleaning

The amplifier is designed to be used in harsh environments, without additional protective covers.

The internal forced air cooling system relies on the internal and external airways being free from blockages. The cooling air enters and exits the unit through slotted panels, which are designed to prevent large items of foreign matter from entering and potentially blocking the internal airways. A maintenance plan should be developed to check and clean the amplifier slotted panels regularly. The frequency of cleaning will be dependent upon the installation and the environment. The maintenance plan should be regularly reviewed and modified according to changes in the environment (this can be seasonal, e.g. airborne seed pods can cause regular blockages at certain times of the year).

The advanced packaging and cooling techniques (Stellar Cool™, patent pending) enable the unit to operate in extreme environmental conditions, from direct rain to direct sunlight.

When cleaning, do not use detergents or other cleaners without consulting e2v technologies. The amplifier must be disconnected from the mains supply before cleaning.

2.5 Maintenance

Airways should be checked regularly for blockages (see section 2.4).

Desiccant should be replaced every 3 to 5 years, depending upon environmental conditions. The typical life of desiccant is 5 years in sub-tropical conditions, assuming that the seal on the lid has not been disturbed.

Check the mains cable for damage.

3 INSTALLATION CONSIDERATIONS

3.1 Mounting

The amplifier can be:

- used free standing;
- mounted in a flight case;
- mounted on the roof of a vehicle;
- mounted to an antenna system.

The amplifier has six M6 mounting points (three each side), 9 mm maximum depth, that can be used to mount the amplifier solidly to the chosen platform (see figure 2). Suitable load spreading washers, locking nuts and/or locking washers should be used to prevent the amplifier from working loose under vibration and shock conditions that each installation may impose. This is especially important for mobile applications.

Where possible, the amplifier should be positioned to avoid the direct entry of rain water into the ventilation slots. The amplifier is provided as standard with two air cowls, the normal orientation of which are pointing towards the base of the unit, to avoid the direct entry of driving rain.

Note: There is a drainage hole in the cover to prevent the build-up of water if the amplifier is inadvertently mounted or left upside-down.

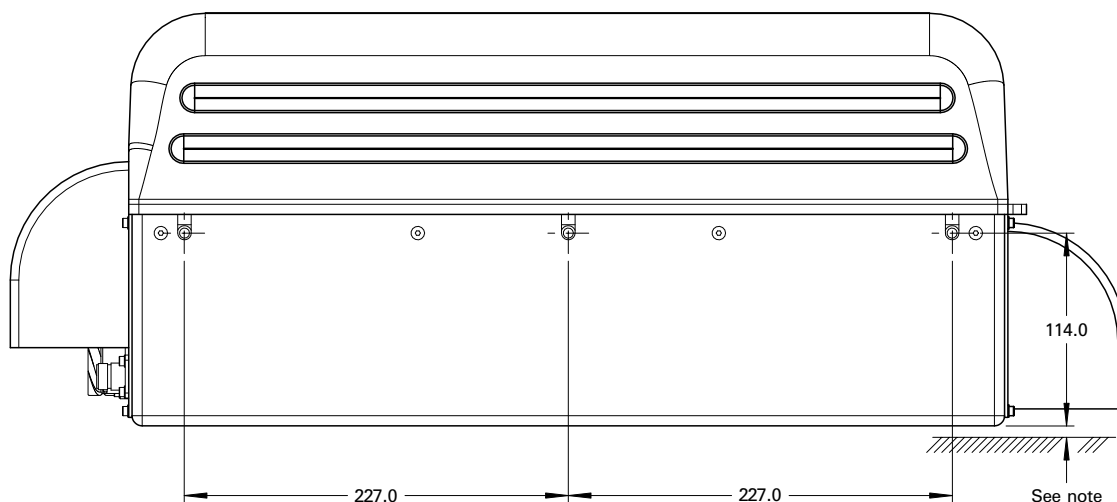


Figure 2 Key mounting dimensions (all dimensions in millimetres)

Note:

Without air cowls fitted, the minimum mounting distance from a flat surface is 5 mm. When air cowls are fitted, the minimum unobstructed distance is 42 mm.

The amplifier should be mounted with clearance from any adjacent equipment/surface (nominally 3 mm). This is to avoid mechanical interference due to tolerances on equipment parts and/or movement under operational vibration.

If the amplifier is to be fitted against a flat surface, a flexible gasket material should be used to minimise excessive noise in mobile applications.

If the amplifier is to be installed where a secondary rain cover is used, the air cowls may be removed.

When designing the installation, a space at the end should be allowed for the disconnection and the bend radius of connection cables (see figure 3).

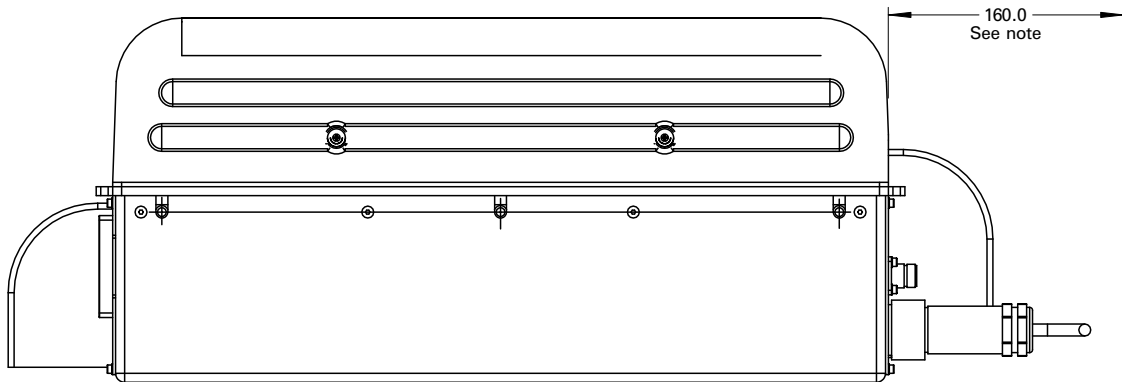


Figure 3 Interface connector and cable space allowance.

Note:

This dimension to be unobstructed for mating/unmating of cables.

3.2 RF Connections

RF input and output connections are made via waveguide connectors on opposite ends of the amplifier.

- **C-Band** Waveguide type WG14 should be used. The RF output is CPR 137F, with eight tapped holes 10-32 UNF-2B requiring eight bolts (10-32 UNF-2B, maximum internal thread depth 8 mm). The amplifier is provided with sufficient bolts for this flange.
- **X-Band** Waveguide type WG15 should be used. The RF output is CPR 112G, with eight tapped holes 10-32 UNF-2B requiring eight bolts. The amplifier is provided with sufficient bolts for this flange.
- **Ku-Band** Waveguide type WG17 or WG75 may be used. The RF output is UBR 120, with four tapped holes 6-32 UNC requiring four bolts (6-32 UNF-2B, maximum internal thread depth 8 mm). The amplifier is provided with sufficient bolts for this flange.
- **DBS-Band** Waveguide type WG18 should be used. The amplifier is provided with sufficient bolts for this flange.

RF input signals applied must be within the frequency range specified for the particular amplifier type (see figure 1). The maximum RF input drive level should not exceed +10 dBm for pre-amplifier option C and -10 dBm for pre-amplifier options A, D or Z.

If the amplifier is to be used in applications where it is exposed to rain or subjected to condensation, all attempts should be made to prevent moisture ingress into the waveguide system. It is recommended that all external waveguide joints are made using flanges fitted with 'O' rings to prevent moisture ingress.

3.3 Cooling Considerations

Temperature affects the life and reliability of high power electronic devices. As the temperature of the device increases, generally reliability and life expectancy decrease; TWTAs are no exception. Please follow the cooling considerations for your amplifier to ensure many trouble-free years of use.

e2v technologies engineers have many years of experience, working with customers to integrate equipment successfully and to ensure that long and reliable product lives are achieved. The information contained within this section has been gained from both field experience and theoretical cooling system design knowledge. As most installations differ, the advice given is only general. Any specific aspects of installation design can be discussed further by contacting, or faxing, the Stellar Product Support Team at e2v technologies.

3.3.1 Some Cooling Facts and Figures

Minimum air flow	42 litre/s (90 feet ³ /minute)
Minimum duct area	70 cm ² (11 inch ²)
Typical internal power dissipation (no RF drive):	
C- or X-band	1100 W
Ku- or DBS-band	1000 W

The amplifier utilises an efficient, integral, forced-air cooling system and is equipped with two thermal sensors to protect it in the event of an over-temperature condition. The cooling fans are continuously variable speed so, when the amplifier is operating normally, the cooling fan will vary in speed to maintain adequate cooling to the TWT collector.

When the temperature of either thermal sensor exceeds preset levels, the amplifier is automatically removed from the XMIT mode and placed into the STBY mode. In the STBY mode the dissipation within the amplifier is greatly reduced and if the airflow is normal, the amplifier will rapidly cool. At this stage, the installation cooling system should be visually inspected for blockages and cleaned as necessary. When normal airflow is confirmed, the amplifier can be taken back into the XMIT mode.

The amplifier is automatically placed in the OFF mode if the over-temperature condition exists for more than 4 minutes. The mains supply should be removed and the amplifier isolated before a full inspection is made of the installation cooling system. The amplifier should be left for 20 minutes before any attempt is made to restart.

Following an over-temperature condition, the TWT COLLECTOR TOO HOT or CASE TOO HOT fault conditions are set; these can be monitored via the user interface or accessed through the serial communications port (see sections 5 and 6).

When deciding on the location of the amplifier the following points should be observed:

- It is important not to obstruct the air inlet or the air exhaust
- In any system, prevent hot exhaust air from recirculating to the inlet, otherwise the inlet air temperature will increase, resulting in potential thermal runaway. This is a prime consideration when designing common ducting systems for multiple amplifiers.
- In any other instance, if there is significant additional obstruction to the air flow, then it may be necessary to provide externally forced/cooled air to the amplifier.

3.3.2 Ducting Considerations

The amplifier is provided as standard with two air cowls, the normal orientation of which is pointing towards the base of the amplifier (see section 3.1). The cowls can be turned through 180° for alternative amplifier mounting configurations. These cowls are designed to avoid driving rain entering the unit if a secondary cover is not used.

Any ducting connected to the inlet or exhaust will create additional back pressure, reduce the airflow and increase the internal temperature of the amplifier; this should be avoided. If minimal ducting is essential for the application:

- Keep ducting lengths to a minimum; check the amplifier maximum operating temperature derating for the length of duct required.
- Route ducting directly; avoid sharp bends and ensure that the minimum bend radius is three times the ducting diameter.
- Use the largest cross-sectional area of ducting possible.
- Use smooth walled ducting; avoid corrugated ducting as it is more restrictive to airflow.
- Transitions in ducting sizes should be smooth; avoid step changes.
- Do not use ducting adaptors that reduce the internal cross-sectional area of the ducting.

If the installation dictates restrictive duct systems, install additional external fans to provide adequate airflow and counteract the effects of ducting. Additional fans should be installed on the air input to the amplifier, where the air is at its coolest.

3.3.3 Equipment Housings

All equipment housings, including basic flight cases, roof mount enclosures, cabins and air conditioned rooms, have common cooling system design requirements:

- Maintain an adequate supply of air to the inlet; a 70 cm² (11 inch²) unimpeded aperture should be provided into any enclosure for each Stellar amplifier.
- The local source and destination of cooling air should ideally be common, to avoid back pressure caused by differential pressure effects.
- Housings that are exposed to environmental wind effects should use a common face for inlet and exhaust vents, to avoid back pressure caused by differential wind effects.
- Terminations of inlet and exhaust vents should be of a design that prevents direct environmental wind effects, whilst avoiding creating additional restriction to airflow.

- If a sealed cooling system, with recirculating air conditioners, is used, an over temperature alarm should be fitted to the cabin to detect air conditioner failures.
- In any system, prevent hot exhaust air from recirculating to the air inlet, otherwise the inlet air temperature will increase, resulting in potential thermal runaway. This is a prime consideration when designing common ducting systems for multiple amplifiers.

3.3.4 Commissioning the Installation

When commissioning the installation, the temperature difference across each amplifier should be checked to assess the suitability of the cooling system. Temperature measurements should be taken as follows:

- Under the worst case operating conditions; with the amplifier in XMIT mode, with no RF drive applied (beam only), and after the amplifier has thermally stabilised (typically 2 hours after XMIT has been selected).
- As close to the amplifier inlet and exhaust cowls as possible (to reduce the effects of inaccuracies caused by radiation from duct walls).
- As an average across the cross-sectional area of the aperture/duct (to avoid inaccuracies caused by uneven temperature distribution).

3.4 Mains Supply Connection

The safety notes at the start of this manual should be read before connecting the amplifier to the mains supply.

The amplifier can be operated from mains supplies of 110 to 240 V ac without any user adjustments. Both the live and the neutral connections on the amplifier are fully rated and isolated for maximum line voltage, full transient and noise immunity.

The amplifier is supplied with one mains plug and a length of cable pre-fitted. Additional mains plugs are available from e2v technologies; please contact your distributor. The connector details are shown in figure 4. If the amplifier is to be used in applications where it is exposed to rain or subjected to condensation, all attempts must be made to prevent moisture entering the mains connector.

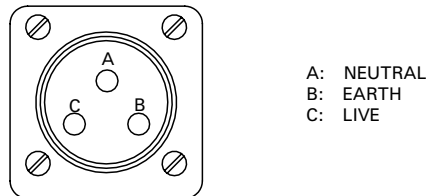


Figure 4 The mains connector pin identification

3.4.1 Mains Supply Cable Selection

The cable will be supplied (connector pre-fitted) with the amplifier. However, if a cable is required to be fitted by a third party, then the following applies:

Cable size and distribution protection must be determined by the user, and will depend on the mains supply voltage to be applied to the amplifier. In general, a cable capable of carrying 16 A (2.5 mm² conductor size) should be used.

It is important when using lower mains supply voltage sources of 110 V and 120 V nominal, to ensure that the required voltage is available at the input connector of the amplifier under conditions of maximum current demand.

It is also important to ensure that for any supply selected, the mains supply source no load to full load voltage drop is less than 10 V rms. On full load, the amplifier mains supply voltage must be greater than 99 V.

Under conditions of a low voltage power source with long power connection leads, this may require selecting a cable for low voltage drop and not just basing the selection on a nominal current rating (refer to local wiring regulations).

3.4.2 Earthing

The mains supply cable provided incorporates an electrical safety protective earth conductor that must be connected to the local system earthing point in conformance with local regulations.

An external protective earth, providing protection against RF and transient currents, must be connected between the amplifier and an adjacent earth point before applying the mains supply and should only be removed after disconnecting the amplifier from the supply. The connections must conform to local regulations. The external protective earth conductor must be a flat copper strap, braided or plain, and must be capable of carrying 30 A. The length of external protective earth conductor must not exceed 400 mm.

3.4.3 Mains Supply Distribution System

A mains supply disconnection device must be provided to isolate the amplifier from the mains supply source. Either a socket outlet or a two-pole isolation switch must be used as the mains supply disconnection device. It must be installed near the amplifier and be easily accessible. The mains connector must not be used as the mains supply disconnection device. It is provided for convenience during installation and for ease of operation.

It is strongly recommended that the mains supply for the amplifier is fed via a double pole Residual Current Circuit Breaker (RCCB). The amplifier earth leakage current is <6 mA rms under nominal operating conditions.

In some circumstances on low voltage 3-phase systems (e.g. 115 V line to neutral and 200 V line to line), it may be preferable to operate the amplifier bi-phase. In this case, the amplifier may be connected across any two lines of the 3-phase system to obtain what is effectively a 200 V single phase source. Under these circumstances the neutral of the 3-phase system is not connected to the amplifier. With smaller 3-phase generators, this may offer a method of partially balancing a number of lower power single phase loads.

If the amplifier is connected bi-phase, an external 2-pole protection device must be provided that disconnects both line connections in the event of a fault on either line.

This equipment has not been designed for connection to an IT power system.

The mains input surge current for this unit is dependent upon mains voltage. The following table shows the I^2t products during the 'power up' phase for 110/120 V and 220/240 V; it should be used to determine the rating of any current overload protection devices. The half cycle average surge current is less than the maximum running current of the unit, therefore typically a 15 A HRC fuse to BS 1362 is adequate for the over-current protection of each amplifier (this can be reduced to a 7 A HRC fuse to BS 1362 if the unit is to be used on high mains voltage supplies).

High Line Conditions (220/240 V nominal)

Time	I^2t
t_0 (switch on)	<2
$t_0 + 100$ ms	<10
$t_0 + 250$ ms	<1.4

Low Line Conditions (110/120 V nominal)

Time	I^2t
t_0 (switch on)	<0.6
$t_0 + 100$ ms	<7.0

3.5 User Interface Connections

Note: Refer to the appendices at the end of the manual for examples of wiring.

The amplifier is supplied with a user interface connector plug, but no cable. Additional connectors are available from e2v technologies; please contact your distributor.

If the amplifier is to be used in applications where it is exposed to rain or subjected to condensation, all attempts must be made to prevent moisture ingress into the connector and cable loom. The connector plug accepts cable diameters up to a maximum of 15 mm.

For use with cable diameters less than 15 mm the effective cable diameter should be increased to approximately 14 to 15 mm to allow an effective seal to be made when the connector is assembled. Self-amalgamating tape or layers of adhesive heat shrink cable are recommended. Connector back shells that accept adhesive heat shrink boots are available, please contact your distributor.

Fully screened cable should be used for interface requirements.

3.6 Redundant Switch Configuration

If two amplifiers are to be connected to a redundant switched system, the control circuitry within the amplifiers can be used to implement a cost-effective switch control solution. Figure 5 on the following page shows the wiring connections required to implement a basic redundant switched system using the N6143 as the controlling device. The N6143 control unit is connected to the serial interface of both amplifiers, allowing remote switching and monitoring of switch position and amplifier operation (for further details on the N6143, contact your distributor).

As the amplifiers do not have a master/slave relationship, the position of the waveguide switch is pre-selected by the user either manually, via the user interface or from the N6143 control unit. The low power alarms on both amplifiers are set if required, then both amplifiers are placed into the XMIT mode. The automatic mode enable (AUTO ENA) input is then selected, via the user interface or from the N6143 control unit, control of the switch is then passed to the amplifiers.

With both amplifiers operating 'normally' in the XMIT mode and giving > 1 W of RF output power, the waveguide switch will remain as set. Each amplifier monitors the status of the other amplifier for potential faults. If the amplifier routed to the antenna develops a fault condition, or its RF output power drops below the low power alarm

setting (1 W minimum low power alarm level), the other amplifier takes control, switching the waveguide switch. If the N6143 control unit is used, an audible alarm will activate indicating the fault condition to the operator.

The amplifiers will remain in the automatic mode as before. If the faulty amplifier does not recover, a fault on the second amplifier will not result in switching of the waveguide switch.

The waveguide switch coil should be a 24 V type and a tell back switch within the waveguide switch should be configured so that each amplifier knows if it is connected to the antenna.

Switching time is dependent upon the waveguide switch selected but will be typically 50 to 100 ms.

The interface between the control unit and the amplifiers is via the local serial communications bus. As the amplifiers do not contain a transmitter/receiver termination, the local serial communications bus should be fitted with $120\ \Omega$ terminating impedances. This should be done within the control connector backshell of the amplifier furthest from the N6143 control unit. $120\ \Omega \pm 1\%$, $\frac{1}{4}\text{ W}$ carbon film or similar resistors should be fitted between pin d (Rx+) and pin e (Rx-), also between pin b (Tx+) and pin c (Tx-) of the 41-pin amplifier control connector. Termination of the serial communications bus is dependent upon the length and type of cable used, and should follow normal transmission line practice.

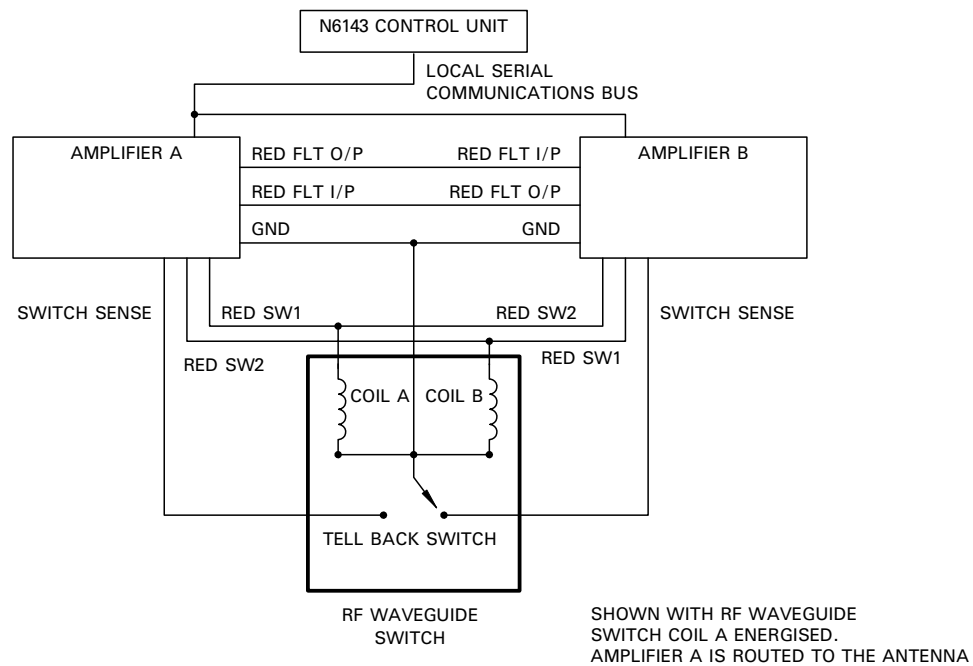


Figure 5 Redundant switch configuration

Notes

1. A wiring schematic diagram is given in the appendices for the connection of two amplifiers, the N6143 control unit and a waveguide switch.
2. If an AUTO ENA signal is not received by the amplifiers, the RED FLT O/P will not be enabled. Therefore, if an external controlling device other than the N6143 is used, this must be taken into account if the RED FLT O/P is to be used to trigger switch-over. Alternatively, the SUM FLT IND multiplexed fault lines or inverted XMIT IND outputs can be used as the trigger for switch-over.

4 BASIC OPERATION OF THE AMPLIFIER

4.1 Applying The Mains Supply

Before applying the mains supply to the amplifier, the operator must be satisfied that:

- both the RF input and RF output connections are correctly terminated (see section 3.2),
- safety and cooling requirements are complied with (see safety notes and section 3.3),
- the correct type of mains cable is in use (see section 3.4).

Once the above has been verified apply the mains supply to the amplifier. The fans will be heard to start.

It is good practice to allow the TWT to cool for three to four minutes after leaving the transmit mode, before disconnecting the amplifier from the mains supply.

4.2 Mains Supply Interruptions

It is common on some mains or local generator derived supplies, for the supply to be temporarily interrupted. This section details the behaviour of the amplifier under these conditions when it is transmitting.

Interrupt < 30 ms - the amplifier will continue to operate normally.

Interrupt > 30 ms < 3 seconds - a degradation of RF performance can be expected, the amplifier will leave the XMIT mode. When the mains supply returns, the amplifier will automatically re-enter the XMIT mode within 1 second. All operating parameters will be as previously set.

Interrupt > 3 seconds - a degradation of RF performance can be expected, the amplifier will leave the XMIT mode. When the mains supply returns, the amplifier will remain in the OFF mode until the user selects another mode of operation either manually or automatically.

4.3 Functions

This section describes the control functions available to the user.

4.3.1 Amplifier OFF mode

Applying prime power to the unit results in the amplifier entering the OFF mode until another mode is selected. In this mode, only the Amplifier control, auxiliary circuits and fans are operational, the cooling fan operating at maximum speed for the first 3 seconds of switch-on.

Following transmission, the OFF mode can be requested to remove the amplifier from the XMIT mode.

4.3.2 Amplifier WARMUP mode

Requesting either the STBY or XMIT mode from the OFF mode will result in the TWT cathode heater power being applied and the warmup timer (180 seconds) being initiated.

Note: If the ambient temperature is less than $-10\text{ }^{\circ}\text{C}$, the warmup timer period is 10 minutes.

During WARMUP, the STBY or XMIT modes can be requested, to select the mode that the amplifier will enter at the end of the warmup period.

4.3.3 Amplifier STBY (Standby) mode

In this mode, the TWT cathode is at its operating temperature and is ready to enter the XMIT mode. Power is applied only to the TWT cathode heater. Unless XMIT mode has been requested, the amplifier will enter STBY mode when the warmup is complete.

Following transmission, the STBY mode can be requested to remove the amplifier from the XMIT mode.

4.3.4 Amplifier XMIT (Transmit) mode

With the amplifier in the STBY mode, selecting the XMIT mode results in the application of helix and collector voltages to the TWT, allowing RF transmission. In the XMIT mode, the RF output power and TWT helix current monitor features are operational and the control of gain is possible using the (optional) Digital Electronically Variable Attenuator.

The cooling fans will alter speed (depending on internal temperature) to maintain adequate cooling to the TWT.

4.4 Upconverter Operation

Products in the C and Ku ranges with a U suffix in the type number (see figure 1) contain an integral L-band block upconverter. Inclusion of the BUC enables the input signal to be in the L-band range as defined in table 1 overleaf. The BUC may be synchronised with an external 10 MHz reference superimposed on the L-band input. Alternatively the unit contains its own stabilised 10 MHz that enables it to be used without an external 10 MHz. This feature is activated when the external 10 MHz locking signal is too low or not present. The BUC must be used in conjunction with either the D or Z input options.

AMPLIFIER	PARAMETER	UNITS	LIMITS		
			Min	Nom	Max
STA1140CC1xU	Output Frequency	GHz	5.85	-	6.425
STA1340KU1xU		GHz	13.75	-	14.5
STA1340KU3xU		GHz	14.0	-	14.5
STA1140CC1xU	Input Frequency	MHz	950	-	1525
STA1340KU1xU		MHz	950	-	1700
STA1340KU3xU		MHz	950	-	1450
STA1140CC1xU	Local Oscillator Frequency	GHz	-	4.9	-
STA1340KU1xU		GHz	-	12.8	-
STA1340KU3xU		GHz	-	13.05	-

Note: In the Amplifier column, x indicates either the D or Z input option.

Table 1 BUC Basic Parameters

4.5 RF Sample Port

Provided as an optional N-type (female) connector, mounted at the opposite end of the amplifier to the waveguide flange. It allows external monitoring of the output power, providing a signal approximately 50 dB lower than the RF output power. It is provided with calibration data across the amplifier's frequency range.

5 USER INTERFACES

The amplifier is provided with two interfaces that are used to control the amplifier: the user port and the serial communications interface (RS-485, 2- or 4-wire). All interfaces are available on the 41-pin control connector, located next to the mains supply connector. This section identifies each control connector pin and describes the function of each pin, including the electrical specification.

5.1 Pin Identification

Code	Function	User interface pin identification
OFF IND	off indicator output	A
WARMUP IND	warm-up indicator output	B
STBY IND	standby indicator output	C
XMIT IND	transmit indicator output	D
SUM FLT IND	summary fault indicator output	E
	spare	F
RF INHIB	RF inhibit control input	G
INV RF INHIB	inverted RF inhibit control input	H
OFF	off control input	J
STBY	standby control input	K
XMIT	transmit control input	L
MUX 4	multiplexed fault line 4 indicator output	M
FWD PW MON	forward power monitor analogue output	N
GND	ground	P
EXT INTLK	external interlock input	R
ADD 0	address select 0	S
ADD 1	address select 1	T
+ 15 V	+ 15 V output	U
ADD SEL	address select	V
CTRL O/R	control override select	W
MUX 0	multiplexed fault line 1 indicator output	X
MUX 1	multiplexed fault line 2 indicator output	Y
MUX 2	multiplexed fault line 3 indicator output	Z
MUX 3	multiplexed fault line 4 indicator output	a
RS TX +	serial interface Tx +	b
RS TX –	serial interface Tx –	c
RS RX +	serial interface Rx +	d

Code	Function	User interface pin identification
RS RX—	serial interface Rx—	e
HX I MON	helix current monitor analogue output	f
ADD 2	address select 2	g
ADD 3	address select 3	h
2/4 BUS SEL	2/4 wire serial bus select	i
	spare	j
RED FLT O/P	redundancy fault indicator output	k
RED SW 1	redundancy RF switch drive 1 - this HPA to antenna	m
RED SW 2	redundancy RF switch drive 2 - this HPA to load	n
RS GND	serial interface signal return	p
SWITCH SENSE	redundancy RF switch sense input	q
AUTO ENA	redundancy automatic mode enable input	r
RED SEL	redundancy select input	s
RED FLT I/P	redundancy fault input	t

5.2 User Interface Features

5.2.1 Indicator Outputs - Type 1

Normally open relay contact outputs switched to GND (pin P on the user interface connector) when condition is true.

Example 1 amplifier in the OFF mode is indicated by pin A on the user interface connector closing to pin 'P'.

Example 2 MUX 0 fault line is at binary 1 when pin X on the user interface connector closes to pin P.

OFF IND Indicates power is applied and that the unit is in the OFF mode.

WARMUP IND Indicates the TWT cathode three minute warm-up timer is operating and that the unit is in the WARMUP mode.

STBY IND Indicates the TWT Cathode warm-up is complete, the unit is in the STDBY (standby) mode and is ready to enter the XMIT mode.

XMIT IND Indicates the unit is in the XMIT (transmit) mode.

SUM FLT IND Indicates the unit has detected a fault condition.

MUX 0

MUX 1
MUX 2
MUX 3
MUX 4

Four binary coded discrete lines that indicate the fault conditions; the following list gives a breakdown of these fault conditions with a brief description of reset conditions.

Fault Code	Fault Type	Reset Code
MUX 43210		
00001	Peak helix over-current	A
00010	Mean helix over-current	A
00011	Reflected power	A
00100	PF correction	P
00101	DC bus supply	P
00110	HV overload	A
00111	External interlock	M
01000		
01001	Main cooling fans	P
01010	Stirrer fans	P
01011	TWT collector too hot	M
01100		
01101		
01110	Case too hot	M
10000		
10001	Heater voltage outside limits	M
10011	Collector voltage outside limits	M
10100	Cathode voltage outside limits	M

Reset Code Description

A (Automatic reset). Units that exhibit faults with this reset code will be immediately removed from the XMIT mode and placed into the STBY mode. The unit will automatically attempt to reset to the XMIT mode after 3 seconds; if this fails the unit will attempt a further two reset cycles. If after the three reset attempts the amplifier still exhibits the fault condition, the unit will remain in the STBY mode for 4 minutes before returning to the OFF mode, unless the fault clears and the XMIT mode is reselected.

M (Manual reset). Units that exhibit faults with this reset code will be immediately removed from the XMIT mode and placed into the STBY mode. The unit will remain in this mode for a period of 4 minutes before returning to the OFF mode, unless the fault clears and the XMIT mode is reselected.

P (Prime power reset). Units that exhibit faults with this reset code will be immediately removed from the XMIT mode and placed into the OFF mode. If the fault is seen to clear, the mains supply should be removed for nominally 10 seconds before reapplying to reset the trip.

5.2.2 Indicator Outputs - Type 2

Normally open relay contact outputs switched to GND (pin P on the user interface connector) when condition is false.

Example Unit is operating normally with no fault condition when pin k on the user interface connector is closed to pin P.

RED FLT O/P Part of the redundant switch control facility. Indicates that the unit has suffered a low power alarm or a fault condition that has resulted in removal from the XMIT mode. This output would normally be

connected to the RED FLT I/P (pin t on the user interface connector) of the other amplifier in the redundant switch system.

Note: Only active if an AUTO ENA input has been received by the amplifier.

5.2.3 Analogue Outputs

The following analogue outputs are provided to allow the user to implement a simple and cost effective monitoring system; these outputs are also available in digital form via the RS-422 or RS-485 serial communications interface (see section 6). These outputs are referenced to GND (pin P on the user interface connector).

It is recommended that a screened cable is utilised to avoid RFI effects.

FWD PW MON Provides a 0 to +10 V dc analogue output that corresponds to an RF output power range of 0 to 500 W. This output is a linear 50 W/V. Maximum output impedance 100 Ω

HX I MON Provides a 0 to +10 V dc analogue output that corresponds to a TWT Helix current range of 0 to 10 mA. This output is a linear 1 mA/V. Maximum output impedance 100 Ω

5.2.4 Control Inputs - Type 1

The following control inputs are of the momentary edge-triggered type. The inputs are internally pulled up to +12 V by 3k3 resistors. The input is asserted on the falling edge i.e. as the input is switched to GND (pin P on the user interface connector). Only one input should be asserted at a time and should be relinquished for at least 10 ms prior to asserting another type 1 input.

Note: The operation of the XMIT control input is modified while the CTRL O/R input is asserted. See section 5.2.6.

Minimum pull down time 1 ms

Maximum external switch 'on resistance' 100 Ω

OFF Selects the OFF mode directly from any of the other three operating modes (WARMUP, STBY or XMIT).

STBY Selects the STBY mode directly from the XMIT mode. When selected from the OFF mode the unit is placed into the WARMUP mode for three minutes before automatically entering the STBY mode.

XMIT Selects the XMIT mode directly from the STBY mode. When selected from the OFF or WARMUP modes, the XMIT mode is automatically entered after the end of the three minute heater warm up time.

RED SEL Part of the redundant switch control facility, selects the amplifier to be routed to the antenna.

5.2.5 Control Inputs - Type 2

The following control inputs are of the level active type. The inputs are internally pulled up to +12 V by 3k3 resistors.

Maximum external switch 'on resistance' 100 Ω

AUTO ENA Part of the redundant switch control facility, toggles between the automatic and manual change over mode. In the automatic mode, a failure of the other amplifier will automatically route this amplifier to the antenna. GND = Automatic mode, Not Connected = Manual mode.

RF INHIB	Only operational with the solid state amplifier option. Allows the RF signal to be inhibited, giving a minimum RF output attenuation of 45 dB. GND = RF Inhibited, Not Connected = RF enabled.
INV RF INHIB	As above except inverted. GND = RF enabled, Not Connected = RF Inhibited.
SWITCH SENSE	Part of the redundant switch control facility, provides the waveguide switch position tell-back input. Should be connected to the waveguide switch so that this pin is connected to ground when the amplifier is routed to the dummy load. GND = RF output routed to dummy load, Not Connected = RF output routed to the antenna.
RED FLT I/P	Part of the redundant switch control facility, receives the status feedback signal from the other amplifier. When the other amplifier indicates a fault condition, the RF output from this unit should be switched to the antenna. This pin should be connected externally to the RED FLT O/P (Pin k on the user interface connector) of the other amplifier in the redundant switch system. GND = Other amplifier operational, Not Connected = Fault on other amplifier, therefore switch.
EXT INTLK	An external interlock input that operates as a fault trip. If the EXT INTLK input is opened whilst the amplifier is in the XMIT mode, the amplifier is automatically placed into the STBY mode. In order to return to the XMIT mode the EXT INTLK input must first be closed (reset conditions are detailed in section 5.2.1). If the external interlock is open in any other mode, the fault condition is indicated but the amplifier mode is not changed. If this feature is not required, this pin should be linked to GND within the 41-pin user interface connector. GND = XMIT available, Not Connected = Inhibit XMIT.

5.2.6 Control Inputs - Type 3

The following control inputs set the modes of operation of the unit. They are designed to be linked within the 41-pin user interface connector during equipment installation and therefore do not form part of the everyday control functions of the unit. To set the mode, the appropriate pins should be linked to +15 V (pin U on the user interface connector).

Maximum external link resistance 100 Ω

Note: Although designed to operate using the internally generated +15 V, with local links, an external supply can be used to remotely set these modes of operation. Any external supply should be capable of nominally +15 V at 4 mA per pin and should conform to the following requirements:

Maximum logic 0 voltage	0.8 V dc
Minimum logic '1' voltage	+12 V dc
Maximum logic '1' voltage	+30 V dc

ADD 0	Four binary coded discrete lines that allow the user to set the address of the unit when using the RS-422 or RS-485 serial communications interfaces (this hardware address select mode is only active when ADD SEL is not connected to +15 V). +15 V = binary '1', Not Connected = binary '0'.
ADD 1	
ADD 2	
ADD 3	

The following gives the binary and equivalent hexadecimal code of these discrete lines.

Address code

ADD	3210	Address in Hex
	0000	30H
	0001	31H
	0010	32H
	" "	"
	1110	3EH
	1111	3FH

ADD SEL Allows the user to select the method of setting the serial communications interface. The address can be set either in hardware using the ADD 0 to ADD 3 lines above, or in software over the serial interface itself (see section 6.3).

Note: With hardware address selection, the only valid baud rate is 9600.

+15 V = Software selection, Not Connected = Hardware selection.

This feature allows the user to return to a known address, in the event of the software losing contact with the unit, by simply cutting the ADD SEL to +15 V link. The amplifier is supplied with no links, hence the interface is set to:

address 30H
 baud rate 9600

CTRL O/R This allows the user to select the 'black box' mode. When selected, as soon as the mains supply is applied to the unit, the three minute WARMUP mode is initiated and subsequently the unit automatically enters the STBY mode. If the XMIT control input is linked to GND the unit then enters the XMIT mode. Switching the XMIT control input between GND and open circuit will switch the unit between XMIT and STBY. In addition, as the mains supply is applied to the unit, the internal digital electronically variable attenuator (DEVA) will be set to minimum attenuation if fitted (units with a D suffix to the product type number). This feature provides operation with the minimum of control connections. Whilst in this mode, all indicator outputs and other control inputs excluding the XMIT operate as normal.

+15 V = Black box mode, Not Connected = Normal mode.

5.2.7 Miscellaneous functions

+15 V Auxiliary supply output of nominally +15 V dc $\pm 5\%$ at 100 mA maximum. Provides the user with a local low voltage output for use with type 3 user port control inputs and other external control interface circuitry.

GND Provides the ground return reference for many of the user interface lines.

RED SW 1	Part of the redundant switch control facility, provides two waveguide switch coil drive outputs. Each output is nominally +24 V dc at 1.6 A, pulsed for 100 ms. An internal 1.8 A current limit is provided along with flywheel diodes for protection, further simplifying the waveguide switch interface considerations. RED SW 1 should be connected so that when asserted, the RF output from the unit is switched to the antenna. RED SW 2 should be connected so that when asserted, the RF output from the unit is switched to the dummy load.
RED SW 2	
RS TX+	Provides connection for a RS-485 or RS-422 interface allowing connection as a slave to an asynchronous, half duplex, multi-drop, four-wire bus. This gives full remote control and monitoring of the HPA as part of an integrated system. The main features, protocols and operation of the serial bus are described in section 6.
RS TX-	
RS RX+	
RS RX-	
RS GND	
2/4 BUS SEL	Allows a 2- or 4-wire serial bus. +15 V = 2-wire, Not Connected = 4-wire. Note: For a 2-wire system, link pins b and d, c and e.

6 RS-485 SERIAL BUS

6.1 General Description and Features

The amplifier (HPA) is equipped with a RS-485 interface allowing connection as a slave to an asynchronous, half-duplex, multi-drop, four-wire bus. This gives full remote control and monitoring of the HPA as part of an integrated system.

The following section describes the main features, protocols and operation of the HPA with the multi-drop serial bus.

6.1.1 HPA Type?

A data request command that prompts a response giving the amplifier type number and the software issue (see section 6.4.3).

6.1.2 Status?

A data request command that prompts a response of 9 data bytes, within which the status flags are contained (see section 6.4.3). The following list summarises the status flags available on the 9 data bytes:

D1 **summary fault;** If set, indicates that the amplifier has seen at least one of the fault conditions described in this section. The amplifier operation and reset conditions will be dependent upon the fault present.

transmitting; If set, indicates that the amplifier is operating in the transmit mode (full details of the operating modes are given in section 4.3).

standby; If set, indicates that the amplifier is operating in the standby mode (full details of the operating modes are given in section 4.3).

warm-up; If set, indicates that the amplifier is operating in the warm-up mode (full details of the operating modes are given in section 4.3).

off; If set, indicates that the amplifier is operating in the off mode (full details of the operating modes are given in section 4.3).

D2 **output to antenna;** When using the redundant switch control feature, if set, indicates that the amplifier is routed to the Antenna. If not set, indicates that the amplifier is routed to the Load. See section 6.1.3 for details on the operation of the redundant switch control feature.

auto-redundancy; If set, indicates that the automatic mode for redundant switch control is enabled. If not set, indicates that the manual mode for redundant switch control is enabled. See section 6.1.3 for details on the operation of the redundant switch control feature.

power too high; If set, indicates that the high power alarm is set and that the RF output power is above the alarm level. The amplifier will remain in the transmit mode, but with the RF inhibited, until either:

i/ the RF output power falls below the alarm level (decrease the RF input power or increase the internal digital attenuator, if fitted) and an 'RF enable' request is sent to clear the 'RF inhibit' or

ii/ the high power alarm is disabled (see section 6.1.4.2).

high power alarm enabled; If set, shows that the high power alarm is enabled. See section 6.1.4 for details on enabling/disabling and operation of the power alarms.

D3 **power too low;** If set, indicates that the low power alarm is set and that the RF output power level is below the alarm level. The amplifier will remain in the transmit mode, but the fault flag will only clear once either:

i/ the RF output power level exceeds the alarm level or

ii/ the low power alarm is disabled (see section 6.1.4.1).

low power alarm enabled; If set, shows that the low power alarm is enabled. See section 6.1.4 for details on enabling/disabling and operation of the power alarms.

RF enabled; If set, shows that the RF is enabled. The RF enabled/inhibited commands are accepted in any of the operational modes. See section 6.1.7 for details on enabling/disabling the RF inhibit feature.

remote enabled; If set, shows that the amplifier is in the remote mode, allowing control via the serial communications interface. See section 6.1.12 for details on enabling/disabling the remote mode.

D4 **HV overload;** If set, indicates that the amplifier has seen an internal HV overload fault trip. The amplifier will revert to the standby mode and automatically attempt to reset three times; for full reset details see section 5.2.1.

external interlock; If set, indicates that the external interlock input is asserted. This prevents the amplifier from entering the transmit state until the input becomes unasserted. The amplifier will revert to standby if the external interlock is asserted while in transmit (see section 5.2.5).

D5 **PF correction;** If set, indicates that the amplifier has seen an internal power factor corrector fault trip. The amplifier will revert to the off mode automatically, prime power must be removed and re-applied to reset the trip.

reflected power; If set, indicates that the amplifier has seen an excessive reflected power trip. The amplifier will revert to the standby mode and automatically attempt to reset three times; for full reset details see section 5.2.1.

mean helix current; If set, indicates that the amplifier has seen an excessive mean helix current trip. The amplifier will revert to the standby mode and automatically attempt to reset three times; for full reset details see section 5.2.1.

peak helix current; If set, indicates that the amplifier has seen an excessive peak helix current trip. The amplifier will revert to the standby mode and automatically attempt to reset three times; for full reset details see section 5.2.1.

D6 **case too hot;** If set, indicates that the amplifier has seen an excessive internal case temperature trip. The amplifier will revert to the standby mode automatically until the fault condition clears.

upconverter warning #1; If set, indicates that the amplifier has a fault with the 10 MHz locking signal (provided, multiplexed onto the RF input). This flag is only active if the amplifier contains an upconverter module (type numbers with a U in the suffix). This is an advisory alarm only and will remain set until the fault condition clears - the amplifier will remain in the transmit mode.

upconverter warning #2; Not currently used.

D7 TWT collector too hot; If set, indicates that the amplifier has seen excessive TWT collector temperature. The amplifier will revert to the standby mode automatically until the fault condition clears.

stirrer fans; If set, indicates that the amplifier has seen an internal cooling fan fault. The amplifier will revert to the off mode automatically, prime power must be removed and re-applied to reset the trip.

main cooling fans; If set, indicates that the amplifier has seen an internal cooling fan fault. The amplifier will revert to the off mode automatically, prime power must be removed and re-applied to reset the trip.

D8 not currently used

D9 TWT cathode volts; If set, indicates the TWT cathode voltage has varied outside the set window limits (unstable). The amplifier will revert to the standby mode automatically until the fault condition clears. For full reset details, see section 5.2.1.

TWT collector volts; If set, indicates the TWT collector voltage has varied outside the set window limits (unstable). The amplifier will revert to the standby mode automatically until the fault condition clears. For full reset details, see section 5.2.1.

TWT heater volts; If set, indicates that the amplifier has seen an internal heater fault. The amplifier will revert to the off mode automatically, prime power must be removed and re-applied to reset the trip.

6.1.3 Redundancy Mode

The following simple command messages that do not have an associated return of data allow control of the built-in redundancy waveguide switching feature (see section 3.6 for details of operation; see section 6.4.1 for details of message format).

6.1.3.1 Enable Manual Redundancy Mode; Cancels the automatic redundant mode, described below.

6.1.3.2 Enable Auto Redundancy Mode; Selects the automatic redundant operating mode. In the event of an amplifier failure, the waveguide switch will be automatically positioned so as to route the output from the good amplifier to the antenna.

6.1.3.3 This HPA to Antenna; Selects the appropriate position of the waveguide switch that routes this amplifier to the antenna.

6.1.3.4 This HPA to Load; Selects the appropriate position of the waveguide switch that routes this amplifier to the load.

6.1.4 Power Alarms

The following command messages allow the control/monitoring of the built in high and low power alarms feature. The associated fault flags are detailed in section 6.1.2.

6.1.4.1 Set Low Power Alarm; Allows the low power alarm level to be set in watts, or disabled when set to zero (see section 6.4.5 for details of passing parameters).

6.1.4.2 Set High Power Alarm; Allows the high power alarm level to be set in watts, or disabled when set to zero (see section 6.4.5 for details of passing parameters).

6.1.4.3 Low Power Alarm?; A command message requesting data, that results in a response showing the current low power alarm setting in watts (see section 6.4.2 for details of command and response format).

6.1.4.4 High Power Alarm?; A command message requesting data, that results in a response showing the current low power alarm setting in watts (see section 6.4.2 for details of command and response format).

6.1.5 Warm-up Time?

A command message requesting data, that results in a response showing the remaining warm-up time in seconds (see section 6.4.2 for details of command and response format). Only active when in the warm-up mode, returns zero seconds in all other operating modes including the off mode.

6.1.6 Attenuator Control

The following command messages allow the control/monitoring of the built in digital attenuator feature, if fitted.

6.1.6.1 Set Attenuator; Allows the digital attenuator level to be set in nominal units. Units range from 0 to 255, 0 signifies zero attenuation or maximum gain (see section 6.4.5 for details of passing parameters).

6.1.6.2 Attenuator?; A command message requesting data, that results in a response showing the current attenuator setting in nominal units of 0 to 255, 0 corresponding to zero attenuation or maximum gain (see section 6.4.2 for details of command and response format).

6.1.7 RF Control

The following simple command messages that do not have an associated return of data allow control of the RF by switching on/off the power supply to the active RF input components, if fitted (see section 6.4.1 for details of message format).

6.1.7.1 Enable RF; Cancels the RF inhibit mode, described below.

6.1.7.2 Inhibit RF; Inhibits the RF output from the unit by removing the power to the active RF input components.

6.1.8 Helix Current Monitoring

The following command messages allow the control/monitoring of the built-in helix current monitoring and recording feature.

6.1.8.1 Helix Record Top of File; A simple command message that returns the helix current record pointer to the top of the non-volatile historical helix current file, detailed below. The 'top of the file' corresponds to the earliest record (see section 6.4.1 for details of message format).

6.1.8.2 Next Ihlx Record?; A command message requesting data, that results in a response showing the historical helix current record in mA. During operation in the transmit mode, the amplifier automatically stores in non-volatile memory a reading of helix current every 15 minutes. After 50 hours (200 readings) an average is taken and stored to the non-volatile historical helix current file. Each request automatically steps the file pointer to the next entry, allowing easy data retrieval. Resetting to the top of the file (earliest entry) is detailed in section 6.1.8.1, above (see section 6.4.2 for details of command and response format).

6.1.8.3 Helix Current?; A command message requesting data, that results in a response showing the helix current in mA. If a request is sent in any mode other than transmit, the response will show zero helix current (see section 6.4.2 for details of command and response format).

6.1.9 Elapsed Hours?

A command message requesting data, that results in a longer data string response showing the total elapsed hours and the elapsed hours in the transmit, standby and off modes (see section 6.4.4 for details of command and response format).

6.1.10 Operating Modes

The following simple command messages that do not have an associated return of data allow control of the amplifier operating modes (see section 4.3 for details of operating modes, see section 6.4.1 for details of message format).

6.1.10.1 Off; Selects the off mode of operation.

6.1.10.2 Standby; Selects the standby mode of operation. Results in the automatic initiation of the cathode heater warm-up timer (180 seconds, or 10 minutes if below $-10\text{ }^{\circ}\text{C}$) if selected from the off mode.

6.1.10.3 Transmit; Selects the transmit mode of operation. Results in the automatic initiation of the cathode heater warm-up timer (180 seconds, or 10 minutes if below $-10\text{ }^{\circ}\text{C}$) if selected from the off mode.

6.1.11 Forward Power?

A command message requesting data, that results in a response showing the RF output power in watts. If a request is sent in any mode other than transmit, the response will show zero forward power (see section 6.4.2 for details of command and response format).

6.1.12 Interface Set-Up

To use the serial communications interface, the amplifier must be placed into the remote mode of operation; this can only be done over the serial communications interface. To send the remote enable command, the address and baud rate must be correctly set. This can be done either:

- i/ in hardware, on the 41-pin control connector using links (see section 5) or
- ii/ via the master controlling device by polling all combinations of address and baud. Once captured either the address or baud rate can be modified.

The following command messages allow the set-up and control of the serial communications interface feature:

6.1.12.1 Set Address; Allows the address to be set in nominal units between 48 and 111, 48 corresponding to address Hex: 30h, 111 corresponding to address Hex: 6Fh (see section 6.4.5 for details of passing parameters).

6.1.12.2 Set Baud Rate; Allows the baud rate to be set in nominal units between 1 and 6, 1 corresponding to a baud rate of 600, 2 = 1200, 3 = 2400, 4 = 4800, 5 = 9600 and 6 = 19200 (see section 6.4.5 for details of passing parameters).

6.1.12.3 Go To Local; A simple command message that places the amplifier into the local mode, allowing control via the 'user interface' discrete control lines. Data requests via the serial communications interface will continue to be serviced in the local mode, however commands other than 'Remote enable' will be rejected as non-executable (see section 6.4.1 for details of message format).

6.1.12.4 Remote Enable; A simple command message that places the amplifier into the remote mode, allowing control via the serial communications interface. When in the remote mode, the standby and transmit 'user interface' discrete control inputs are disabled; all other control inputs and monitor outputs remain active.

6.2 Protocol

6.2.1 Interface and Termination

RS-485 compatible 4-wire with no receiver biasing option. When using this amplifier with the serial communications interface, a 120 Ω bus termination should be fitted externally between the Rx+ (pin d) and Rx- (pin e) connections of the 41-pin control connector. If used in the redundant mode with another amplifier, or on a multi-drop system, the bus termination is only required on one equipment, typically the furthest from the master device.

A screened cable, terminated to the backshell of the user interface connector, should be used to prevent radio frequency interference from adversely affecting operation; when connecting the screen of the cable to the backshell, a full 360° electrical connection should be made (pig-tailed connections should be avoided).

For short cable runs up to approximately 5 m, a suitable data transmission cable would include a twin twisted pair conductor arrangement, typical conductor size of 24 to 26 AWG, screened in aluminised tape with an overall tinned copper braid. A pin is provided on the connector for the connection of a drain wire if available on the cable. For cable runs above 5 m, an additional insulated conductor core should be used as a signal return connection.

6.2.2 Data format

The format is:

- 1 start bit
- 8 data bits with most significant bit sent as EVEN parity
- 1 stop bit

Which can be realised as:

- 1 start bit
- 7 data bits
- EVEN parity
- 1 stop bit

6.2.3 Data Rate

The default data rate is 9600 baud but other baud rates may be selected using the appropriate command.

6.2.4 Generalised Message Format

<delimiter>	address	command	data	<delimiter>	checksum
delimiter:	Function		ASCII		Hex
	Start of text		<STX>		2h
	End of text		<ETX>		3h
	Acknowledge		<ACK>		6h
	Not acknowledge		<NAK>		15h
address:	The unique address of the HPA in the range: Dec: 48 to 111 ASCII: 0 to o Hex: 30h to 6Fh The HPA will respond only to messages containing this address and will ignore all other messages.				
command:	A character specifying a particular function for the HPA to perform. The character can be in the range: ASCII: 0 to Hex: 30h to 7Fh				
data:	A parameter qualifying a command or data returned in response to a command. Characters can be in the range: ASCII: <SP> to Hex: 20h to 7Fh				
checksum:	Bit by bit exclusive OR of all characters in message between and including the delimiters. Characters can be in the range: ASCII: <NUL> to Hex: 0h to 7Fh				

6.2.5 Command Message Format

<STX> address command <ETX> checksum
Command message with no qualifying data.

<STX> address command data <ETX> checksum
Command message including a qualifying parameter.

6.2.6 Response Message Format

All valid command messages are acknowledged in the following forms. The address and command characters are a reiteration of those in the command message.

<ACK> address command <ETX> checksum
Simple acknowledgment.

<ACK> address command data <ETX> checksum
Acknowledgment with data.

Any unrecognised or unexecutable commands will be acknowledged in the form shown below.

<NAK> address command data <ETX> checksum
Not acknowledge, with explanation for the command rejection.

Any command containing a parity, framing, overrun, or checksum error will be ignored and consequently the master must reissue the command.

6.2.7 Message Timing

The maximum time between each character of a message must not exceed 10 ms, and a pause of 10 ms minimum should be inserted after a command message to allow units to recognise bus inactivity between commands.

6.3 Summary Of Command Messages

Command	ASCII	Hex	Type (see below)
HPA type?	0	30	US
Status?	1	31	US
Enable manual redundancy mode	5	35	UC
Enable auto redundancy mode	6	36	UC
This HPA to antenna	7	37	UC
This HPA to load	8	38	UC
Set low power alarm	A	41	UC + p
Set high power alarm	B	42	UC + p
Warm-up time?	C	43	US
Set attenuator	D	44	UC + p
Enable RF	E	45	UC
Helix record top of file	F	46	UC
Next lhlx record?	G	47	US
Helix current?	H	48	US
Input power? (see note)	I	49	US
Elapsed hours?	J	4A	US
Go to local	L	4C	UC
Inhibit RF	N	4E	UC
Off	O	4F	UC
Forward power?	P	50	US
Remote enable	R	52	UC
Standby	S	53	UC
Reflected power?	T	54	US
Attenuator?	U	55	US
High power alarm?	V	56	US
Low power alarm?	W	57	US
Transmit	X	58	UC
Set address	Y	59	UC + p
Set baud rate	Z	5A	UC + p

Type:

UC	user command
UC + p	user command with parameter
US	user status/data request

Note: Input power and reflected power are not monitored.

Data requests will be serviced with the HPA in either 'local' or 'remote' mode. However, for other commands to be executed, (with the exception of 'remote enable') the HPA must be in 'remote' mode. Commands will be rejected as unexecutable with the HPA in 'local' mode.

6.4 Examples Of Command And Response Messages

Examples for each command type are given in a generalised, ASCII and hexadecimal form using the address 5 (35h) for the specific examples. The expected response message for each command is shown using the same format.

Note:

- ASCII non-printable characters are enclosed thus < >.
- The final character in each example is the checksum.

6.4.1 Simple Command Message (no return of data)

Command	ASCII	Hex
Enable manual redundancy mode	5	35
Enable auto redundancy mode	6	36
This HPA to antenna	7	37
This HPA to load	8	38
Enable RF	E	45
Helix record top of file	F	46
Go to local	L	4C
Inhibit RF	N	4E
Off	O	4F
Remote enable	R	52
Standby	S	53
Transmit	X	58

Command: Gen: <STX> address S <ETX> checksum
 ASCII: <STX> 5S <ETX> g
 Hex: 02 35 53 03 67

Response: Gen: <ACK> address S <ETX> checksum
 ASCII: <ACK> 5S <ETX> c
 Hex: 06 35 53 03 63

6.4.2 Command Messages Requesting Data

Command	ASCII	Hex
Warm-up time?	C	43h
Next lhlx record?	G	47
Helix current?	H	48
Elapsed hours?	J	4A
Forward power?	P	50
Attenuator?	U	55
High power alarm?	V	56
Low power alarm?	W	57

Command: Gen: <STX> address H <ETX> checksum
 ASCII: <STX> 5H <ETX> |
 Hex: 02 35 48 03 7C

Response: Gen: <ACK> address H xx.xmA <ETX> checksum
 ASCII: <ACK>5H 12.4mA<ETX>M
 Hex: 06 35 48 31 32 2E 34 6D 41 03 4D

6.4.3 Universal Command Messages Requesting Data

Command	ASCII	Hex
HPA type?	0	30h

Command: Gen: <STX> address 0 <ETX> checksum
 ASCII: <STX>50<ETX><EOT>
 Hex: 02 35 30 03 04

Response: Gen: <ACK> address 0 mmmmn <ETX> checksum
 ASCII: <ACK>50114001<ETX>5
 Hex: 06 35 30 31 31 34 30 30 31 03 35

The amplifier type is returned as 114001. STA1140 operating with control software issue 01.

Command	ASCII	Hex
Status?	1	31h

Command: Gen: <STX> address 1 <ETX> checksum
 ASCII: <STX>51<ETX><ENQ>
 Hex: 02 35 31 03 05

Response: Gen: <ACK> address 1 D1 D2 D3 D4 D5 D6 D7 D8 D9 <ETX> checksum
 ASCII: <ACK>51P@A@@A@@@<ETX>Q
 Hex: 06 35 31 50 40 41 40 40 41 40 40 03 51

The status response comprises 9 data bytes defined as follows. D1 to D3 are data bytes representing the operational status of the amplifier:

D1	D2
bit 7 (parity)	bit 7 (parity)
bit 6 1	bit 6 1
bit 5 0	bit 5 0
bit 4 fault	bit 4 0
bit 3 transmitting	bit 3 output to antenna
bit 2 standby	bit 2 auto-redundancy enabled
bit 1 warm-up	bit 1 power too high
bit 0 off	bit 0 high power alarm enabled

D3
bit 7 (parity)
bit 6 1
bit 5 0
bit 4 0
bit 3 power too low
bit 2 low power alarm enabled
bit 1 RF enabled
bit 0 remote enabled

D4 to D9 are data bytes representing the fault/warning status of the amplifier:

D4		D5	
bit 7	(parity)	bit 7	(parity)
bit 6	1	bit 6	1
bit 5	0	bit 5	0
bit 4	0	bit 4	0
bit 3	0	bit 3	PFC fault
bit 2	external interlock	bit 2	reflected power
bit 1	HV overload	bit 1	mean helix current
bit 0	0	bit 0	peak helix current
D6		D7	
bit 7	(parity)	bit 7	(parity)
bit 6	1	bit 6	1
bit 5	0	bit 5	0
bit 4	upconverter warning #2	bit 4	0
bit 3	lineariser enabled	bit 3	0
bit 2	n/a	bit 2	collector too hot
bit 1	case too hot	bit 1	stirrer fan(s) fault
bit 0	upconverter warning #1	bit 0	main fan fault
D8		D9	
bit 7	(parity)	bit 7	(parity)
bit 6	1	bit 6	1
bit 5	0	bit 5	0
bit 4	0	bit 4	0
bit 3	0	bit 3	TWT cathode volts outside limits
bit 2	0	bit 2	TWT collector volts outside limits
bit 1	0	bit 1	0
bit 0	0	bit 0	TWT heater volts outside limits

6.4.4 Command messages requesting longer data strings

The command J (elapsed hours?) returns longer data strings than other commands. The format is as follows:

Command	ASCII	Hex
Elapsed hours?	J	4A

Command: <STX> address J <ETX> checksum
 Response: <ACK> address J Tnnnnn Xnnnnn Snnnnn
 Onnnnn <ETX> checksum

where:

Tnnnnn - total elapsed hours
 Xnnnnn - elapsed hours in transmit mode
 Snnnnn - elapsed hours in standby mode
 Onnnnn - elapsed hours in off mode

6.4.5 Command Messages Passing Parameters

Command	ASCII	Hex
Set low power alarm	A	41h
Set high power alarm	B	42h
Set attenuator	D	44h
Set address	Y	59
Set baud rate	Z	5A

Command: Gen: <STX> address A = nnn <ETX> checksum
ASCII: <STX> 5A = 150 <ETX> |
Hex: 02 35 41 3D 31 35 30 03 7C

Response: Gen: <ACK> address A <ETX> checksum
ASCII: <ACK> 5A <ETX> q
Hex: 06 35 41 03 71

The alarm setting is sent as '=nnn', where 'nnn' is in watts (leading zeros not required). The alarms are disabled by setting to zero (A=0, B=0).

The attenuator setting is sent as '=nnn' where 'nnn' is in nominal units (leading zeros not required).

If the '=' is omitted, the command will be considered invalid and a 'not acknowledge' response sent.

6.4.6 Response To An Invalid Command Message:

Command messages will be classed as invalid if the command is not recognised, a parameter is out of range or not numeric or the command cannot be executed. For example, if a command which is not part of the amplifier command set is used, the response will be as follows:

Command: Gen: <STX> address B <ETX> checksum
ASCII: <STX> 5b <ETX> v
Hex: 02 35 42 03 76

Response: Gen: <NAK> address B D1 <ETX> checksum
ASCII: <NAK> 5Bp <ETX> <DC1>
Hex: 15 35 42 70 03 11

D1 is a byte representing the invalid command code. It is defined as follows:

D1

bit 7 (parity)

bit 6 1

bit 5 1

bit 4 1

bit 3 0

bit 2 0

bit 1 0

bit 0 0 = command/data invalid, 1 = command not executed

6.5 Application Notes

Before attempting to control the amplifier using the RS-485 4-wire multi-drop bus, check the following:

- Ensure that the data connector is correctly wired (Rx+ , Rx– are not reversed etc.)
- Check that the amplifier data rate is the same as that of the master (should be set to 9600 baud).
- Ensure that the amplifier has a unique address.
- Check that the master has the same data format as the amplifier (1 start bit, 7 data bits, EVEN parity and 1 stop bit).

If the amplifier is being controlled using the 2-wire system:

- Link b with d, and c with e.

7 RELATED DOCUMENTS

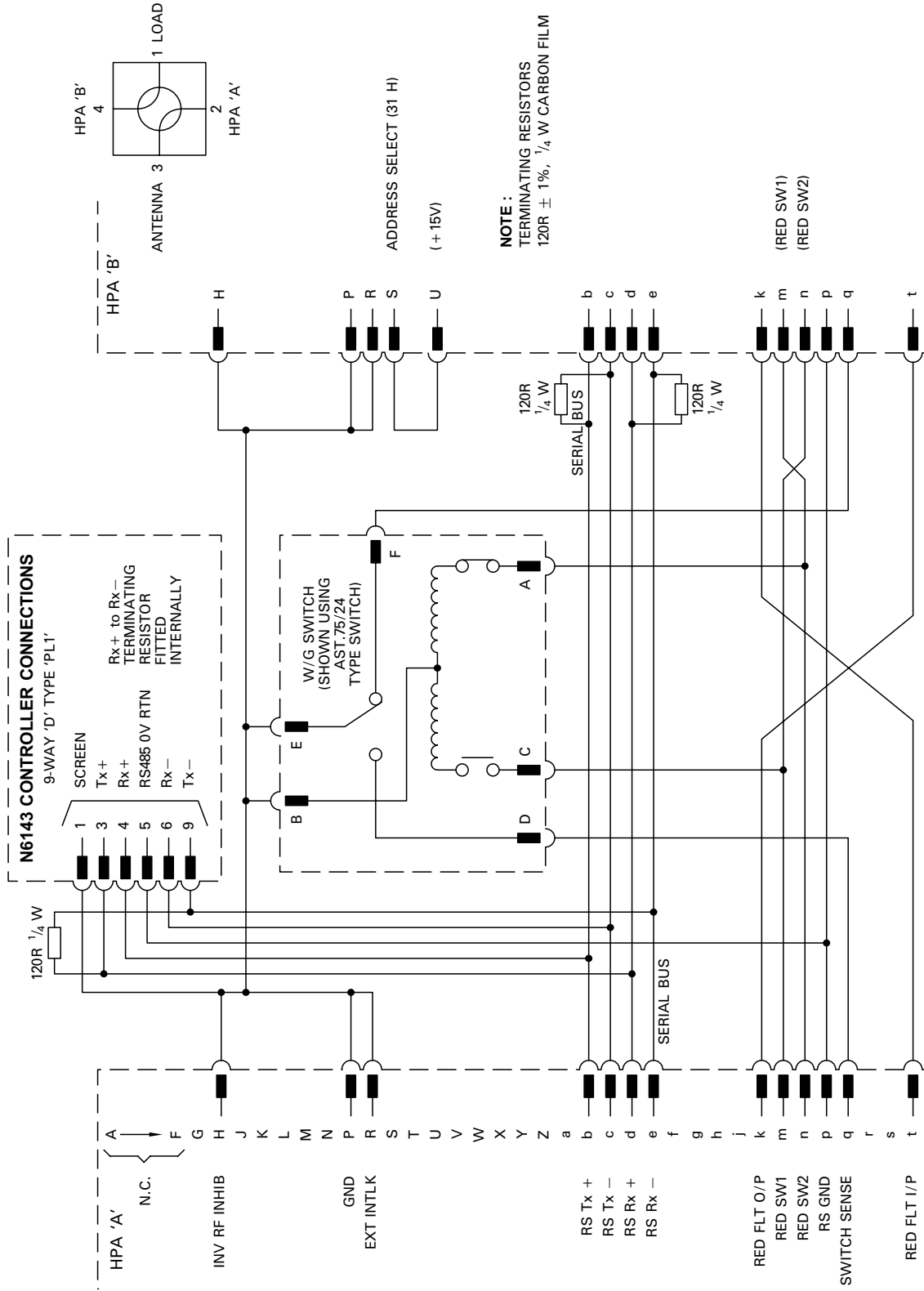
IDENTITY	TITLE
A1A-STA1140 Series	Data sheet, Stellar 400 W C-Band Antenna Mount TWTA
A1A-STA1340 Series	Data sheet, Stellar 400 W Ku-Band Antenna Mount TWTA
HBN6143-1	N6143 Operation Manual

Check with e2v technologies to ensure that any of the above documents supplied are of the most recent issue.

APPENDIX A

Dual Amplifier Redundant Configuration using N6143 Controller

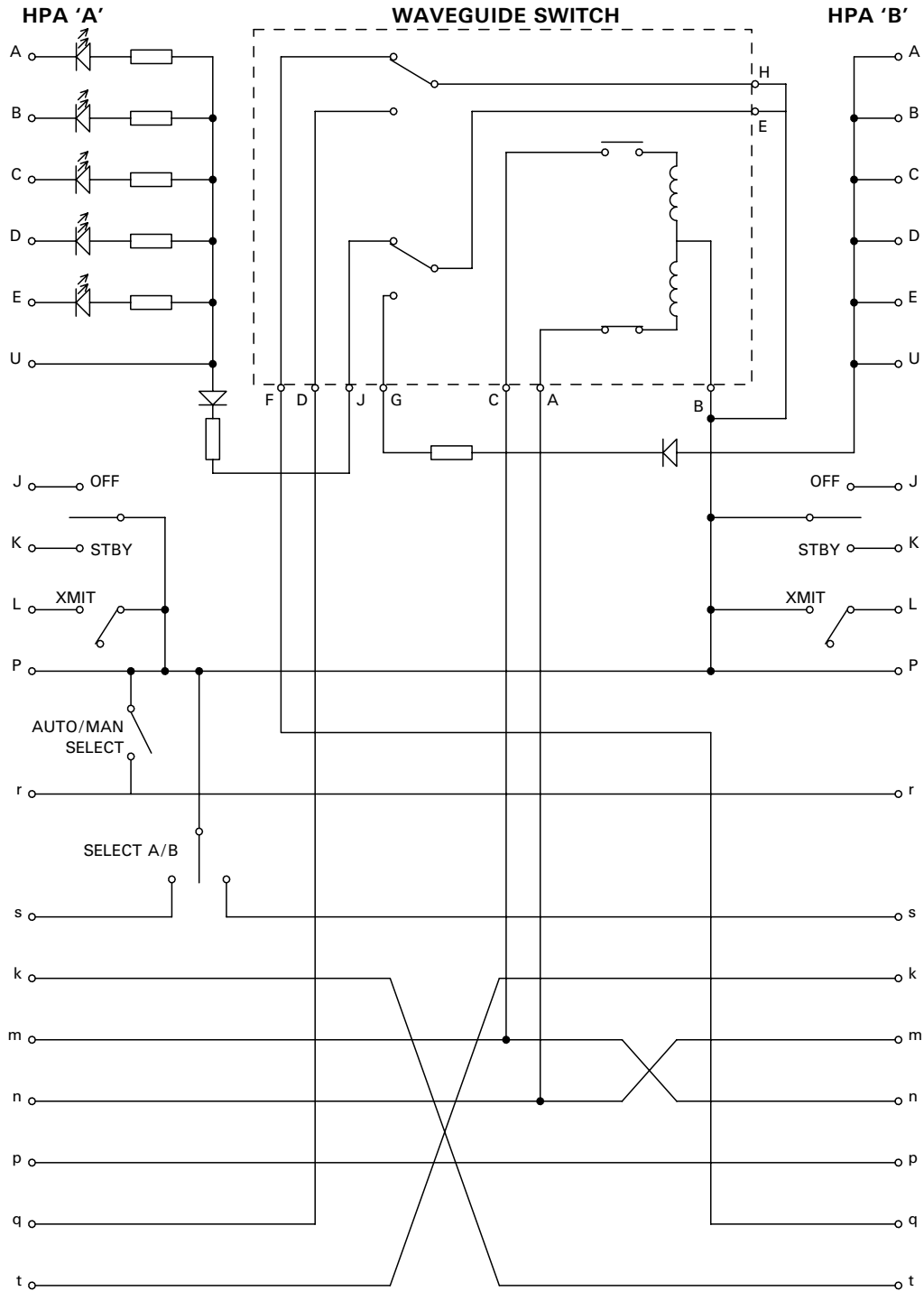
If the requirement is for a two-amplifier redundant system, the following wiring can be used. A personal computer can be used in place of the N6143 controller; commands and protocols are detailed in this manual.



APPENDIX B

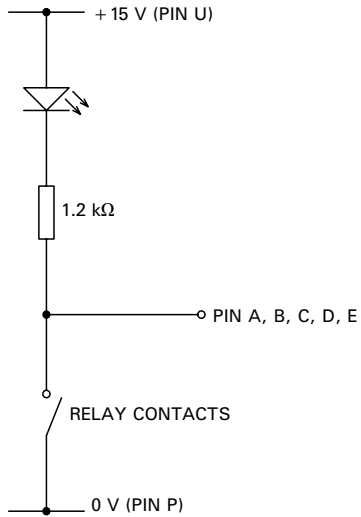
Dual Amplifier Redundant Configuration with Manual Control

Basic control functions can be obtained by using manual toggle switches. An example of the interface wiring for this is as follows:



APPENDIX C

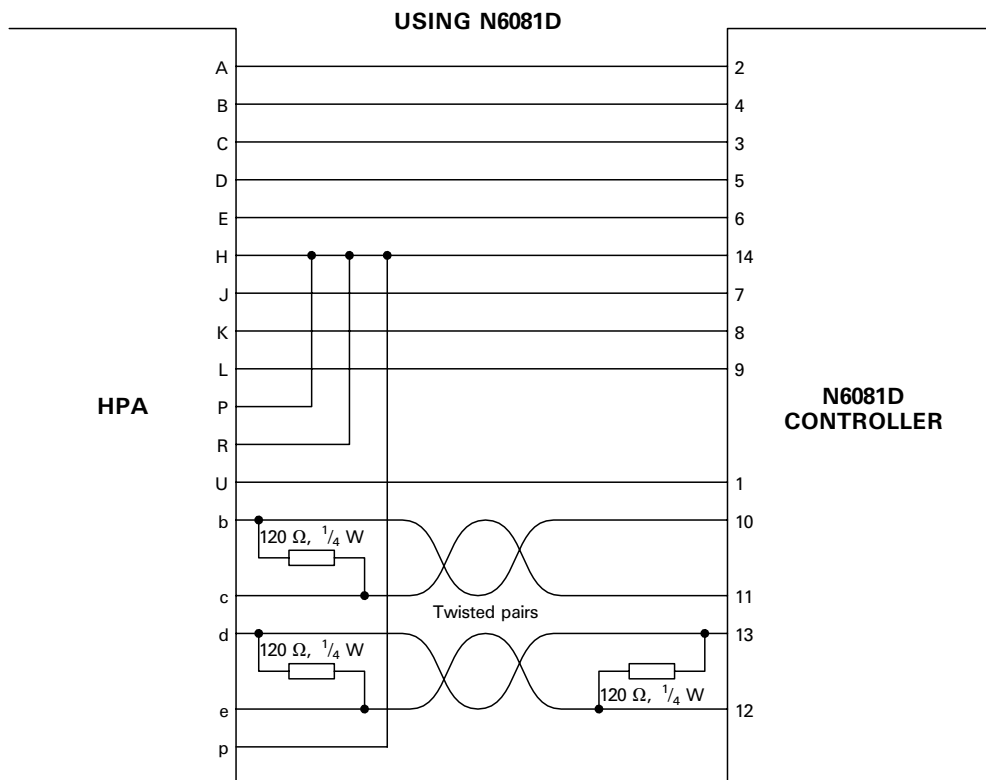
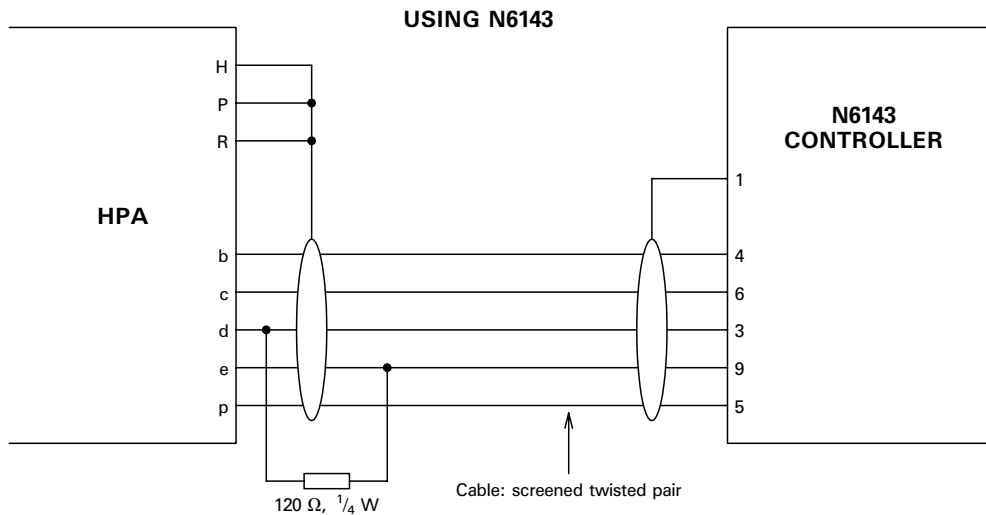
This circuit is connected to the indicator outputs OFF IND, WARMUP IND, STBY IND, XMIT IND and SUM FLT IND as described in Section 5.2.1.



APPENDIX D

Single Amplifier Configuration with N6143/N6081D Controllers

If operating in single amplifier mode, the remote interfacing becomes easier to provide. A simple RS-485 link is required between the amplifier and the controller to give full functionality. The dual amplifier controller (N6143) can still be used in this set-up as it is fully configurable to either single or dual amplifier mode of operation. The N6081D is a low-cost, single amplifier controller that also provides the amplifier parameter display (it uses the low voltage DC supply from the amplifier, so it does not require a mains power connection). Examples of the interface wiring for this method of control are as follows:



APPENDIX E

Single Amplifier Configuration with Manual Control

When operating in single amplifier mode with no serial bus controller, it is possible to provide full control manually as shown below.

Notes:

1. If switch 2 is set to XMIT on application of prime power, the amplifier will automatically enter the XMIT state after 3 minutes warm-up.
2. To enter the OFF state, switch 2 must be in the STBY position prior to the OFF state being selected via switch 1.
3. The resistor values will depend on the type of LED used.
4. If specific fault indication is required, this circuit can be used. Refer to section 5.2.1 for codes.

