

# **BridgeMaster**

## **Series Radar**

# **Technical Manual**

**(Scanner Units & Transceivers, Display Monitors,  
Processor Electronic Units and Control Modules)**

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# BridgeMaster E

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## Preamble

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## WARNINGS AND CAUTIONS

The Radar features, functionality and capability which are described in this manual are not necessarily present in all versions or configurations of the BridgeMaster E.

### WARNING: Lethal Voltage Hazard

When access covers are removed, lethal voltages may be exposed. Some capacitors used in the equipment take several minutes to discharge their stored voltages after switch OFF, this is a lethal voltage hazard. Always set the supply switch-fuse to OFF and remove the fuses, before removing the access covers of the equipment.

### WARNING: Health Hazard

When cleaning the inside of the equipment, take care not to inhale dust. The dust is a temporary health hazard, depending on individual allergies.

### WARNING: Radiation Hazard

Keep outside the hazard zone around an antenna or open waveguide radiating power. Refer to the table below for hazard zones. When it is necessary to work on the Scanner Unit, make sure that radar is switched OFF, and that both the Mains Isolator and the Scanner Control Unit are turned to the OFF position.

Never look directly into an open waveguide.

Radar and other forms of RF radiation can cause Cardiac Pacemakers to malfunction. If you use a Cardiac Pacemaker and suspect a malfunction, leave the vicinity of the radar system immediately and seek medical advice.

Most countries accept that there is no significant radiation hazard at RF power density levels of up to 10 mW/cm<sup>2</sup>.

Hazard Zones		
Antenna Length	10 mW/cm <sup>2</sup>	1 mW/cm <sup>2</sup>
1.2 m X-Band	1.7 m	17 m
1.8 m X-Band	1.05 m	10.5 m
2.4 m X Band	0.75 m	7.5 m
2.7 m S-Band	0.73 m	7.3 m
3.7 m S-Band	0.55 m	5.5 m

### **CAUTION: Electrostatic Sensitive Devices (ESSDs)**

This equipment contains ESSDs. Take care not to damage these devices by discharge of electrostatic voltages.



**REVISION RECORD**

<b>Revision No.</b>	<b>Issue Date</b>	<b>Date Incorporated</b>	<b>Incorporated By</b>
Issue 1	May 1999		

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### PREFACE

#### HOW TO USE THIS MANUAL

This manual is intended for use by the Installation Engineer and Radar Operator. It is intended also to be used in conjunction with the User Guide 65800010A and other related documents (see Page (ix) for full list).

- Chapter 1 - **S-Band Scanner Units and Transceivers**. This chapter gives technical specifications, descriptions and parts lists for S-Band Scanner Units and Transceivers.
- Chapter 2 - **X-Band Scanner Units and Transceivers**. This chapter gives technical specifications, descriptions and parts lists for X-Band Scanner Units and transceivers.
- Chapter 3 - **Display Monitor Units and Consoles**. This chapter gives technical specifications, descriptions and parts lists for Display Monitor Units and Consoles.
- Chapter 4 - **Processor Electronics Units** This chapter gives technical specifications, descriptions and parts lists for Processor Electronics Units.
- Chapter 5 - **Radar Control Modules**. This chapter gives technical specifications, descriptions and parts lists for Radar Control Panels and individual Control Modules.
- Chapter 6 - **Fault Reporting and First Line Servicing**. This chapter gives procedures for fault reporting and details of items that may be replaced as part of First Line Servicing Procedures.
- Chapter 7 - **Maintenance**. This chapter gives details of any procedures required for routine maintenance of the units covered in earlier chapters.
- Chapter 8 - **Modifications**. This chapter is used for the recording of modifications and information released after publication.

#### NOTICE

Litton Marine Systems BV have a policy of continuous development. This may lead to the equipment described in this manual being at variance with equipment manufactured after its publication.

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## BridgeMaster E Radar Series

### Technical Manual

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**RELATED DOCUMENTS**

Other documents in the series:

- BridgeCard ..... (Publication Ref 65800008)
- User Guide ..... (Publication Ref 65800010A)
- Ship's Manual ..... (Publication Ref 65800010B)
- Ancillary Units & Radar Systems Manual ..... (Publication Ref 65800012)
- BridgeMaster II S-Band Supplement ..... (Publication Ref 65601012)
- **BridgeMaster II X-Band Supplement** ..... (Publication Ref 65601013)

Note that the BridgeMaster II S-Band Supplement, and the BridgeMaster II X-Band Supplement, cover Hybrid Systems containing BridgeMaster II Series Display Units with BridgeMaster E Series Scanner Units.

Note that for original BridgeMaster, the 180/250 and 340 Display Technical Manuals are Publication Ref 65600011 and 65626011 respectively.

### GLOSSARY OF TERMS

Scanner Unit . . . . .	Comprises the Antenna and Turning Unit.
Antenna . . . . .	Slotted waveguide array for transmitting and receiving microwave signals.
Turning Unit . . . . .	Contains the Antenna rotation motor, the microwave rotating joint, and may contain an integral Transceiver.
Integral Transceiver . . . .	Transmitter/Receiver housed in the Turning Unit.
Bulkhead Transceiver . . . .	Transmitter/Receiver mounted below decks with microwave or co-axial connection to the Turning Unit.
Display Unit . . . . .	The radar screen and control panel(s).
Display Console . . . . .	Combined Display Unit and Pedestal/Plinth (340 Series only).
Performance Monitor . . . .	A unit which warns the operator of reduced radar performance. May be integral with the Turning Unit (X-Band) or separate (S-Band).
Scanner Control Unit . . . .	A unit which switches power to the S-Band Turning Unit, under the control of the Display.
Interswitch Unit . . . . .	Enables two radar systems to be connected together so that either Display may be connected to either Scanner Unit.
A . . . . .	Ampere
AC . . . . .	Alternating Current
ARPA . . . . .	Automatic Radar Plotting Aid
CRT . . . . .	Cathode Ray Tube
dB . . . . .	decibel
DC . . . . .	Direct Current
ft . . . . .	foot or feet
GPS . . . . .	Global Positioning System
Hz . . . . .	Hertz (unit of Frequency)
I/O . . . . .	Input/Output
Kt . . . . .	Knot
kW . . . . .	Kilowatt
LCD . . . . .	Liquid Crystal Display
LED . . . . .	Light Emitting Diode
LNFE . . . . .	Low Noise Front End
m . . . . .	metre
nm . . . . .	nautical mile
NMEA . . . . .	National Marine Electronic Association
NNF . . . . .	Not Normally Fitted
PCB . . . . .	Printed Circuit Board
PPI . . . . .	Plan Position Indicator
PSU . . . . .	Power Supply Unit
RFI . . . . .	Radio Frequency Interference
rpm . . . . .	revolutions per minute
sm . . . . .	statute mile
TX/RX . . . . .	Transmitter/Receiver (Transceiver)
V . . . . .	Volt



## SOFTWARE LICENCE AGREEMENT

When you receive your radar, it will include factory installed software, the use of which is subject to the following Licence Agreement below.

★★★ IMPORTANT ★★★

**READ THE LICENCE TERMS PRINTED BELOW BEFORE USING THE EQUIPMENT. USE OF THE EQUIPMENT INDICATES YOUR ACCEPTANCE OF THE TERMS OF THE LICENCE AGREEMENT.**

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## Preamble

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### **MARINE EQUIPMENT DIRECTIVE COMPLIANCE STATEMENT**

The series of equipment that this manual covers has met the requirements of EN60936-1, EN60936-2, EN60945, EN60872-1 (EN60872-2, EN60872-3 Draft) where applicable.

The equipment has been issued with European Union EC Type-Examination Certificates for the Marine Equipment Directive.

The assessment of this was carried out by the Defence Evaluation Research Agency, Fraser, which is appointed as a Notified Body No. 0191 by the Department of Trade and Industry under the European Union Marine Equipment Directive 96/98/EC.

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# Chapter 4

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## Processor Electronics Units

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## Radar Control Modules

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**CHAPTER 7**  
**ROUTINE MAINTENANCE**

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# Chapter 7

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**CHAPTER 8**  
**MODIFICATIONS**

**Contents**

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# Chapter 8

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## Modifications

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## 1 General Description

There are two basic types of S-Band Scanner Unit:

- with an integral transceiver module
- without an integral transceiver

Each type can have a number of variants dependent on motor supply and the options that are fitted.

The Scanner Unit comprises an Antenna, an antenna support casting, and a Turning Unit.

Included in the Turning Unit is a motor and gearbox, a Bearing and Heading Marker pcb, an Input pcb, and optionally a Performance Monitor and integral transceiver module.

The Transceiver Unit comprises, a base casting, a cover, a transceiver module, and an Input pcb.

Communication between the Transceiver and the Display is by means of a serial data link. Where a separate Transceiver Unit is used, an RF feeder (coaxial) is used to transfer the microwave energy between the Transceiver Unit and the Turning Unit.

The Scanner Unit and the Transceiver Unit are compatible with BridgeMaster II display units if a Display Compatibility Unit is used.

See Figures 1.1 to 1.4.

### 1.1 Physical Arrangements

The Turning Unit is constructed from a central aluminium casting, to one side of which is attached a motor and gearbox. The terminal strips for interconnecting cables to other units are under a cover on the opposite side to the motor and gearbox.

At either end of the Turning Unit there is an aluminium cover. The performance monitor is housed under the front cover and, when fitted, the Transceiver Unit is housed under the rear cover. If no transceiver module is fitted, a shallower cover is used. The transceiver module can be removed for below decks servicing.

Four M16 bolts are used to attach the Scanner Unit to the radar platform or wheelhouse roof. The Antenna is attached to the Turning Unit by the antenna support casting, an RF feeder cable is used to transfer the microwave signals between the Turning Unit and the Antenna.

Interconnections between the Scanner Unit and other units in the system are made using screened cables. All the cables that enter the Scanner Unit do so via waterproof cable glands that incorporate an EMC gasket that makes contact with the cable braid.

The separate Transceiver is designed to be Bulkhead mounted and is attached using four M8 bolts, studs or screws (coachbolts).

## 1.2 Transceiver Module Overview (S-Band)

The transceiver module can be fitted in the Turning Unit, or mounted on a casting for below decks bulkhead mounting as a separate unit. The module incorporates the Modulator pcb, a Power Supply pcb, Trigger pcb, the Receiver, and the microwave components.

Communication between the Transceiver Unit and the Display Unit is by means of two serial data links, one from the Transceiver to the Display Unit, and one from the Display Unit to the Transceiver.

This information is transmitted using a special data cable that incorporates four twisted pairs. Two pairs are used for data transmission, one pair is used for trigger, and the other pair is spare.

The data passed from the Transceiver to the Display includes:

- Heading Marker
- Incremental Bearing
- Transceiver Status
- Error Messages
- Built In Test Equipment (BITE) data
- Tuning Indicator
- Azimuth Data

The data transmitted from the Display to the Transceiver includes:

- Standby/Transmit
- Pulse Length
- Tuning
- AFC/Manual
- Sector Blanking
- Performance Monitor Control, and Installation Settings.

### 1.2.1 Power Supply

The power supply operates from the ship's AC mains, and provides all of the power requirements for the electronic modules within the Turning Unit and Transceiver. The AC mains is always present at the power supply even when the radar is switched off at the display. Note that the antenna motor is supplied via the Scanner Control Unit.

The presence of active lines in the serial data link when the display is switched on is detected by the power supply, which then becomes active. The power supply includes a Power Factor Correction circuit, and a number of switching regulators to generate the necessary voltage supplies. Overcurrent detection circuits protect the power supply against overloads on its outputs.

### 1.2.2 Trigger PCB

The Trigger PCB processes the serial data from the Display Unit, and generates the required control signals for the Transceiver. It monitors functions within the Transceiver, the Heading Marker, and encodes the information for transmission to the Display Unit. The data is transmitted each time a bearing pulse is received from the Turning Unit. The various timing signals required by the transceiver including the pulse repetition frequency (prf), are generated by the trigger pcb.

### 1.2.3 Modulator PCB

The modulator pcb generates the high voltage negative pulses required to drive the magnetron. The modulator pulse widths and timing signals are controlled from the trigger pcb. A spark gap on the modulator is fired if the magnetron fails to operate. Continual operation of the spark gap is detected and signal is fed back to the trigger pcb. When the trigger pcb detects this signal it switches the radar to standby, and generates an error signal to be transmitted to the Display Unit via the serial data link. The error signal causes the Display Unit to switch to standby and generate an error alarm. The modulator is a line type modulator. The transmitter pulse lengths are determined by the pulse forming network.

### 1.2.4 Microwave Circuit

The transceiver employs a conventional three port circulator to direct the path of the microwave energy to and from the antenna. A magnetron coupled to the circulator provides the RF energy to be transmitted. A solid state limiter coupled to the circulator protects the receiver from high powered microwave signals from the magnetron, or adjacent radars. A signal from the trigger pcb is used to enable swept attenuation to be applied to the solid state limiter to reduce the system sensitivity at short ranges.

### 1.2.5 Receiver

The receiver consists of a low noise amplifier, a mixer, a linear preamplifier, a logarithmic amplifier, and a video amplifier. The 60MHz output of the mixer is amplified by the linear preamplifier followed by a logarithmic amplifier, the output of which is detected, the resulting video signal is then further amplified before transmission to the Display Compatibility Unit, or Display.

The receiver also incorporates an AFC system. Once the receiver has been tuned, the AFC system ensures that the receiver remains on tune during variations in tuning due to thermal drift of the mixer and magnetron etc.

The operator can select between manual tuning and automatic tuning. A signal from the trigger pcb is used to select the mode of operation. A signal from the AFC circuit is fed to the trigger circuit to indicate the state of tune of the receiver. This signal is at its minimum value when the receiver is correctly tuned.

## 1.3 Turning Unit Overview (S-Band)

### 1.3.1 Drive System

The scanner motor is an AC induction motor. It drives a 10:1, 12:1 or 20:1 reduction gearbox. The output of the gearbox drives the final output helical gear via a pinion to give an overall reduction between the motor and Antenna of approximately 30:1, 36:1 or 60:1 dependant on whether the Turning Unit is a high speed variant or not.

The scanner motor is connected to the ship's AC Supply by a Scanner Control Unit. This unit incorporates a contactor controlled by the Transceiver to switch the scanner motor on.

When standby is selected, rotation of the Antenna is inhibited. Unless in test mode, transmission from the radar is inhibited if the Antenna is not rotating. An isolating switch is provided to switch the scanner motor supply off for safe servicing. S-band drive systems are always AC powered

### 1.3.2 Pulse Bearing & Heading Marker System

A disc with 128 teeth is attached to the Antenna torque tube and combined with an opto-coupler generates 128 pulses per rotation of the Antenna.

A second opto-coupler together with a flag on the toothed disc generates a Heading Marker approximately  $10^\circ$  before the Antenna is pointing dead ahead. Correct alignment of the Heading Marker is set at installation by electronic adjustment within the Display Unit.

Both opto-couplers are on the Pulse Bearing PCB. The Pulse Bearing PCB multiplies the 128 bearing pulses by 32 to generate 4096 pulses per Antenna revolution. The 4096 azimuth pulses and the heading marker are routed through the Input PCB to the Trigger PCB where they are incorporated into the serial data to be transmitted to the Display Unit.

Where it is not possible to adjust the Heading marker alignment at the display, optional extra circuitry can be fitted to the Input pcb to allow the alignment to be made electronically within the Turning Unit. When this option is fitted an additional ( isolated ) Heading Marker output, and RS422 Heading Marker and Azimuth outputs are provided. As an option for special applications a size 11 synchro can be fitted as an alternative source of bearing information.

### 1.3.3 Interconnections

AC power to the motor is by direct connection to terminal strips in the terminal box attached to the motor. The terminations for interconnections for the transceiver and the Turning Unit are under a cover on the side of the Turning Unit. The AC power for the Transceiver from the isolating switch is terminated at a terminal block within the filter box. All other connections are made to plugs or removable terminal strips on the input pcb.

## 2 Unit Configurations

### 2.1 General Information

The S-Band scanner unit and transceiver form only part of a complete BridgeMaster E Series radar, and cannot be operated in isolation. For details of complete system installations refer to the BridgeMaster E, Ship's Manual 65800010B.

S-Band top units are supplied with either, an integral transceiver unit (which is mounted as part of the turning unit), or with a separate transceiver which is suitable for bulkhead mounting.

The motor in the Turnig Unit is fed with its own supply via a Scanner Control Unit. This supply may differ from the Transceiver power supply.

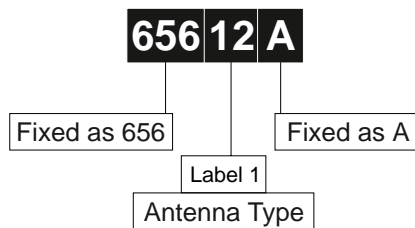
### 2.2 Unit Type Numbers

BridgeMaster E, S-Band top units are configured from the following unit types:

- Antenna Unit
- Turning Unit (with or without Integral Transceiver)
- Bulkhead Transceiver Unit

#### 2.2.1 Antenna Unit

The Antenna Unit type number consists of a five figure number followed by a single letter suffix. The first three digits and the suffix are fixed (656xxA), and digits four and five identify antenna type as follows:



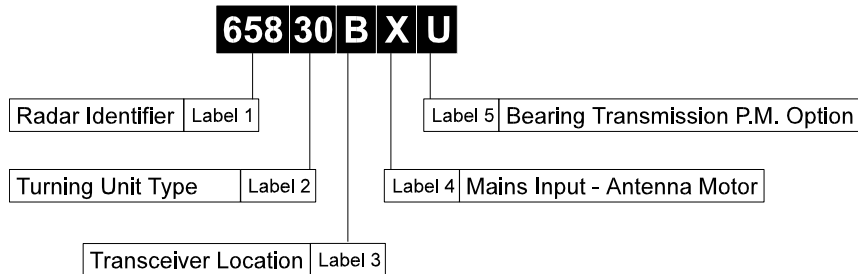
Label 1 **Antenna Type**

Label	Antenna Type
<b>09</b>	9 FT (S-Band)
<b>12</b>	12 FT (S-Band)



## 2.2.2 Turning Unit

The Turning Unit type numbers are as follows:



Label 1 **BridgeMaster E Identifier** (fixed as **658**)

Label 2 **Turning Unit Type** (fixed as **30** for S-Band 30 kW Transceiver) S-Band Turning Units are correctly set for their turning speed.

Label 3 **Transceiver Location**

Label	Transceiver Mounting
<b>B</b>	Bulkhead
<b>M</b>	Masthead
<b>C</b>	Bulkhead with additional facilities
<b>N</b>	Masthead with additional facilities

Label 4 **Mains Input - Antenna Motor**

Label	Phases	Voltages	Frequency	Speed	Band*
<b>E</b>	1	110 - 120	50/60	S	S
<b>F</b>	1	220 - 240	50/60	S	S
<b>G</b>	3	110 - 120	50/60	S	S
<b>H</b>	3	220 - 240/380 - 440	50/60	S	S
<b>J</b>	1	110 - 120	50	H	S
<b>K</b>	1	220 - 240	50	H	S
<b>L</b>	3	110 - 120	50	H	S
<b>M</b>	3	220 - 240/380 - 440	50	H	S
<b>P</b>	1	110 - 120	60	H	S
<b>Q</b>	1	220 - 240	60	H	S
<b>R</b>	3	110 - 120	60	H	S
<b>S</b>	3	220 - 240/380 - 440	60	H	S

\*For **S-Band** Turning Units the motor is fed from its own supply via a Scanner Control Unit and can differ from the Transceiver/Processor Electronics Unit supply.

# Chapter 1

## S-Band Scanner Units and Transceivers

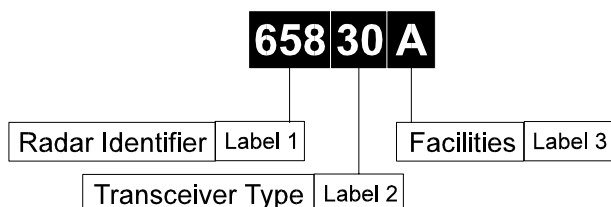
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Label 5 **Bearing Transmission P.M. Options**

Label	Performance Monitor	Synchro
<b>P</b>	No	No
<b>R</b>	Yes	No
<b>S</b>	No	Yes
<b>T</b>	Yes	Yes

### 2.2.3 Bulkhead Transceiver Unit

The Bulkhead Transceiver Unit type numbers are as follows:



Label 1 **BridgeMaster E Identifier** (fixed as **658**)

Label 2 **Transceiver Type**

Label	Transceiver Type
<b>30</b>	30 kW S-Band

Label 3 **Facilities**

Label	Facilities
<b>A</b>	Standard
<b>B</b>	With additional facilities

## 3 Installation and Commissioning

### 3.1 General Information

The Scanner Unit comprises the following main elements, each of which is supplied in its own packing, together with relevant Installation Drawings:

<b>Turning Unit</b>	with/without Integral Transceiver Despatch Kit 65830660 (Installation Drawing 65830050)
<b>Support Casting</b>	(Installation Drawing A0/65612050-054)
<b>Antenna</b>	12ft or 9ft Despatch Kit 65612610 (Installation Drawing A0/65612050-054)

Installation of the Scanner Unit entails carrying out the following operations, preferably in the sequence outlined below:

1. Preparation of the site.
2. Bolting the Turning Unit to the mounting platform (ship's structure) as detailed in Installation Drawing 65830050 supplied with the Turning Unit.
3. Bolting the Support Casting to the Turning Unit as detailed in Installation Drawing 65612050-054 supplied with the Antenna.
4. Bolting the Antenna to the Support Casting as detailed in Installation Drawing 65612050-054 supplied with the Antenna.
5. Laying in and installing the cables for the Motor and the Turning Unit in accordance with the appropriate Cabling Schedules. This includes RF Feeder co-ax in bulkhead systems.

Figures 1.1 to 1.5 also show installation details which are intended to duplicate those provided with the equipment. However, as it is possible that changes may occur to the details which may not be reflected in this manual, the installation drawings supplied with the equipment take precedence in the event of differences arising.

### 3.2 Turning Unit

**CAUTION:** *The weight and spread of the Antenna can cause a free-standing Turning Unit to topple over. The Turning Unit should therefore be bolted down onto its mounting platform before attaching the Antenna and Support Casting to the Turning Unit.*

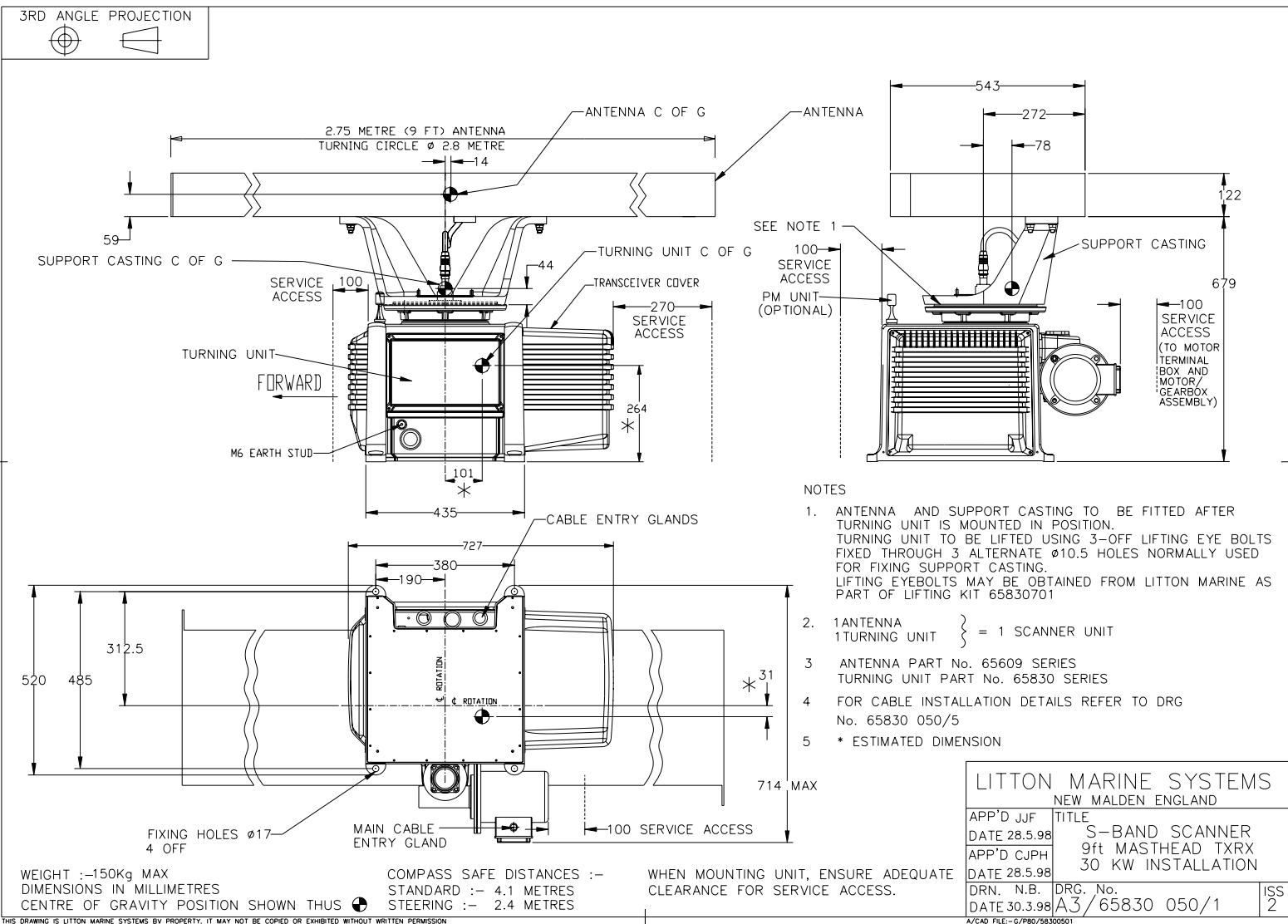


Figure 1.1 - S-Band Scanner 9ft Masthead Tx/Rx 30kW Installation

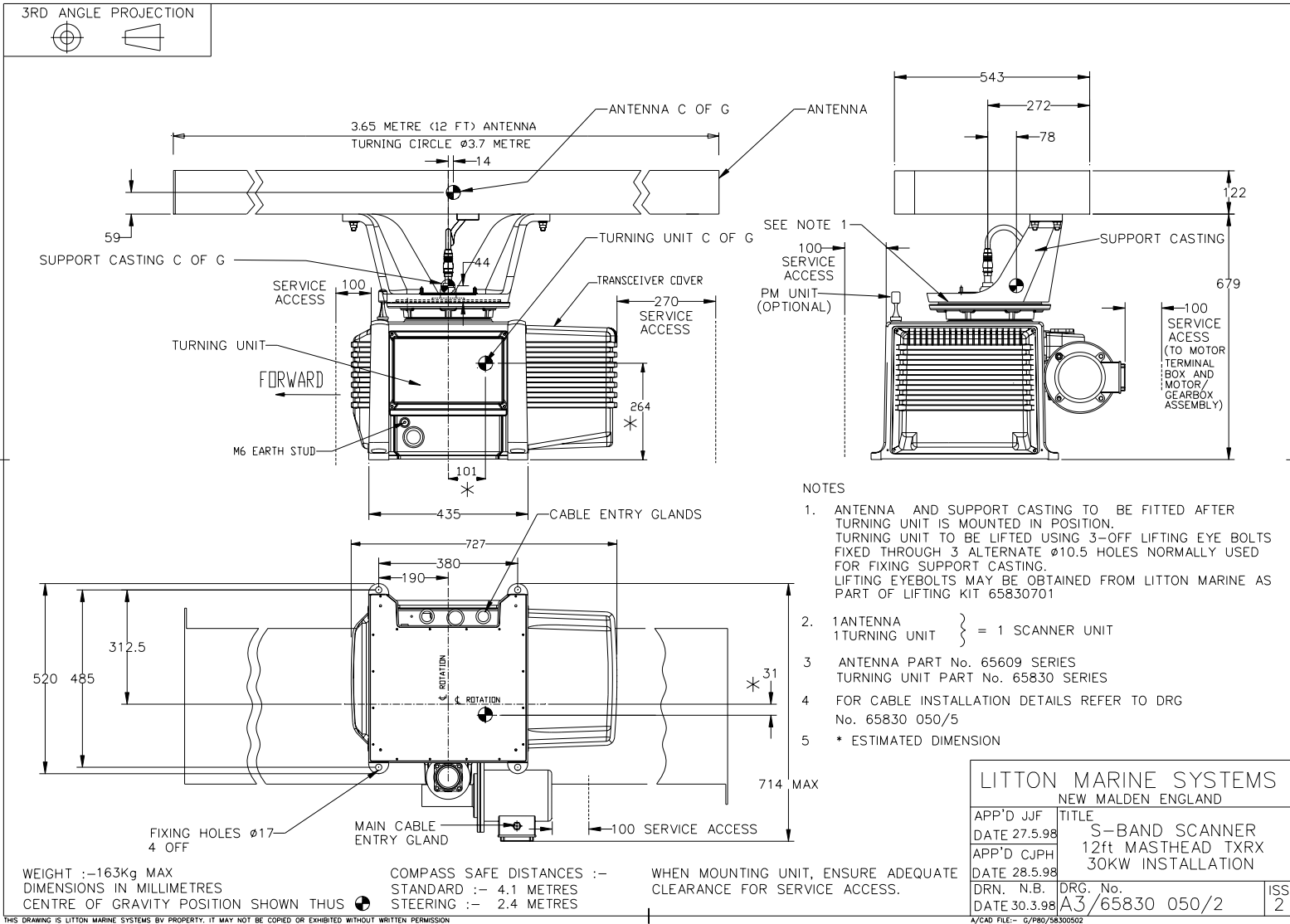


Figure 1.2 - S-Band Scanner | 12ft Masthead Tx/Rx 30kW Installation

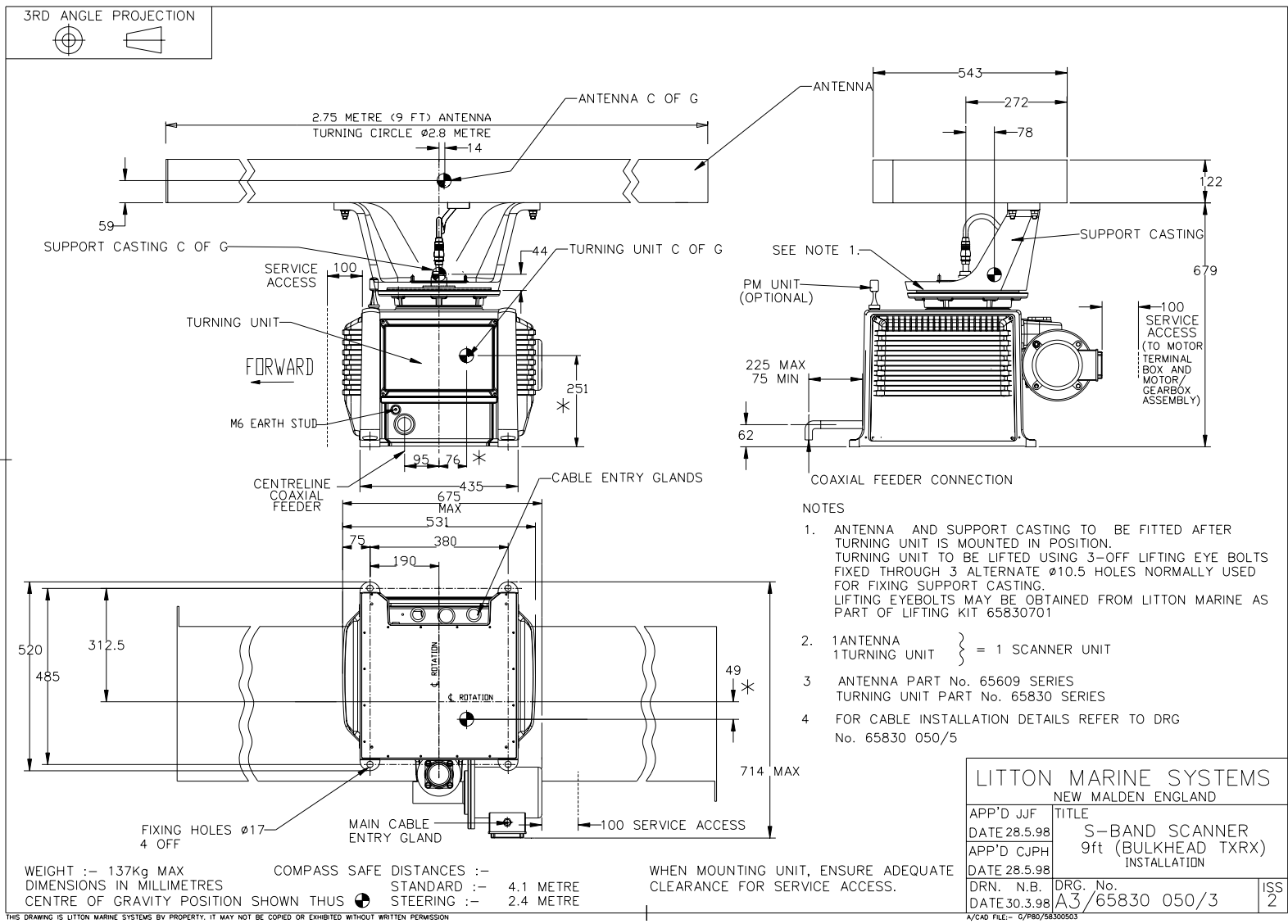


Figure 1.5 - S-Band Scanner 9ft (Bulkhead Tx/Rx) Installation

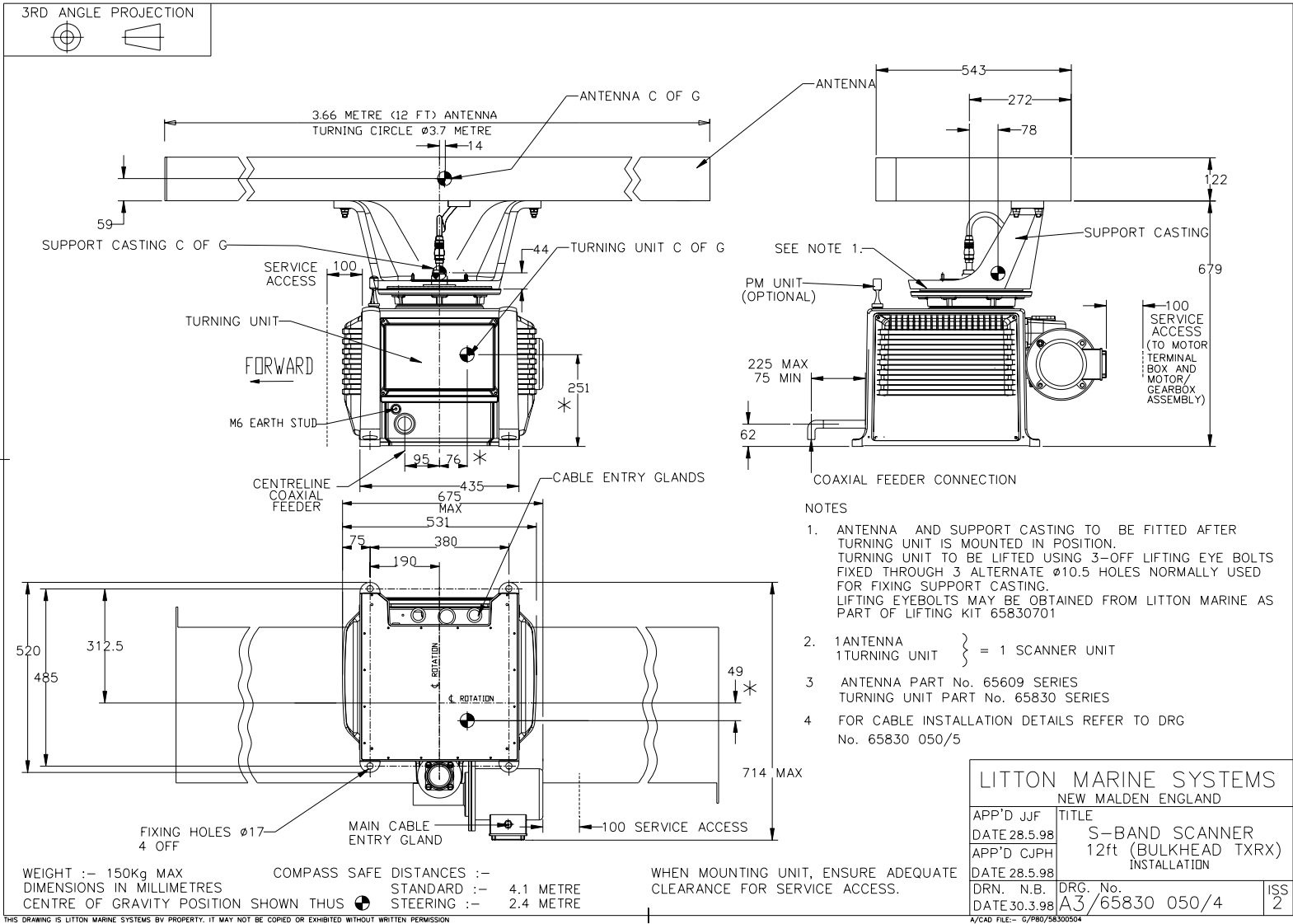


Figure 1.4 - S-Band Scanner | 12ft (Bulkhead Tx/Rx) Installation

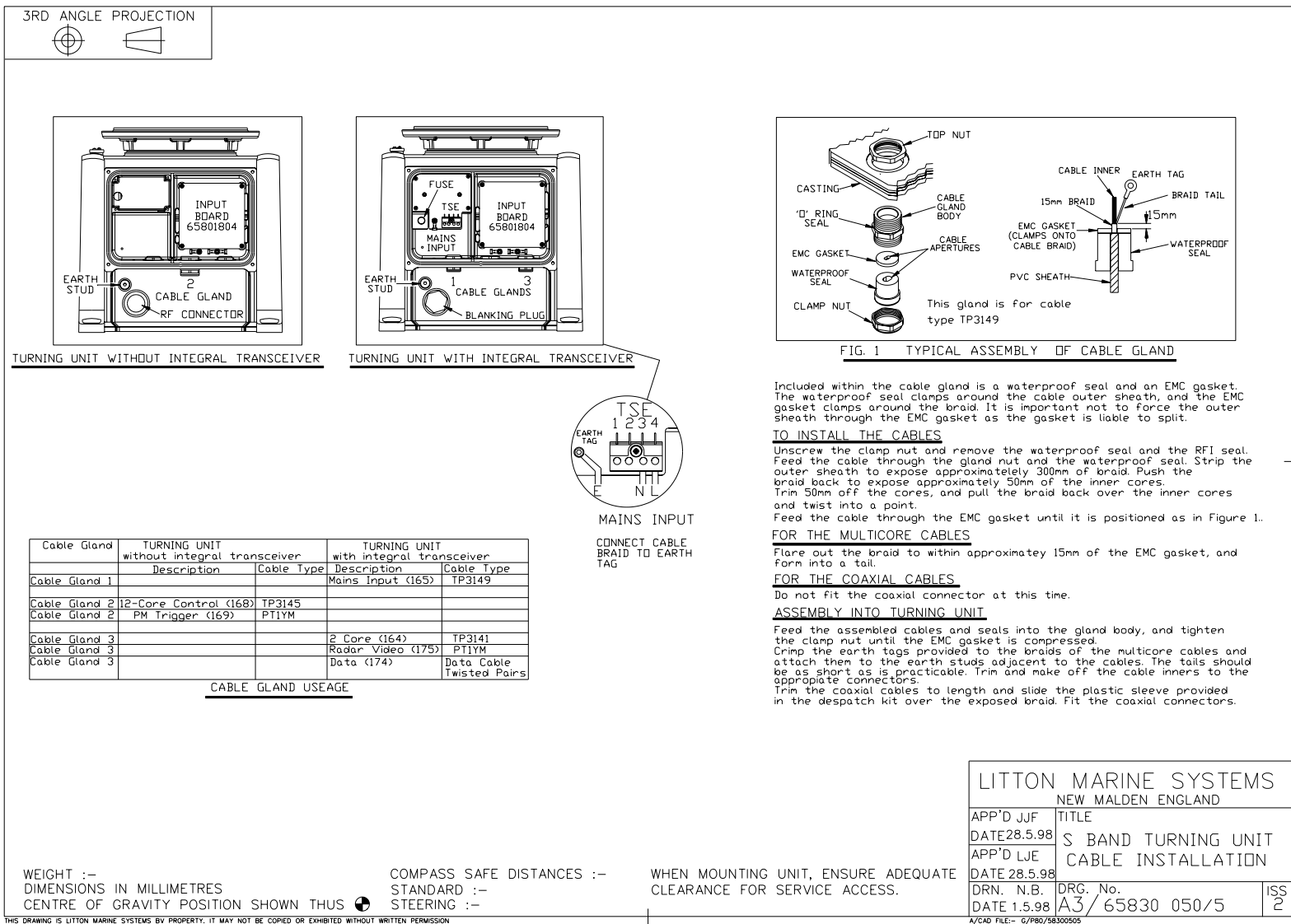


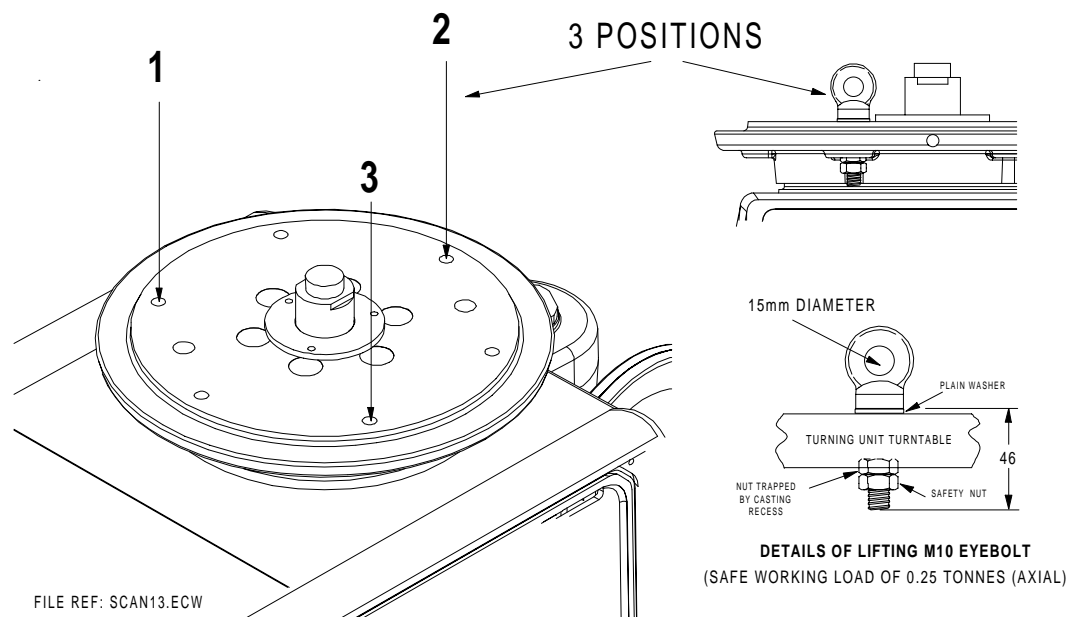
Figure 1.5 - S-Band Turning Unit Cable Installation



## S-Band Scanner Units and Transceivers

If it is necessary to lift the Turning Unit by crane, three lifting eyebolts (part of Lifting Kit 65830701 available from Litton Marine Systems) must first be attached securely to the torque tube in three positions as shown in Figure 1.6. The eyebolts are fitted in a symmetrical pattern in three of the six holes normally used for attaching the Support Casting to the Turning Unit. If M12 eyebolts are supplied in the lifting kit, fit the associated M12 washers, and screw the eyebolts into the threaded hole positions. If M10 eyebolts are supplied, the associated M10 nuts and washers must be used to fix the eyebolts, as shown in Figure 1.6. One large diameter washer and two nuts supplied with the kit are used with each eyebolt as a safety measure. The M10 nuts are prevented from turning by hexagonal recesses in the casting. Remove the eyebolts and nuts after the Turning Unit has been bolted to the mounting platform. (Reference should be to "BS4278 Eyebolts for Lifting Purposes" and the safe use of lifting equipment in accordance with the Health and Safety at Work Act, Part I Section 6.)

**NOTE - Under no circumstances should a combined Turning Unit and Antenna Unit be lifted by the Antenna Unit. To do so would be dangerous and would result in damage to the Antenna Unit.**



**Figure 1.6** - Attachment of Lifting Eyebolts

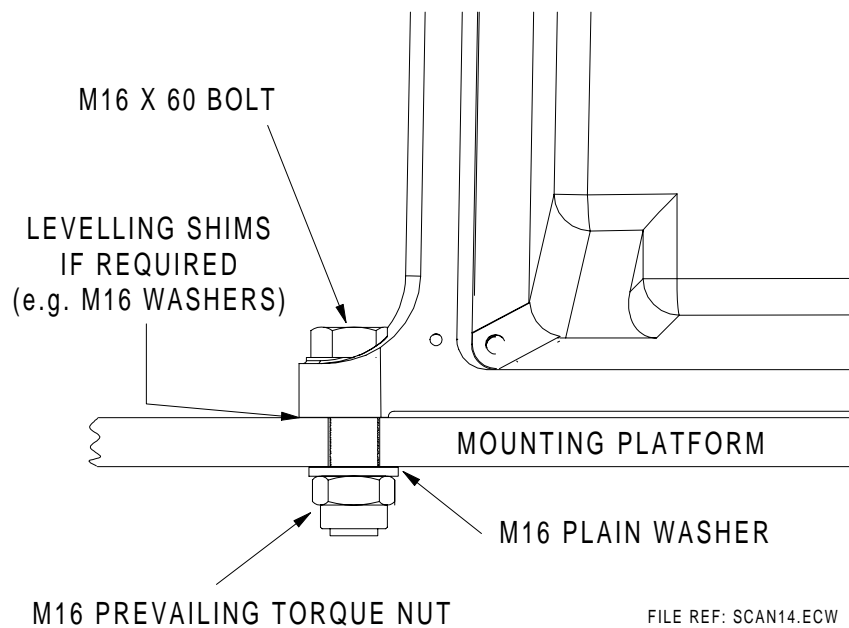
The Turning Unit is attached to the mounting platform using the fixings supplied in the Turning Unit Despatch Kit 65830660.

# Chapter 1

## S-Band Scanner Units and Transceivers

Figure 1.7 below shows how these are fitted. Ensure that all threads and bushes are coated with Densopaste.

**Note** - The Turning Unit is bolted directly to the mounting platform without any intervening washer, except for the purpose of levelling the mounting so that the Turning Unit casting is not subject to twist when the bolts are tightened. M16 washers may be used as shims, or purpose made parts produced locally may be used.

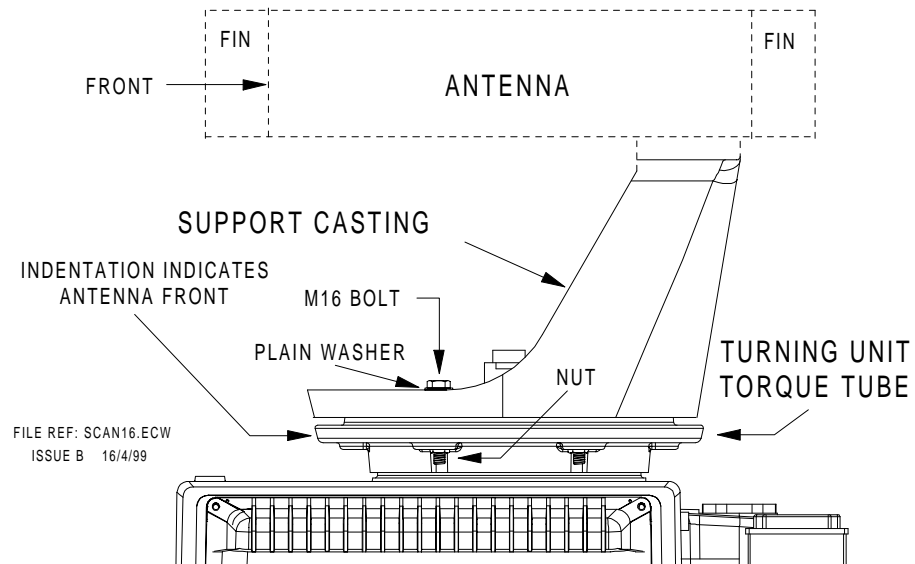


**Figure 1.7** - Fixing the Turning Unit to the Mounting Platform

### 3.2.1 Support Casting

The Support Casting is fitted to the Turning Unit torque tube using Fixing Kit 65612611, which is part of the Antenna Despatch Kit 65612610.

Figure 1.8 below shows how these are fitted. Ensure that all threads and bushes are coated with Densopaste.



**Figure 1.8** - Fixing the Support Casting to the Torque Tube

### 3.3 Antenna

The Antenna is fitted to the Support Casting using the parts listed below which are supplied with the antenna.

- 4 off M12 Stainless Steel Prevailing Torque Nuts
- 4 off M12 Stainless Steel Plain Washers
- 2 off Lock Tabs

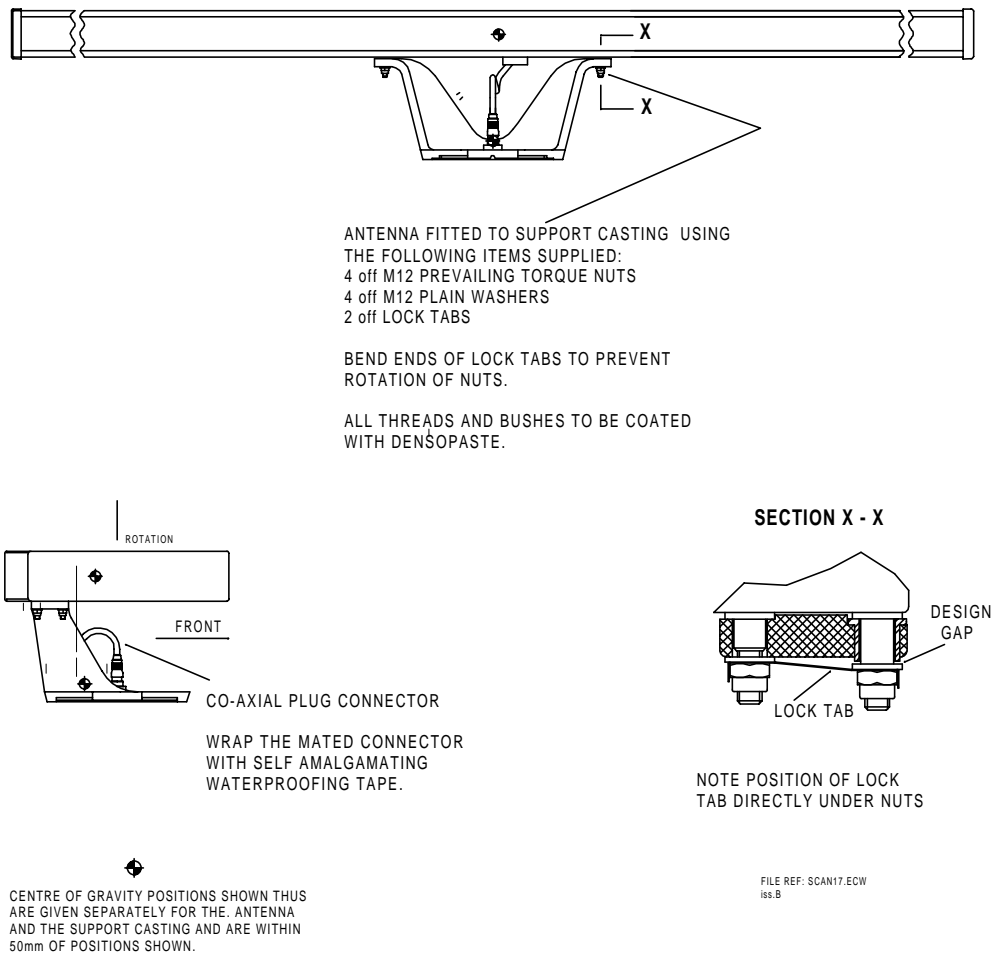
Figure 1.9 shows how these are fitted. Ensure that all threads and bushes are coated with Densopaste.

**NOTE - The lock tab ends must be bent as shown to prevent rotation of the nuts.**

The next step is to mate the S-Band co-axial cable from the Antenna with the Turning Unit RF connector and to wrap the mated connector with self amalgamating tape as an additional precaution against water ingress.

# Chapter 1

## S-Band Scanner Units and Transceivers



**Figure 1.9** - Fixing the Antenna to the Support Casting

### Pulse Bearing PCB Assembly

The position of the link LK1 fitted to the Pulse Bearing PCB Assembly 65801805 (Refer to Figure 2.8).

**Note** - This link does not physically affect the rotational speed of the scanner, but does affect the ability of the phase-locked loop within the board to track the scanner rotational speed.

The factory default setting is 'LOW' speed.

**Note** - With no jumper fitted, the PCB defaults defaults to HIGH speed configuration.

With the jumper in the position marked '1' ( pins 1 & 2 - the lower pair ), the PCB is configured for LOW speed operation.

With the jumper in the upper pair position ( pins 2 & 3 ), the PCB is configured for HIGH speed operation.

The link is set during installation and commissioning. The link can be moved with the PCB in place.

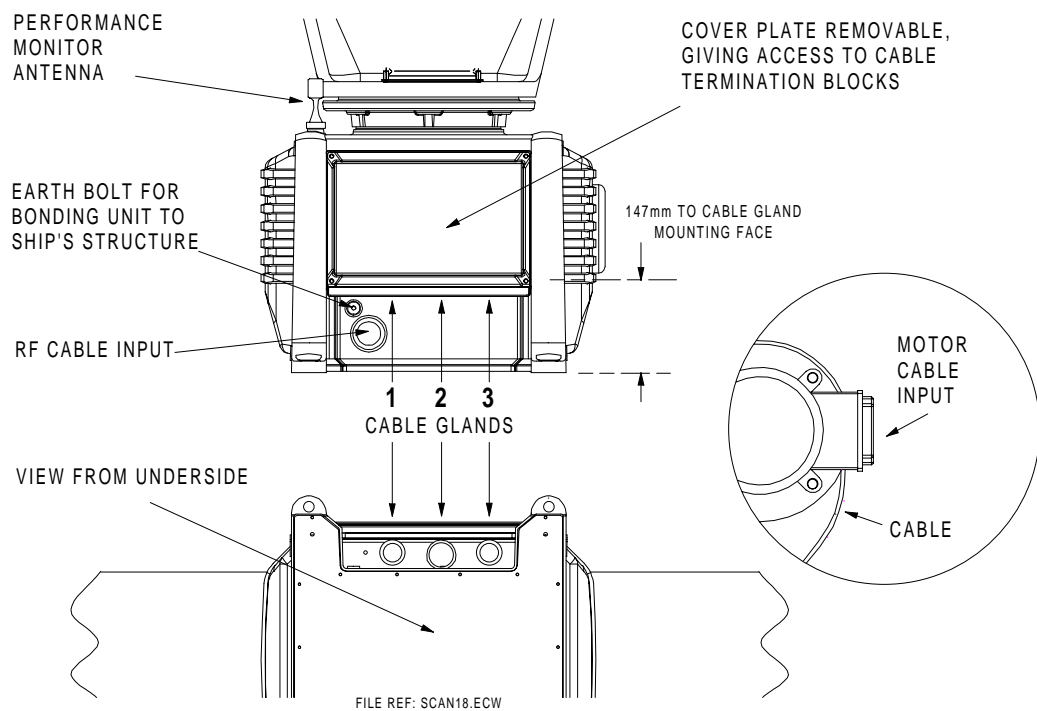
### 3.3.2 Cabling Information

Figure 1.10 below shows the cable entry points. Three of these are via cable glands labelled 1, 2, & 3, details of which are given in the accompanying table.

The RF Cable input is only required when the Transceiver is mounted below decks (Bulkhead).

The Motor supply cable is connected directly to the Motor termination blocks mounted in the box on the side of the Motor.

A 6mm stud is provided for bonding the unit to the Ship's structure. This is an important safety requirement, and the stud must not be used for any other connection.



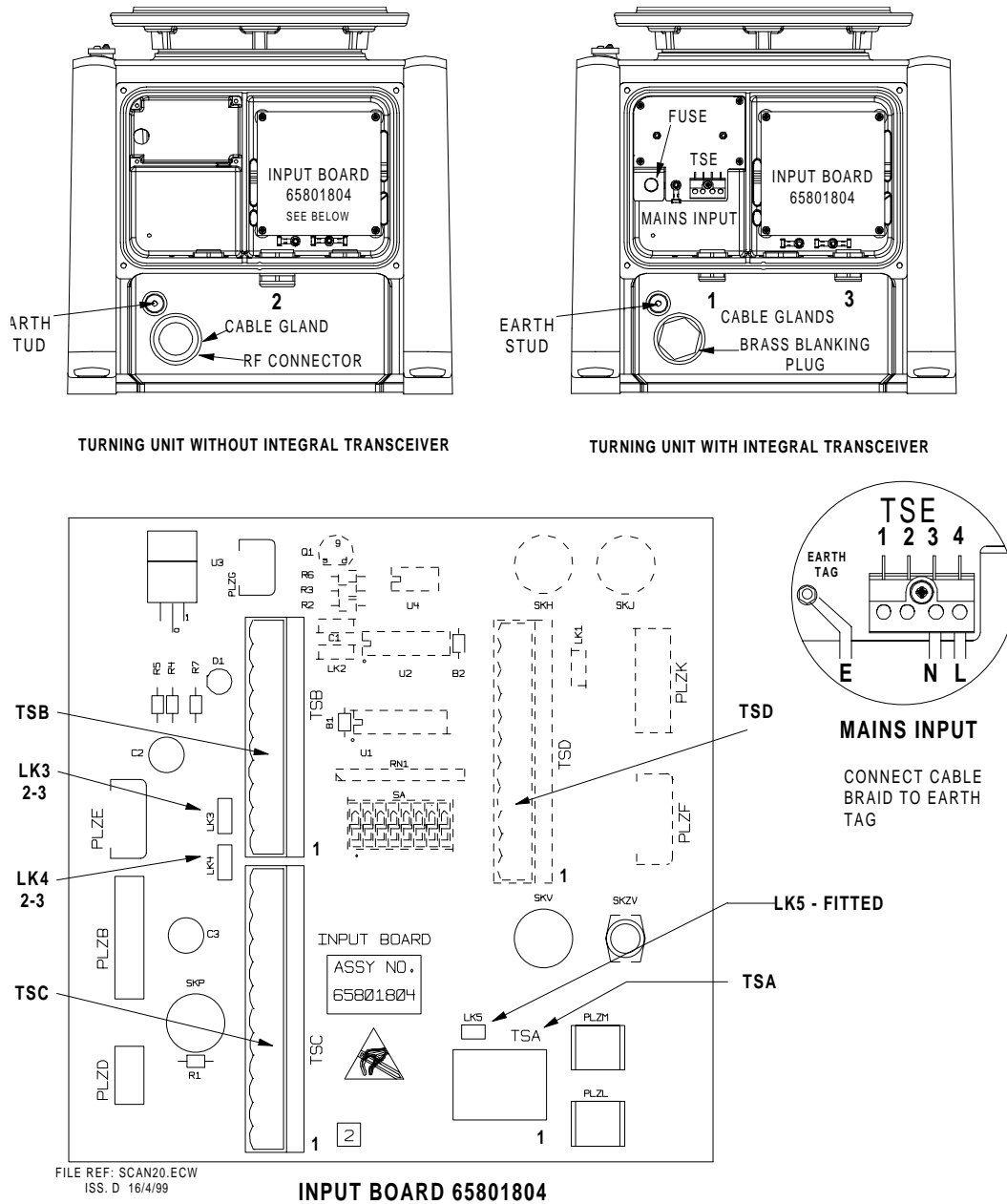
NOTE: TURNING UNIT WITHOUT INTEGRAL TRANSCEIVER SHOWN ABOVE. REFER TO THE TABLE ON PAGE 3.19 FOR DETAILS OF THE CABLES FITTED FOR THE DIFFERENT VARIANTS.

**Figure 1.10** - Turning Unit - Cable Entry Locations

# Chapter 1

## S-Band Scanner Units and Transceivers

The diagrams below show details of the Input Board 65801804 or 65801813 and the Mains Input connector (Integral Transceiver only) TSE. These are revealed on removal of the cover plate, which is retained by 4 fixing screws (see Figure 3.38). Links 3 and 4 on the Input Board should be set as shown in Figure 1.11. Link 5 is fitted. Details of the Motor connections are described separately in Section 2.3.2.



**Figure 1.11** - Turning Unit - Input Board and Mains Input Details

## S-Band Scanner Units and Transceivers

The Table below shows the route by which each cable enters the Turning Unit (with or without an Integral Transceiver). Ref to Ship's Manual 65800010B Chapter 3, for details of how to terminate the cables into their connector blocks, and for cabling schedules (Section 3.2) and system diagrams (Section 3.1). The numbers in parentheses e.g. (168) refer to the cable schedule number.

Each of the Cable Glands has a waterproof seal and a separate EMC seal, both of which must be installed as shown in Figure 1.12.

Details of terminating the R.F. Feeder Cable (S-Band Co-ax) are in Section 2.4.2

Cable Gland	TURNING UNIT without Integral Transceiver		TURNING UNIT with Integral Transceiver	
	Description	Cable Type	Description	Cable Type
Cable Gland 1	-	-	Mains Input (165)	TP3149
Cable Gland 2	12-Core (168)	TP3145	-	-
Cable Gland 2	PM Trigger (169)	75 $\Omega$ Co-ax	-	-
Cable Gland 3	-	-	2-Core (164)	TP3141
Cable Gland 3	-	-	Radar Video (175)	75 $\Omega$ Co-ax
Cable Gland 3	-	-	Data (174)	T/Pairs
RF Connector	RF Feed	S-Band Co-ax	-	-

**Turning Unit - Cable Entry Details**

### 3.3.3 Motor Connections

Various motor types are available to cater for the different mains supplies, and the standard/high speed antenna rotation rate variants.

The following table gives the available Motor alternatives:

Mains Supply Characteristics	Motor Type for Standard Speed Antenna	Motor Type for High Speed Antenna
110/120 Volts, 1 $\phi$ (50/60 Hz)	91003757	91003759
220/240 Volts, 1 $\phi$ (50/60 Hz)	91003758	91003760
110/120 Volts, 3 $\phi$ (50/60 Hz)	91003752	91003754
220/240/380/440 Volts, 3 $\phi$ (50/60 Hz)	91003751	91003753

As can be seen from the table, the same 3-phase motor type is used for both 220/240V and 380/440V supplies. In addition to the wiring up of the mains supply to these motors, the windings must also be correctly configured for the appropriate voltage. Information for configuring the motor is supplied with the motor.

For all motor types, the mains cable must first be fed through the cable gland on the motor termination box housing. The cable braid **must be connected** to the motor chassis as a safety feature, and the individual insulated conductors connected to the appropriate terminals as detailed for each motor type in the following section. Ensure that the cable is not under strain in the termination box area, and that sufficient slack is available to remake the connection, should this ever be necessary e.g. if a motor is changed in service. Also ensure that the insulated conductors are terminated appropriately, using ring crimp terminals on threaded studs.

Ensure that any gasket fitted for sealing the terminal box cover is correctly seated when the cover is re-secured.



### Single Phase Motor Connections

Make connections according to the label on the inside of the termination box cover. Ensure that the rated motor volts are matched to the supply.

Cable Schedule No 166 Reference	Description	Motor Label Reference
TSH1	AC LINE	L, L1 or U1
TSH2	AC NEUTRAL	N, L2, U2 or V1

### Three Phase Motor Connections

For dual voltage motors, ensure that windings are configured for the appropriate voltage. Delta connected windings are for low voltage operation, Star for high voltage.

The label on the inside or outside of the termination box cover, will give details of mains supply connections, and of the winding re-configuration details for alternate voltages if appropriate.

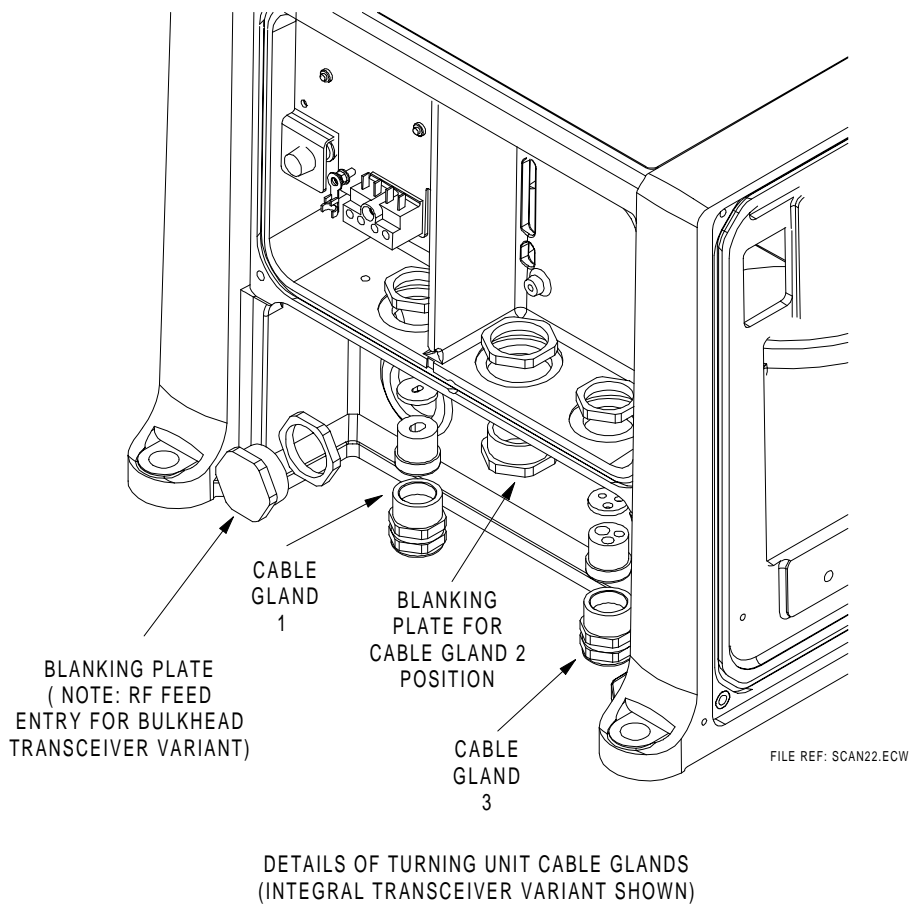
Ensure that the rated motor volts are matched to the supply. If the motor rotates in the wrong direction, reversal of any two phases will correct this (the radar antenna should rotate anti-clockwise when viewed from below).

Note that if the motor rotates slowly it indicates that it is configured for the wrong voltage.

Cable Schedule No 166 Reference	Description	Motor Label Reference
TSH1	AC LINE 1	L1 or U1
TSH2	AC LINE 2	L2 or V1
TSH3	AC LINE 3	L3 or W1

### 3.3.4 Fitting the Cable Glands

The installation cables are connected into the Turning Unit via the appropriate cable glands (see earlier table). The body of the gland fits through a hole in the casting and is held in position by the Top Nut. Note the 'O' ring seal, which is fitted below the casting surface (input side). Two seals are provided with each gland as shown in Figure 1.12 below. The lower seal provides for waterproofing, and the upper for EMC. Some glands are designed to take a single cable whilst others are intended for several cables. Blanking plugs are supplied to seal unused cable entries in the glands.

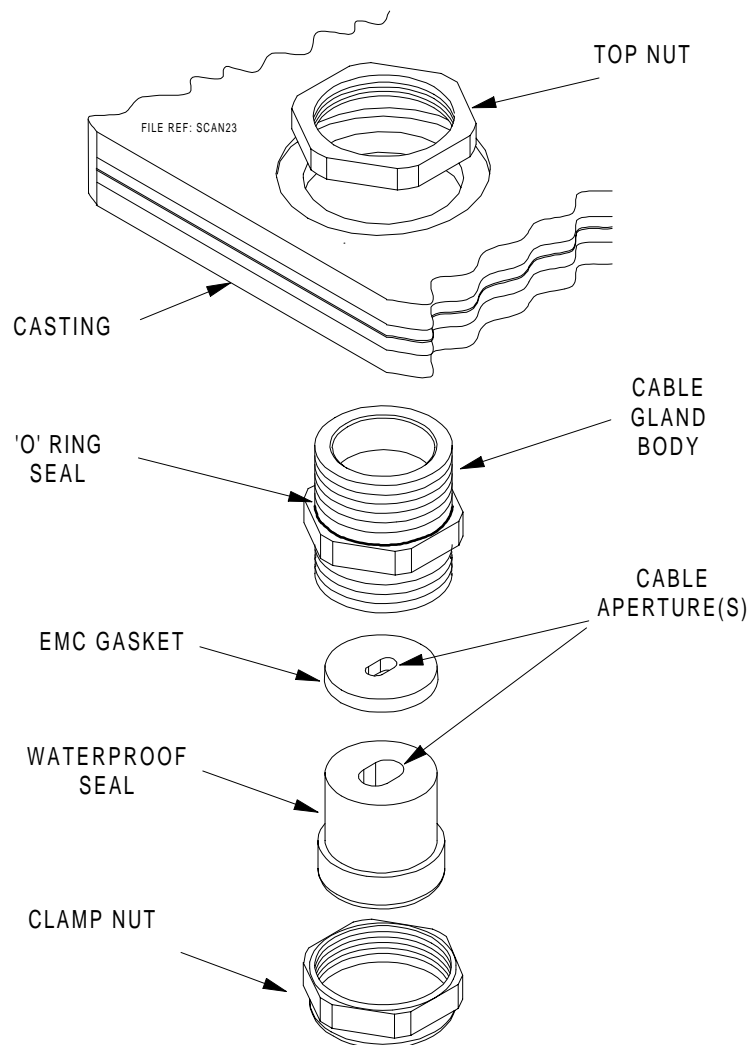


**Note** - Cable Glands and Blanking Plates are normally factory fitted to the Turning Unit.

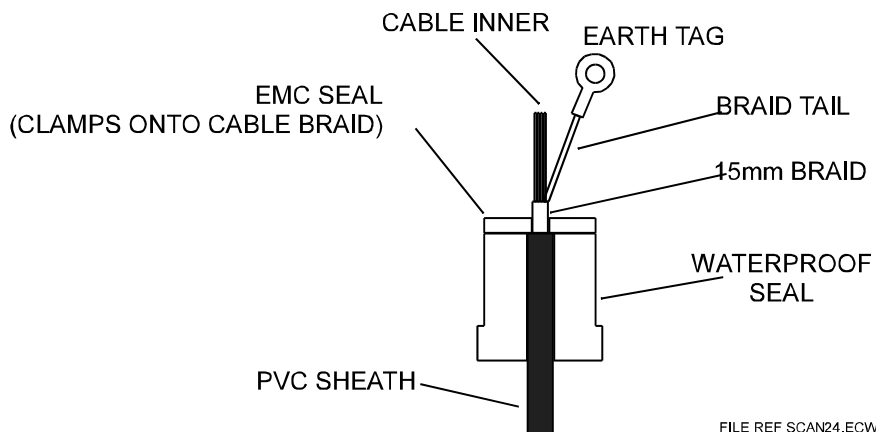
**Figure 1.12** - General View of the Cable Glands

## S-Band Scanner Units and Transceivers

The waterproofing seal works by clamping onto the cable PVC sheath whereas the EMC seal clamps onto the cable braid. **It is important not to force the outer sheath through the EMC seal, as the seal is liable to split.** The braid is also formed into a tail which is grounded by means of an adjacent earth tag. The fitting procedure is detailed in Figure 1.14.



**Figure 1.13** - Detailed view of a Cable Gland



Included within the cable gland is a waterproof seal and an EMC seal. The waterproof seal clamps around the cable outer sheath, and the EMC seal clamps around the braid. **It is important not to force the outer sheath through the EMC seal as the seal is liable to split.**

**To install the cables:**

Unscrew the gland nut and remove the waterproof seal and the EMC seal. Feed the cable through the gland nut and the waterproof seal. Strip the outer sheath to expose approximately 300mm of braid.

Push the braid back to expose approximately 50mm of the inner cores.

Trim 50mm off the inner cores, and pull the braid back over the inner cores and twist into a point.

Feed the braid through the EMC seal until the cable is positioned as in Figure 1.13

**For the multicore cables:**

Flare out the braid to within approximately 15mm of the EMC seal, and form into a tail.

**For the coaxial cables:**

Do not fit the coaxial connector at this time.

**Assembly into Turning Unit.**

Feed the assembled cables and seals into the gland body, and tighten the gland nut until the EMC seal is compressed.

Crimp the earth tags provided to the braids of the multicore cables and attach them to the earth studs adjacent to the cables. The tails should be as short as is practicable.

Trim and make off the cable inners to the appropriate terminal blocks.

Trim the coaxial cables to length and slide the plastic sleeve provided in the despatch kit over the exposed braid.

Fit the coaxial connectors, and plug them into the appropriate sockets.

**Figure 1.14** - Cable Installation Details

### 3.3.5 Performance Monitor

The Performance Monitor comprises the Performance Monitor Antenna, the Performance Monitor module, and an associated cable. The equipment is normally factory fitted.

### 3.4 S-Band Bulkhead Transceiver

The Bulkhead Transceiver 6583 IA is installed below decks in a suitable location such as the ship's equipment room. The installation should pay due regard to accessibility for maintenance and servicing, ventilation and the distance between the Transceiver and the Scanner Unit. For maximum performance, this should be kept as short as practicable, as the loss per metre of the S-Band co-ax is typically 8.3 dB per 100 metres, i.e. 1.7dB for 20 metres. This loss applies to both the transmitted RF pulse and the received signals.

The maximum permissible separation between the Turning Unit and the Transceiver Unit is 30 metres, and that between the Transceiver (or Turning Unit) and Display is 67 metres. Separation up to 300m is possible if a special low loss co-axial cable is used for the video.

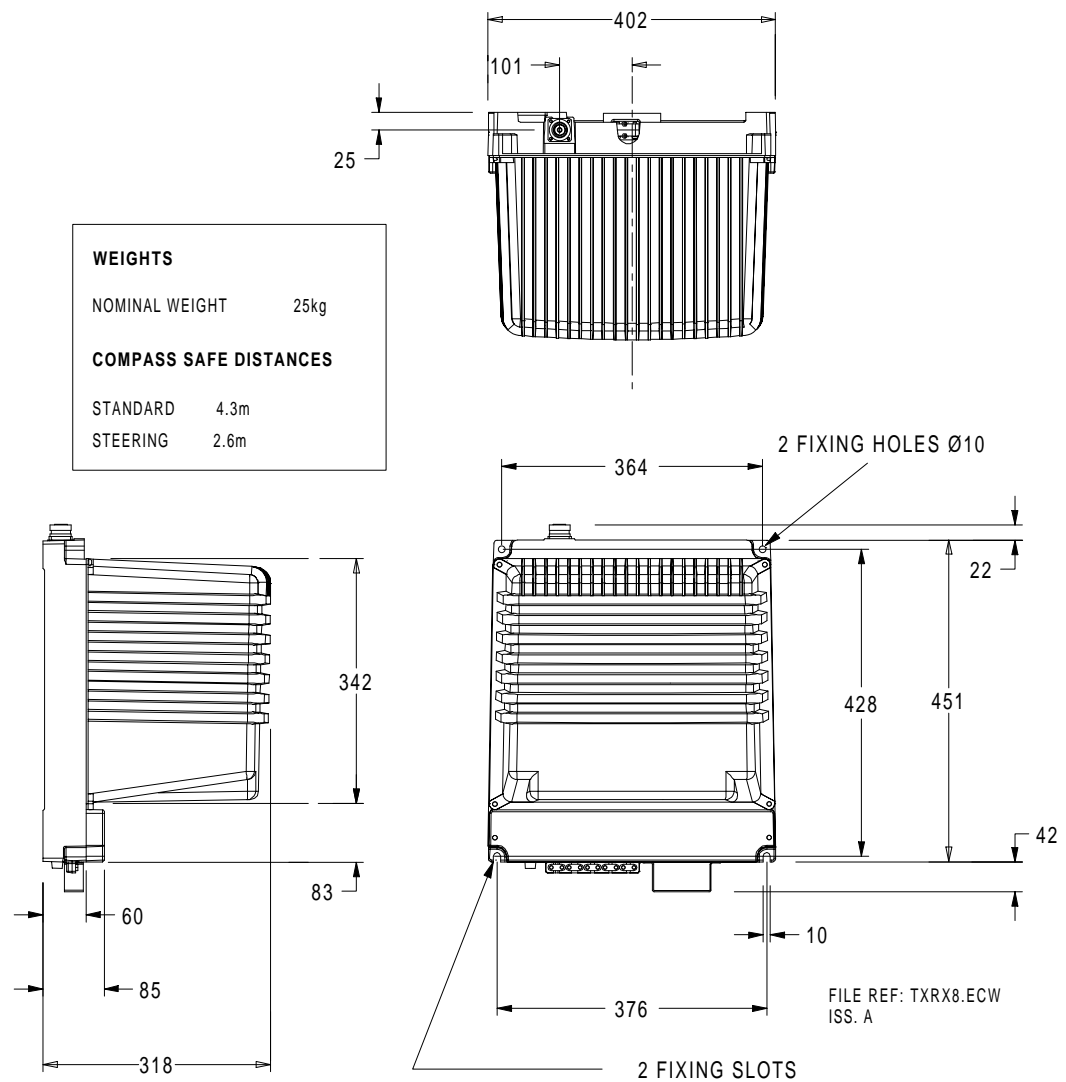


Figure 1.15 - Dimensions - Bulkhead Transceiver

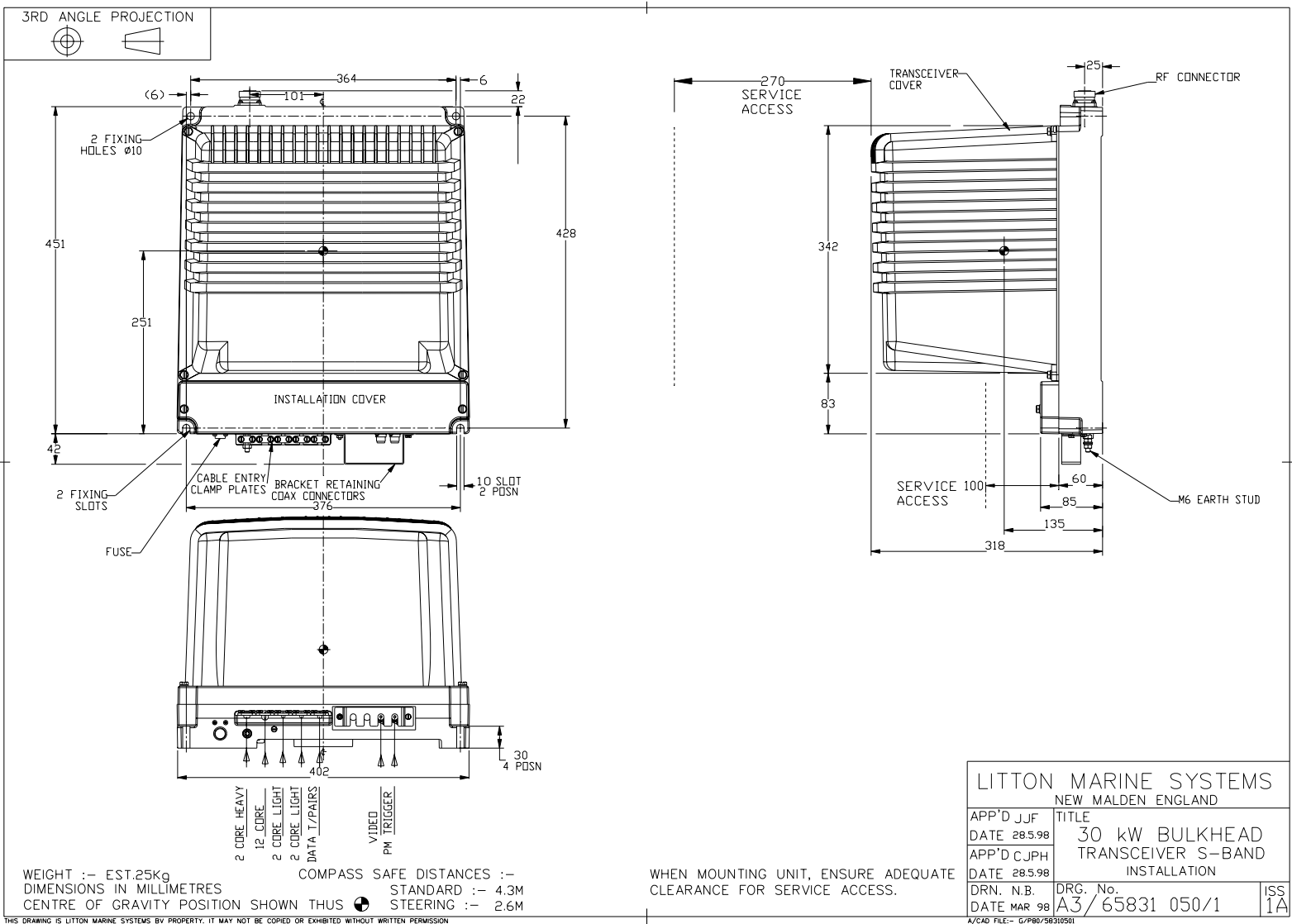


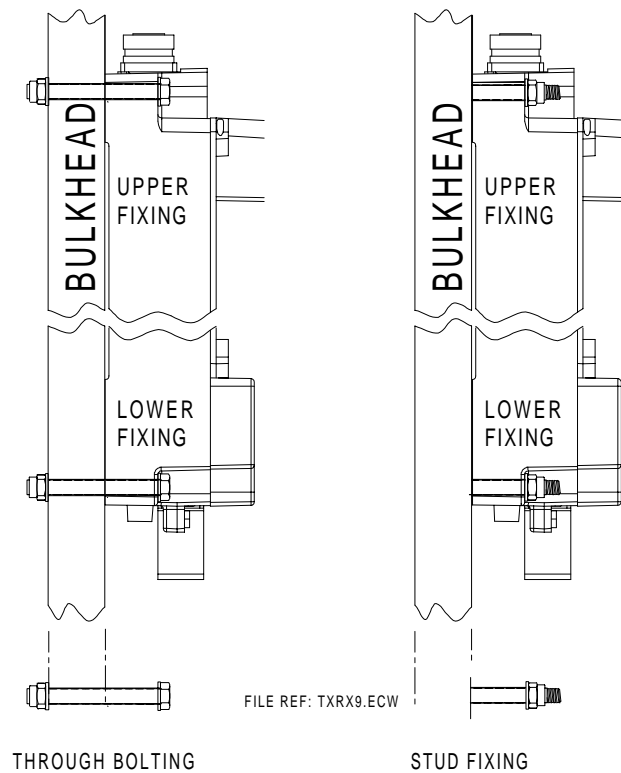
Figure 1.16 - S-Band Bulkhead Transceiver 30kW Installation

## S-Band Scanner Units and Transceivers

The Transceiver may be attached to the bulkhead by several methods. The actual method chosen will depend on individual circumstances, but due regard must be given to the likely vibration and shock loading which may be experienced. The available methods include through bolting to the bulkhead, or mounting on studs provided by the shipyard.

**Notes** - The positions of the four fixings for the unit are not on a rectangle - i.e., the horizontal spacing of the top fixings is 364mm compared with 376mm for the lower fixings.

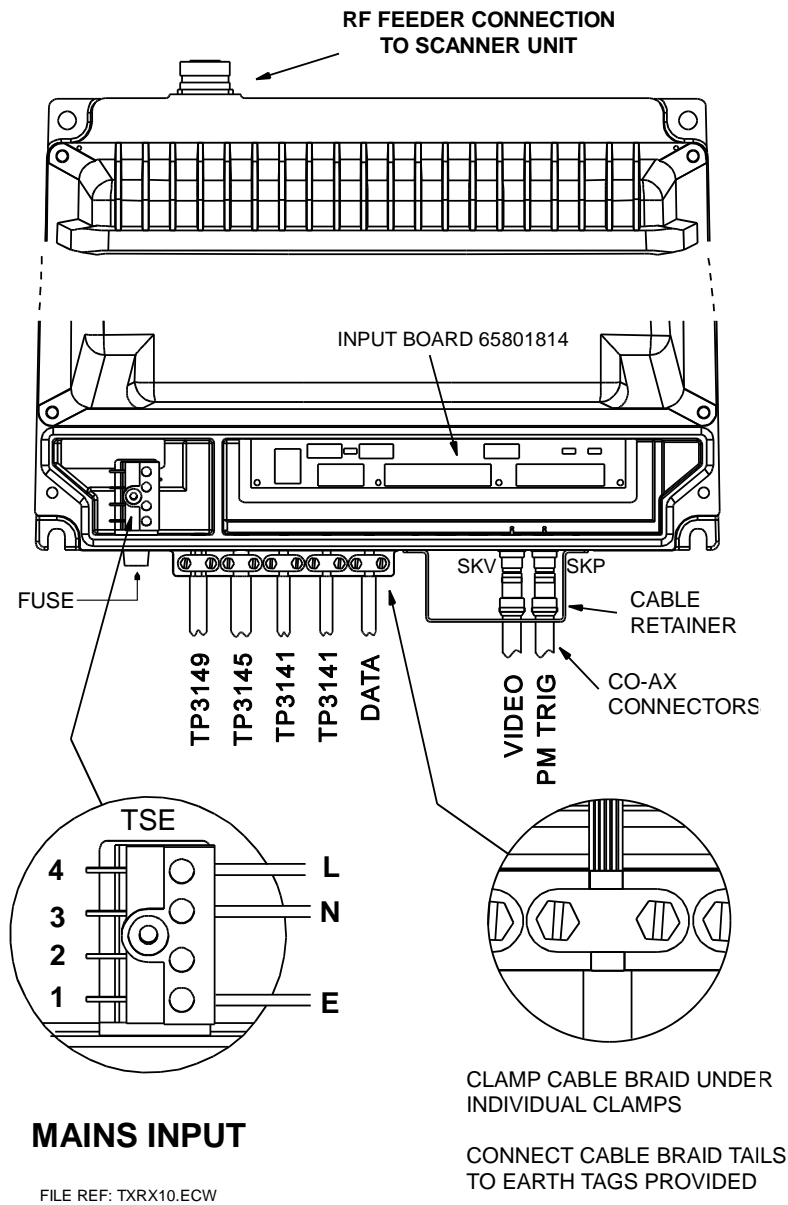
When choosing the installation location for the Transceiver, due regard must be made for the routing of the RF Feeder coax.



**Figure 1.17** - Bulkhead Transceiver - Mounting Alternatives

### 3.4.1 Cabling Information

Figure 1.18 below shows details of the cable inputs. The cable cover plate, which is secured by two fixing screws, is shown removed. Note that the co-ax cables are retained by a cable retainer which must be fitted after the cables are in place. All other cables, with the exception of the RF Feeder S-Band co-ax, are individually clamped on their cable braids to provide emc shielding. The braids are also made off as tails and connected to earth tags provided. The a.c. mains input is connected to TSE as shown.



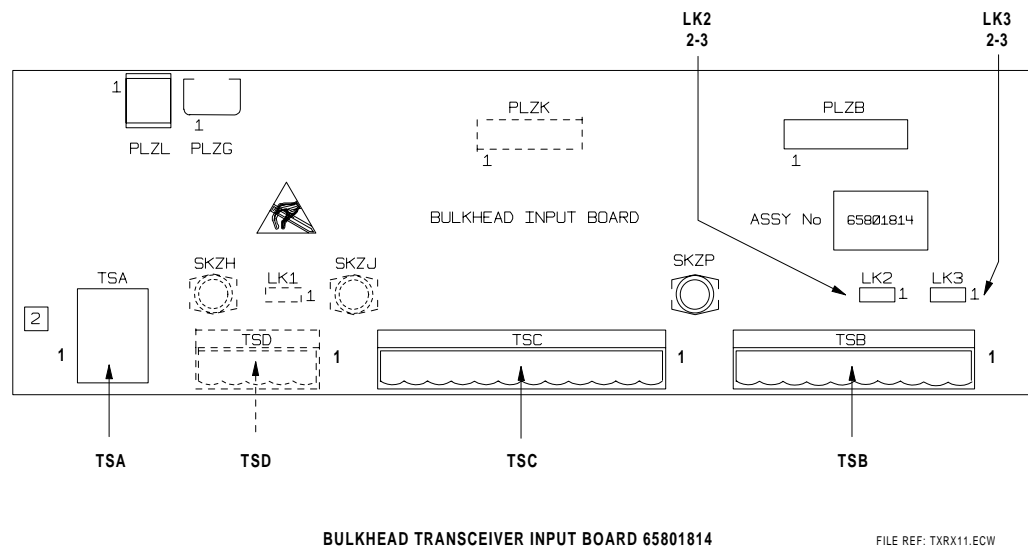
**Figure 1.18** - Bulkhead Transceiver - Cable Input Details



# S-Band Scanner Units and Transceivers

A 6mm stud is provided adjacent to the cable input clamps for bonding the unit to the ship's structure. This is an important safety requirement and the stud must not be used for any other connection.

Figure 1.19 below shows details of the Input Board 65801814. Refer to the cabling schedules for details of the connections, which are made via the two part connectors provided. Links 2 and 3 on the Input Board should be set as shown. Link 1 is not fitted.



**Figure 1.19** - Bulkhead Transceiver - Input Board Details

### 3.4.2 Fitting the R.F. Feeder Cable (S-Band Co-ax)

#### General Information

1. A radio frequency (R.F.) coaxial cable is used for the run between the Bulkhead Transceiver Unit and the Turning Unit with S-Band radars. The cable used is Andrew Antennas Heliac LDF5-50A 7/8in. 50-ohm - overall diameter 28mm (1.1in.).

(Figures 1.20 to 1.29 are reproduced by permission of Andrew Antennas).

2. Although apparently robust, the cable must be protected against strain and kinking, and must be treated with the utmost care at all times. The ends of the cable must be kept sealed against the ingress of moisture before the connectors are assembled.
3. Wherever possible, bends should have as great a bending radius as practicable. A single bend may be made when necessary with a minimum bending radius (measured from the axis of the cable) of 250mm (10in.).
4. For convenience, the upper (Turning Unit) connector can be fitted prior to installation of the cable, but due to the possibility of movement of the inner conductor relative to the outer conductor, the following precautions must be taken:-
  - 4.1 Any bend required within 1m (3ft) of the cable end must be preformed before carrying out the cutting and assembly procedure detailed in subsequent paragraphs. Note that no bend may be nearer that 250mm (10in.) from the end of the cable (see para 8.1)
  - 4.2 To allow for relative movement between the Turning Unit and mast, whenever possible a double bend should be formed in the cable so as to produce an offset immediately below the Turning Unit.
  - 4.3 The cable and assembled connector should be fitted to the Turning Unit so that a minimum amount of distortion of the cable occurs between the connector and the pre-formed bend.
  - 4.4 The cable should be installed and secured in position (using the waveguide supports shown in Figure 1.29) as far as is practicable before the lower (Transceiver Unit) connector is fitted to the cable. The precautions given in sub-para. 4.1 above must be observed if a bend is required adjacent to the Transceiver Unit.

## ASSEMBLING THE CONNECTORS

**General**

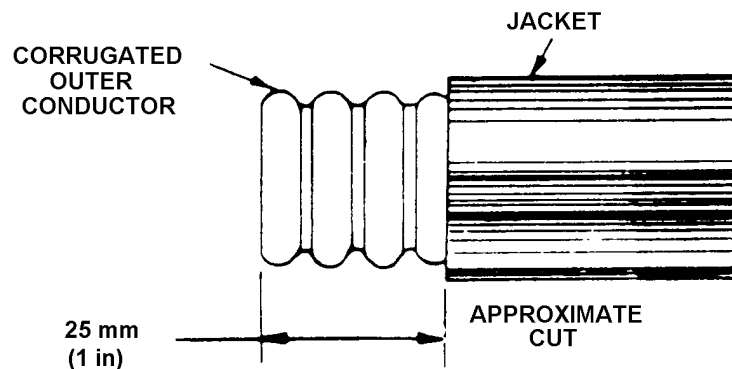
5. A straight connector (Type L45DM) is used to terminate the feeder cable at each end.

**Tools required**

6. The normal tools found in an Engineer's tool kit, plus a hacksaw (with a fine-toothed blade) and 1 1/4 in. open-ended spanners, will be sufficient for fitting the connectors to the cable.

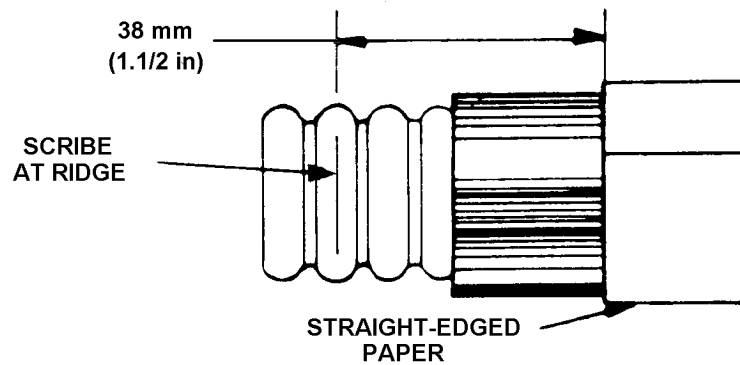
**Procedure**

7. The procedure which follows is applicable to the straight connectors at each end of the feeder cable. Note that it is most important that swarf and other foreign matter should be prevented from entering the cable.
8. Prepare the cable end and assemble the connector as follows:-
  - 8.1 Ensure that the end of the cable is straight for at least 10 in. (250mm). Using a knife, remove approximately 1 in. of the jacket. Deburr the sharp end of the cut outer conductor (see Figure 1.20).



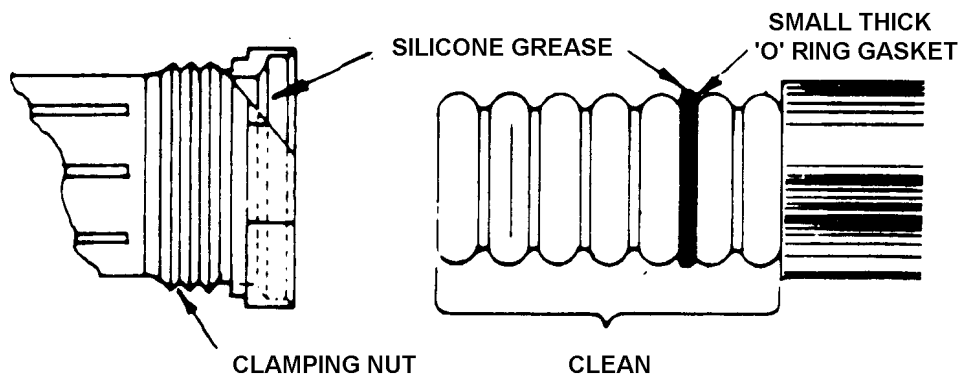
**Figure 1.20** - Preparing the Cable

- 8.2 Scribe a line on a ridge of the exposed corrugated outer conductor (Figure 1.21). Using a straight-edged piece of heavy paper, wrapped around the cable as a cutting guide, remove the jacket to the dimension shown in Figure 1.21.



**Figure 1.21** - Second Jacket Cut

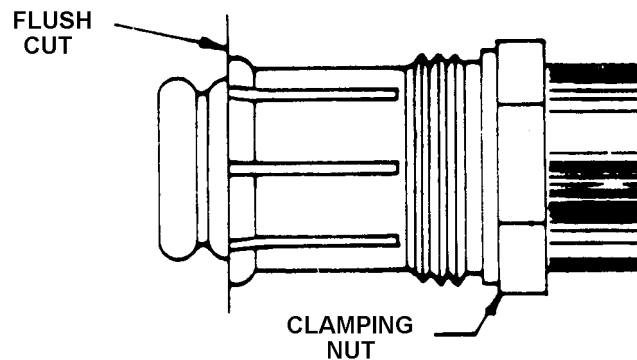
- 8.3 Clean the outer conductor with solvent and then add the small thick O-ring gasket to the second fully-exposed corrugation groove from the jacket (see Figure 1.22). Apply a thin coating of silicone grease to the outer surface of the gasket and the gasket lead chamfer in the clamping nut, using the finger tip.



**Figure 1.22** - Installing the Gasket

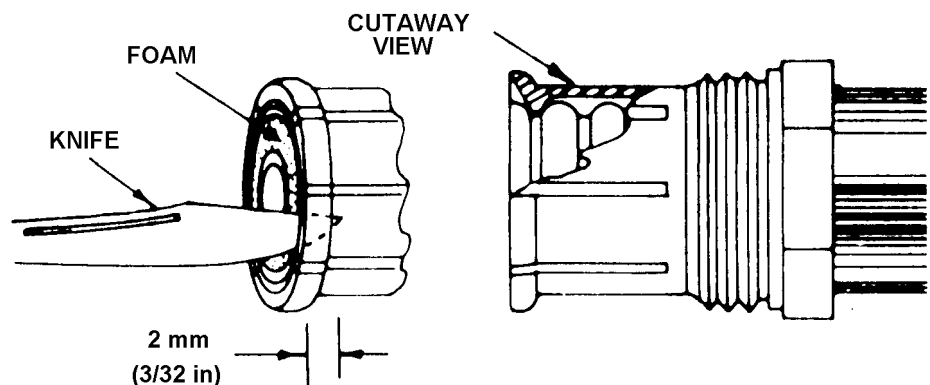
## S-Band Scanner Units and Transceivers

- 8.4 Push the clamping nut onto the cable, using a twisting motion to ensure that the spring contacts snap into the first groove (see cutaway view in Figure 1.24). Grip the clamping nut with one hand and align the edge with the line scribed in sup-para. 4.2 above. Using a hacksaw with a fine-toothed blade, carefully cut the cable flush with the end of the clamping nut (see Figure 1.23).



**Figure 1.23** - Adding the Clamping Nut and Cutting the Cable

- 8.5 Using the tip of a knife, work around the entire circumference separating all foam completely from the edge of the outer conductor. This is to ensure a good electrical contact between the outer conductor and the outer body of the connector. (See the enlarged cutaway view in Figure 1.25 which (at the arrow) shows the eventual positive grip of the outer conductor between the clamping nut and the outer body of the connector).
- 8.6 Use a knife to remove all burrs from the inside edges of the outer and inner conductors. Use a wire brush or scraper to remove all copper particles from the foam (Figure 1.23).

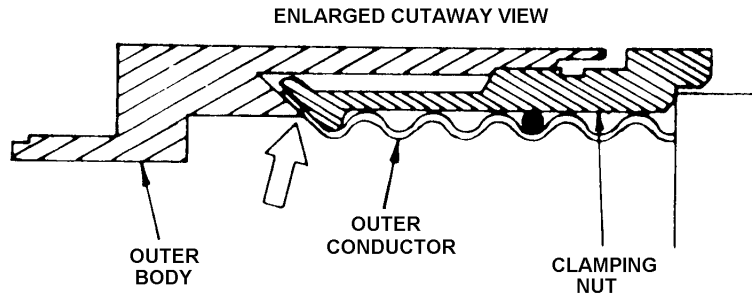


**Figure 1.24** - Detaching Foam and Removing Burrs

# Chapter 1

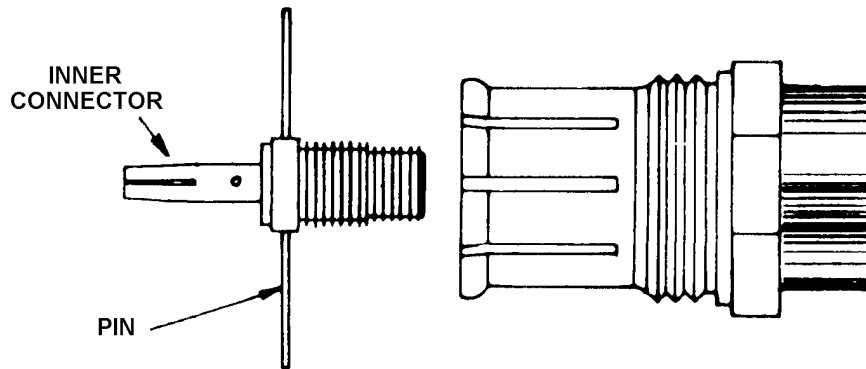
## S-Band Scanner Units and Transceivers

- 8.7 Screw the outer body on to the clamping nut and tighten with the 1 1/4in. spanners. Hold the clamping nut and turn the connector outer body; do not turn the clamping nut. Unscrew and remove the outer connector body and inspect the end of the outer conductor for good metal-to-metal contact (Figure 1.25).



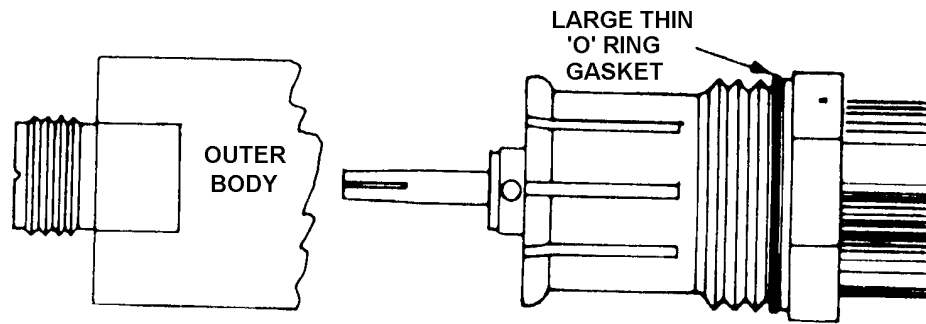
**Figure 1.25** - Enlarged Cutaway View

- 8.8 Place a 'pin' through the hole in the self-tapping inner connector (Figure 1.26) and use it as a 'tommy bar' to tap the connector into the inner conductor. To aid tapping, use a small amount of solvent as a lubricant. If tapping becomes difficult, 'back off' the inner connector after every few turns. Tap until the inner connector 'bottoms' against the inner conductor and then tighten. Remove the 'pin' from the inner connector.



**Figure 1.26** - Installing the Inner Connector

- 8.9 Place the large thin O-ring in the gasket groove in the clamping nut (Figure 1.27) and coat the outer surface of the gasket lightly with silicone grease. Screw the outer body of the connector on to the clamping nut and tighten with spanners. Turn the outer body only; do not turn the clamping nut.

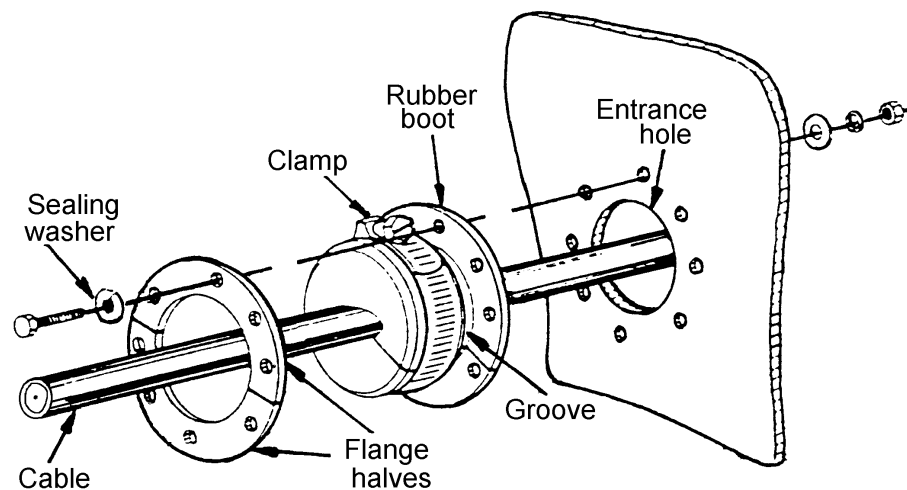


**Figure 1.27** - Installing the Outer Body

#### FITTING THE DECK GLAND

9. The 7/8in. R.F. feeder cable passes through its own separate deck gland (Andrew Feed-Thru Kit Type 40656-1), positioned near to the foot of the mast. The gland kit comprises a rubber boot, metal flange halves, eight Lock-o-seal washers and an adjustable clamp (Jubilee clip). In addition eight 1/4in. bolts (of a suitable length), flat washers, lock washers and nuts will be required. See Figure 1.28.
10. To fit the deck gland proceed as follows:-
  - 10.1 Cut a 75mm (3in.) diameter hole in the deck and, having installed and secured the cable from the Turning Unit downwards, pass the Transceiver Unit end down through the hole.
  - 10.2 Apply silicone grease to the hole and to the slit and tapered edge of the rubber boot.
  - 10.3 Place the boot around the feeder, slide the boot down into the hole in the deck and then mark the location of the eight holes for the fixing bolts.
  - 10.4 Withdraw the boot from the hole and drill eight 8mm (5/16in.) mounting holes through the deck.
  - 10.5 Slide the boot back into the hole in the deck and position the flange halves in the groove in the boot.

- 10.6 Align the flange holes with the boot holes and secure the assembly in position with eight 1/4in. bolts, flat washers, lock washers and nuts, together with the Lock-o-seal washers provided in the gland kit. Note that the bolts are inserted downwards and that the Lock-o-seal washers only go under the bolt heads.
- 10.7 Fit the adjustable clamp (Jubilee clip) around the boot and tighten to ensure a leakproof seal.

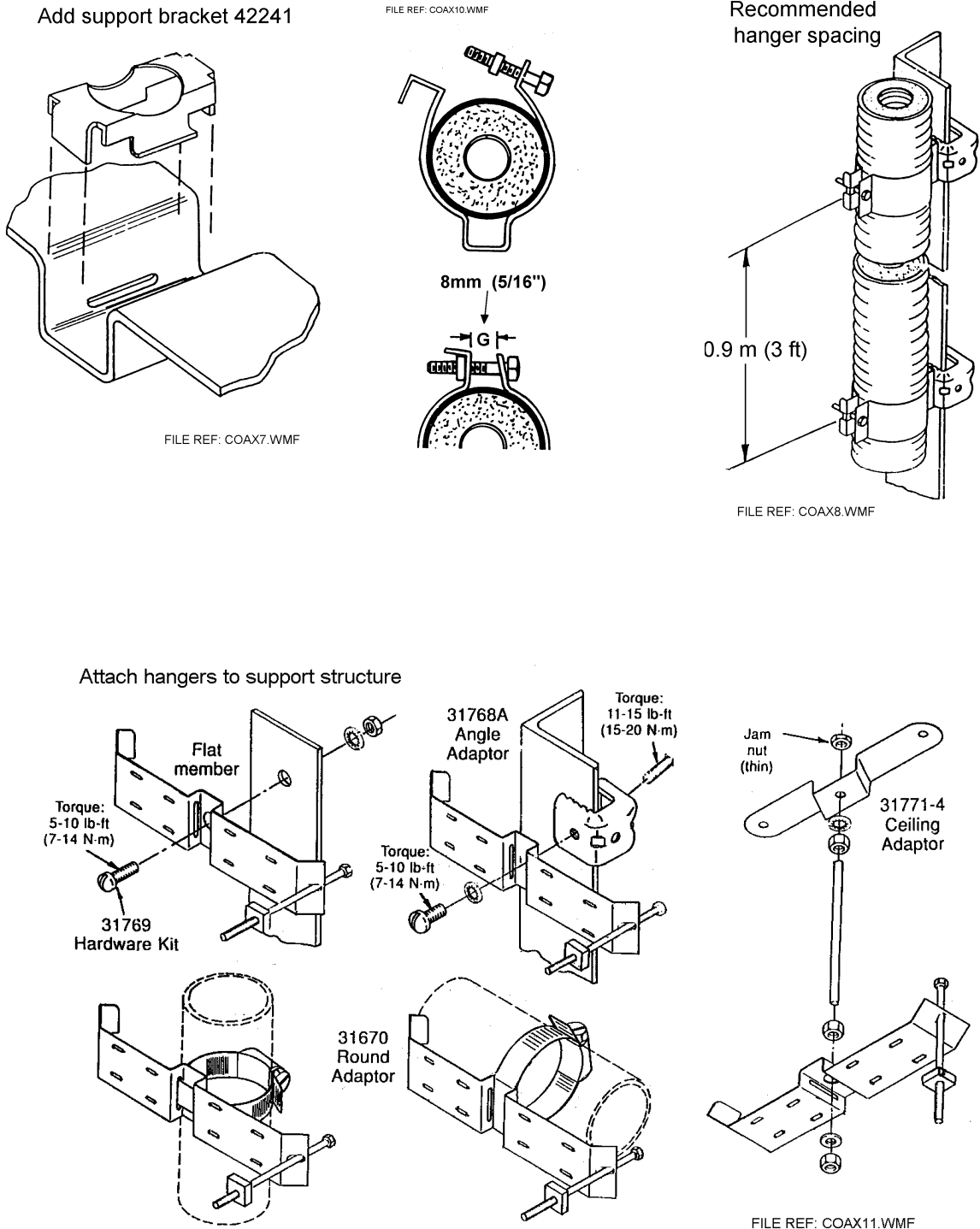


**Figure 1.28** - Deck Gland Details

### INSTALLING THE CABLE

1. Cable Hangers are supplied (Andrew Hanger Kit Type 42396A-5) for supporting the cable along the cable run between the Scanner Unit and the Bulkhead Transceiver. Each kit contains 10 Hangers plus their associated Support Brackets (Andrew Type 42241). Normally, a hanger is attached to a cable tray, using suitable bolts, at a recommended spacing of 0.9 metres (3 feet). The support brackets must be fitted to the hangers to prevent distortion when the hanger is wrapped around the coax as shown in Figure 1.29.
2. Figure 1.29 also shows additional hardware (not supplied in the Installation Kit) which facilitate special mounting arrangements. If required, these are obtainable from Andrew Corporation.





**Figure 1.29** - Deck Gland Details

### **3.5 Initialisation and Commissioning**

The S-Band Scanner Unit and Transceiver are only part of a complete BridgeMaster E Series Radar, and cannot be operated independently. For details of complete system installations refer to the BridgeMaster E, Ship's Manual 65800010B.

After a complete system has been installed it must be Initialised and Commissioned as detailed in Chapter 4 of the BridgeMaster E, Ship's Manual 65800010B.

## 5 Technical Description

### 5.1 Start-up Sequence (S-Band)

The start-up sequence described below, should be read in conjunction with Figure 1.33 'S-Band Turning Unit Schematic'.

#### 5.1.1 Start-up

**Important Notice** - Once mains is applied to the PSU board the Power Factor Correction (PFC) circuitry starts and generates 390V. It should be noted that whilst mains is applied the PFC is active and cannot be manually switched off. The start circuitry only controls the flyback converter so High Voltage DC is present on primary power components whenever mains is present on the board. **This fact should be noted when servicing the Transceiver.**

The Power Supply in the Transceiver is only active during normal operation when there is a Display (or Compatibility Unit) connected to it. The RS422 serial data stream from the Display is used to drive an opto-coupler in the PSU which detects the presence of either polarity voltage and enables the flyback converter in the PSU.

The RS422 serial data stream from the Display enters the Input Board on connector TSB 1, 2 as "DU DATA+ and DU DATA-". It is then passed to the Trigger Board via PLYB 16, 17, and then on to the PSU via PLTH 11, 12 (as PSU START and PSU START RTN). For test purposes the PSU can be turned on in the absence of a serial data stream by linking pins 1-2 on LKA (PSU).

#### 5.1.2 Transmit Enable

When the operator selects Transmit, the TU Enable signal is activated LOW on the Trigger PCB ( PLYH 10). On the S-Band Scanner Unit, this signal is fed via the Power Supply Unit to the Input PCB and (via TSB 10) to the Scanner Control Unit to start the antenna rotating. Once the antenna has done one complete revolution transmission is started. When standby is selected, transmission is immediately halted and, after one complete revolution of the antenna, TU Enable is disabled.

The Modulator starts to generate radar pulses when the Trigger PCB sends it MOD TRIGGER pulses (to PLVC 9). Note that the CHARGE TRIGGER pulses (on PLVC 8) are present even in Standby mode.

A signal indicating that the Magnetron has fired is fed via MAG SAMPLE from PLVC 7 on the Modulator PCB to the Trigger PCB. This signal is processed on the Trigger PCB and outputted as TX TRIG (PLYB 20 & 21) to the Input PCB (PLZB 20 & 21) and then to the Display Unit via TSB 5 & 6.

**Note** - TX DATA is sent from the Transceiver to the Display Unit.  
DU DATA is sent from the Display Unit to the Transceiver Unit.

The Trigger PCB processes the serial data input from the display, and generates the required control signals for the Transceiver. The data is transmitted each time a bearing pulse is received from the Turning Unit. The various timing signals required by the Transceiver including the Pulse Repetition Frequency (PRF), are generated by the Trigger pcb.

### 5.1.3 Transmitter Operation

The high-voltage negative pulses required to drive the magnetron are generated by the Modulator PCB. The modulator pulse widths are selected by the Trigger pcb but are defined by the Modulator pcb. Timing signals are controlled from the Trigger pcb. A spark gap on the Modulator is fired if the magnetron fails to operate. Continual operation of the spark gap is detected and a signal is fed back to the Trigger pcb, as the spark gap detect signal.

When the spark gap detect signal reaches approximately 2.5v, the microcontroller inhibits transmission for approximately one second. On detection of this signal, the Trigger pcb switches the radar to Standby, and generates an error signal which is transmitted to the Display Unit via the serial data link.

When Standby is selected, rotation of the Antenna is inhibited. Unless in Test Mode, transmission from the radar is inhibited if the Antenna is not rotating.

On the Trigger PCB, there is a timer circuit which is basically a capacitor that slowly discharges (between 4s and 18s) when power is removed from the PCB. On power-up the microcontroller measures the charge remaining on the capacitor to determine whether the transceiver has been switched off for long enough to warrant inhibiting transmit for three minutes until the magnetron heaters have had time to warm up again.

The other analogue signals into the Trigger PCB come from the Modulator. The Modulator supply voltage and the magnetron current (only when transmitting) are measured and sent to the Display as an aid to fault finding.

## 5.2 Trigger PCB (S-Band)

### 5.2.1 General Description

The Trigger PCB controls the operation of the Transceiver under instruction from the Display. There are two serial links, which are used to transfer control messages from the Display to the Trigger PCB and Transceiver information back to the Display. The Trigger PCB generates the control and tuning signals required by the Modulator, Receiver, Performance Monitor and Biased Limiter. The PSU is enabled with a signal from the Trigger PCB.

### 5.2.2 Signals To/From the Trigger PCB

#### To/From Display

- Serial Data to Display
- Serial Data from Display
- Trigger to Display

#### To/From Modulator

- Pulse Length select lines
- Charge and Modulator Triggers
- Magnetron Heater Turndown signal (only used for S-Band, Long Pulse operation)
- Voltage/Current Monitor signals

#### To/From Receiver

- Tuning Voltage signal
- Bandwidth Control signal
- AFC/Manual control
- AFC Trigger
- Tune Indicator signal

#### To Biased Limiter

- Trigger signal

#### To Performance Monitor

- On/Off signal
- Mode Control signal
- Tuning Voltage signals

#### To/From Power Supply PCB

- +30V, +12V, +5V, 0V & -12V Supply lines
- Turning Unit Enable
- Power Supply Start and Return

### 5.2.3 Functional Description (S-Band Trigger PCB)

The 80C51 family microcontroller provides overall control of the Trigger PCB functions. Program memory and RAM are included within the microcontroller IC. Serial I/O is handled by the microcontrollers internal UART and an external RS422A driver and receiver. Baud rate is fixed at 76800 baud for operational use but is link selectable to 19200 or 38400 baud for test purposes. The serial data format is 8-bit data, 1 stop bit and even parity.

The Display sends serial messages comprising four or five characters depending on message content. Control messages are four bytes long and tuning messages are five. The tuning voltage levels are sent as 12-bit values which are converted on the Trigger PCB using a four-channel DAC before amplification/buffering and distribution to the Receiver and Performance Monitor.

The Bearing signal from the Turning Unit is used to initiate serial transmission from the Trigger PCB such that each time one of the 4096 azimuth pulses per rev is generated and fed into one of the microcontrollers interrupt pins, a character (one byte) is sent to the Display. One bit in each of the characters sent is dedicated to the heading marker, on every new heading marker pulse from the Turning Unit, the bit is toggled.

The Power Supply in the Transceiver is only active during normal operation when there is a Display (or Compatibility Unit) connected to it. The RS422 serial input from the Display is used to drive an opto-isolator which detects the presence of either polarity voltage and enables the PSU.

#### Trigger Outputs

There are a number of trigger signals generated by the Trigger PCB:

- Pre-Trigger (optional)
- Charge Trigger
- Modulator Trigger
- Display Trigger
- Performance Monitor Trigger
- AFC Trigger
- Swept Attenuation Initiate

The Charge Trigger is the timing signal used to recharge the Modulator PFN. This is generated by the microcontroller using an internal timer routine set to the appropriate PRF for the pulse length selected. A wobble factor is added to the basic timing to ensure that no two radar transmissions are locked together. The wobble is calculated according to the number of serial messages received before going to transmit and the position of the antenna between each trigger pulse.

An optional Pre-trigger will be produced approximately  $11\mu\text{s}$  before the modulator trigger. This is not a normally fitted option and is intended for use in Special Options applications.

The Modulator Trigger is used to discharge out the PFN into the magnetron and is the trigger that initiates the modulator firing. The PFN is recharged by the Charge Trigger pulse which follows  $100\mu\text{s}$  after each Modulator Trigger pulse. In standby mode, the Charge Trigger pulse is still generated, but the Modulator Trigger pulse is gated off.

In standby, the Display and Performance Monitor Triggers are generated from the Mod Trigger pulse. When the transceiver is in transmit mode the triggers begin on the leading edge of the magnetron sample pulse and end after a preset time, adjustable using RV1.

The AFC Trigger is used by the receiver when in AFC mode and is only generated when the transceiver is in transmit mode. The pulse is started on the front edge of the Modulator Trigger and terminates on the back edge of the magnetron sample pulse.

The Swept Attenuation Initiate pulse is the timing signal fed to the Limiter Drive PCB which generates the control for the biased limiter. It is initiated by the front edge of the Pre-trigger (approximately  $2\mu\text{s}$  prior to magnetron firing) and terminated  $2.5\mu\text{s}$  after the leading edge of the magnetron sample pulse.

The Display and PM Triggers are essentially the same trigger and are present at all times when the radar is powered up. They are initiated by the Modulator Pulse and last for approximately  $2.5\mu\text{s}$ .

### **Analogue Outputs**

The Trigger PCB generates four variable DC signals; LO Tune, PM Tune, Xr Adjust and Xt Adjust. These signals are coded as 12-bit digital values and incorporated into the serial messages from the Display. A 12-bit, four channel DAC is used to generate the signals from the message data. Additional buffering is added to the LO and PM Tune outputs of the DAC and x3.5 amplification to the Xr and Xt Adjust signals.

LO Tune is the 0V to +5V receiver tuning signal, and PM Tune the 0V to +5V Performance Monitor tuning signal. Xr and Xt Adjust are 0V to +1.5V signals used to control the receive and transmit attenuators in the Performance Monitor.

### **Analogue Inputs**

There are various analogue inputs to the Trigger PCB from other PCBs in the transceiver and some on-board signals that are fed into an eight channel 8-bit ADC, and converted to digital values either for further processing by the microcontroller or to be passed to the Display via the serial message link.

The signals on the Trigger PCB that are measured are the dropout timer and +12V and +30V supplies. The timer circuit is basically a capacitor that slowly discharges (between 4s and 18s) when power is removed from the PCB. On power-up the microcontroller measures the charge remaining on the capacitor to determine whether the transceiver has been switched off for long enough to warrant inhibiting transmit for three minutes until the magnetron heaters have had time to warm up again. The power supply levels are measured and the results sent to the Display as an aid to fault diagnosis.

One channel of the ADC is used to detect whether a Performance Monitor has been fitted to the system. The voltage on this channel will be lower than a preset value if a Performance Monitor is present otherwise it will be pulled to the +5V supply rail. This information is encoded and sent as part of the configuration message to the Display.

The Receiver sends a tune indicator signal to the Trigger PCB which indicates how close it is to being on tune. This signal is coded as part of the serial message and sent to the Display.

The other analogue signals into the Trigger PCB come from the Modulator. The Modulator supply voltage and the magnetron current (only when transmitting) are measured and sent to the Display as an aid to fault finding. The spark gap detect signal is generated by the modulator when the spark gap arcs over, if it reaches a predetermined level the microcontroller inhibits transmission for approximately one second and sends an error message to the Display.

### **Digital Outputs**

The digital outputs from the Trigger PCB are all straight forward on/off control signals to various parts of the transceiver.

Signals to the Receiver select wide or narrow bandwidth (Wideband) and AFC or manual tuning mode (AFC On). Narrowband is selected when the modulator is transmitting in long pulse and briefly during pulse length changing. AFC or manual mode is selected by the radar operator and is part of the control message sent from the Display.

Modulator signals MP and SP are used to set the pulse length as requested by the radar operator, SP set to 0V indicates short pulse operation, MP set to 0V indicates medium pulse operation and both SP and MP set to +5V indicates long pulse operation. SP and MP both set to 0V is an illegal state and will not happen in normal operation. Turndown enable is used to reduce the heater current in the magnetron and is only set when an S-Band magnetron is fitted and is transmitting in long pulse.

The control signals PM On/Off and PM Tx/Rx are used to switch the Performance Monitor on and to switch it between system test mode and receiver test mode.

TU Enable is the control signal fed to the Motor Drive PCB to initiate rotation of the antenna. When the operator selects transmit the TU Enable signal is activated to start the antenna rotating.

Once the antenna has done one complete revolution transmission is started. When standby is selected, transmission is immediately halted and, after one complete revolution of the antenna, TU Enable is disabled.

### **Optional I/O**

There are several optional I/O signals for use with Special Options variants of the PCB; Pre-trigger (as described in the section on triggers), External Trigger Input and Radar Inhibit. The External Trigger input is used when the modulator needs to be triggered from an external source rather than the Trigger PCB. Trigger signals fed to this input are prf limited to prevent



damage to the modulator. Radar Inhibit is a method of inhibiting transmission without using the appropriate command in the serial message. An active signal at this input will cause the microcontroller to inhibit transmission within one trigger pulse at either of the internal prfs.

### **Built In Self Test (BIST)**

The microcontroller performs a number of self test operations and reports the results to the Display as part of the serial message link. Error situations that are monitored in the transceiver are; serial message corruption, loss of Display messages, loss of Heading Marker signal, loss of either Charge or Modulator Trigger and spark gap arcing. Error situations will in all cases cause the microcontroller to inhibit transmission until the error has been cleared. The other signals that are monitored and sent directly to the Display without further action by the microcontroller are the power supply lines and magnetron current as described in the section on analogue inputs.

### **Test Modes**

There are two test modes for the Trigger PCB. The production test mode is used solely during production testing of the PCB and is initiated by fitting the test link LK4. This must only be done on the production test bed as connecting this link when incorporated into a transceiver could lead to unpredictable and possibly dangerous operation.

The second test mode, of use to service engineers can be initiated by fitting the two links LK5 and LK6 to position 2-3. When in this mode the transceiver can be operated without the antenna rotating, and may be removed from the turning unit, reconnected to the Display below decks (with suitable test cables) and run as per normal operation. Fitting the links causes the Trigger PCB to generate bearing and heading marker data internally, allowing the transmitter to operate without the antenna rotating. A dummy load **MUST** be connected to the RF output. Since the Transceiver has been removed from the Turning Unit and the Pulse Bearing PCB outputs, the bearing and heading marker information normally required for Trigger PCB operation is simulated on a section of test circuitry on the Trigger PCB.

### 5.3 Transceiver Power Supply (S-Band)

#### 5.3.1 General Information

The power supply is an AC to DC inverter that generates the supplies for the Transceiver. The inverter is housed on a single board and is powered by an AC supply of nominal 115V or 230V in the frequency range 47-64Hz.

The power unit uses a boost converter front end to provide a regulated high voltage d.c. to a flyback converter providing the output supplies. Some of these supplies use additional switch mode converters to provide regulated outputs.

The outputs supplied by this power supply are:-

Variable -600V, +30V, +20V, magnetron heaters (via further regulator, +12V, -12V and +5V) and for the X-Band Turning Unit variant, +50V for the Motor Drive pcb.

The power unit has the following features:

- -600V adjustable over the range -550V to -650V for control of magnetron current via modulator.
- Output short circuit protection.
- Universal input from 95V to 276V without tap changing. Power factor corrected providing a PF of better than 0.9.

#### 5.3.2 Functional Description (S-Band Transceiver Power Supply)

The following functional description is based on the block diagram given at Figure 1.30.

##### Principles of Operation

This power supply utilises a boost converter to provide approximately 390V d.c. to the main flyback converter which drives the power transformer T2. The principles of operation are as follows:

The incoming AC supply is filtered mainly to suppress noise emitted from the p.s.u. but also to attenuate incoming noise. Mains is then passed to the power factor controller which converts mains between 95V to 276V RMS to a stable high voltage d.c. (390V). The p.f.c. takes the form of a boost regulator which forces the input current to follow the waveshape of the input voltage as if a resistor were connected across the rectified AC supply. The p.f.c. also aims to regulate the output voltage to a level greater than the peak supply voltage. These factors are achieved by the control circuit (U3) which senses the input and output voltage as well as the input current. The control circuit sends a stream of constant frequency but varying width pulses, to the switching FET (Q1) such as to control the input current and output voltage.

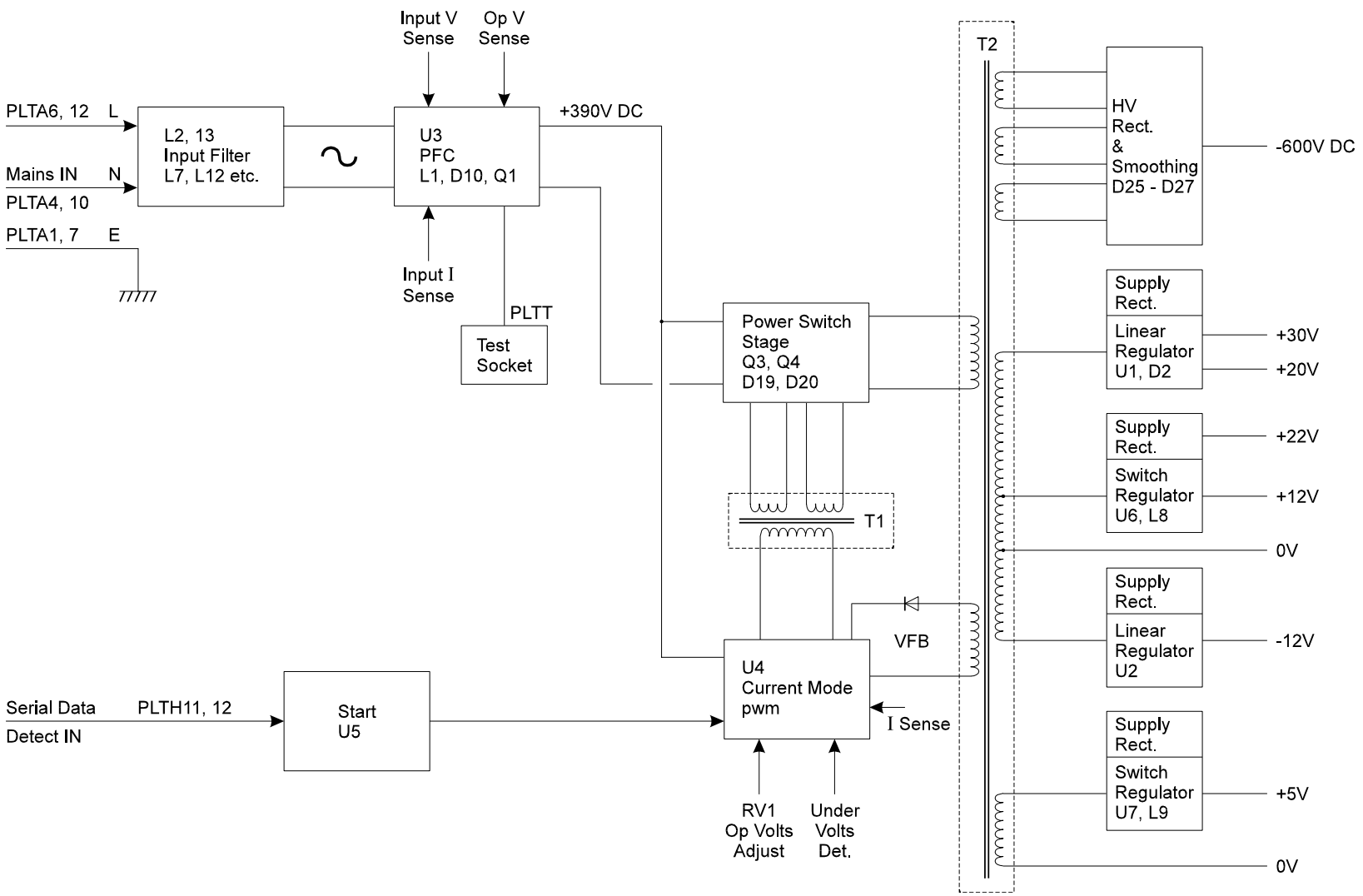


Figure 1.30 Block Diagram - Power Supply Board

The choke (L1) current increases during the FET on period and falls during the FET off period when the boost diode D10 conducts. This produces a triangular current waveform at 100kHz superimposed on the sinusoidal current in the choke. At full load this triangular current may be 10% of the actual peak current. The High Voltage DC (390V) is applied to the main Current Mode power converter comprising U4, Q3, Q4 and T2.

The high voltage DC line is switched to the primary of transformer T2 by the two FETs Q3, and Q4, These FETs are driven by the control circuitry (U4) such that they will both be either 'on' or 'off' together. Flyback action takes place during the off state. A small drive transformer T1 is used to provide the simultaneous but isolated drives to the two FET switches. The cross-connected diodes D19, D20 return excess flyback energy to the supply lines and provide hard voltage clamping of the FETs at a value of a diode drop above and below the supply line voltages. Switching devices with a 500V rating can be used. Energy recovery action of D19, D20 eliminates the need for an energy recovery winding or even snubbing components. Output current is fed back to U4 via sense resistor R47 which stabilised the control circuit and provides overcurrent protection under fault conditions. A further control winding provides a voltage feedback path via D32 which is used to supply power to U4 and regulate the voltage output.

### DC Outputs

All output voltages are taken from the secondary winding of T2. A series of rectifiers, reservoir capacitors, linear and switch mode regulators are connected to the secondary windings of T2 to provide the following DC voltage outputs.

1. -600V	120mA max.	Modulator HT
2. +30V	20mA max	Tuning Range
3. +20V	15mA max.	Drive to IGBTs
4. 20V(approx:)	0.7A	to magnetron heaters via a switch mode step down regulator.
5. +12v	1.5A	Rx, trigger board modulator
6. -12V	0.6A	Rx, trigger board modulator
7. +5V 0	5A	Rx, trigger and pulse bearing board

As the modulator requires HT voltage that can be varied over 550V to 650V to set up the correct magnetron current, all outputs have to be further regulated to ensure stability. Adjustment of RV1 sets the required modulator HT voltage and thus the required magnetron anode current.

To produce the 600V d.c. HT, three windings on the secondary of T2 each produce 200V and are added together at the output of the rectifier circuits. The 30V and -12V rails are fed via three terminal linear regulators whilst the 20V is Zener stabilised. The +12V and +5V rails are fed via 'simple switches' five terminal regulators and chokes with flywheel diodes.

The flyback current mode converter formed by U4, Q3, Q4 and T2 is started by detection of a serial data stream applied to U5 from the display at PLTH 11, 12. On detection of the data stream the photo transistor within U5 is turned on pulling down the gate of Q2 below its threshold voltage.

Q2 turns off allowing the compensation pin 1 U4 to rise enabling output of the IC U4. In the PSU off state Q2 is held on by current in R37 from Vcc.

In the absence of a serial data link from the display, for test purposes, LKA 1-2 can be made and the p.s.u. will output the required d.c. voltages.

The operating frequency of the PFC section is approximately 100kHz. That of the p.w.m. flyback converter is approximately 40kHz whilst the 'simple-switchers' run at approximately 52kHz.

Once the mains supply is applied to the PSU board, the PFC (Power Factor Correction) circuit starts and generates 390V. Whilst mains is applied, the PFC is active and cannot be manually switched off. The start circuitry only controls the flyback converter and so High Voltage DC is present on primary power components whenever mains is present on the board. **This fact should be noted when servicing the Transceiver.**

### 5.3.3 Circuit Description (S-Band Transceiver Power Supply)

The following circuit description is based on Circuit Diagram 65801909 at Figure 1.31.

#### Mains Input

The AC supply enters the power supply from the external input filter via plug PLTA pins 6, 12 live, PLTA pins 4, 10 neutral and PLTA pins 1, 7 earth, to the comprehensive EMC suppression circuitry. Although the filtering provides some rejection of mains born interference its main task is to suppress pfc and main switcher interference generated from within the PSU. Due to the 100kHz triangular choke current and capacitive switching currents in the pfc power stage, common mode and differential mode interference pulses are present either side of C16. The multi-element filter formed by common mode chokes L2, L3. and differential mode chokes L7 and L12 together with the adjacent capacitors C18-C21 effectively minimise conducted 100kHz and harmonics from being superimposed on the incoming mains. VDR1 suppresses transient voltages on the AC supply whilst RT1 limits inrush currents to the smoothing capacitors C4, C5.

#### Power Factor Correction Circuit (PFC)

The PFC takes the form of a continuous mode fixed frequency, average current mode boost regulator. It produces a stable 390V DC rail from the incoming mains whilst ensuring the input current remains sinusoidal. The drive pulses for the main switching FET Q1 are generated by the PFC controller U3 pin 16. The ground pin 1 is referenced to HVRTN which is Q1 source and via the current sense resistors R20, 21 the bridge rectifier -ve output.

The Vcc supply for U3 pin 15 is derived from:-

1. Winding pins 7, 8 on the main choke L1.
2. Resistors R2, 3 and D31 from +HV DC
3. An external 17V dc PSU for test purposes.

All the following pins refer to U3. The V sense pin 11 senses the +HV DC (390V) line and causes Q1 drive pulses to adjust in width to keep the d.c. output voltage constant for load changes. The OVP pin 11 senses the +HV DC line and cuts off Q1 drive if the output voltage exceeds 390V by approximately 5%. The IAC pin 6 receives a current proportional to the rectified AC voltage from the bridge rectifier D1. V ref pin 9 outputs a 7.5V reference voltage. PK lim pin 2 receives a -ve voltage from current sense resistors R20, 21 via R1. When this is large enough to take pin 2 voltage below 0V, against the current flowing through R41, Q1 drive is cut off.

The EN/SYNC pin 10 is permanently held in the enable state by resistor R19 connected to Vcc. The C set and R set pins 14 and 12 are connected to C7 and R18. These components set the frequency of the internal oscillator to 100kHz. The SS pin 13 is for slow startup which is not used in this application.

The Va out pin 7 in conjunction with components C13, C8, R14 and R13 stabilise the +HV DC feedback control circuit in U3. The M out pin 5 receives the current sense voltage via resistors R22 and R59. The I sense pin 4 senses the voltage on the HV RTN end of the current sense resistors.

Inputs on pins 4, 5 and 6 are used in U3 to control Q1 drive pulse width such as to make the average current waveform in the choke L1 follow the rectified AC output voltage from bridge rectifier D1. The CA out pin 1 in conjunction with components R23, 8, C14 and C15 stabilise the current sensing feedback control circuit in U3.

### **Overcurrent Limit Operation of PFC**

There are two separate circuits to protect the power switching components.

- a) A controlled and stable current limit circuit is built into the average current feedback control loop. The current limit value is determined by resistors R20, 21. Increasing the PFC load current above the maximum level will cause the pfc input current to progressively have a flat top to the full wave rectified waveform.
- b) A second current limit path is provided by the level of voltage appearing at PKLIM pin 2 of U3. The level of this current limit point is set slightly higher than the previous one in a) above.

### **Start Sequence of the PFC**

(with the application of mains from the ship's supply contactor)

Initially C4, C5 charge up to the peak value of the AC supply via D24, L1 and D1. Vcc line capacitor C3 starts charging via R2, R3 and D31. When C3 voltage reaches about 16V the pfc IC U3 starts operating and delivers pulses to Q1. The +HV DC starts to increase towards 390V whilst Vcc falls due to U3 current drain. The +HVDC line reaches 390V before C3 voltage drops to 10.5V where U3 would switch off. With the HVDC line at 390V, Vcc is then maintained from winding 7, 8 of L1 via D14, D15, C29 and C30.

All the time the +HVDC line is building up the current limit circuits are operating allowing the 390V line to build up in the shortest time. As the HVDC line builds up the flyback converter drive IC U4 Vcc rises. Upon reaching approximately 1.6V (pin 7 VCC) the IC becomes active and the power output FETs are driven. The output voltage from the power supply starts approximately 2-3 seconds from initial mains application.

Capacitors C23 and C24 serve to provide a return path for the capacitive currents resulting from stray capacities of Q1, D10 and D11 thermal insulating material on the heatsink. Prior to Q1 switching on, L1 current is passing through D10. When Q1 switches on D10 takes a finite time to switch off. At this time Q1 sees the full +HVDC voltage present on C4, C5.

A very high current pulse results causing significant power dissipation in Q1. With inductor L4 in circuit Q1 current is allowed to build up slowly until L4 saturates. At this time Q1 is switched on and its drain current has risen sufficiently to reverse D10 current. D10 turns off. This L4 circuit significantly reduces the switching losses in Q1. Diode D11 and resistors R25-R27 serve to absorb the stored energy in L4 when Q1 switches off. In particular it prevents Q1 drain voltage rising significantly above 390V.

The PFC circuit can be tested separately from the rest of the PSU by utilising the test plug PLTT. Testing the pfc is achieved by removing LKB, fitting a variac to the AC supply and applying a floating DC supply of 16 to 20V across Vcc and HVRTN (pins 4 and 5 of PLTT). The floating external PSU provides power to U3. With the low voltage supply on, the variac can be turned up whilst monitoring +HVDC. The pfc circuit should produce an output of 390V d.c. with about 4V AC input. The +HVDC line should remain stable at 390V for all IP voltages up to 276V RMS. If it rises above 390V do not increase variac input as there is a feedback fault. An external resistive load may also be connected to the pfc via PLTT pins 1, 5.

### **Main PWM Power Supply Stage**

The pfc provides stable +390V d.c. for the current mode flyback converter over the full mains input specification. In spite of the converters dual power FETs the converter is of single ended flyback design. The high voltage DC line is switched to the primary of transformer T2 by two power FETs Q3 and Q4. These switches are driven via T1 from the control IC U4. They are both either on or off together. Drive transformer T1 provides simultaneous but isolated drive to the two FETs.

The cross coupled diodes D19, D20 return excess flyback energy to the supply line and provide hard clamping of the two FETs at a value of only one diode drop above or below the supply line voltages. In addition, energy recovery action of D19, 20 eliminates the need for an energy recovery winding or even snubbing components. This reduces the waste heat in the psu.

When both power FETs are 'on' the supply voltage appears across the transformer primary and series leakage inductance. All secondary rectifiers will be reverse biased and no secondary current flows. The primary current increases linearly and energy will be stored in the coupled magnetic field of the transformer and also energy will be stored in the leakage

inductance. At the end of the 'on' period both FETs Q3, Q4 turn off simultaneously and the primary supply current in the FETs falls to zero. By flyback action all voltages on the transformer reverse. Initially clamp diodes D19, D20 conduct clamping the flyback voltage to the supply line. All output rectifiers become forward biased and secondary current flows. When the secondary current has built up (to  $n \times I_p$ ) and the energy stored in the primary leakage inductance has been transferred back to the supply line the energy recovery clamps D19, D20 cease conduction and the primary voltage falls back to the reflected secondary voltage. Thus all surplus stored energy is recovered to the supply line and dissipation is minimised.

On application of HVDC (390V) when the mains input is first connected C55 charges up via R48. When C55 attains 16V the under voltage lockout within U4 is released and V ref is enabled and outputs 5V. Output pin 6 delivers 15V pulses to the primary of T1 and Q3, Q4 receiver in phase drive pulses which in turn causes primary current to build up. Primary current is sensed across R47 and fed back to pin 3 U4 for feedback stability and overcurrent detection. Voltage feedback is generated from windings 10, 50 from T2 via resistor network formed by R31, R32, R33 and RV1 into pin 2 U4. frequency compensation for the error amps within U4 is accomplished by network formed by C53, R30. In addition to providing voltage feedback the feedback winding (10, 50) supplies power to U4 via D32 and C55 once the psu has started operating and supplying output power. The feedback voltage as applied to pin 2 U4 is adjustable via RV1 which sets the raw output voltage levels of all secondary windings.

Overcurrent trip operation occurs should the primary current exceed 4.5A approximately. Once I sense pin 3 (U4) exceeds 1V then the gate drive output ceases and the feedback voltage falls. Once the feedback voltage on pin 7 (U4) falls to less than 10V the V ref shuts down and C55 discharges. The only charge path for C55 now is R48 and after approximately 1-2 seconds C55 exceeds 16V and output pulses are initiated and the PSU operates.

Should a permanent short circuit be applied to one of the power output lines the psu will 'hiccup' continuously with an approximately 3 sec off time. Thus the mean power dissipated within the psu under fault conditions should be low. Gate drive is clamped by D21, 22, 17 and 18 so as not to exceed the FET gate voltage specification. R49, 50 serve, together with the FET gate capacitance, to slow the switching edges of the power drain waveform thus minimising conducted and radiated interference without causing excessive power dissipation within the FETs.

To switch the flyback converter on the opto-coupler detects the presence of a serial data stream from the display at PLTH 11, 12. On detection of the data stream the photo transistor within U5 is turned on pulling down the gate of Q2 below its threshold voltage. Q2 turns off allowing the compensation pin 1 U4 to rise enabling output of the IC U4. In the PSU off state Q2 is held on by current in R37 from Vcc. For test purposes the psu can be turned on in the absence of a serial data stream by linking 1-2 on LKA.



## T2 Secondary Circuits

### Modulator -600

The three isolated windings of T2 (1-20, 2-19, 3-18) are individual 200V windings each having a rectifier and reservoir capacitor. The supplies are connected in series to give the required -600V supply for the modulator.

### Receiver Tuning Supply +30V

Rectifier D9 and capacitor C41 provide d.c. input to the three terminal linear regulator U1 which produces a fixed 30V output. L5 and C10 provide additional noise filtering.

### Modulator IGBT Drive Supply +20V

Zener stabilisation formed by D2 and R15 converts +30V input to a stable 20V supply using L6 and C39 as additional noise filters.

### Magnetron Heater Supply

D28 together with C31, 32 provide approximately 20V d.c. for the magnetron heater switch mode regulator on the modulator pcb.

### Rx/Trigger Board +12V

With approximately 20V input from D28, C31, and C32 the five terminal 'simple switcher' U6 output is set to +12V by R52, R53 and R54. The switcher operates at approximately 50kHz using L8 as the step down regulator inductor and D3 as the flywheel diode. Whilst the power device within U6 is off energy is transferred to the load via L8 and D3.

### Rx/Trigger Board -12V

D12, C33 provides approximately 20V d.c. into the three terminal linear regulator U2. R16, R17 set the output of U2 to -12V.

### Rx/Trigger Board +5V

D29, C44 provide approximately 15V d.c. to the input of U7 a 5 terminal 'simple switcher' power IC. R55, R56 sets the output of U7 to 5V. L9 supplies power to the load, during the off period of U7, via D7. This simple switcher operates at approximately 50kHz.

All output linear regulators are protected against input short circuits by reverse diodes connected from output to input (D8, D6). Both linear regulators and simple switchers are current limited for short circuit protection.

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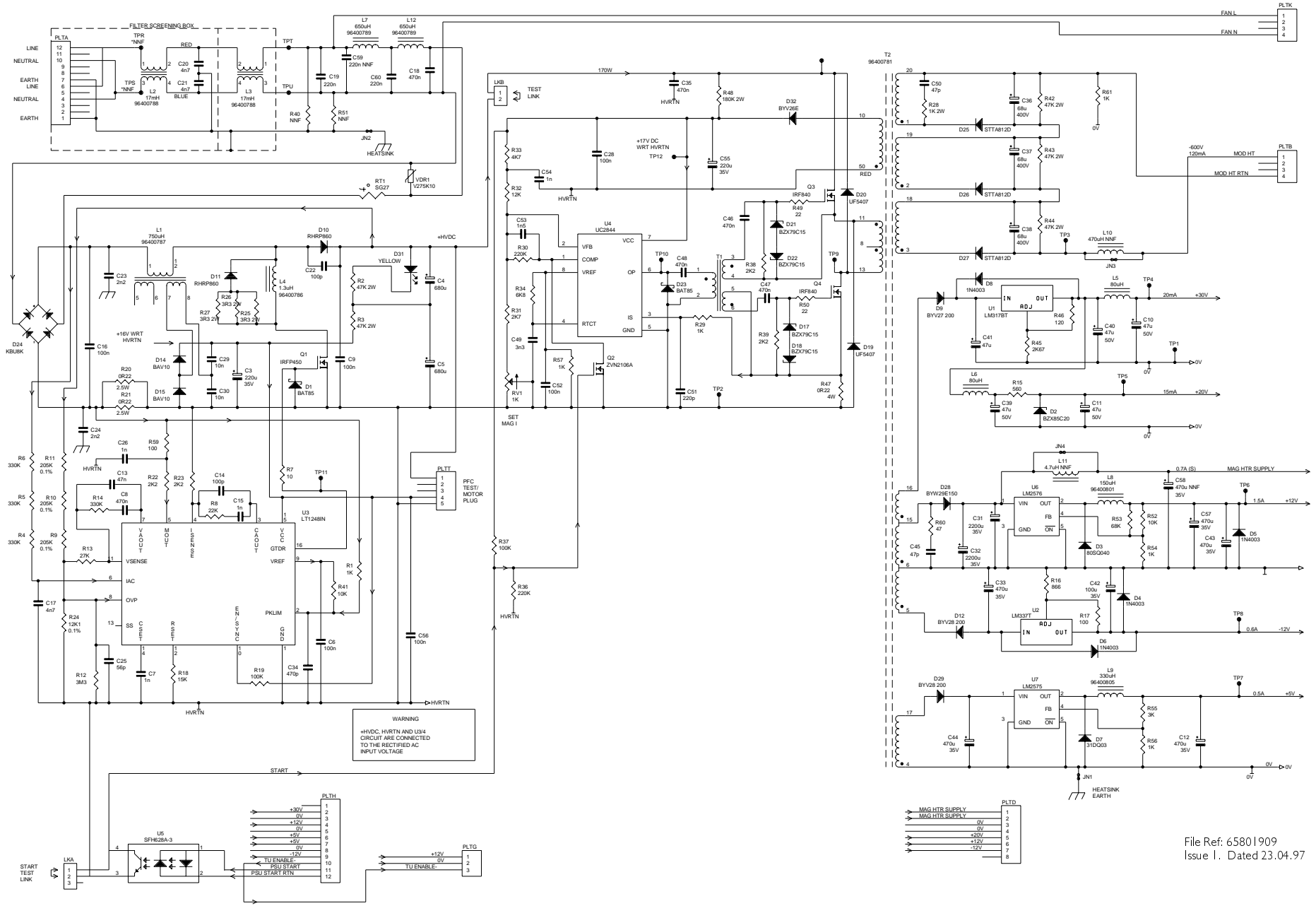


Figure 1.31 Circuit Diagram 65830909 - S-Band Transceiver Power Supply

File Ref: 65801909  
Issue 1, Dated 23.04.97

# Chapter 1

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## S-Band Scanner Units and Transceivers

A3 page 1-61/62 Figure 1.31, discard this A4 sheet.

## 5.4 Modulator PCB (S-Band)

### 5.4.1 Functional Description

The principal function of the Modulator PCB is to generate an 8kV, 8A negative pulse to drive the cathode of the magnetron. An SCR is used to resonantly charge a Pulse Forming Network (PFN) to -1200V from the -600V Modulator HT supply. The charging cycle is initiated by the Charge Trigger. The number of sections of the PFN is selectable by the relays controlled by the Pulse Length Control Lines. The number of sections of the PFN used defines the length of the output pulse.

At a defined time after the PFN is fully charged it is discharged by three series connected Insulated Gate Bipolar Transistors through a pulse transformer. The discharge is initiated by the Modulator Trigger. The Pulse Transformer, which has step up ratio of 12:1, transforms the resulting pulse to 8kV. The back edges of the medium and short pulses are speeded up by a saturable reactor connected across the primary of the pulse transformer.

Other functions include regulating the magnetron heater supply, monitoring a spark gap to ensure correct operation of the magnetron, and generation of a timing reference for the Radar Trigger.

### 5.4.2 Inputs to the Modulator PCB

-600V Modulator HT Supply  
 +20V Modulator Trigger Supply  
 +16V - +27V Magnetron Heater Bulk Supply  
 +12V  
 -12V

Short Pulse Control Line	when 0V selects short pulse.
Medium Pulse Control Line	when 0V selects medium pulse.
Charge Trigger	initiates charging of Pulse Forming Network. Typically 1Amp current pulse.
Modulator Trigger	initiates discharge of Pulse Forming Network. Typically 4us, 3.5V positive pulse.
Turn Down Enable	dc voltage controls the magnetron heater voltage. 0V on long pulse, 3.5V Standby Medium and Short Pulse

### 5.4.3 Outputs from the Modulator PCB

Primary sample	positive pulse sample from pulse transformer used to initiate Radar Trigger. Typically 40V amplitude.
Magnetron current sample	a dc voltage proportional to the magnetron current derived from the secondary of the pulse transformer. Typically +2.5V (on long pulse).

TX Active	a signal that is normally 0V that rises to >2.5V if the spark gap operates continuously for 2 seconds. This signal is used by the Trigger PCB to indicate a transmitter fault to the display.
HT Sense	sample of Modulator HT Supply fed to Trigger PCB for inclusion in BITE message sent to display.
TX Define	Link settings used to define modulator type to Trigger PCB. 0V or 3.5V dependant on link settings.

### 5.4.4 Circuit Description (S-Band Modulator PCB)

The following circuit description is based on Circuit Diagram 65830912 given at Figure 1.32.

#### Magnetron Heater Supply

The magnetron heaters are derived from the Magnetron Heater Supply at PLVD1 and PLVD2. This supply may vary between 16V and 27V.

The Modulator PCB is configured for the intended magnetron by the setting of link LK1 fitted on the PCB. Refer to Figure 6.18 'Link Settings - Modulator PCB' in Chapter 6.

***WARNING - On no account should the heater voltage be measured whilst the Transceiver is transmitting.***

In a 30KW S-Band system, the magnetron requires a heater voltage (measured between TSJ1 and TSJ2) of 6.1V on Standby, Short Pulse, and Medium Pulse. On Long Pulse, this may be turned down to 5.1V depending on the type of magnetron fitted.

The Mag Heater Supply is connected to the input of the switching regulator U1. U1 is configured as a buck regulator running at a constant frequency of approximately 52kHz. During the time that the regulator is switched on, power is supplied to the load from the Mag Heater Supply via L106. When the regulator switches off, energy stored in L106 is transferred to the load via commutation diode D112. C112 provides output smoothing. The output voltage is sampled by the feedback network R132, R133, R145, R136, and Q102. The sample voltage is fed back to pin 4 of U1 where it is compared with an internal voltage reference. If the sample voltage fed back is greater than the internal reference voltage the time that the regulator is switched on for is reduced until the sampled voltage equals the reference voltage. Similarly if the sample voltage is less than the internal reference voltage the time that the regulator is switched on for is increased until the two voltages are equal. In this way a constant output voltage can be set by selecting values in the feedback network.

When long pulse is selected, the Turn Down Enable signal at the gate of Q102 is 0V biasing Q102 off. In this condition R136 is connected in series with the feedback network, increasing the voltage at U1 pin 4. The regulator 'on' time is therefore reduced and the output voltage is reduced to the level required for 5.0V magnetron heaters.

When Standby, Short Pulse, or Medium Pulse is selected the Turn Down Enable signal at the gate of Q102 is set by the Trigger PCB to 3.5V turning Q102 on. When Q102 is turned on, R136 is short circuited and the voltage at pin 4 of U1 is reduced.

The regulator 'on' time is therefore increased and the output voltage is increased to the level required to set the magnetron heaters to 6.3V. The inductor L103 and capacitor C115 isolate the regulator from the high voltage pulse that appears at the bias winding of T107. The voltage at the output of the regulator measured at TP106 is typically 1.5V greater than the 6.3V or 5.0V to allow for the voltage drop across L103 and the secondary of the Pulse Transformer.

### Charging the PFN

With -600V supplied from the Power Supply PCB via L101, the PFN charging is initiated by the positive edge of the Charge Trigger signal on PLVC8. This trigger signal passes via the isolating transformer T101 to the gate of input SCR Q101. The positive pulse turns the SCR on to start the resonant charge. Because L101 and the capacity of the PFN form a resonant circuit, the input current to the PFN is sinusoidal in character and the line charges to about 1.8 times the Modulator HT supply voltage.

The PFN charges through Q101, the isolating diode D101, and the delay reactor L105. The charge current reaches a peak and decays to zero, and at this point D101 becomes reverse biased and Q101 turns off. This occurs when the voltage on the PFN is at its maximum value. R106, R107, and R108 provide a discharge path for any voltage on the anode of Q101. R126, R129, R130, and R131 form a potential divider across the Modulator HT Supply to feed a sample voltage to the Trigger PCB for incorporation into the BITE message sent to the display.

### Discharging the PFN

The modulator is triggered by the Modulator Trigger pulse from the Trigger PCB. This positive pulse of typically +3.5V amplitude is amplified to 20V by U3. The output of U3 is fed to the primary of the isolating transformer T105. The transformer has three identical secondary outputs, each of which drives one of the gates of the series connected IGBT's Q103, Q104, and Q105. The transformer turns ratio is 1:1 so each gate emitter of the IGBT's is driven by a 20V positive pulse.

By clamping any signals fed back from the transformer to a safe level, D111 and D110 protect the output of U3. R121, R122, and R123 control the peak current spike into the capacity of each gate to ensure the IGBT's turn on together. Initially the delay reactor L105 is high impedance and momentarily delays the discharge of the PFN until the IGBT's are fully turned on. This ensures that high current does not flow through the IGBT's until the voltage across them has fallen to a low level. Approximately 250nS after the trigger pulse the delay reactor saturates, and the PFN is discharged through the primary of the Pulse Transformer T107. The resulting 650V primary pulse is transformed up to 8kV to drive the magnetron.

D107 in the charging circuit clamps any positive spike fed back through the capacity of D101 to protect Q101. R125, R126, R127, VDR1, VDR2, and VDR3 ensure that the voltage is shared equally across each IGBT.

# Chapter 1

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## S-Band Scanner Units and Transceivers

### Defining the Pulse Length

The PFN defines the transmitted pulse shape. It is only when long pulse is selected that all the energy stored in the PFN is transferred to the magnetron. On medium and short pulse the transmitted pulse length is controlled in two places, using RL1 and RL2.

- a) The PFN  
The relays are used to select the number of sections of the PFN that are used for a given pulse length. The more sections used, the longer the pulse.
- b) The Tailbiter.  
On short and medium pulse the PFN is used to define the start of the pulse but the width of the pulse is determined by a saturable reactor L104 (tailbiter) connected directly across the primary of the pulse transformer. The number of turns on L104 is varied to suit the pulse length required. The number of turns is selected by RL1 and RL2 dependant on the pulse length selected.

The tailbiter acts by changing from a high impedance to a low impedance to short circuit the primary of T107, terminating the drive pulse to the magnetron. The time that L104 remains in the high impedance state is dependant on the number of turns and the voltage impressed across it. Any charge remaining in the PFN when L104 changes state, is dumped into the circuit consisting of D102 and R115. The PFN is then in a fully discharged state ready for the next charging cycle.

Pulse Length	Relay Energised	PFN Capacitors in Circuit	L104 Tailbiter Winding Used
Long	None	All	None
Medium	RL2	C105, C107, C108 C109	1 - 3
Short	RL1	C105, C107	2 - 3

### Relay 1 and Relay 2 Operation

#### Pulse Transformer

The purpose of the Pulse Transformer T107 is to match the impedance of the PFN to the impedance of the magnetron. In doing this, it also steps up the voltage pulse to the correct level to drive the magnetron. The output of the PFN is directly connected to the primary of the Pulse Transformer, and the secondary is connected directly to the magnetron cathode. A bifilar wound secondary is used to allow the heater supply to be connected to the magnetron. An additional secondary winding carrying the heater current is used to bias the core of the transformer magnetically, so that the number of secondary turns required to support the long pulse voltage pulse can be kept to minimum.

R137 and current transformer T108 in series with the primary of T107 provide a 40V positive pulse ( Mag Sample) to the Trigger PCB as a timing reference for the Radar Trigger, and AFC Trigger.



R119, D104, C118, R118, and current transformer T106 in series with the Pulse Transformer secondary provide a rectified output (Mag Current Sense) proportional to the magnetron current. This voltage is passed to the Trigger PCB where it is incorporated into the BITE message sent to the display.

Zener diode D127 restricts the maximum output voltage below the level that would damage the circuit on the trigger PCB. The voltage can be monitored at TP100, and is used to set the magnetron current in service.

### **The EHT PCB**

The two leads from the bifilar secondary of the Pulse Transformer are routed through the EHT PCB. D106, D113, and R120 clamp any positive overswing at the end of the magnetron pulse and absorb any surplus energy from the secondary of the Pulse Transformer. The spark gap (Gap 1) operates at approximately 12kV and provides protection for the Pulse Transformer if the magnetron mistriggers, or if the magnetron heaters become disconnected.

### **Spark Gap Detection Circuit**

The earth return for the Spark Gap is routed through current transformer T104. When the Spark Gap operates the current through T104 generates a positive pulse across R138. This pulse is used to trigger monostable U4A. D124 and D125 clamp the input voltage to the monostable to a safe level. The resulting positive pulse at the "Q" of U4A charges capacitor C125 positively. The voltage at C125 +ve rises from its normal value of 0V towards +12V. This voltage is sampled by the Trigger PCB, and when the voltage rises to +2.5V the Transceiver is switched to standby and an error message is sent to the display.

On long pulse the spark gap has to be triggered for approximately two seconds for the voltage on C125 +ve to reach 2.5V. R143 provides a discharge path for C125, which discharges between monostable pulses such that the voltage on C125 returns to its normal level in approximately four seconds if there is no spark gap activity.

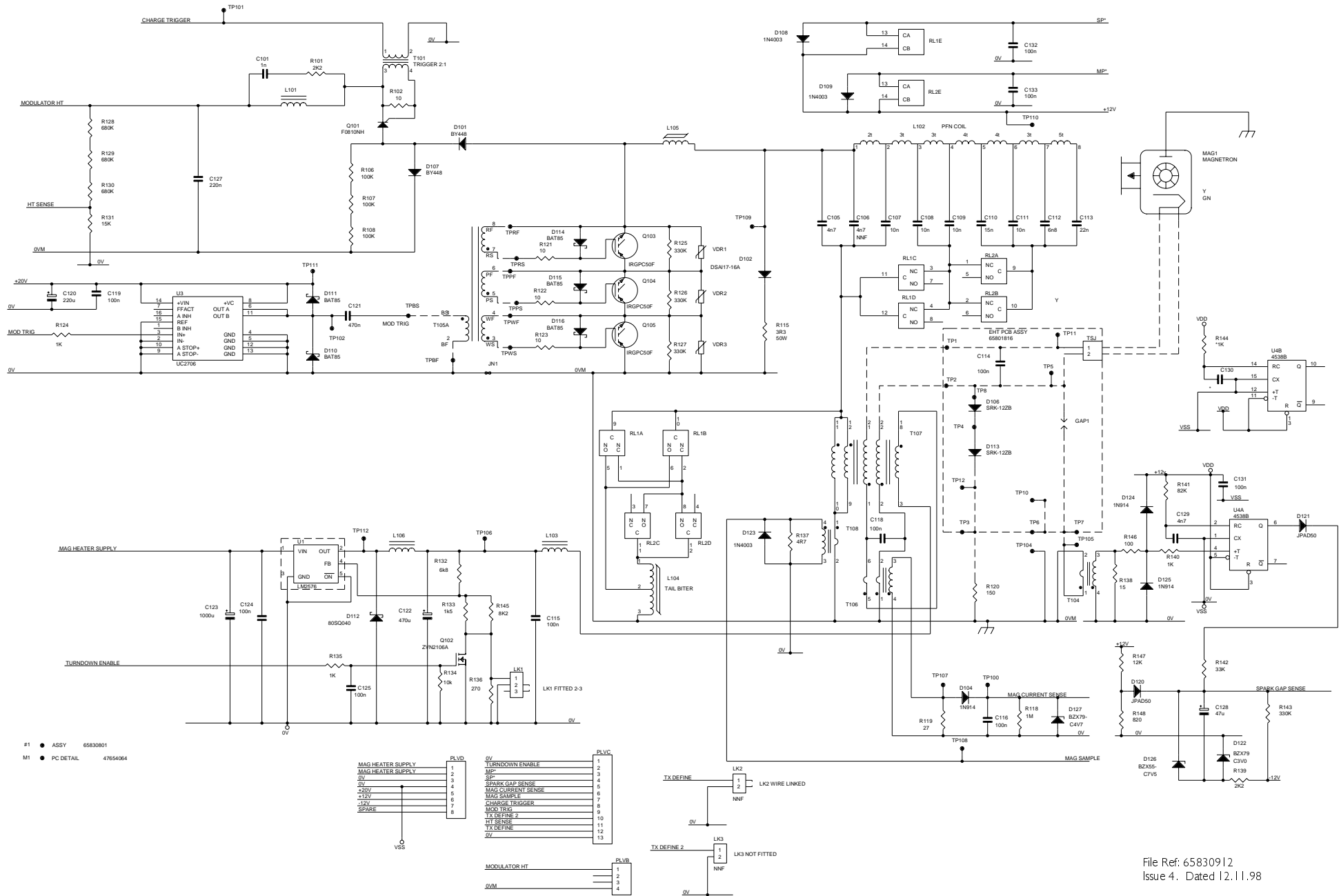
R139 and zener diode D122 provide a 3V bias for the electrolytic capacitor. Zener diode D126 together with D122 restrict the maximum voltage at C125 +ve to 4.5V. R147, R148 and D120 ensure that the voltage at C125 +ve is always positive. These limits are required to protect the circuitry on the Trigger PCB. Low leakage diode D121 prevents C125 discharging through the output of U4A.

## **5.5 Input Board (S-Band)**

The following circuit diagram is also included.

Circuit Diagram 65830904 - S-Band Input Board - Figure 1.33

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File Ref: 65830912  
Issue 4. Dated 12.11.98

Figure 1.32 Circuit Diagram 65830912 - S-Band Modulator Board (30kW)

# Chapter 1

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## S-Band Scanner Units and Transceivers

A3 page I-69/70 Figure I.32, discard this A4 sheet

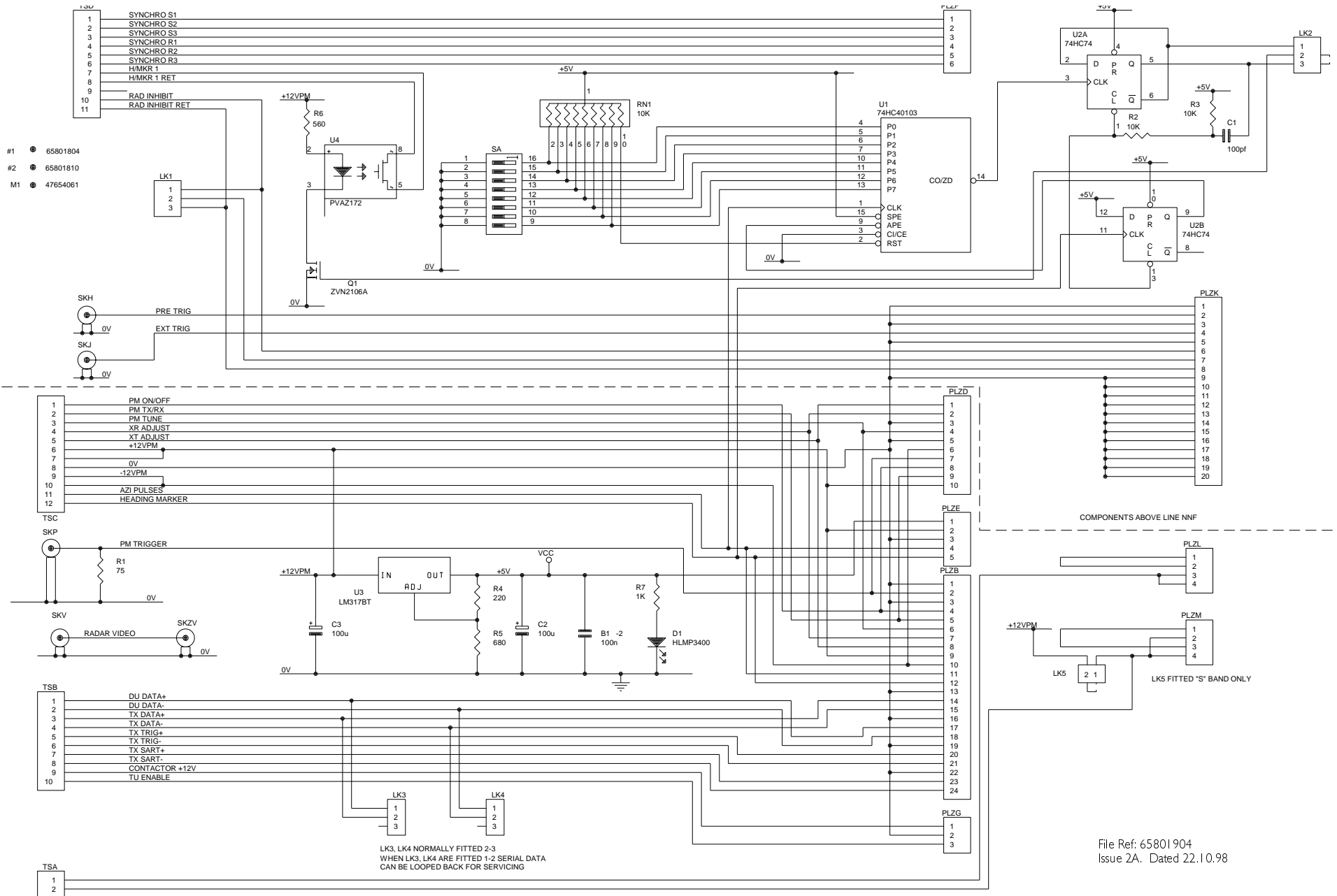


Figure 1.33 Circuit Diagram 65801904 - S-Band Input Board

# Chapter 1

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## S-Band Scanner Units and Transceivers

A3 page 1-71/72 Figure 1.33, discard this A4 sheet.

## 6 Replacement Spares

Refer to Chapter 6 for a full list of replacement spares.

## 7 Wiring Diagrams

Refer to Ship's Manual 65800010B Chapter 3 for complete system installation diagrams.

The wiring diagrams Included in this section are as follows:

Figure 1.34 S-Band Turning Unit Schematic

Figure 1.35 S-Band Bulkhead Transceiver Schematic.

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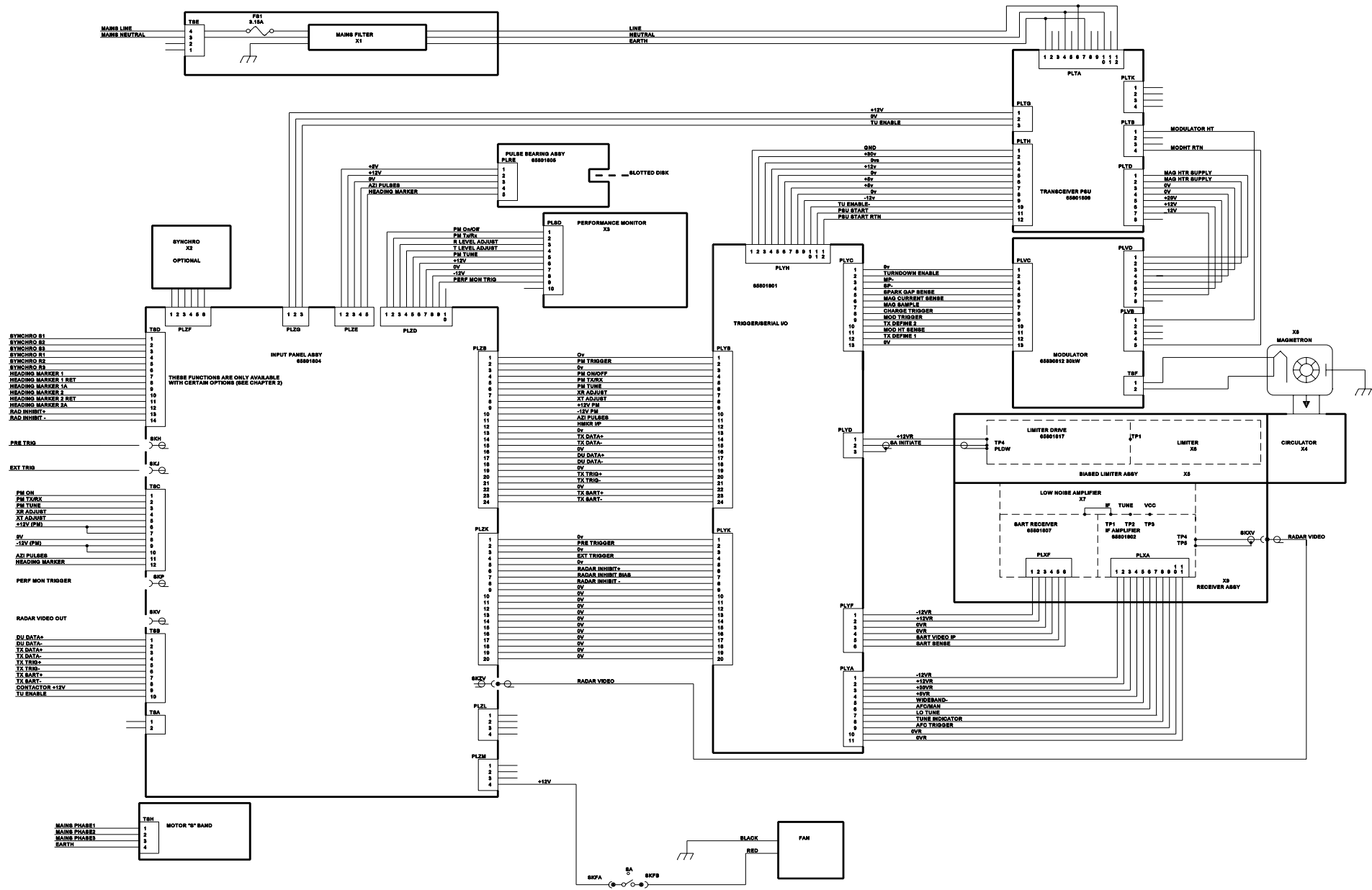


Figure 1-34 S-Band Turning Unit Schematic

# Chapter 1

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## S-Band Scanner Units and Transceivers

A3 page 1-75/76 Figure 1.34, discard this A4 sheet.

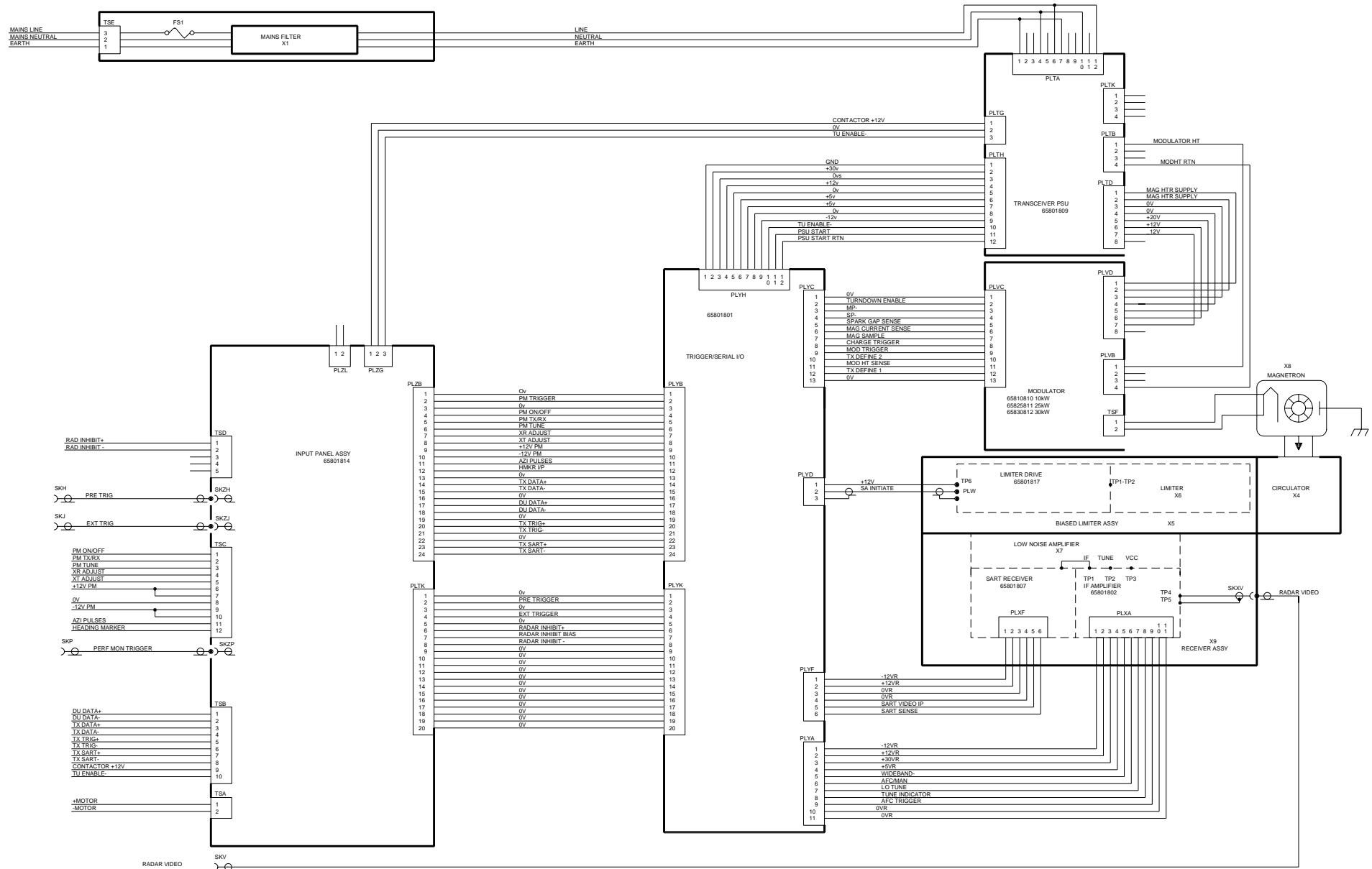


Figure 1.35 S-Band Bulkhead Transceiver Schematic

# Chapter 1

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## S-Band Scanner Units and Transceivers

A3 page 1-77/78 Figure 1.35, discard this A4 sheet.

## 1 General Description

There are two basic types of X-Band Scanner Unit:

- with an integral transceiver module
- without an integral transceiver

Each type can have a number of variants dependent on motor supply and the options that are fitted.

The Scanner Unit comprises an Antenna, an antenna support casting, and a Turning Unit.

Included in the Turning Unit is a motor and gearbox, a Bearing and Heading Marker pcb, an Input pcb, and optionally a Performance Monitor and integral transceiver module.

The Transceiver Unit comprises, a base casting , a cover, a transceiver module, and an Input pcb.

Communication between the Transceiver and the Display is by means of a serial data link. Where a separate Transceiver Unit is used, an RF feeder ( waveguide ) is used to transfer the microwave energy between the Transceiver Unit and the Turning Unit.

The Scanner Unit and the Transceiver Unit are compatible with BridgeMaster **II** display units if a Display Compatibility Unit is used.

See Figures 2.1 to 2.4.

## 1.1 Physical Arrangements

The Turning Unit is constructed from upper and lower aluminium castings. The upper casting is hinged at one end to the lower casting for service and installation. The motor, gearbox and drive assembly are bolted to the upper casting. The transceiver module, when fitted, is bolted to the upper casting and can be removed as a unit for below decks servicing.

The terminal strips for the interconnecting cables to other units are under a screening cover on the base of the lower casting. The Performance monitor is housed beneath the upper casting and has a microwave transparent cover protecting it, fitted on the top surface of the upper casting

Four M10 x 45 bolts are used to attach the Scanner Unit to the radar platform or wheelhouse roof. The Antenna is attached to the Turning Unit by the Antenna Support Casting and this directly transfers the microwave signals between the Turning Unit and the Antenna.

Interconnections between the Scanner unit and other units in the system are made using screened cables, with the exception of the Bulkhead system, where the microwave signals are carried between the Turning Unit and the Transceiver via a waveguide. All the cables that enter the Scanner Unit do so via waterproof cable glands that incorporate an EMC gasket that makes contact with the cable braid.

The separate Transceiver is designed to be bulkhead mounted and is attached using four M8 bolts, studs or screws (coachbolts).

## 1.2 Transceiver Module Overview (X-Band)

The transceiver module can be fitted in the Turning Unit, or mounted on a chassis for below decks bulkhead mounting as a separate unit. The module incorporates the Modulator pcb, a Power Supply pcb, Trigger pcb, the Receiver, and the microwave components.

Communication between the Transceiver Unit and the Display Unit is by means of two serial data links, one from the Transceiver to the Display Unit, and one from the Display Unit to the Transceiver.

This information is transmitted using a special data cable that incorporates four twisted pairs. Two pairs are used for data transmission, one pair is used for trigger, and the other pair is spare.

The data passed from the Transceiver to the Display includes:

- Heading Marker
- Incremental Bearing
- Transceiver Status
- Error Messages
- Built In Test Equipment (BITE) data
- Tuning Indicator
- Azimuth Data

The data transmitted from the Display to the Transceiver includes:

- Standby/Transmit
- Pulse Length
- Tuning
- AFC/Manual
- Sector Blanking
- Performance Monitor Control, and Installation Settings.

### 1.2.1 Power Supply

The power supply operates from the ship's AC mains, and provides all of the power requirements for the electronic modules within the Turning Unit and Transceiver. The AC mains is always present at the power supply even when the radar is switched off at the display.

The presence of active lines in the serial data link when the display is switched on is detected by the power supply, which then becomes active.

The power supply includes a Power Factor Correction circuit, and a number of switching regulators to generate the necessary voltage supplies. Overcurrent detection circuits protect the power supply against overloads on its outputs.

### 1.2.2 Trigger PCB

The Trigger PCB processes the serial data from the Display Unit, and generates the required control signals for the Transceiver. It monitors functions within the Transceiver, the Heading Marker, and encodes the information for transmission to the Display Unit. The data is transmitted each time a bearing pulse is received from the Turning Unit. The various timing signals required by the transceiver including the pulse repetition frequency (prf), are generated by the trigger pcb.

### 1.2.3 Modulator PCB

The modulator pcb generates the high voltage negative pulses required to drive the magnetron. The modulator pulse widths and timing signals are controlled from the trigger pcb. A spark gap on the modulator is fired if the magnetron fails to operate. Continual operation of the spark gap is detected and signal is fed back to the trigger pcb. When the trigger pcb detects this signal it switches the radar to standby, and generates an error signal to be transmitted to the Display Unit via the serial data link. The error signal causes the Display Unit to switch to standby and generate an error alarm. The modulator is a line type modulator. The transmitter pulse lengths are determined by the pulse forming network.

### 1.2.4 Microwave Circuit

The transceiver employs a conventional three port circulator to direct the path of the microwave energy to and from the antenna. A magnetron coupled to the circulator provides the RF energy to be transmitted. A solid state limiter coupled to the circulator protects the receiver from high powered microwave signals from the magnetron, or adjacent radars. A signal from the trigger pcb is used to enable swept attenuation to be applied to the solid state limiter to reduce the system sensitivity at short ranges.

### 1.2.5 Receiver

The receiver consists of a low noise amplifier, a mixer, a linear preamplifier, a logarithmic amplifier, and a video amplifier. The 60MHz output of the mixer is amplified by the linear preamplifier followed by a logarithmic amplifier, the output of which is detected, the resulting video signal is then further amplified before transmission to the Display Compatibility Unit, or Display.

The receiver also incorporates an AFC system. Once the receiver has been tuned, the AFC system ensures that the receiver remains on tune during variations in tuning due to thermal drift of the mixer and magnetron etc.

The operator can select between manual tuning and automatic tuning. A signal from the trigger pcb is used to select the mode of operation. A signal from the AFC circuit is fed to the trigger circuit to indicate the state of tune of the receiver. This signal is at its minimum value when the receiver is correctly tuned.



## 1.3 Turning Unit Overview (X-Band)

### 1.3.1 Drive System

The scanner motor is a 3-phase electronically commutated DC motor. The motor commutation drive signals are provided by the Motor Drive pcb which has the capability of providing High and Low speed operation by link selection. The Motor Drive pcb is supplied with +50VDC from the Transceiver power supply ( in both Aloft and Bulkhead fits ).

The motor drives an integral 32:1 reduction gearbox. The output of the gearbox drives a pulley system with a single toothed belt having a reduction ratio of 3:1. The final pulley is attached to the Antenna torque tube assembly. The overall reduction between the motor and Antenna is approximately 96:1.

When standby is selected, rotation of the Antenna is inhibited. Unless in test mode, transmission from the radar is inhibited if the Antenna is not rotating. An isolating switch is provided to inhibit rotation for servicing on the Turning Unit.

### 1.3.2 Motor Drive Board (Incorporating the Dynamic Brake facility)

The Motor Drive PCB generates the supply and control signals for the 3-phase electronically commutated DC motor that turns the Scanner Unit. The Motor Drive PCB has the capability of providing High and Low speed operation by link selection on the PCB.

The Motor Drive PCB is supplied with +50VDC and +12V from the Transceiver power supply ( in both Aloft and Bulkhead fits ).

Pulling control line 'TU Enable' below 1.5 volts starts a slow build up of speed up to the maximum set by the speed selection link. The 6 output FET switches which perform the commutation, are protected by a current sensing and limiting circuit, in the event of overload or stall.

Signals from the Hall Sensors in the motor are used to control the commutation sequence, and are also used to provide a degree of speed compensation in high wind load conditions. An additional feature of the PCB is a Dynamic Brake which limits the 'windmilling' speed of the Antenna when the radar is turned-off, or in Standby mode. This circuit is passive and will operate with no supply voltage.

### 1.3.3 Pulse Bearing & Heading Marker System

A disc with 128 teeth is attached to the Antenna torque tube and combined with an opto-coupler generates 128 pulses per rotation of the Antenna.

A second opto-coupler together with a flag on the toothed disc generates a Heading Marker approximately 10° before the Antenna is pointing dead ahead. Correct alignment of the Heading Marker is set at installation by electronic adjustment within the Display Unit.

Both opto-couplers are on the Pulse Bearing PCB. The Pulse Bearing PCB multiplies the 128

bearing pulses by 32 to generate 4096 pulses per Antenna revolution. The 4096 azimuth pulses and the heading marker are routed through the Input PCB to the Trigger PCB where they are incorporated into the serial data to be transmitted to the Display Unit.

A jumper link LK1 is fitted to the Pulse Bearing PCB to select High or Low speed operation. The link should be set between pins 1 & 2 for Low Speed operation ( Factory Default ). For High Speed operation, pins 2 & 3 should be used. Note that if no link is fitted, the default is High Speed operation.

Where it is not possible to adjust the Heading marker alignment at the display, optional extra circuitry can be fitted to the Input pcb to allow the alignment to be made electronically within the Turning Unit. When this option is fitted an additional ( isolated ) Heading Marker output is provided. As an option for special applications a size 11 synchro can be fitted as an alternative source of bearing information.

### **1.3.4 Interconnections**

The terminations for interconnections for the Transceiver and the Turning Unit are under a cover on the inside of the lower casting of the Turning Unit. The AC power from the isolating switch is terminated at a terminal block within the filter box on the inside of the lower casting of the Turning Unit. All other connections are made to plugs or removable terminal strips on the input pcb.

## 2 Unit Configurations

### 2.1 General Information

The X-Band scanner unit and transceiver form only part of a complete BridgeMaster E Series radar, and cannot be operated in isolation. For details of complete system installations refer to the BridgeMaster E, Ship's Manual 65800010B.

X-Band top units are supplied with either, an integral transceiver unit (which is mounted as part of the turning unit), or with a separate transceiver which is suitable for bulkhead mounting.

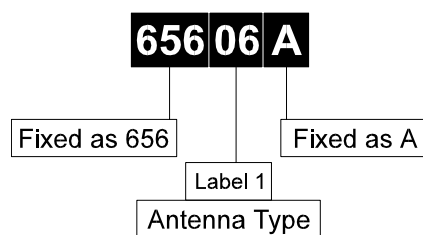
### 2.2 Unit Type Numbers

A BridgeMaster E, X-Band top units are configured from the following unit types:

- Antenna Unit
- Turning Unit (with or without Integral Transceiver)
- Bulkhead Transceiver Unit

#### 2.2.1 Antenna Unit

The Antenna Unit type number consists of a five figure number followed by a single letter suffix. The first three digits and the suffix are fixed (656xxA), and digits four and five identify antenna type as follows:

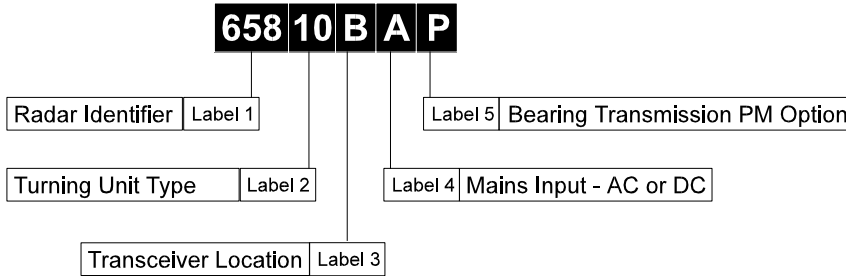


Label 1 **Antenna Type**

Label	Antenna Type
04	4 FT (X-Band)
06	6 FT (X-Band)
08	8 FT (X-Band)

**2.2.2 Antenna Turning Unit**

The Antenna Turning Unit type numbers are as follows:



Label 1 **BridgeMaster E Identifier** (fixed as **658**)

Label 2 **Turning Unit Type**

Label	Turning Unit Type
<b>01</b>	X-Band without Transceiver
<b>10</b>	X-Band with 10 kW Transceiver
<b>25</b>	X-Band with 25 kW Transceiver

X-Band Turning Units are supplied set to 'Standard Speed'. Speed changes are effected by link changes within the unit.

Label 3 **Transceiver Location**

Label	Transceiver Mounting
<b>B</b>	Bulkhead
<b>M</b>	Masthead
<b>C</b>	Bulkhead with additional facilities
<b>N</b>	Masthead with additional facilities

Label 4 **Mains Input - AC or DC**

Label	Phases	Voltages	Frequency	Speed	Band*
<b>A</b>	I	110/240	50/60	S/H	X
<b>D</b>	DC	24 - 32	0	S	X

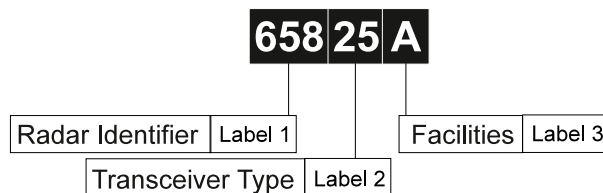
\*For **X-Band** Turning Units the motor is powered from the transceiver. This supply matches the Processor Electronics Unit supply.

Label 5 **Bearing Transmission PM Option**

Label	Performance Monitor	Synchro
<b>P</b>	No	No
<b>R</b>	Yes	No
<b>S</b>	No	Yes
<b>T</b>	Yes	Yes

### 2.2.3 Bulkhead Transceiver Unit

The Bulkhead Transceiver Unit type numbers are as follows:



Label 1 **BridgeMaster E Identifier** (fixed as **658**)

Label 2 **Transceiver Type**

Label	Transceiver Type
<b>10</b>	10 kW X-Band
<b>25</b>	25 kW X-Band

Label 3 **Facilities**

Label	Facilities
<b>A</b>	Standard
<b>B</b>	With additional facilities

## 3 Installation and Commissioning

### 3.1 General information

The Scanner Unit comprises the following main elements, each of which is supplied in its own packing, together with relevant Installation Drawings:

**Turning Unit** with/without Masthead Transceiver ( 10 or 25kW )  
Despatch Kit 65801660  
(Installation Drawing 65801050 )

**Transceiver Unit** Bulkhead Transceiver only ( 10 or 25kW )  
Despatch Kit 65825660  
(Installation Drawing 65825050 )

**Note** that a Bulkhead system would be supplied with both Despatch Kits.

**Antenna** 4ft, 6ft or 8ft  
Despatch Kit is supplied in Antenna carton.  
(Installation Drawing 65601275 )

Installation of the Scanner Unit entails carrying out the following operations, preferably in the sequence outlined below:

1. Preparation of the site.
2. Bolting the Turning Unit to the mounting platform (ship's structure) as detailed in Installation Drawing 65801050 supplied with the Turning Unit.
3. Bolting the Antenna to the Support Casting as detailed in Installation Drawing 65601275 supplied with the Antenna.
4. Laying in and installing the cables for the Turning Unit in accordance with the appropriate Cabling Schedules (Including X-Band co-axial feeder or waveguide in Bulkhead systems).
5. Ensuring that in the Turning Unit, the Motor Drive Board and the Pulse Bearing Board are correctly set for the required High or Low Speed operation set via their relevant jumper links.

Figures 2.1 to 2.4 also show installation details which are intended to duplicate those provided with the equipment. However, as it is possible that changes may occur to the details which may not be reflected in this manual, the installation drawings supplied with the equipment take precedence in the event of differences arising.

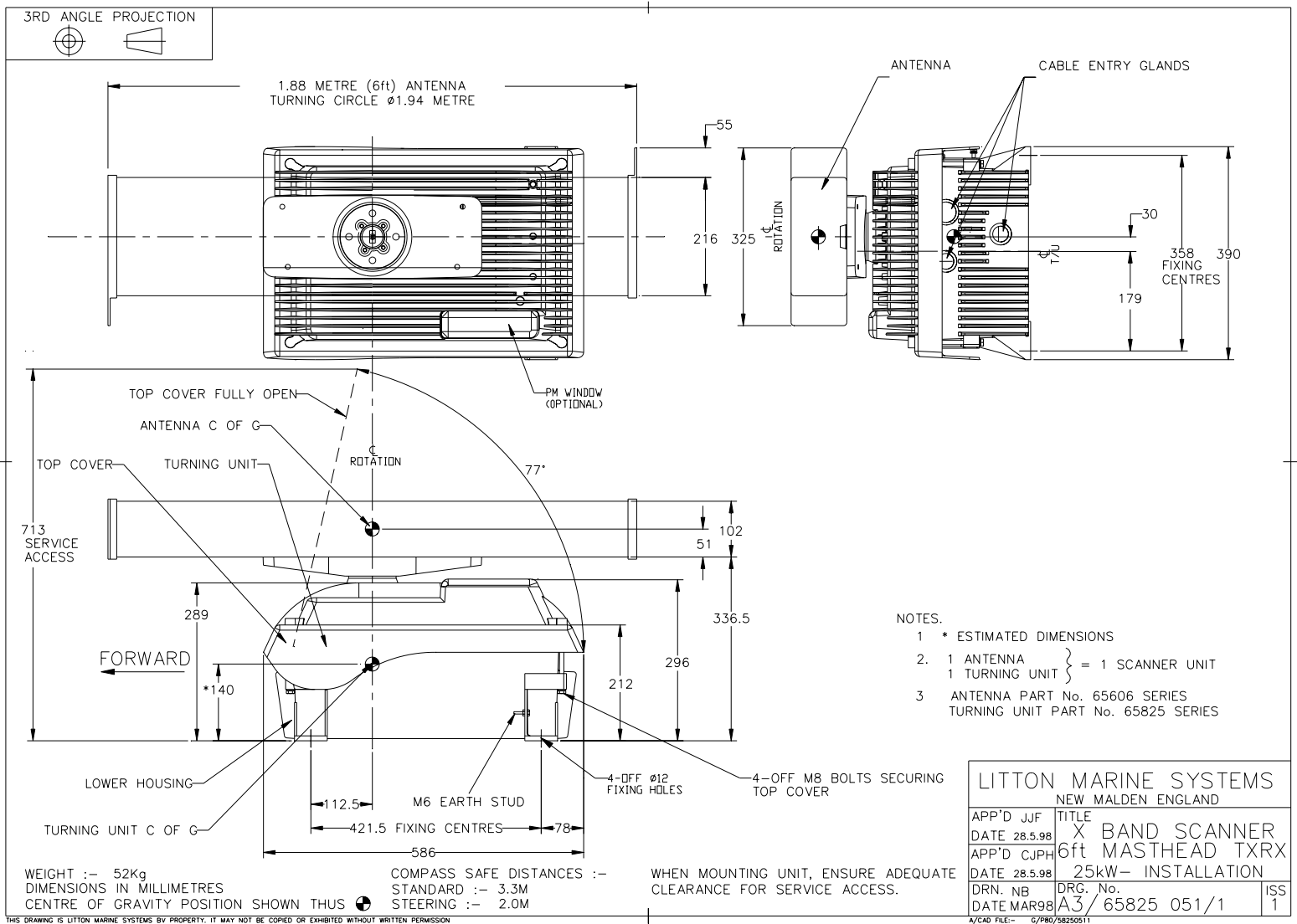


Figure 2.1 - X-Band Scanner 6ft Masthead Tx/Rx 25kW Installation

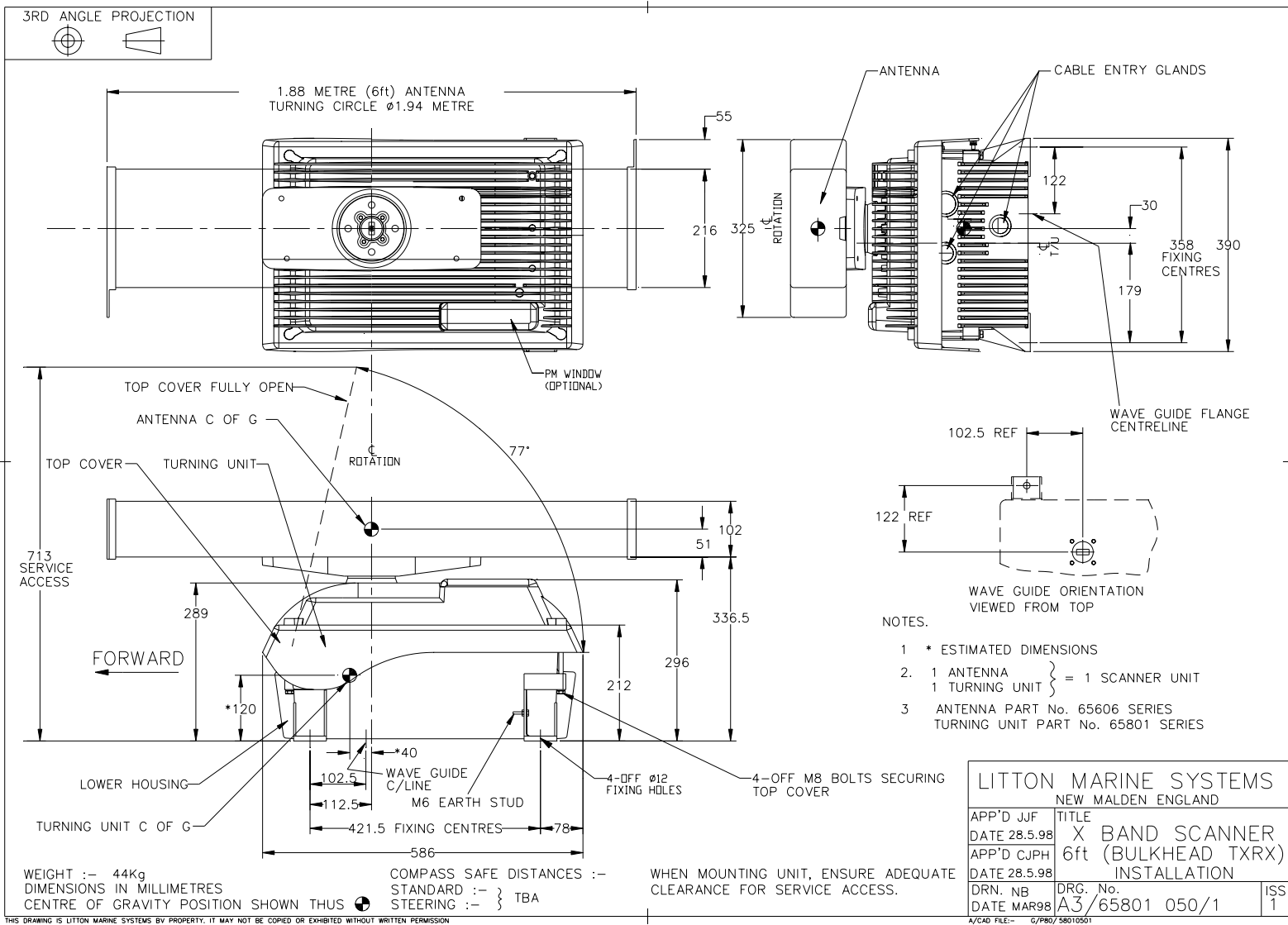


Figure 2.2 - X-Band Scanner 6ft (Bulkhead Tx/Rx) Installation



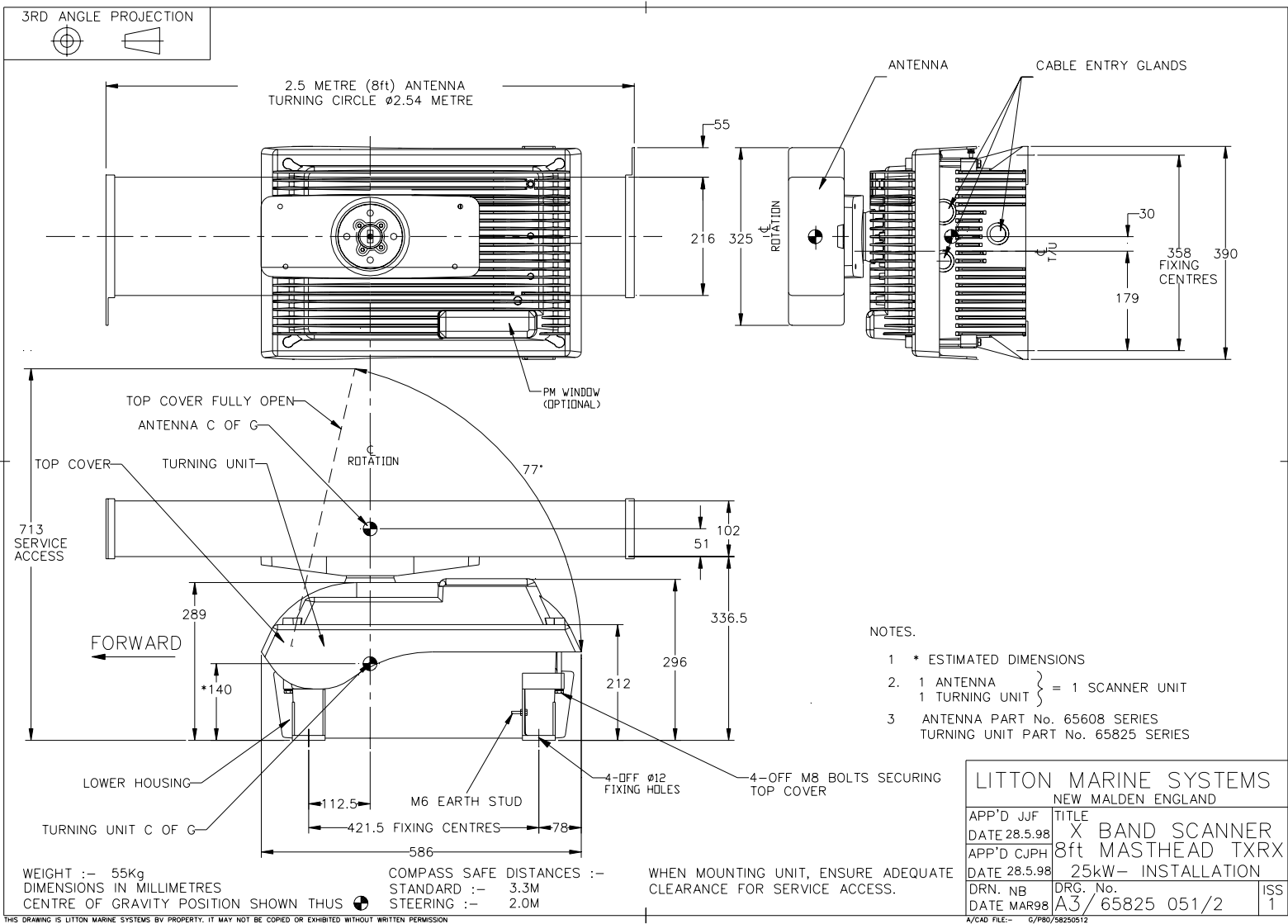


Figure 2.5 - X-Band Scanner 8ft Masthead Tx/Rx 25kW Installation

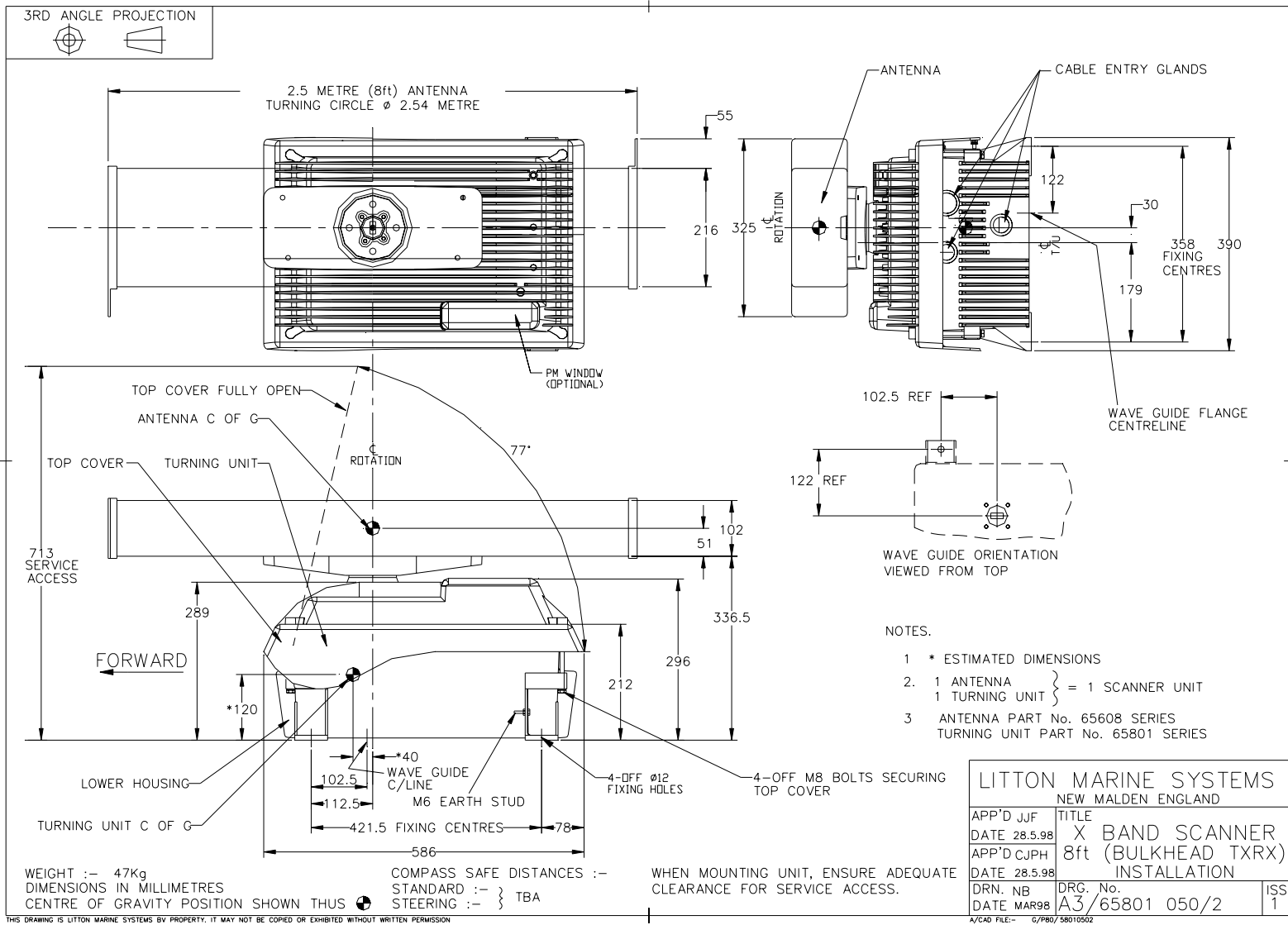
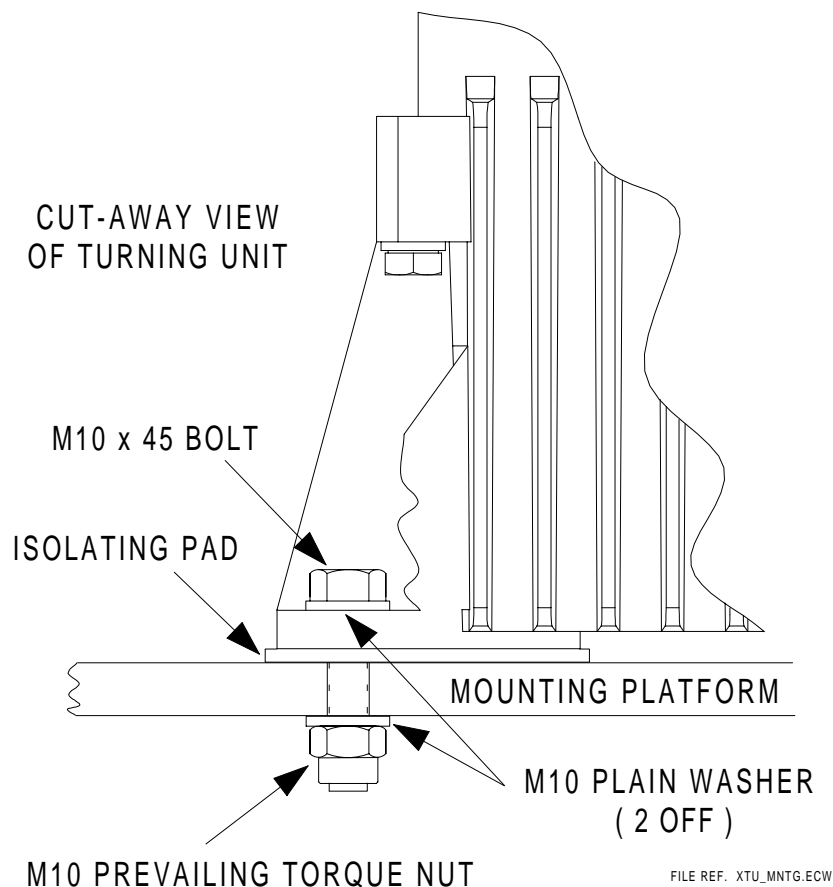


Figure 2.4 - X-Band Scanner 8ft (Bulkhead Tx/Rx) Installation

## 3.2 Turning Unit

**CAUTION** The Turning Unit should only be lifted using the four fixing holes at the base of the unit. The weight and spread of the Antenna can cause a free-standing Turning Unit to topple over. The Turning Unit should therefore be bolted down onto its mounting platform before attaching the Antenna and Support Casting to the Turning Unit. When working on the Turning Unit with the top casting raised, always ensure that the locking bolt on the stay is in the locked position. **DO NOT** lift the Scanner Unit by the Antenna, this is dangerous and will seriously damage the Antenna.

**Note** -The Turning Unit is bolted to the mounting platform with Neoprene isolating pads (4 off - 65601251) between the Turning Unit casting and the mounting platform, to prevent Galvanic corrosion. Additional washers or pads, may be added for the purpose of levelling the mounting so that the Turning Unit casting is not subject to twist when the bolts are tightened. M10 washers may be used as shims, or purpose made parts produced locally may be used.



**Figure 2.5** - Fixing the Turning Unit to the Mounting Platform

### 3.2.1 Support Casting

The Support Casting is factory fitted to the Turning Unit and requires no further assembly during installation.

### 3.2.2 Performance Monitor

The Performance Monitor comprises the Performance Monitor module, and an associated control cable. The equipment is normally factory fitted.

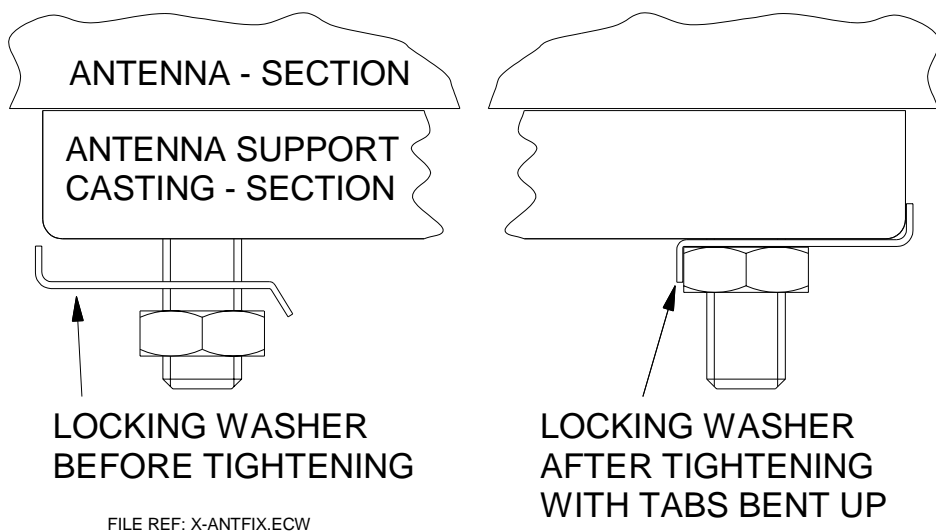
### 3.3 Antenna

The Antenna is fitted to the Support Casting using the parts listed below which are supplied with the antenna. Note that the holes in the support casting are assymmetrically placed to prevent the antenna being fitted backwards. The support casting has the letters 'FRONT' visible from above to aid initial antenna location.

- 4 off - M8 Stainless Steel Plain Nut                    4411544
- 4 off - Washer with locking tab                        65602116

Figure 2.6 shows how these are fitted.  
Ensure that all threads and bushes are coated with Densopaste.

**Note - The lock tab ends must be bent as shown to prevent rotation of the nuts.**



**Figure 2.6** - Fixing the Antenna to the Support Casting

### 3.3.1 Scanner Speed Settings

Two scanner speed settings, 'LOW' and 'HIGH', are available, depending on the following settings of the Motor Drive Board and the Pulse Bearing PCB Assembly.

#### Motor Drive Board

The position of the link LK1 fitted to the Motor Drive Board 65801811.

The link is set during installation and commissioning, and requires no tools to change.

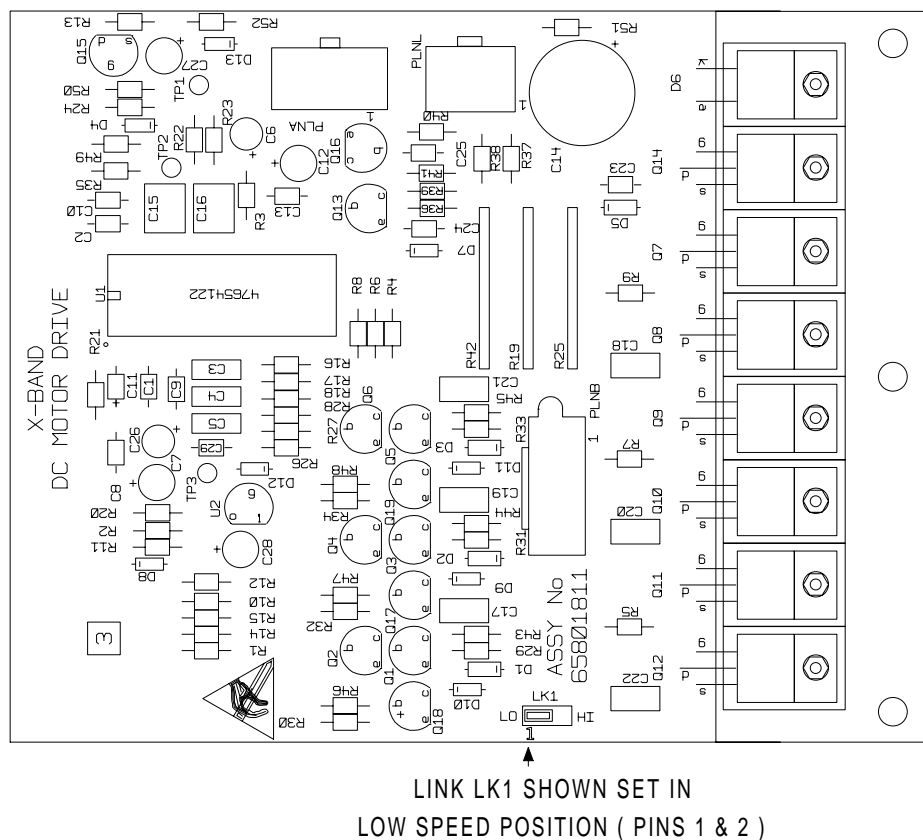
The factory default setting is 'LOW' speed ( 28 RPM nominal ).

Note that with no jumper fitted, the rotational speed defaults to HIGH speed.

Under no circumstances should the link position be moved whilst the motor is running.

With the jumper in the position marked 'LO' ( pins 1 & 2 - left hand pair ), the nominal scanner speed is 28 RPM.

With the jumper in the position marked 'HI' ( pins 2 & 3 - right hand pair ), the nominal scanner speed is 45 RPM.



**Figure 2.7** - Motor Drive Board 65801811 - Showing Link Position

### Pulse Bearing PCB Assembly

The position of the link LK1 fitted to the Pulse Bearing PCB Assembly 65801805.

**Note** - This link does not physically affect the rotational speed of the scanner, but does affect the ability of the phase-locked loop within the board to track the scanner rotational speed.

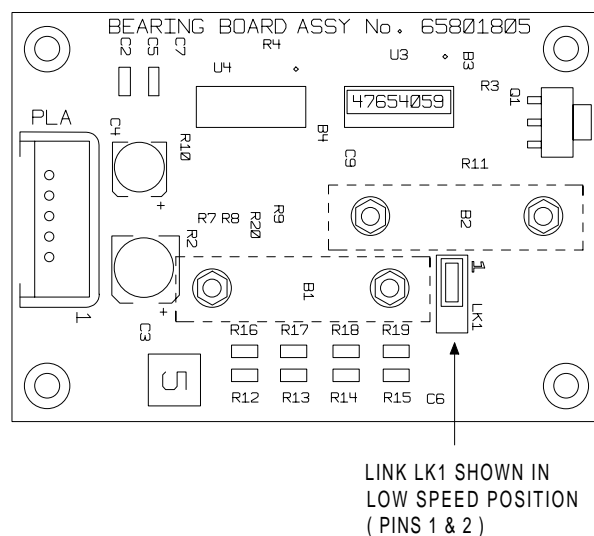
The factory default setting is 'LOW' speed.

**Note** - With no jumper fitted, the PCB defaults defaults to HIGH speed configuration.

With the jumper in the position marked '1' ( pins 1 & 2 - the lower pair ), the PCB is configured for LOW speed operation.

With the jumper in the upper pair position ( pins 2 & 3 ), the PCB is configured for HIGH speed operation.

The link is set during installation and commissioning. The link can be moved with the PCB in place using long nose pliers but the operation is not easy due to the PCB mounting bracket which tends to obscure the position of the link. The recommended method is to loosen the 2 Pozidrive screws that retain the mounting bracket and slide the whole assembly to the right using the slotted screw holes in the mounting bracket. The assembly can then be brought forward into a more accessible position for the link to be moved. Take care during removal and refitting of the mounting bracket not to damage the teeth on the pulse disc assembly which run between opto-couplers mounted on the rear of the Pulse Bearing PCB. Before re-tightening the 2 Pozidrive screws, check that both pairs of plain and single coil washers are above the top surface of the mounting bracket and not trapped beneath it. For ease of installation, it is recommended that this operation be carried out, if required, before mounting the Turning Unit aloft.



**Figure 2.8** - Pulse Bearing Board 65801805 - Showing Link Position

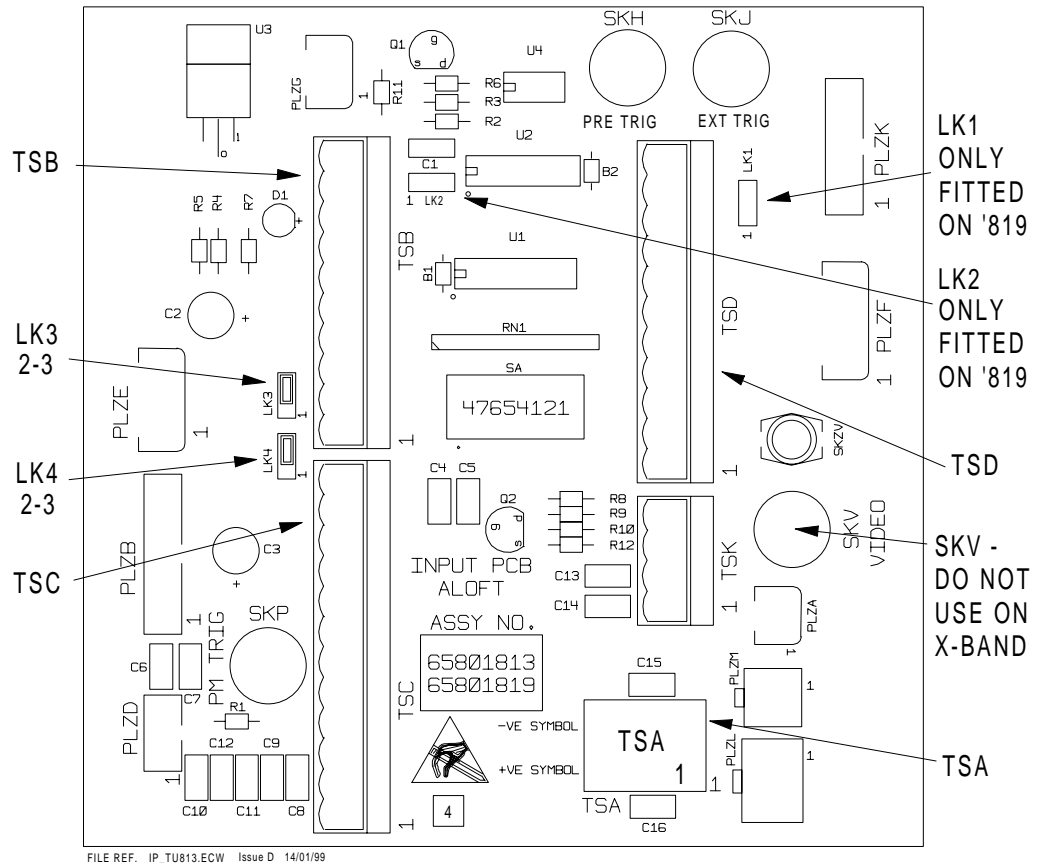
### Turning Unit Input Board 65801813

The diagram below shows details of the Turning Unit Input Board 65801813. This is revealed by lifting up the upper casting cover on its hinges after releasing the four retaining bolts, see Figures 2.1 to 2.4. The screening cover is then removed by releasing four securing screws

Normal configuration of the PCB links is as follows:

- Link 1 Not Normally Fitted
- Link 2 Not Normally Fitted
- Link 3 Link Pins 2 & 3
- Link 4 Link Pins 2 & 3

**Note** - The Video cable does not plug into the Input Board, but goes directly to the Receiver. Refer to Section 3.4.2 'Fitting the Cable Glands' for further details.

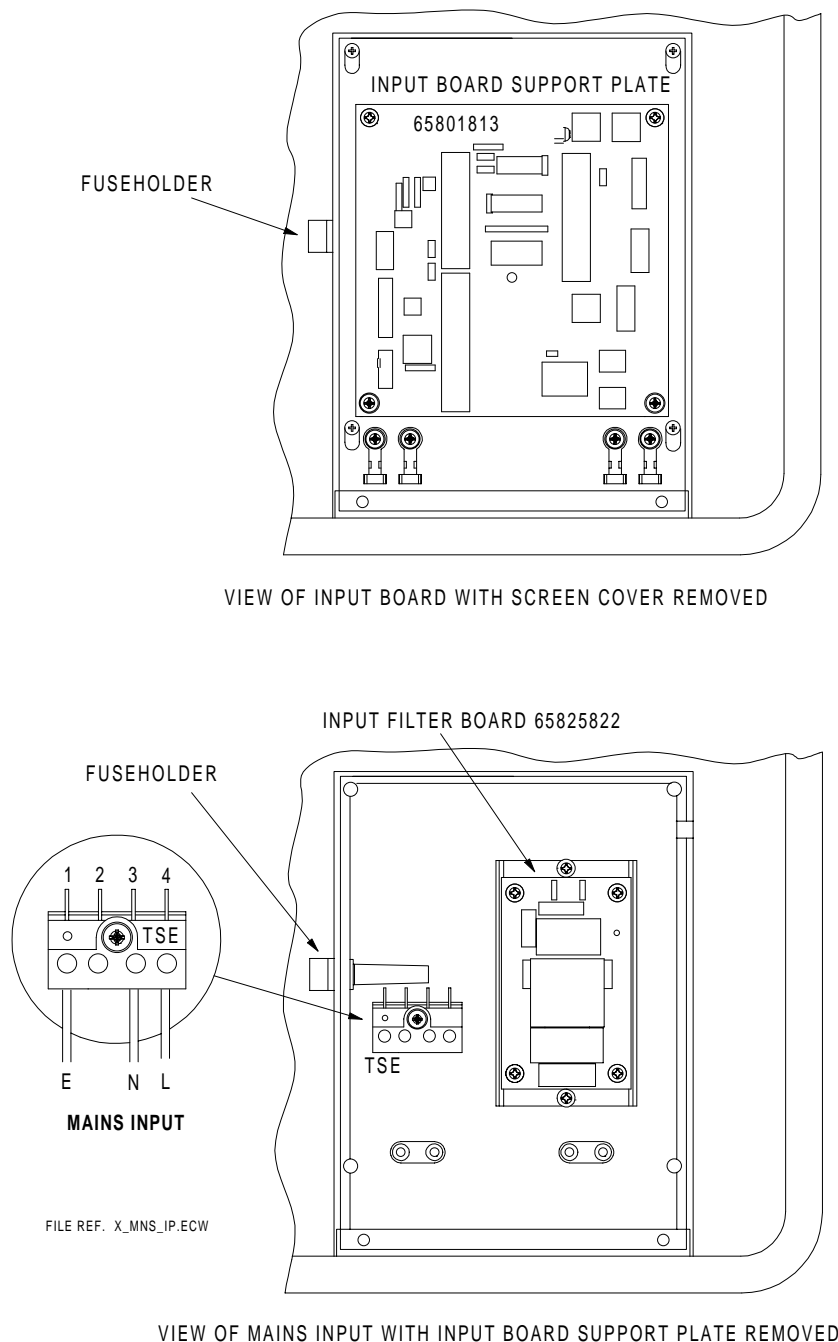


INPUT BOARD 65801813 ( & 65801819 ) - TURNING UNIT

**Figure 2.9** - Turning Unit - Input Board Details

### 3.4 Turning Unit Mains Input Connector (Aloft Transceiver)

The diagram below shows details of the Mains Input connector TSE (Integral Transceiver only). These are revealed on removal of the screenig cover and the support plate, which is retained by 4 fixing screws (see below). Note that the screws need only be partially undone to allow the plate to be slid out.



**Figure 2.10** - Turning Unit - Mains Input Details



### 3.4.1 Cabling Information

The Table below shows the route by which each cable enters the Turning Unit (with or without an Integral Transceiver). Figures 2.11 and 12 show the cable entry points. Three of these are via cable glands labelled 1, 2, & 3.

The RF Feeder ( waveguide ) input is only required when the Transceiver is mounted below decks (Bulkhead). The Bulkhead lower casting is different from the Masthead variant in the respect that an X-Band waveguide flange is mounted on the underside face. See Figure 2.1 or 2.4 for details.

A hole is provided for a 6mm bolt to enable bonding the unit to the Ship's structure. This is an important safety feature and must not be used for any other connection.

For details of how to terminate the cables into their connector blocks, see the Interconnection Diagrams and Cabling Schedules in Section 3. The numbers in parentheses e.g. (203) refers to the cable schedule number.

Each of the Cable Glands has a waterproof seal and a separate EMC seal, both of which must be installed as shown in Figure 2.14.

Details for terminating the R.F. Feeder (waveguide) are given in Section 3.6.3.

Cable Gland	TURNING UNIT without Integral Transceiver		TURNING UNIT with Integral Transceiver	
	Description	Cable Type	Description	Cable Type
Cable Gland 1	Blanking Plug	-	Mains Input (204)	TP3   49
Cable Gland 2	PM/Bearing (206)	TP3   45	Blanking Plug	-
Cable Gland 2	PM Trigger (207)	75 $\Omega$ Co-ax	-	-
Cable Gland 2	TU Enable (209)	TP3   41		
Cable Gland 3	Motor 50V (208)-	TP3   49	Radar Video (175)	75 $\Omega$ Co-ax
Cable Gland 3	-	-	Data (245)	T/Pairs
RF Connector	RF Feed	X-Band Waveguide	-	-

**Turning Unit** - Cable Entry Details

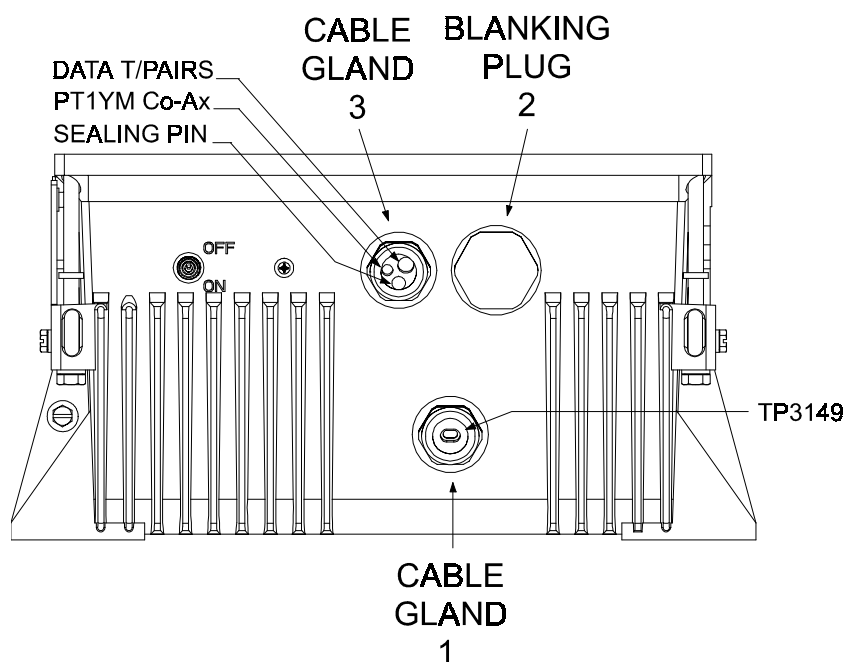


Figure 2.11 - Turning Unit (Aloft Transceiver) - Cable Entry Positions

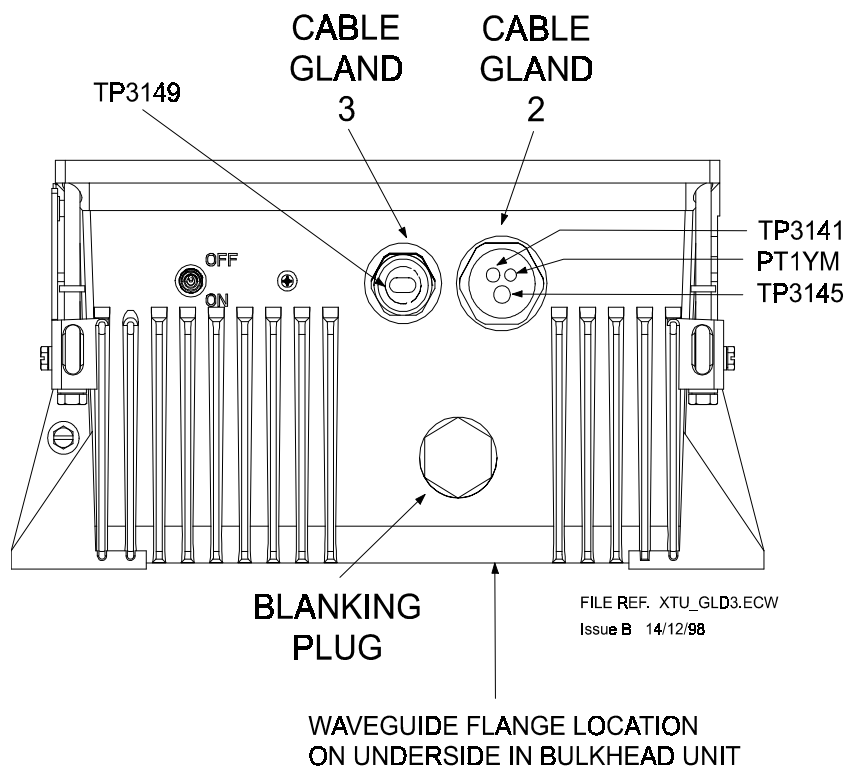
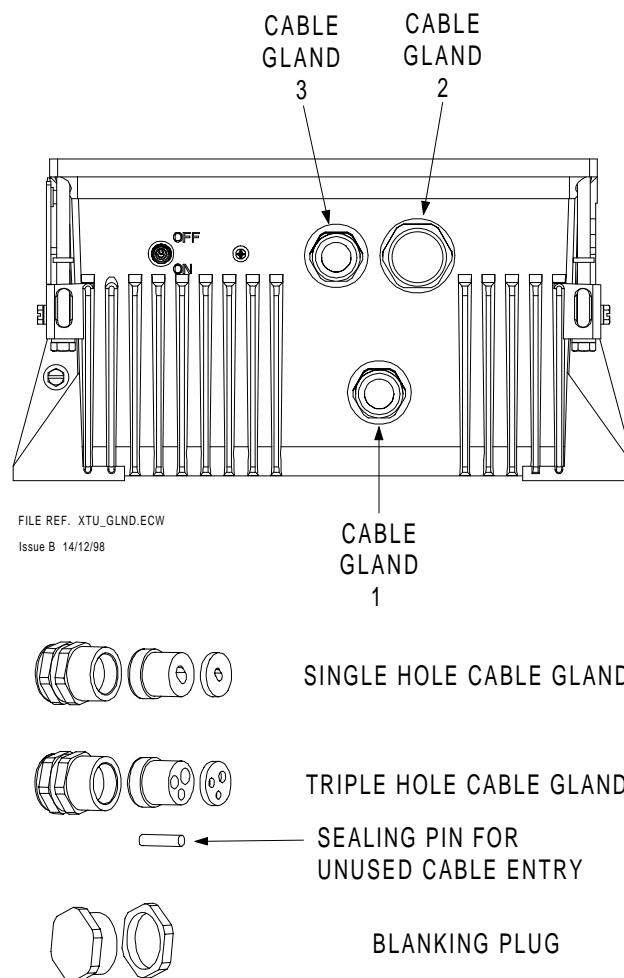


Figure 2.12 - Turning Unit (Bulkhead Transceiver) - Cable Entry Positions

### 3.4.2 Fitting the Cable Glands

The installation cables are connected into the Turning Unit via the appropriate cable glands (see earlier table). The body of the gland fits through a hole in the casting and is held in position by the Top Nut. Note the 'O' ring seal, which is fitted below the casting surface (input side). Two seals are provided with each gland as shown in Figure 2.13 below. The lower seal provides for waterproofing, and the upper for EMC. Some glands are designed to take a single cable whilst others are intended for several cables. Unused glands are fitted with a blanking plug, and unused cable entries are fitted with a sealing pin to maintain the seal.



**Note** - Cable Glands and Blanking Plugs are normally Factory fitted to the Turning Unit.

**Figure 2.13** - General view of Cable Glands

### CABLE INSTALLATION “X” BAND SCANNER UNIT

Included within the cable gland is a waterproof seal, and an EMC gasket. The waterproofing seal works by clamping onto the cable PVC sheath whereas the EMC seal clamps onto the cable braid. **It is important not to force the outer sheath through the EMC seal, as the seal is liable to split.** The braid is also formed into a tail which is grounded by means of an adjacent earth tag. The fitting procedure is detailed in Figure 3.14.

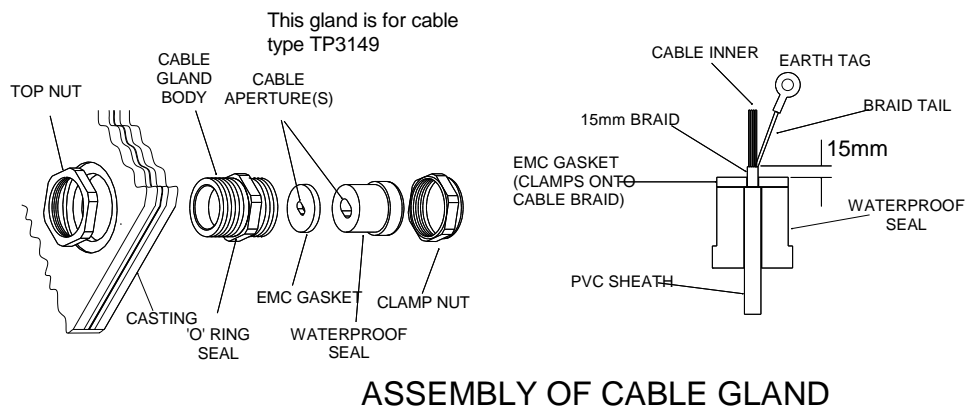


Figure 3.14 - Detailed view of Cable Gland Assembly

#### To Install the Cables:

Unscrew the gland nut and remove the waterproof seal and the EMC gasket. Feed the cables through the gland nut and the water proof seal.

For the multicore cables strip the outer sheath to expose approximately 300mm of braid, and for the Video coaxial cable to expose about 1200mm of braid.

Push the braid back to expose approximately 50mm of the inner cores.

Trim 50mm off the cores, and pull the braid back and twist into a point.

Feed the cable through EMC gasket until it positioned as shown above.

#### For the Multicore Cable:

Flare the braid out to within approximately 15mm of the EMC gasket and form a tail.

#### For the Coaxial Cable:

Do not fit the connector at this time.

**Assembly Into the Scanner Unit:**

Feed the assembled cables and seals into the gland body, and tighten the gland nut to compress the waterproof seal.

Crimp the earth tags provided to the braids of the multicore cables, keeping them as short as possible attach them with the screws provided. Trim and make off the cable inners to the appropriate connectors.

The Video coaxial cable does not plug into SKV on the Input PCB, but is connected to SKV on the Receiver Assy.

Sleeve the braid of the coaxial cable with the 6mm sleeving provided.

Route the cable through the slot at the end of the filter box cover, along the cable loom on the right hand side of the scanner unit. Use cable ties to clip it to the loom.

Trim to length and fit the coaxial plug.

For systems using below decks transceivers, the Performance Monitor Trigger coaxial cable is terminated in the same manner but only needs to be stripped back 200mm as it is plugged into SKP on the input Pcb.

### 3.5 X-Band Bulkhead Transceiver

The Bulkhead Transceiver 65810A (10kW) or 65825A (25kW) is installed below decks in a suitable location such as the ship's equipment room. The installation should pay due regard to ventilation, accessibility for maintenance and servicing, and the distance between the Transceiver and the Scanner Unit. For maximum performance, this should be kept as short as practicable, as the loss per metre of the X-Band waveguide is typically 10dB per 100 metres, i.e. 2dB for 20 metres. This loss applies to both the transmitted RF pulse and the received signals.

The maximum permissible separation between the Turning Unit and the Transceiver Unit is 30 metres, and that between the Transceiver (or Turning Unit) and Display is 67 metres. Separation up to 300m is possible if a suitable low-loss co-axial cable is used for the video. When choosing the installation location for the Transceiver, due regard must be made for the routing of the RF Feeder (waveguide).

The Transceiver may be attached to the bulkhead by several methods. The actual method chosen will depend on individual circumstances, but due regard must be given to the likely vibration and shock loading which may be experienced. The available methods include through bolting to the bulkhead, or mounting on studs provided by the shipyard. Note that slotted mounts are provided at the bottom for ease of installation.

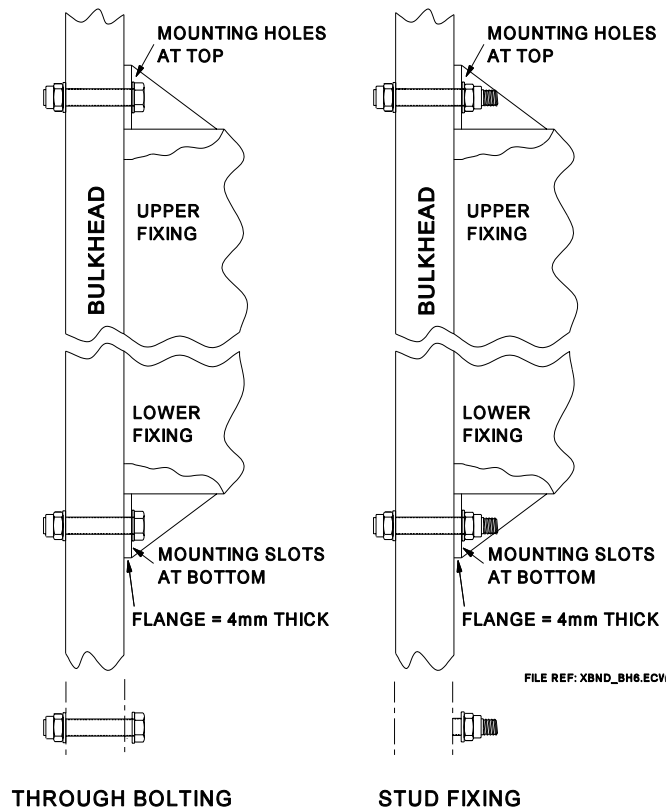


Figure 2.15 - X-Band Bulkhead Transceiver - Mounting Alternatives

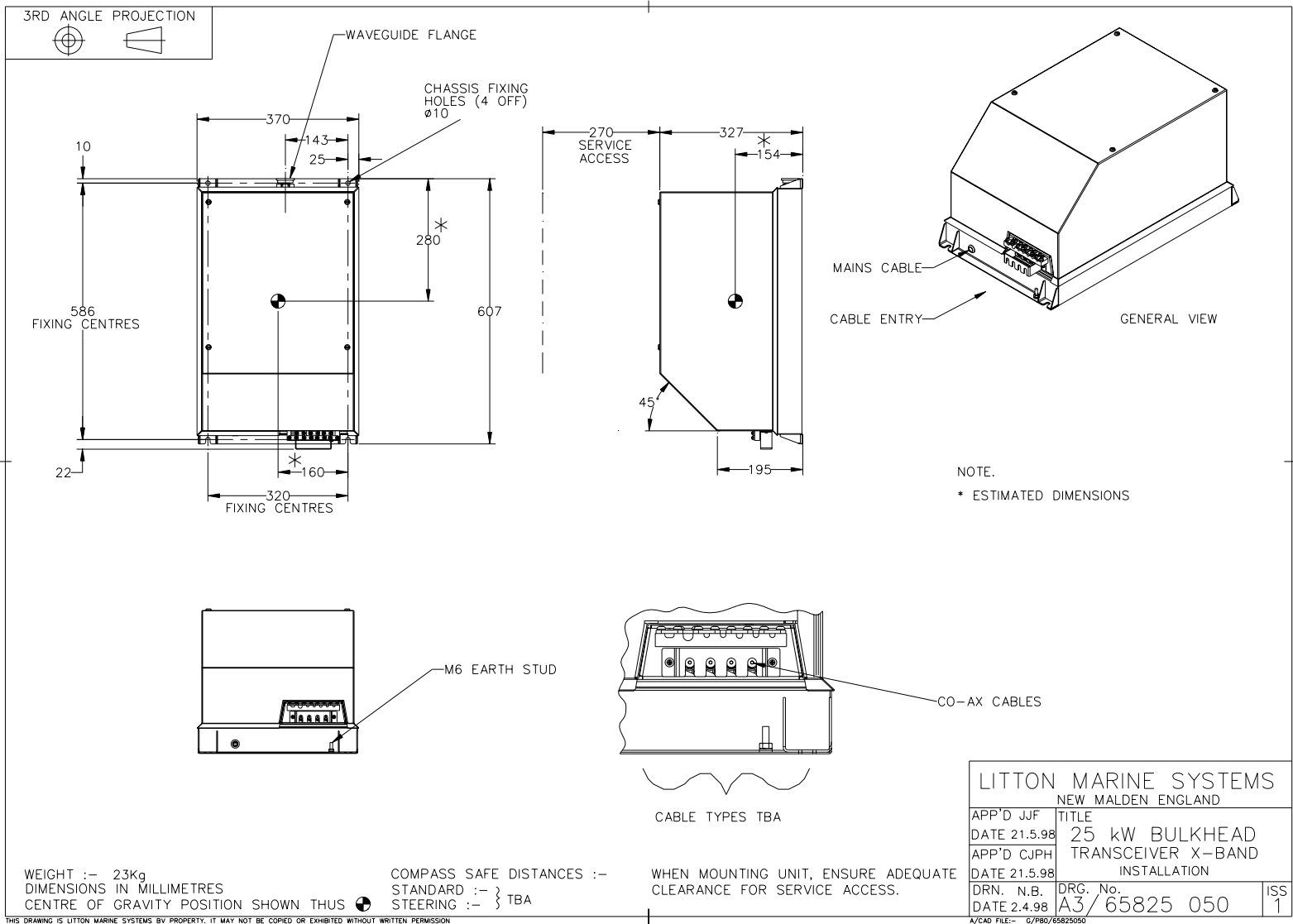


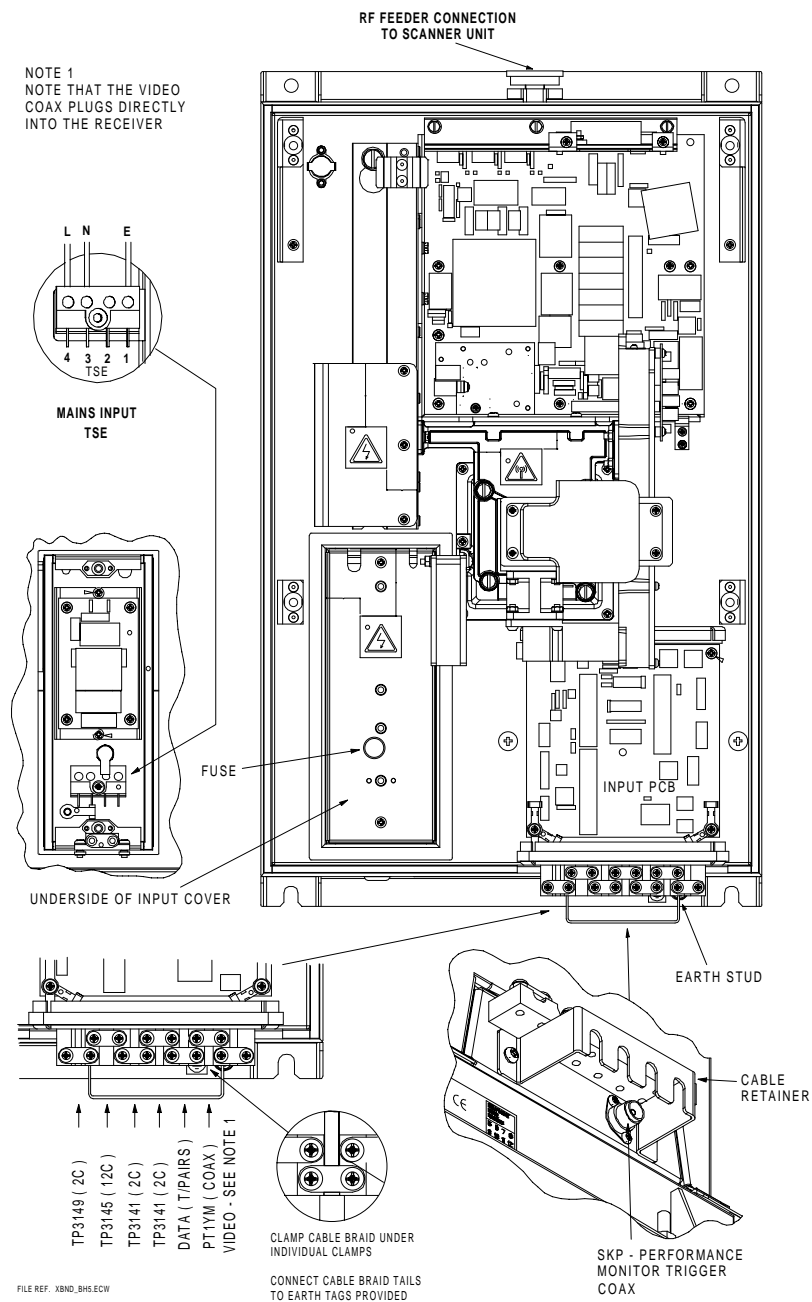
Figure 2.16 - X-Band Bulkhead Transceiver 25KW Installation

# Chapter 2

## X-Band Scanner Units and Transceivers

### 3.5.1 Cabling Information

Figure 2.17 below shows details of the cable inputs. The Transceiver cover, which is secured by four fixing screws, is shown removed. Note that the co-ax cables are retained by a cable retainer which must be fitted after the cables are in place. All other cables, with the exception of the X-Band RF Feeder ( waveguide ), are individually clamped on their cable braids to provide EMC shielding. The braids are also made off as tails and connected to earth tags provided. The a.c. mains input is connected to TSE located underneath the cover plate as shown.



**Figure 2.17** - X-Band Bulkhead Transceiver - Cable Input Details

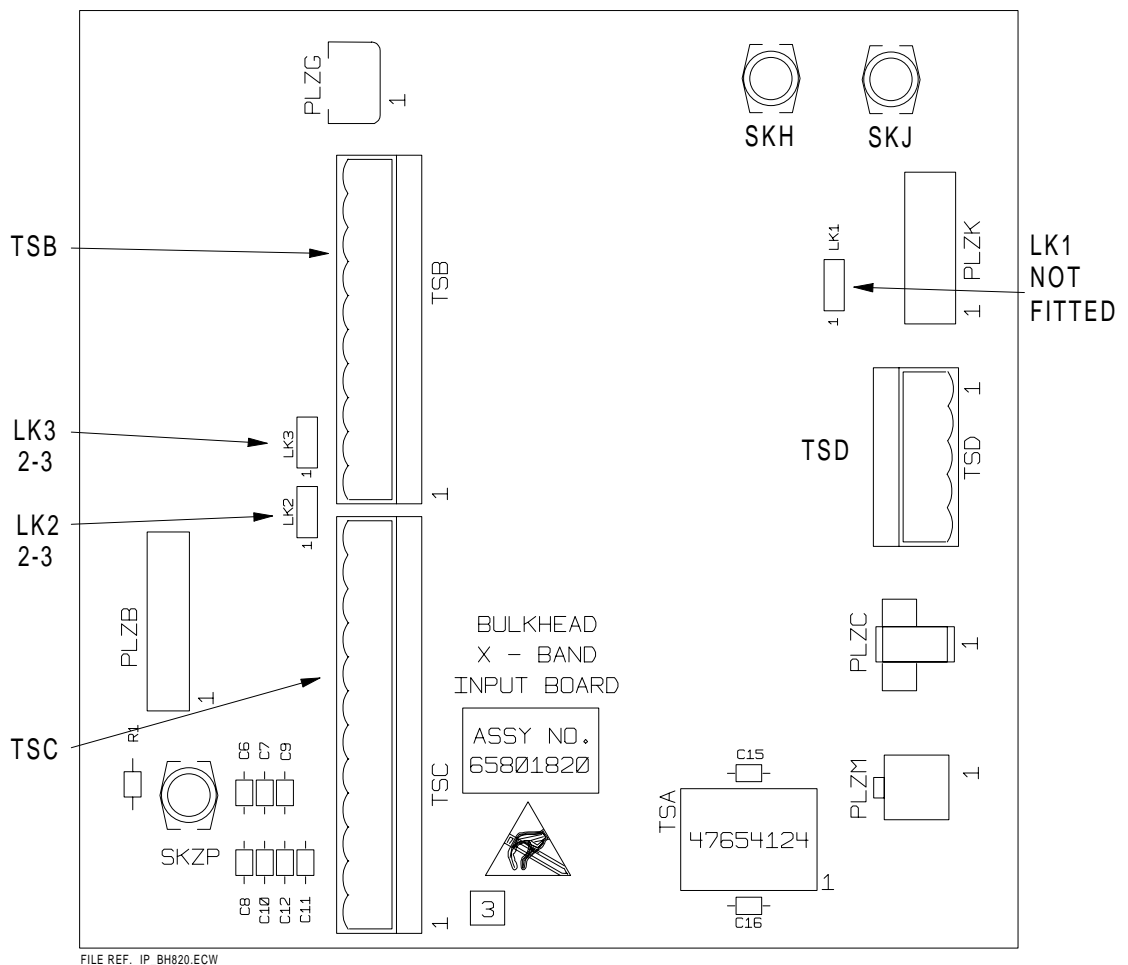


X-Band Scanner Units and Transceivers

Figure 2.18 below shows details of the Input Board 65801820. Access to the board is made by removal of the main Transceiver cover. Refer to the cabling schedules for details of the connections, which are made via the two part connectors provided.

Configuration for normal operation is by link settings as follows:

- Link 1            Not Normally Fitted
- Link 2            Link Pins 2 & 3
- Link 3            Link Pins 2 & 3



INPUT BOARD 65801820 - BULKHEAD TRANSCEIVER

**Note** - SKH, SKJ, PLZK and TSD are not normally fitted.

**Figure 2.18** - X-Band Bulkhead Transceiver - Input Board Details

### **3.5.2 Scanner Speed Settings**

Two scanner speed settings, 'LOW' and 'HIGH', are available, depending on the position of the link LK1 fitted to the Motor Drive Board 65801811.

Ensure that the correct scanner speed is selected, and that the corresponding Pulse Bearing speed is also selected. Refer to sub-section 3.3.1

### 3.5.3 Fitting the RF Elliptical Waveguide (X-Band)

#### General Information

1. A 33.5mm x 22.9mm corrugated elliptical waveguide is used for the run between the Bulkhead Transceiver Unit and the Turning Unit with X-Band radars. The waveguide used is Andrew Antennas Type EW85 - 9.8GHz.

A 12" flexible waveguide (Part No. 1189.z, supplied) must be fitted between the elliptical waveguide and the turning unit.

(Figures 2.19 to 2.26 are reproduced by permission of Andrew Antennas).

2. Although apparently robust, the waveguide must be protected against strain and kinking, and must be treated with the utmost care at all times. The ends of the waveguide must be kept sealed against the ingress of moisture before the connectors are assembled. The maximum permissible twist is 3°/metre (39").
3. Wherever possible, bends should have as great a bending radius as practicable. A single bend may be made when necessary with a minimum bending radius (measured from the axis of the cable) of 203mm (8in.) in the 'E' plane, and 482mm (19in.) in the 'H' plane
4. For convenience, the upper (Turning Unit) connector can be fitted prior to installation of the waveguide, but the following precautions must be taken:-
  - 4.1 Any bend required within 1m (3ft) of the waveguide end must be preformed before carrying out the cutting and assembly procedure detailed in subsequent paragraphs. Note that no bend may be nearer than 250mm (10in.) from the end of the waveguide.
  - 4.2 To allow for relative movement between the Turning Unit and mast, whenever possible a double bend should be formed in the cable so as to produce an offset immediately below the Turning Unit.
  - 4.3 The waveguide and assembled connector should be fitted to the Turning Unit so that a minimum amount of distortion of the waveguide occurs between the connector and the pre-formed bend.
  - 4.4 The waveguide should be installed and secured in position (using the waveguide supports shown in Figure 2.26) as far as is practicable before the lower (Transceiver Unit) connector is fitted to the waveguide. The precautions given in sub-para. 4.1 above must be observed if a bend is required adjacent to the Transceiver Unit.

### ASSEMBLING THE CONNECTORS

#### General

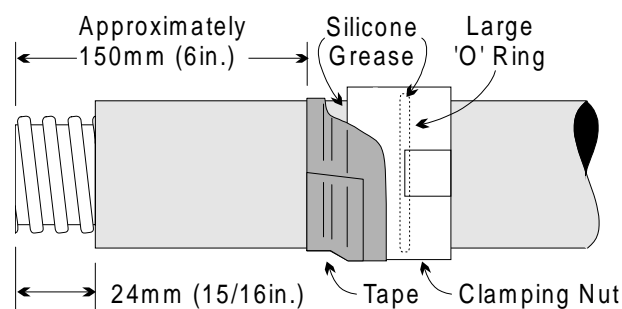
5. A straight connector (Type I85BC) is used to terminate the waveguide at each end.

#### Tools required

6. The normal tools found in an Engineer's tool kit, plus a hacksaw (with a fine-toothed blade) and 1-15/16in. open-ended spanner, will be sufficient for fitting the connectors to the waveguide.

#### Procedure

7. The procedure which follows is applicable to the straight connectors at each end of the waveguide. Note that it is most important that swarf and other foreign matter should be prevented from entering the waveguide.
8. Prepare the waveguide end and assemble the connector as follows:-
  - 8.1 Ensure that the end of the waveguide is straight for at least 250mm (10in.). The ends of the EW85 must be cut squarely. Wrap a straight edged piece paper around the wave guide to ensure squareness, tilt waveguide downwards to prevent copper swarf entering, then remove a 24mm (15/16in.) Length of the polyethylene jacket. Clean external copper with Comothene (or Ultraclean) solvent and the interior with a bottle brush, see Figure 2.19.

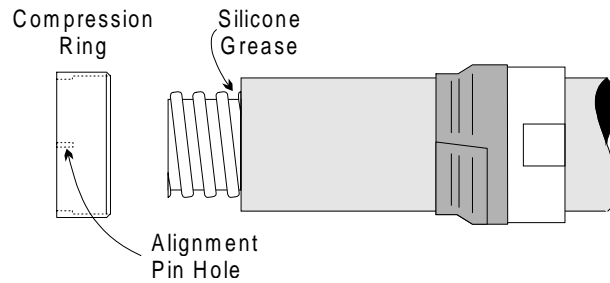


**Figure 2.19** - Cut Jacket

- 8.2 Apply a thin film of silicone grease (MS4 or similar) to the large 'O' ring and insert in the internal groove of clamping nut; apply a thin film of grease to smooth internal surface of clamping nut and slip the nut over end of waveguide as shown in Figure 2.19. Wrap several turns of tape around clamping nut and jacket to prevent foreign matter from entering.
- 8.3 Grease the cut edge of jacket, slip chamfered end of compression ring over

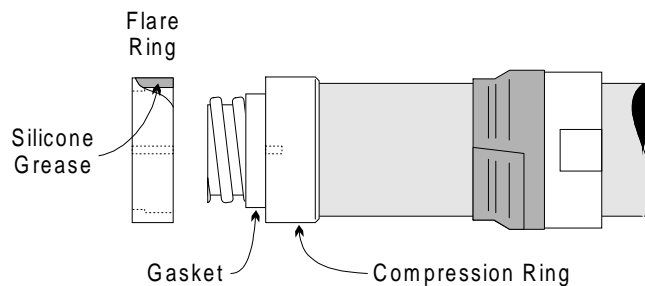
## X-Band Scanner Units and Transceivers

until recessed edge bottoms against jacket (align pin in holes facing away from jacket) as shown in Figures 2.20 and 2.21.



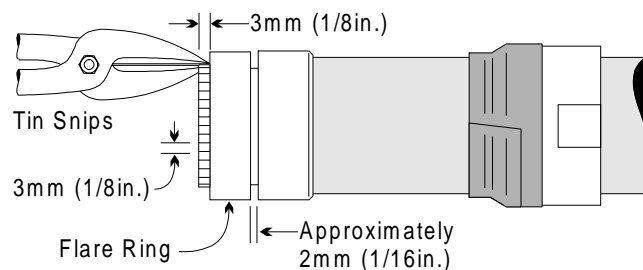
**Figure 2.20** - Fit Compression Ring

- 8.4 Turn gasket inside out and fit on end of waveguide, apply thin film of silicone grease to gasket threads, roll gasket over to correct position and against compression ring. See Figure 2.21 and apply a thin film of grease to outside surface of gasket. Clean any grease from exposed copper, with solvent.



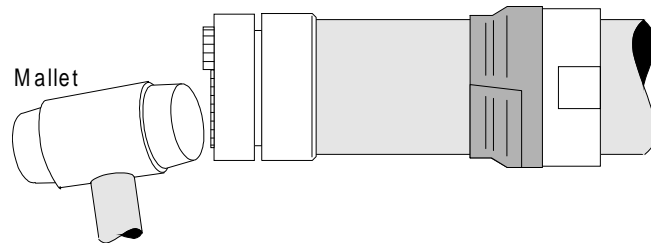
**Figure 2.21** - Fit Flare Ring

- 8.5 Fit recessed side of flare ring over gasket, with alignment holes of flare ring and compression ring corresponding. Push flare ring firmly against compression ring, see Figure 2.22.



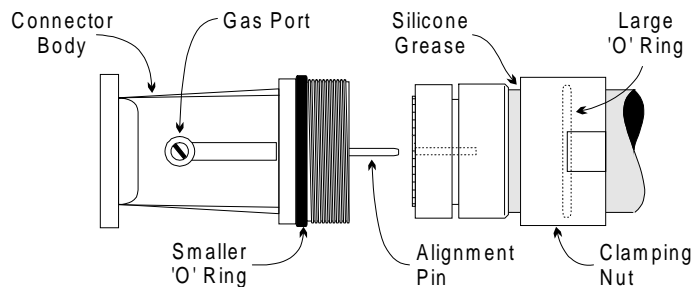
**Figure 2.22** - Cut Tabs

- 8.6 With tin-snips, cut the bared end of EW85 into tabs 1/8in wide and 1/8in deep - as close to flange as possible, see Figure 2.22. Flatten tabs against flare ring with a mallet using minimum force, heavy blows will reduce thickness of copper, see Figure 2.23. Trim off any tab protruding beyond periphery of flare ring; clean tabs with solvent to remove any silicone grease.



**Figure 2.23** - Flare End

- 8.7 Ensure that the mating R.F. contact face of the Type 185AC Connector body is clean and thoroughly grease-free. Clean inside of waveguide with a bottle brush.
- 8.8 Fit the smaller 'O' ring to external groove on connector body without any grease, see Figure 2.24. Apply a thin film of grease to rear outer surface of compression ring (so that large 'O' ring in clamping nut will slide over compression ring and seat in the recess).

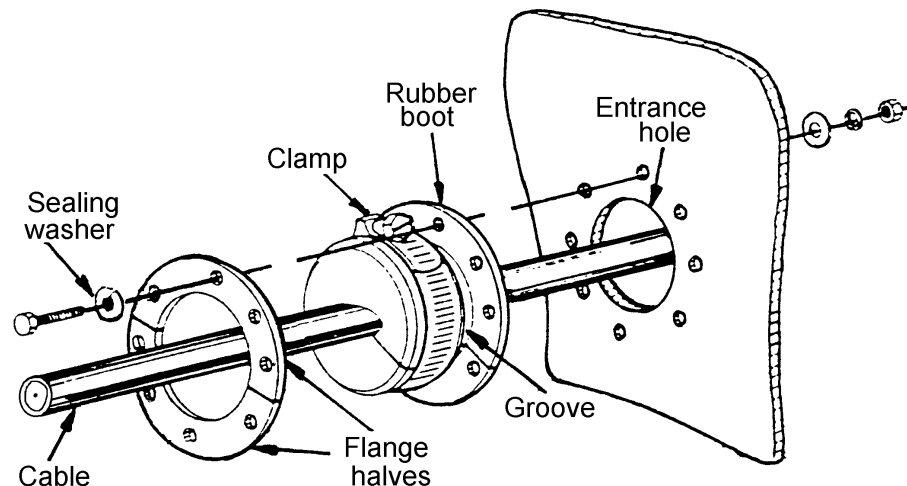


**Figure 2.24** - Fit Connector

- 8.9 Place connector body against flare ring, insert alignment pin in holes of flare ring and compression ring. Untape the clamping nut, slide it over the rings and screw to thread on connector body.
- 8.10 Hold the rectangular part of connector body with an adjustable spanner and tighten the clamping nut with a 1-15/16in set spanner across the flats. DO NOT turn connector body.

### Fitting the Deck Gland

9. The EW85 waveguide passes through its own separate deck gland (Part No. SKS.86347.A), positioned near to the foot of the mast. The gland kit comprises a rubber boot, metal flange halves, eight Lock-o-seal washers and an adjustable clamp (Jubilee clip). In addition eight 1/4in. bolts (of a suitable length), flat washers, lock washers and nuts will be required.
10. To fit the deck gland refer to Figure 2.25 and proceed as follows:-
  - 10.1 Cut a 75mm (3in.) diameter hole in the deck and, having installed and secured the waveguide from the Turning Unit downwards, pass the Transceiver Unit end down through the hole.
  - 10.2 Apply silicone grease to the hole and to the slit and tapered edge of the rubber boot.
  - 10.3 Place the boot around the feeder, slide the boot down into the hole in the deck and then mark the location of the eight holes for the fixing bolts.
  - 10.4 Withdraw the boot from the hole and drill eight 8mm (5/16in.) mounting holes through the deck.
  - 10.5 Slide the boot back into the hole in the deck and position the flange halves in the groove in the boot.



**Figure 2.25** - Deck Gland Details

- 10.6 Align the flange holes with the boot holes and secure the assembly in position with eight 1/4in. bolts, flat washers, lock washers and nuts, together with the Lock-o-seal washers provided in the gland kit. Note that the bolts are

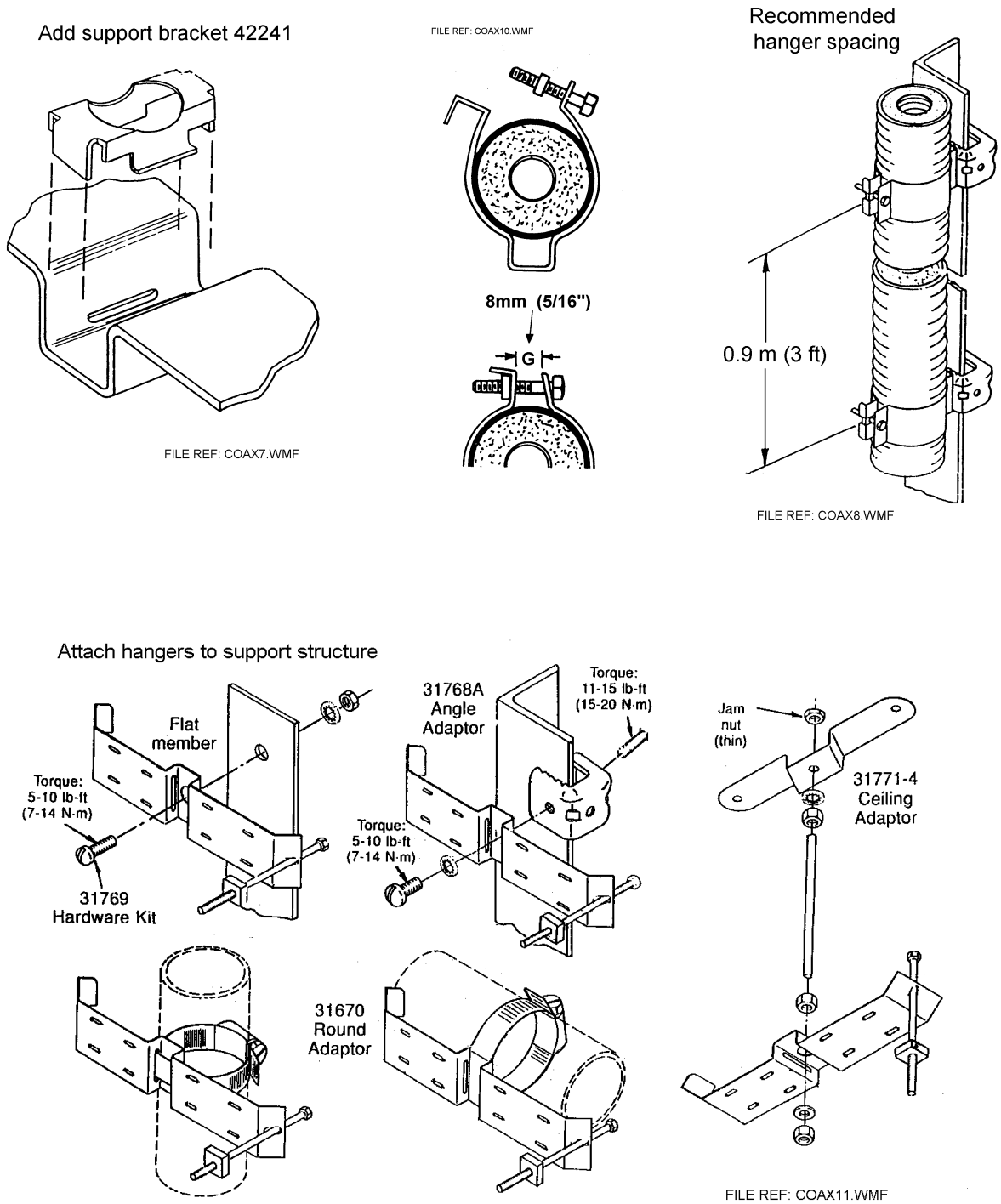
inserted downwards and that the Lock-o-seal washers only go under the bolt heads.

- 10.7 Fit the adjustable clamp (Jubilee clip) around the boot and tighten to ensure a leakproof seal.

### **Installing the Waveguide**

11. Waveguide Hangers are supplied (Andrew Hanger Kit Type 42396A-5) for supporting the waveguide along its run between the Scanner Unit and the Bulkhead Transceiver. Each kit contains Hangers plus their associated Support Brackets (Andrew Type 42241), the quantity supplied is dependant on waveguide length. Normally, a hanger is attached to a cable tray, using suitable bolts, at a recommended spacing of 0.9 metres (3 feet). The support brackets must be fitted to the hangers to prevent distortion when the hanger is wrapped around the waveguide as shown in Figure 2.26.
12. Figure 2.26 also shows additional hardware (not supplied in the Installation Kit) which facilitate special mounting arrangements. If required, these are obtainable from Andrew Corporation.





**Figure 2.26** - Waveguide Support Details

### **3.6 Initialisation and Commissioning**

The X-Band Scanner Unit and Transceiver are only part of a complete BridgeMaster E Series Radar, and cannot be operated independently. For details of complete system installations refer to the BridgeMaster E, Ship's Manual 65800010B.

After a complete system has been installed it must be Initialised and Commissioned as detailed in Chapter 4 of the BridgeMaster E, Ship's Manual 65800010B.

## 4 Technical Specification

### 4.1 X-Band Scanner Unit

Operating frequency: 9410 MHz  $\pm$ 30 MHz

Specification	Aperture Size		
	1.2 m (4 ft)	1.8 m (6 ft)	2.4 m (8 ft)
Horizontal Beam Width, -3 dB (maximum)	2.0°	1.3°	1.0°
Vertical Beam Width, -3 dB (nominal)	24°	24°	24°
Sidelobes within 10° of Beam (minimum)	-23 dB	-23 dB	-23 dB
Sidelobes outside 10° of Beam (minimum)	-30 dB	-30 dB	-30 dB
Gain (nominal)	29 dB	30 dB	31 dB
Polarisation	Horizontal	Horizontal	Horizontal
Limiting Relative Wind Speed	100 kt	100 kt	100 kt

The rotational speeds given below apply to all sizes of X-Band antenna.

Rotational Speed	rpm
Standard	28 rpm
High	45 rpm

## 4.2 Transceiver Specification

### 4.2.1 Mounting Arrangements

Option	X-Band
Masthead	Aloft within Turning Unit
Bulkhead	Waveguide feed to Turning Unit

### 4.2.2 Transmitter

Parameter	X-Band
Magnetron Frequency	9410 MHz $\pm$ 30 MHz
Magnetron Peak Power	10 kW nominal or 25 kW nominal
Pulse Length/PRF	0.05 $\mu$ s/1800 Hz nominal (Short Pulse) 0.25 $\mu$ s/1800 Hz nominal (Medium Pulse) 0.75 $\mu$ s/785 Hz nominal (Long Pulse)
Pulse Generator	Solid-state with pulse forming network driving the magnetron.

### 4.2.3 Receiver

Parameter	Detail
Type	Logarithmic, with Low Noise Front End (LNFE)
Tuning	AFC/Manual
IF (Intermediate Frequency)	Centred at 60 MHz
IF Bandwidth	20 MHz on short and medium pulses (nominal) 3 MHz on long pulse (nominal)
Noise Factor	5.0 dB nominal
Dynamic Range	80 dB nominal

### 4.3 Performance Monitor (optional with non Type Approved systems)

Parameter	Detail
Performance Monitored	Separate monitors for Radar System and Radar Receiver
Type	Transponder
Presentation	Four concentric arcs on Display Unit. Arcs are of reducing brightness outwards, showing degradation in performance (including antenna) in 5 dB increments relative to inner arc.

## 4.4 Power Supplies

### 4.4.1 Power Supply (AC)

Parameter	Detail	
Input voltage range	92 - 276V RMS	
Input voltage frequency range	47 to 64 Hz.	
Maximum Input Power	X-Band Scanner (Including Transceiver and Motor)	
	Standard Speed Unit	250 VA
	High Speed Unit	370 VA
Transient protection	Overvoltage transient of up to 40 % above nominal input voltage with maximum duration of one second. Pulse transient of up to $\pm 1200$ V peak, with a rise time of 2 to 10 $\mu$ s and duration up to 20 $\mu$ s.	
Protection facilities	Output short circuit. High and low input voltage. Output overvoltage. Slow start.	
High voltage multiphase operation	Via a suitable transformer.	

### 4.4.2 Power Supply (DC)

Parameter	Detail
Input voltage range	22 to 32 V DC
Maximum Input Power	X-Band Scanner (Including Transceiver and Motor) 250W
Transient Protection	Symmetrical (line-line) 500 V of duration 10 $\mu$ s (100 $\mu$ s rise/fall time). Line to ground 500 V of duration 60 $\mu$ s (1 $\mu$ s rise/fall time)
Protection Facilities	Output short circuit. High and low input voltage. Slow start.

## 4.5 Mechanical Specification

### 4.5.1 Weights and Dimensions

Component	Height (mm)	Depth (mm)	Width (mm)	Weight (kg)
X-Band Scanner Unit with 1.2 m Antenna	440	586	1305*	49
X-Band Scanner Unit with 1.8 m Antenna	440	586	1914*	52
X-Band Scanner Unit with 2.4 m Antenna	440	586	2550*	55
X-Band Bulkhead Transceiver Unit	607	327	370	23

\*Antenna Turning Circle

## 4.6 Compass Safe Distances

Component	Type No.	Standard	Steering
X-Band Scanner Unit 10 kW	65810M	1.4 m	0.8 m
X-Band Scanner Unit 25 kW	65825M	3.3 m	2.0 m
X-Band Scanner Unit (without Transceiver)	65801B	0.4 m	0.3 m
X-Band Bulkhead Transceiver 10 kW	65810A	1.3 m	0.7 m
X-Band Bulkhead Transceiver 25 kW	65825A	3.3 m	2.0 m

## 4.7 Environmental Specification

To the requirements of the International Standard for Marine Navigational Equipment CEI/IEC 945 (1988) and Amendment 1 (1992).

## 5 Technical Description

### 5.1 Automatic Start-up Sequence (X-Band)

The automatic start-up sequence described below, should be read in conjunction with Figures 1.30 'X-Band Turning Unit (Aloft) Schematic'.

#### 5.1.1 Start-up

**Important Notice** - Once mains is applied to the PSU board the Power Factor Correction (PFC) circuitry starts and generates 390V. It should be noted that whilst mains is applied the PFC is active and cannot be manually switched off. The start circuitry only controls the flyback converter so High Voltage DC is present on primary power components whenever mains is present on the board. **This fact should be noted when servicing the Transceiver.**

The Power Supply in the Transceiver is only active during normal operation when there is a Display (or Compatibility Unit) connected to it. The RS422 serial data stream from the Display is used to drive an opto-coupler in the PSU which detects the presence of either polarity voltage and enables the flyback converter in the PSU.

The RS422 serial data stream from the Display enters the Input Board on connector TSB 1, 2 as "DU DATA+ and DU DATA-". It is then passed to the Trigger Board via PLYB 16, 17, and then on to the PSU via PLTH 11, 12 (as PSU START and PSU START RTN).

For test purposes the PSU can be turned on in the absence of a serial data stream by linking pins 1-2 on LKA (PSU).

#### 5.1.2 Transmit Enable

When the operator selects Transmit, the TU Enable signal is activated LOW on the Trigger PCB ( PLYH 10). On the X-Band Scanner Unit, this signal is fed to the Power Supply Unit and via the Turning Unit On/Off and Input PCB to the Motor Drive PCB to start the antenna rotating.

Once the antenna has done one complete revolution transmission is started. When standby is selected, transmission is immediately halted and, after one complete revolution of the antenna, TU Enable is disabled.

The Modulator starts to generate radar pulses when the Trigger PCB sends it MOD TRIGGER pulses (to PLVC 9). Note that the CHARGE TRIGGER pulses (on PLVC 8) are present even in Standby mode.

A signal indicating that the Magnetron has fired is fed via MAG SAMPLE from PLVC 7 on the Modulator PCB to the Trigger PCB. This signal is processed on the Trigger PCB and outputted as TX TRIG (PLYB 20 & 21) to the Input PCB (PLZB 20 & 21) and then to the Display Unit via TSB 5 & 6.

**Note** - *TX DATA is sent from the Transceiver to the Display Unit.  
DU DATA is sent from the Display Unit to the Transceiver Unit.*

The Trigger PCB processes the serial data input from the display, and generates the required control signals for the Transceiver. The data is transmitted each time a bearing pulse is received from the Turning Unit. The various timing signals required by the Transceiver including the Pulse Repetition Frequency (PRF), are generated by the Trigger pcb.

### 5.1.3 Transmitter Operation

The high-voltage negative pulses required to drive the magnetron are generated by the Modulator PCB. The modulator pulse widths are selected by the Trigger pcb but are defined by the Modulator pcb. Timing signals are controlled from the Trigger pcb. A spark gap on the Modulator is fired if the magnetron fails to operate. Continual operation of the spark gap is detected and a signal is fed back to the Trigger pcb, as the spark gap detect signal.

When the spark gap detect signal reaches approximately 2.5v, the microcontroller inhibits transmission for approximately one second. On detection of this signal, the Trigger pcb switches the radar to Standby, and generates an error signal which is transmitted to the Display Unit via the serial data link.

When Standby is selected, rotation of the Antenna is inhibited. Unless in Test Mode, transmission from the radar is inhibited if the Antenna is not rotating.

On the Trigger PCB, there is a timer circuit which is basically a capacitor that slowly discharges (between 4s and 18s) when power is removed from the PCB. On power-up the microcontroller measures the charge remaining on the capacitor to determine whether the transceiver has been switched off for long enough to warrant inhibiting transmit for three minutes until the magnetron heaters have had time to warm up again.

The other analogue signals into the Trigger PCB come from the Modulator. The Modulator supply voltage and the magnetron current (only when transmitting) are measured and sent to the Display as an aid to fault finding.



## 5.2 Trigger PCB (X Band)

### 5.2.1 General Description

The Trigger PCB controls the operation of the Transceiver under instruction from the Display. There are two serial links, which are used to transfer control messages from the Display to the Trigger PCB and Transceiver information back to the Display. The Trigger PCB generates control and tuning signals required by the Modulator, Receiver, Performance Monitor and Biased Limiter. The PSU is enabled with a signal from the Trigger PCB.

### 5.2.2 Signals To /From the Trigger PCB

#### To/From Display

- Serial Data to Display
- Serial Data from Display
- Trigger to Display

#### To/From Modulator

- Pulse Length select lines
- Charge and Modulator Triggers
- Magnetron Heater Turndown signal ( only used for S-Band, Long Pulse operation )
- Voltage/Current Monitor signals
- I0/25kW and X-Band Configuration signals

#### To/From Receiver

- Tuning Voltage signal
- Bandwidth Control signal
- AFC/Manual control
- AFC Trigger
- Tune Indicator signal

#### To Biased Limiter

- Trigger signal

#### To Performance Monitor

- On/Off signal
- Mode Control signal
- Tuning Voltage signals

#### To/From Power Supply PCB

- +30V, +12V, +5V, 0V & -12V Supply lines
- Turning Unit Enable
- Power Supply Start and Return

### 5.2.3 Functional Description (X-Band Trigger PCB)

The 80C51 family microcontroller provides overall control of the Trigger PCB functions. Program memory and RAM are included within the microcontroller IC. Serial I/O is handled by the microcontrollers internal UART and an external RS422A driver and receiver. Baud rate is fixed at 76800 baud for operational use but is link selectable to 19200 or 38400 baud for test purposes. The serial data format is 8-bit data, 1 stop bit and even parity.

The Display sends serial messages comprising four or five characters depending on message content. Control messages are four bytes long and tuning messages are five. The tuning voltage levels are sent as 12-bit values which are converted on the Trigger PCB using a four-channel DAC before amplification/buffering and distribution to the Receiver and Performance Monitor.

The Bearing signal from the Turning Unit is used to initiate serial transmission from the Trigger PCB such that each time one of the 4096 azimuth pulses per rev is generated and fed into one of the microcontrollers interrupt pins, a character (one byte) is sent to the Display. One bit in each of the characters sent is dedicated to the heading marker, on every new heading marker pulse from the Turning Unit, the bit is toggled.

The Power Supply in the Transceiver is only active during normal operation when there is a Display (or Compatibility Unit) connected to it. The RS422 serial input from the Display is used to drive an opto-isolator which detects the presence of either polarity voltage and enables the PSU.

#### Trigger Outputs

There are a number of trigger signals generated by the Trigger PCB:

- Pre-Trigger (optional)
- Charge Trigger
- Modulator Trigger
- Display Trigger
- Performance Monitor Trigger
- AFC Trigger
- Swept Attenuation Initiate

The Charge Trigger is the timing signal used to recharge the Modulator PFN. This is generated by the microcontroller using an internal timer routine set to the appropriate PRF for the pulse length selected. A wobulation factor is added to the basic timing to ensure that no two radar transmissions are locked together. The wobulation is calculated according to the number of serial messages received before going to transmit and the position of the antenna between each trigger pulse.

An optional Pre-trigger will be produced approximately  $11\mu\text{s}$  before the modulator trigger. This is not a normally fitted option and is intended for use in special options applications.

The Modulator Trigger is used to discharge out the PFN into the magnetron and is the trigger that initiates the modulator firing. The PFN is recharged by the Charge Trigger pulse which follows  $100\mu\text{s}$  after each Modulator Trigger pulse. In standby mode, the Charge Trigger pulse is still generated, but the Modulator Trigger pulse is gated off.

In standby, the Display and Performance Monitor Triggers are generated from the Mod Trigger pulse. When the transceiver is in transmit mode the triggers begin on the leading edge of the magnetron sample pulse and end after a preset time, adjustable using RV1.

The AFC Trigger is used by the receiver when in AFC mode and is only generated when the transceiver is in transmit mode. The pulse is started on the front edge of the Modulator Trigger and terminates on the back edge of the magnetron sample pulse.

The Swept Attenuation Initiate pulse is the timing signal fed to the Limiter Drive PCB which generates the control for the biased limiter. It is initiated by the front edge of the Pre-trigger (approximately  $2\mu\text{s}$  prior to magnetron firing) and terminated  $2.5\mu\text{s}$  after the leading edge of the magnetron sample pulse.

The Display and PM Triggers are essentially the same trigger and are present at all times when the radar is powered up. They are initiated by the Modulator Pulse and last for approximately  $2.5\mu\text{s}$ .

### **Analogue Outputs**

The Trigger PCB generates four variable DC signals; LO Tune, PM Tune, Xr Adjust and Xt Adjust. These signals are coded as 12-bit digital values and incorporated into the serial messages from the Display. A 12-bit, four channel DAC is used to generate the tuning signals from the message data. Additional buffering is added to the LO and PM Tune outputs of the DAC and x3.5 amplification to the Xr and Xt Adjust signals.

LO Tune is the 0V to +5V receiver tuning signal and PM Tune the 0V to +5V Performance Monitor main tuning signal. Xr and Xt Adjust are 0V to +1.5V signals used to control the receive and transmit attenuators in the Performance Monitor.

### **Analogue Inputs**

There are various analogue inputs to the Trigger PCB from other PCBs in the transceiver and some on-board signals that are fed into an eight channel 8-bit ADC, and converted to digital values either for further processing by the microcontroller or to be passed to the Display via the serial message link.

The signals on the Trigger PCB that are measured are the dropout timer and +12V and +30V supplies. The timer circuit is basically a capacitor that slowly discharges (between 4s and 18s) when power is removed from the PCB. On power-up the microcontroller measures the charge remaining on the capacitor to determine whether the transceiver has been switched off for long enough to warrant inhibiting transmit for three minutes until the magnetron heaters have had time to warm up again. The power supply levels are measured and the results sent to the Display as an aid to fault diagnosis.

One channel of the ADC is used to detect whether a Performance Monitor has been fitted to the system. The voltage on this channel will be lower than a preset value if a Performance Monitor is present otherwise it will be pulled to the +5V supply rail. This information is encoded and sent as part of the configuration message to the Display.

The Receiver sends a tune indicator signal to the Trigger PCB which indicates how close it is to being on tune. This signal is coded as part of the serial message and sent to the Display.

The other analogue signals into the Trigger PCB come from the Modulator. The Modulator supply voltage and the magnetron current (only when transmitting) are measured and sent to the Display as an aid to fault finding. The spark gap detect signal is generated by the modulator when the spark gap arcs over, if it reaches a predetermined level the microcontroller inhibits transmission for approximately one second and sends an error message to the Display.

### **Digital Outputs**

The digital outputs from the Trigger PCB are all straight forward on/off control signals to various parts of the transceiver.

Signals to the Receiver select wide or narrow bandwidth (Wideband) and AFC or manual tuning mode (AFC On). Narrowband is selected when the modulator is transmitting in long pulse and briefly during pulse length changing. AFC or manual mode is selected by the radar operator and is part of the control message sent from the Display.

Modulator signals MP and SP are used to set the pulse length as requested by the radar operator, SP set to 0V indicates short pulse operation, MP set to 0V indicates medium pulse operation and both SP and MP set to +5V indicates long pulse operation. SP and MP both set to 0V is an illegal state and will not happen in normal operation. Turndown enable is used to reduce the heater current in the magnetron and is only set when an S-Band magnetron is fitted and is transmitting in long pulse.

The control signals PM On/Off and PM Tx/Rx are used to switch the Performance Monitor on and to switch it between system test mode and receiver test mode.

TU Enable is the control signal fed to the Motor Drive PCB to initiate rotation of the antenna. When the operator selects transmit the TU Enable signal is activated to start the antenna rotating.

Once the antenna has done one complete revolution transmission is started. When standby is selected, transmission is immediately halted and, after one complete revolution of the antenna, TU Enable is disabled.

### **Optional I/O**

There are several optional I/O signals for use with special options variants of the PCB; Pre-trigger (as described in the section on triggers), External Trigger Input and Radar Silence. The External Trigger input is used when the modulator needs to be triggered from an external source rather than the Trigger PCB. Trigger signals fed to this input are prf limited to prevent damage to the modulator. Radar Silence is a method of inhibiting transmission without using

the appropriate command in the serial message. An active signal at this input will cause the microcontroller to inhibit transmission within one trigger pulse at either of the internal prfs.

### **Built In Self Test (BIST)**

The microcontroller performs a number of self test operations and reports the results to the Display as part of the serial message link. Error situations that are monitored in the transceiver are; serial message corruption, loss of Display messages, loss of Heading Marker signal, loss of either Charge or Modulator Trigger and spark gap arcing. Error situations will in all cases cause the microcontroller to inhibit transmission until the error has been cleared.

The other signals that are monitored and sent directly to the Display without further action by the microcontroller are the power supply lines and magnetron current as described in the section on analogue inputs.

### **Test Modes**

There are two test modes for the Trigger PCB. The production test mode is used solely during production testing of the PCB and is initiated by fitting the test link LK4. This must only be done on the production test bed as connecting this link when incorporated into a transceiver could lead to unpredictable and possibly dangerous operation.

The second test mode, of use to service engineers can be initiated by fitting the two links LK5 and LK6 to position 2-3. When in this mode the transceiver can be operated without the antenna rotating, and may be removed from the turning unit, reconnected to the Display below decks (with suitable test cables) and run as per normal operation. Fitting the links causes the Trigger PCB to generate bearing and heading marker data internally, allowing the transmitter to operate without the antenna rotating. A dummy load **MUST** be connected to the RF output. Since the Transceiver has been removed from the Turning Unit and the Pulse Bearing PCB outputs, the bearing and heading marker information normally required for Trigger PCB operation is simulated on a section of test circuitry on the Trigger PCB.

### 5.3 Transceiver Power Supply (X-Band)

#### 5.3.1 General Information

The DC power supply is described at sub-section 5.7.

The AC power supply is an AC to DC inverter that generates the supplies for the Transceiver. The inverter is housed on a single board and is powered by an AC supply of nominal 115V or 230V in the frequency range 47-64Hz.

The power unit uses a boost converter front end to provide a regulated high voltage d.c. to 2 flyback converters providing the output supplies. Some of these supplies use additional switch mode converters to provide regulated outputs.

The outputs supplied by this power supply are:-

Variable -600V, +30V, +20V, magnetron heaters (via further regulator, +12V, -12V and +5V) and for the X-Band Turning Unit variant, +50V for the Motor Drive pcb.

The power unit has the following features:

- -600V adjustable over the range -550V to -650V for control of magnetron current via modulator.
- Output short circuit protection.
- Universal input from 95V to 276V without tap changing. Power factor corrected providing a PF of better than 0.9.

#### 5.3.2 Functional Description (X-Band Transceiver AC Power Supply)

The following functional description is based on the block diagram given at Figure 2.27.

##### Principles of Operation

This power supply utilises a boost converter to provide approximately 390V d.c. to the main flyback converter which drives the power transformer T2. The principles of operation are as follows:

The incoming AC supply is filtered mainly to suppress noise emitted from the p.s.u. but also to attenuate incoming noise. Mains is then passed to the power factor controller which converts mains between 95V to 276V RMS to a stable high voltage d.c. (390V). The p.f.c. takes the form of a boost regulator which forces the input current to follow the waveshape of the input voltage as if a resistor were connected across the rectified AC supply. The p.f.c. also aims to regulate the output voltage to a level greater than the peak supply voltage. These factors are achieved by the control circuit (U3) which senses the input and output voltage as well as the input current. The control circuit sends a stream of constant frequency but varying width pulses, to the switching FET (Q1) such as to control the input current and output voltage.

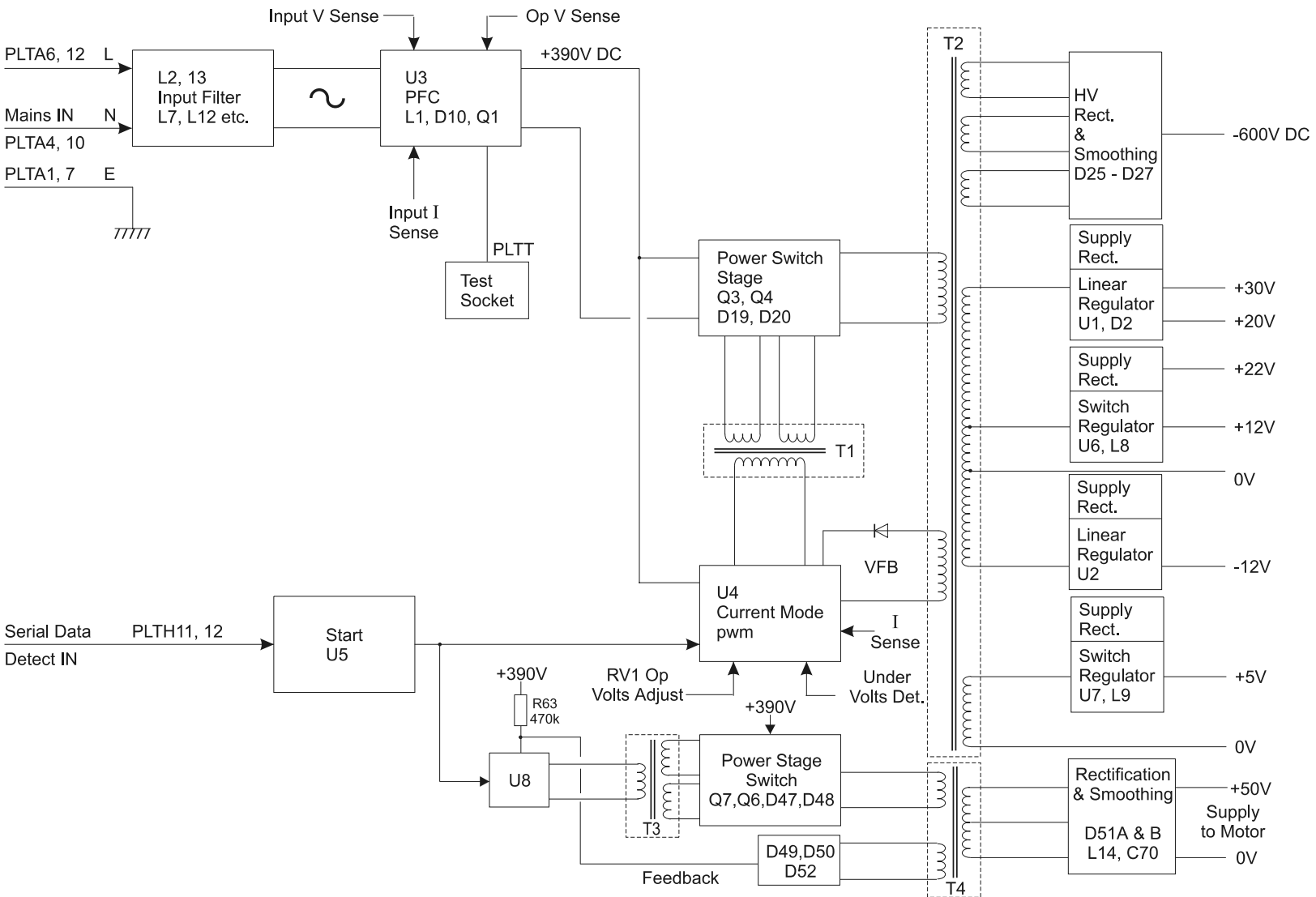


Figure 2.27 Block Diagram - AC Power Supply Board

The choke (L1) current increases during the FET on period and falls during the FET off period when the boost diode D10 conducts. This produces a triangular current waveform at 100kHz superimposed on the sinusoidal current in the choke. At full load this triangular current may be 10% of the actual peak current. The High Voltage DC (390V) is applied to the main Current Mode power converter comprising U4, Q3, Q4 and T2.

The high voltage DC line is switched to the primary of transformer T2 by the two FETs Q3, and Q4, These FETs are driven by the control circuitry (U4) such that they will both be either 'on' or 'off' together. Flyback action takes place during the off state. A small drive transformer T1 is used to provide the simultaneous but isolated drives to the two FET switches. The cross-connected diodes D19, D20 return excess flyback energy to the supply lines and provide hard voltage clamping of the FETs at a value of a diode drop above and below the supply line voltages. Switching devices with a 500V rating can be used. Energy recovery action of D19, D20 eliminates the need for an energy recovery winding or even snubbing components. Output current is fed back to U4 via sense resistor R47 which stabilised the control circuit and provides overcurrent protection under fault conditions. A further control winding provides a voltage feedback path via D32 which is used to supply power to U4 and regulate the voltage output.

### DC Outputs

The following output voltages are taken from the secondary winding of T2. A series of rectifiers, reservoir capacitors, linear and switch mode regulators are connected to the secondary windings of T2 to provide the following DC voltage outputs.

1. -600V	120mA max.	Modulator HT
2. +30V	20mA max	Tuning Range
3. +20V	15mA max.	Drive to IGBTs
4. 20V(approx:)	0.7A	to magnetron heaters via a switch mode step down regulator.
5. +12v	1.5A	Rx, trigger board modulator
6. -12V 0.6A		Rx, trigger board modulator
7. +5V 0	5A	Rx, trigger and pulse bearing board

An additional output ( +50V @ 6A ) for the Motor Supply PCB is produced from a separate switching regulator U8 and transformer T4.

As the modulator requires HT voltage that can be varied over 550V to 650V to set up the correct magnetron current, all outputs have to be further regulated to ensure stability. Adjustment of RV1 sets the required modulator HT voltage and thus the required magnetron anode current.

To produce the 600V d.c. HT, three windings on the secondary of T2 each produce 200V and are added together at the output of the rectifier circuits. The 30V and -12V rails are fed via three terminal linear regulators whilst the 20V is Zener stabilised. The +12V and +5V rails are fed via 'Simple Switchers', five terminal regulators and chokes with flywheel diodes.

The flyback current mode converter formed by U4, Q3, Q4 and T2 is started by detection



of a serial data stream applied to U5 from the display at PLTH 11, 12. On detection of the data stream the photo transistor within U5 is turned on pulling down the gate of Q2 below its threshold voltage. Q2 turns off allowing the compensation pin 1 U4 to rise enabling output of the IC U4. In the PSU off state Q2 is held on by current in R37 from Vcc.

In the absence of a serial data link from the display, for test purposes, LKA 1-2 can be made and the PSU will output the required d.c. voltages.

The operating frequency of the PFC section is approximately 100kHz. That of the PWM flyback converter is approximately 40kHz whilst the 'Simple-Switchers' run at approximately 52kHz.

Once the mains supply is applied to the PSU board, the PFC (Power Factor Correction) circuit starts and generates 390V. Whilst mains is applied, the PFC is active and cannot be manually switched off. The start circuitry only controls the flyback converter and so High Voltage DC is present on primary power components whenever mains is present on the board. **This fact should be noted when servicing the Transceiver.**

### 5.3.3 Circuit Description (X-Band Transceiver AC Power Supply)

The following circuit description is based on Circuit Diagram 65825916 given at Figure 2.28.

#### Mains Input

The AC supply enters the power supply from the external input filter via plug PLTA pins 6, 12 live, PLTA pins 4, 10 neutral and PLTA pins 1, 7 earth, to the comprehensive EMC suppression circuitry. Although the filtering provides some rejection of mains born interference its main task is to suppress pfc and main switcher interference generated from within the PSU. Due to the 100kHz triangular choke current and capacitive switching currents in the PFC power stage, common mode and differential mode interference pulses are present either side of C16. The multi-element filter formed by common mode chokes L2, L3. and differential mode chokes L7 and L12 together with the adjacent capacitors C18-C21 effectively minimise conducted 100kHz and harmonics from being superimposed on the incoming mains. VDR1 suppresses transient voltages on the AC supply whilst RT1 limits inrush currents to the smoothing capacitors C4, C5.

#### Power Factor Correction Circuit (PFC)

The PFC takes the form of a continuous mode fixed frequency, average current mode boost regulator. It produces a stable 390V DC rail from the incoming mains whilst ensuring the input current remains sinusoidal. The drive pulses for the main switching FET Q1 are generated by the PFC controller U3 pin 16. The ground pin 1 is referenced to HVRTN which is Q1 source and via the current sense resistors R20, 21 the bridge rectifier -ve output.

The Vcc supply for U3 pin 15 is derived from:-

1. Winding pins 7, 8 on the main choke L1.
2. Resistors R2, 3 and D31 from +HV DC
3. An external 17V dc PSU for test purposes.

All the following pins refer to U3. The V sense pin 11 senses the +HV DC (390V) line and causes Q1 drive pulses to adjust in width to keep the d.c. output voltage constant for load changes. The OVP pin 11 senses the +HV DC line and cuts off Q1 drive if the output voltage exceeds 390V by approximately 5%. The IAC pin 6 receives a current proportional to the rectified AC voltage from the bridge rectifier D1. V ref pin 9 outputs a 7.5V reference voltage. PK lim pin 2 receives a -ve voltage from current sense resistors R20, 21 via R1. When this is large enough to take pin 2 voltage below 0V, against the current flowing through R41, Q1 drive is cut off.

The EN/SYNC pin 10 is permanently held in the enable state by resistor R19 connected to Vcc. The C set and R set pins 14 and 12 are connected to C7 and R18. These components set the frequency of the internal oscillator to 100kHz. The SS pin 13 is for slow startup which is not used in this application.

The Va out pin 7 in conjunction with components C13, C8, R14 and R13 stabilise the +HV DC feedback control circuit in U3. The M out pin 5 receives the current sense voltage via resistors R22 and R59. The I sense pin 4 senses the voltage on the HV RTN end of the current sense resistors.

Inputs on pins 4, 5 and 6 are used in U3 to control Q1 drive pulse width such as to make the average current waveform in the choke L1 follow the rectified AC output voltage from bridge rectifier D1. The CA out pin 1 in conjunction with components R23, 8, C14 and C15 stabilise the current sensing feedback control circuit in U3.

### **Overcurrent Limit Operation of PFC**

There are two separate circuits to protect the power switching components.

- a) A controlled and stable current limit circuit is built into the average current feedback control loop. The current limit value is determined by resistors R20, 21. Increasing the PFC load current above the maximum level will cause the pfc input current to progressively have a flat top to the full wave rectified waveform.
- b) A second current limit path is provided by the level of voltage appearing at PKLIM pin 2 of U3. The level of this current limit point is set slightly higher than the previous one in a) above.

### Start Sequence of the PFC

(with the application of mains from the ship's supply contactor).

Initially C4, C5 charge up to the peak value of the AC supply via D24, L1 and D1. Vcc line capacitor C3 starts charging via R2, R3 and D31. When C3 voltage reaches about 16V the pfc IC U3 starts operating and delivers pulses to Q1. The +HV DC starts to increase towards 390V whilst Vcc falls due to U3 current drain. The +HVDC line reaches 390V before C3 voltage drops to 10.5V where U3 would switch off. With the HVDC line at 390V, Vcc is then maintained from winding 7, 8 of L1 via D14, D15, C29 and C30.

All the time the +HVDC line is building up the current limit circuits are operating allowing the 390V line to build up in the shortest time. As the HVDC line builds up the flyback converter drive IC U4 Vcc rises. Upon reaching approximately 16V (pin 7 VCC) the IC becomes active and the power output FETs are driven. The output voltage from the power supply starts approximately 2-3 seconds from initial mains application.

Capacitors C23 and C24 serve to provide a return path for the capacitive currents resulting from stray capacities of Q1, D10 and D11 thermal insulating material on the heatsink. Prior to Q1 switching on, L1 current is passing through D10. When Q1 switches on D10 takes a finite time to switch off. At this time Q1 sees the full +HVDC voltage present on C4, C5.

A very high current pulse results causing significant power dissipation in Q1. With inductor L4 in circuit Q1 current is allowed to build up slowly until L4 saturates. At this time Q1 is switched on and its drain current has risen sufficiently to reverse D10 current. D10 turns off. This L4 circuit significantly reduces the switching losses in Q1. Diode D11 and resistors R25-R27 serve to absorb the stored energy in L4 when Q1 switches off. In particular it prevents Q1 drain voltage rising significantly above 390V.

The PFC circuit can be tested separately from the rest of the PSU by utilising the test plug PLTT. Testing the pfc is achieved by removing LKB, fitting a variac to the AC supply and applying a floating DC supply of 16 to 20V across Vcc and HVRTN (pins 4 and 5 of PLTT). The floating external PSU provides power to U3. With the low voltage supply on, the variac can be turned up whilst monitoring +HVDC. The pfc circuit should produce an output of 390V d.c. with about 4V AC input. The +HVDC line should remain stable at 390V for all IP voltages up to 276V RMS. If it rises above 390V do not increase variac input as there is a feedback fault. An external resistive load may also be connected to the pfc via PLTT pins 1, 5.

### Main PWM Power Supply Stage

The pfc provides stable +390V d.c. for the current mode flyback converter over the full mains input specification. In spite of the converters dual power FETs the converter is of single ended flyback design. The high voltage DC line is switched to the primary of transformer T2 by two power FETs Q3 and Q4. These switches are driven via T1 from the control IC U4. They are both either on or off together. Drive transformer T1 provides simultaneous but isolated drive to the two FETs.

The cross coupled diodes D19, D20 return excess flyback energy to the supply line and provide hard clamping of the two FETs at a value of only one diode drop above or below the supply line voltages. In addition, energy recovery action of D19, 20 eliminates the need for an energy recovery winding or even snubbing components. This reduces the waste heat in the psu.

When both power FETs are 'on' the supply voltage appears across the transformer primary and series leakage inductance. All secondary rectifiers will be reverse biased and no secondary current flows. The primary current increases linearly and energy will be stored in the coupled magnetic field of the transformer and also energy will be stored in the leakage inductance. At the end of the 'on' period both FETs Q3, Q4 turn off simultaneously and the primary supply current in the FETs falls to zero. By flyback action all voltages on the transformer reverse. Initially clamp diodes D19, D20 conduct clamping the flyback voltage to the supply line. All output rectifiers become forward biased and secondary current flows. When the secondary current has built up (to  $n \times I_p$ ) and the energy stored in the primary leakage inductance has been transferred back to the supply line the energy recovery clamps D19, D20 cease conduction and the primary voltage falls back to the reflected secondary voltage. Thus all surplus stored energy is recovered to the supply line and dissipation is minimised.

On application of HVDC (390V) when the mains input is first connected C55 charges up via R48. When C55 attains 16V the under voltage lockout within U4 is released and V ref is enabled and outputs 5V. Output pin 6 delivers 15V pulses to the primary of T1 and Q3, Q4 receive in phase drive pulses which in turn causes primary current to build up. Primary current is sensed across R47 and fed back to pin 3 U4 for feedback stability and overcurrent detection. Voltage feedback is generated from windings 10, 50 from T2 via resistor network formed by R31, R32, R33 and RV1 into pin 2 U4. frequency compensation for the error amps within U4 is accomplished by network formed by C53, R30. In addition to providing voltage feedback the feedback winding (10, 50) supplies power to U4 via D32 and C55 once the psu has started operating and supplying output power. The feedback voltage as applied to pin 2 U4 is adjustable via RV1 which sets the raw output voltage levels of all secondary windings.

Overcurrent trip operation occurs should the primary current exceed 4.5A approximately. Once I sense pin 3 (U4) exceeds 1V then the gate drive output ceases and the feedback voltage falls. Once the feedback voltage on pin 7 (U4) falls to less than 10V the V ref shuts down and C55 discharges. The only charge path for C55 now is R48 and after approximately 1-2 seconds C55 exceeds 16V and output pulses are initiated and the PSU operates.

Should a permanent short circuit be applied to one of the power output lines the psu will 'hiccup' continuously with an approximately 3 sec off time. Thus the mean power dissipated within the psu under fault conditions should be low. Gate drive is clamped by D21, 22, 17 and 18 so as not to exceed the FET gate voltage specification. R49, 50 serve, together with the FET gate capacitance, to slow the switching edges of the power drain waveform thus minimising conducted and radiated interference without causing excessive power dissipation within the FETs.

To switch the flyback converter on the opto-coupler detects the presence of a serial data stream from the display at PLTH 11, 12. On detection of the data stream the photo transistor within U5 is turned on pulling down the gate of Q2 below its threshold voltage. Q2 turns off allowing the compensation pin 1 U4 to rise enabling output of the IC U4. In the PSU off state Q2 is held on by current in R37 from Vcc. For test purposes the PSU can be turned on in the absence of a serial data stream by linking 1-2 on LKA.

## T2 Secondary Circuits

### Modulator -600

The three isolated windings of T2 (1-20, 2-19, 3-18) are individual 200V windings each having a rectifier and reservoir capacitor. The supplies are connected in series to give the required -600V supply for the modulator.

### Receiver Tuning Supply +30V

Rectifier D9 and capacitor C41 provide d.c. input to the three terminal linear regulator U1 which produces a fixed 30V output. L5 and C10 provide additional noise filtering.

### Modulator IGBT Drive Supply +20V

Zener stabilisation formed by D2 and R15 converts +30V input to a stable 20V supply using L6 and C39 as additional noise filters.

### Magnetron Heater Supply

D28 together with C31, 32 provide approximately 20V d.c. for the magnetron heater switch mode regulator on the modulator pcb.

### Rx/Trigger Board +12V

With approximately 20V input from D28, C31, and C32 the five terminal 'Simple Switcher' U6 output is set to +12V by R52, R53 and R54. The switcher operates at approximately 50kHz using L8 as the step down regulator inductor and D3 as the flywheel diode. Whilst the power device within U6 is off energy is transferred to the load via L8 and D3.

### Rx/Trigger Board -12V

D12, C33 provides approximately 20V d.c. into the three terminal linear regulator U2. R16, R17 set the output of U2 to -12V.

### Rx/Trigger Board +5V

D29, C44 provide approximately 15V d.c. to the input of U7 a 5 terminal 'Simple Switcher' power IC. R55, R56 sets the output of U7 to 5V. L9 supplies power to the load, during the off period of U7, via D7. This simple switcher operates at approximately 50kHz.

All output linear regulators are protected against input short circuits by reverse diodes connected from output to input (D8, D6). Both linear regulators and simple switchers are current limited for short circuit protection.

### T4 Motor Supply Output

On application of HVDC (390V) when the mains is first connected, C73 charges up via R63. When the voltage on C73 attains 16V the under voltage lockout within U8 is released and V<sub>ref</sub> is enabled and outputs 5V. Output pins 11 and 14 deliver 15V pulses to the primary of T3. Power Mosfets Q6, Q7 receive out of phase drive pulses which in turn causes primary current to build up. Q6, Q7 and capacitors C4, C5 form half bridge power stage. Capacitor C69 AC couples the power switch signal to the power transformer T4. This minimises the possibility of core saturation in T4. Diodes D45, D48 are incorporated to ensure that the integral Drain/Source diodes within the power Fets do not conduct during voltage reversals in the Fet switch off periods. Primary current is sensed across by T5 and fed back to pin 9 U8 for feedback stability and overcurrent detection. Voltage feedback is generated from windings 10, 9 from T4 via D49, D50 and L13 to pin 1 of U8 via R79.

The feedback voltage as applied to pin 1 U8 is set via the ratio of R79 and R65 which sets the output voltage level of secondary windings 5, 6 of T4 to a nominal 50V. Frequency compensation for the error amps within U8 is accomplished by a network formed by C72, R80, R78 and R65. In addition to providing voltage feedback the feedback winding (10, 9) supplies power to U8 via D49, D50, D52 and C65 to pins 13 and 15 once the PSU has started operating and supplying output power.

Overcurrent trip operation occurs should the primary current exceed 1.5A approximately. Once ILIM pin 9 (U8) exceeds 1.2V then the gate drive output ceases and the feedback and output voltage falls. Once the feedback voltage on pin 15 (U8) falls to less than 10V the V<sub>ref</sub> shuts down and C65 and C73 discharge. The only charge path for C73 now is R63 and after approx 1-2 seconds C73 exceeds 16V and output pulses are initiated and the PSU operates.

The Motor supply output (+50V) is derived from windings 5, 6 of T4 via D51A/B, L14 and C70. R77 and C71 perform noise suppression of switching edges. A train of pulses is produced from the rectifying diodes D51A,B, the mean DC level of which is controlled by the ratio of the on to the off period. By varying the mark-space ratio, the mean DC level at the output of the low pass filter, formed by L14 and C70, can be controlled to the required level.

Should a permanent short circuit be applied to the power output line the psu will 'hiccup' continuously with an approximate 3 sec off time. Thus the mean power dissipated within the psu under fault conditions should be low. Gate drive is clamped by D34, 35, 36 and 37 so as not to exceed the FET gate voltage specification. R74, 75 serve, together with the FET gate capacitance, to slow the switching edges of the power drain waveform thus minimising conducted and radiated interference without causing excessive power dissipation within the FETs.

To switch the half-bridge converter on, the opto-coupler U5 detects the presence of a serial data stream from the display at PLTH 11, 12. On detection of the data stream the photo transistor within U5 is turned on pulling down the gate of Q5 below its threshold voltage. Q5 turns off allowing the soft start pin 8 U8 to rise enabling output of the IC U8. In the PSU off state Q5 is held on by current via R37 from V<sub>cc</sub>. For test purposes the psu can be turned on in the absence of a serial data stream by linking pins 1-2 on LKA.

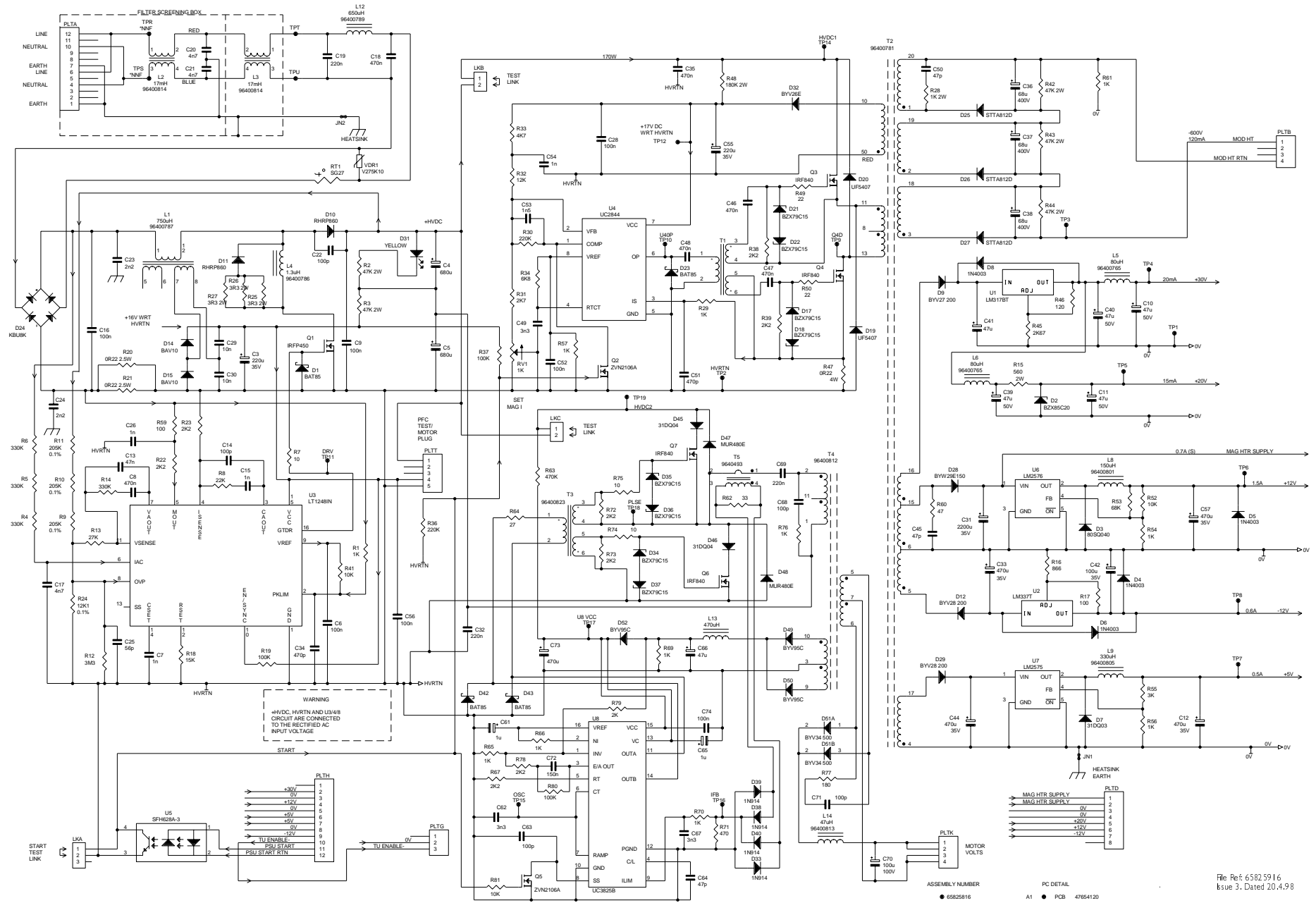


Figure 2.28 Circuit Diagram 65825916 - X-Band Transceiver Power Supply

A3 page 2-59/60 Figure 2.28, discard this A4 sheet.



## 5.4 Modulator PCB (X-Band)

### 5.4.1 Functional Description

The principal function of the Modulator PCB is to generate an 8kV, 8A negative pulse to drive the cathode of the magnetron. An SCR is used to resonantly charge a Pulse Forming Network (PFN) to -1200V from the -600V Modulator HT supply. The charging cycle is initiated by the Charge Trigger. The number of sections of the PFN is selectable by the relays controlled by the Pulse Length Control Lines. The number of sections of the PFN used defines the length of the output pulse.

At a defined time after the PFN is fully charged it is discharged by three series connected Insulated Gate Bipolar Transistors through a pulse transformer. The discharge is initiated by the Modulator Trigger. The Pulse Transformer, which has step up ratio of 12:1, transforms the resulting pulse to 8kV. The back edges of the medium and short pulses are speeded up by a saturable reactor connected across the primary of the pulse transformer.

Other functions include regulating the magnetron heater supply, monitoring a spark gap to ensure correct operation of the magnetron, and generation of a timing reference for the Radar Trigger.

### 5.4.2 Inputs to the Modulator PCB

-600V Modulator HT Supply	
+20V Modulator Trigger Supply	
+16V - +27V Magnetron Heater Bulk Supply	
+12V	
-12V	
Short Pulse Control Line	when 0V selects short pulse.
Medium Pulse Control Line	when 0V selects medium pulse.
Charge Trigger	initiates charging of Pulse Forming Network. Typically 1Amp current pulse.
Modulator Trigger	initiates discharge of Pulse Forming Network. Typically 4us, 3.5V positive pulse.
Turn Down Enable	dc voltage controls the magnetron heater voltage. 0V on long pulse, 3.5V Standby Medium and Short Pulse

### 5.4.3 Outputs from the Modulator PCB

Primary sample	positive pulse sample from pulse transformer used to initiate Radar Trigger. Typically 40V amplitude.
Magnetron current sample	a dc voltage proportional to the magnetron current derived from the secondary of the pulse transformer. Typically +2.5V (on long pulse).
TX Active	a signal that is normally 0V that rises to >2.5V if the spark gap operates continuously for 2 seconds. This signal is used by the Trigger PCB to indicate a transmitter fault to the display.

HT Sense	sample of Modulator HT Supply fed to Trigger PCB for inclusion in BITE message sent to display.
TX Define	Link settings used to define modulator type to Trigger PCB. 0V or 3.5V dependant on link settings.

### 5.4.4 Circuit Description (X-Band Modulator PCB)

The following circuit description is based on Circuit Diagrams 65810912 (X-Band 10kW Modulator PCB) Figure 2.29, and 65825912 (X-Band 25kW Modulator PCB) Figure 2.30.

#### Magnetron Heater Supply

The magnetron heaters are derived from the Magnetron Heater Supply at PLVD1 and PLVD2. This supply may vary between 16V and 27V.

The Modulator PCB is configured for the intended magnetron by the setting of link LK1 fitted to the Modulator PCB. Refer to Figure 6.38 'Link Settings - Modulator PCB', in Chapter 6, for further information.

***WARNING - On no account should the heater voltage be measured whilst the Transceiver is transmitting.***

In a 10KW X-Band system, the magnetron requires a heater voltage (measured between TSJ1 and TSJ2) of 6.1V on Standby, Short Pulse, Medium Pulse and Long Pulse.

In a 25KW X-Band system, the magnetron requires a heater voltage (measured between TSJ1 and TSJ2) of 6.1V on Standby, Short Pulse, and Medium Pulse. On Long Pulse, this may be turned down to 5.1V depending on the type of magnetron fitted.

The Mag Heater Supply is connected to the input of the switching regulator U1. U1 is configured as a buck regulator running at a constant frequency of approximately 52kHz. During the time that the regulator is switched on, power is supplied to the load from the Mag Heater Supply via L106. When the regulator switches off, energy stored in L106 is transferred to the load via commutation diode D112. C112 provides output smoothing. The output voltage is sampled by the feedback network R132, R133, R145, R136, and Q102. The sample voltage is fed back to pin 4 of U1 where it is compared with an internal voltage reference. If the sample voltage fed back is greater than the internal reference voltage the time that the regulator is switched on for is reduced until the sampled voltage equals the reference voltage. Similarly if the sample voltage is less than the internal reference voltage the time that the regulator is switched on for is increased until the two voltages are equal. In this way a constant output voltage can be set by selecting values in the feedback network.

When long pulse is selected, the Turn Down Enable signal at the gate of Q102 is 0V biasing Q102 off. In this condition R136 is connected in series with the feedback network, increasing the voltage at U1 pin 4. The regulator 'on' time is therefore reduced and the output voltage is reduced to the level required for 5.0V magnetron heaters.

When Standby, Short Pulse, or Medium Pulse is selected the Turn Down Enable signal at the gate of Q102 is set by the Trigger PCB to 3.5V turning Q102 on. When Q102 is turned on, R136 is short circuited and the voltage at pin 4 of U1 is reduced.

The regulator 'on' time is therefore increased and the output voltage is increased to the level required to set the magnetron heaters to 6.3V. The inductor L103 and capacitor C115 isolate the regulator from the high voltage pulse that appears at the bias winding of T107. The voltage at the output of the regulator measured at TP106 is typically 1.5V greater than the 6.3V or 5.0V to allow for the voltage drop across L103 and the secondary of the Pulse Transformer.

### Charging the PFN

With -600V supplied from the Power Supply PCB via L101, the PFN charging is initiated by the positive edge of the Charge Trigger signal on PLVC8. This trigger signal passes via the isolating transformer T101 to the gate of input SCR Q101. The positive pulse turns the SCR on to start the resonant charge. Because L101 and the capacity of the PFN form a resonant circuit, the input current to the PFN is sinusoidal in character and the line charges to about 1.8 times the Modulator HT supply voltage.

The PFN charges through Q101, the isolating diode D101, and the delay reactor L105. The charge current reaches a peak and decays to zero, and at this point D101 becomes reverse biased and Q101 turns off. This occurs when the voltage on the PFN is at its maximum value. R106, R107, and R108 provide a discharge path for any voltage on the anode of Q101. R126, R129, R130, and R131 form a potential divider across the Modulator HT Supply to feed a sample voltage to the Trigger PCB for incorporation into the BITE message sent to the display.

### Discharging the PFN

The modulator is triggered by the Modulator Trigger pulse from the Trigger PCB. This positive pulse of typically +3.5V amplitude is amplified to 20V by U3. The output of U3 is fed to the primary of the isolating transformer T105. The transformer has three identical secondary outputs, each of which drives one of the gates of the series connected IGBT's Q103, Q104, and Q105. The transformer turns ratio is 1:1 so each gate emitter of the IGBT's is driven by a 20V positive pulse.

By clamping any signals fed back from the transformer to a safe level, D111 and D110 protect the output of U3. R121, R122, and R123 control the peak current spike into the capacity of each gate to ensure the IGBT's turn on together. Initially the delay reactor L105 is high impedance and momentarily delays the discharge of the PFN until the IGBT's are fully turned on. This ensures that high current does not flow through the IGBT's until the voltage across them has fallen to a low level. Approximately 250nS after the trigger pulse the delay reactor saturates, and the PFN is discharged through the primary of the Pulse Transformer T107. The resulting 650V primary pulse is transformed up to 8kV to drive the magnetron.

D107 in the charging circuit clamps any positive spike fed back through the capacity of D101 to protect Q101. R125, R126, R127, VDR1, VDR2, and VDR3 ensure that the voltage is shared equally across each IGBT.

### Defining the Pulse Length

The PFN defines the transmitted pulse shape. It is only when long pulse is selected that all the energy stored in the PFN is transferred to the magnetron. On medium and short pulse the transmitted pulse length is controlled in two places, using RL1 and RL2.

- a) The PFN  
The relays are used to select the number of sections of the PFN that are used for a given pulse length. The more sections used, the longer the pulse.
- b) The Tailbiter.  
On short and medium pulse the PFN is used to define the start of the pulse but the width of the pulse is determined by a saturable reactor L104 (tailbiter) connected directly across the primary of the pulse transformer. The number of turns on L104 is varied to suit the pulse length required. The number of turns is selected by RL1 and RL2 dependant on the pulse length selected.

The tailbiter acts by changing from a high impedance to a low impedance to short circuit the primary of T107, terminating the drive pulse to the magnetron. The time that L104 remains in the high impedance state is dependant on the number of turns and the voltage impressed across it. Any charge remaining in the PFN when L104 changes state, is dumped into the circuit consisting of D102 and R115. The PFN is then in a fully discharged state ready for the next charging cycle.

Pulse Length	Relay Energised	PFN Capacitors in Circuit	L104 Tailbiter Winding Used
Long	None	All	None
Medium	RL2	C105, C107, C108 C109	1 - 3
Short	RL1	C105, C107	2 - 3

Relay 1 and Relay 2 Operation

### Pulse Transformer

The purpose of the Pulse Transformer T107 is to match the impedance of the PFN to the impedance of the magnetron. In doing this, it also steps up the voltage pulse to the correct level to drive the magnetron. The output of the PFN is directly connected to the primary of the Pulse Transformer, and the secondary is connected directly to the magnetron cathode. A bifilar wound secondary is used to allow the heater supply to be connected to the magnetron. An additional secondary winding carrying the heater current is used to bias the core of the transformer magnetically, so that the number of secondary turns required to support the long pulse voltage pulse can be kept to a minimum.

R137 and current transformer T108 in series with the primary of T107 provide a 40V positive pulse (Mag Sample) to the Trigger PCB as a timing reference for the Radar Trigger, and AFC Trigger.

R119, D104, C118, R118, and current transformer T106 in series with the Pulse Transformer secondary provide a rectified output (Mag Current Sense) proportional to the magnetron current. This voltage is passed to the Trigger PCB where it is incorporated into the BITE message sent to the display.

Zener diode D127 restricts the maximum output voltage below the level that would damage the circuit on the trigger PCB. The voltage can be monitored at TP100, and is used to set the magnetron current in service.

### **The EHT PCB**

The two leads from the bifilar secondary of the Pulse Transformer are routed through the EHT PCB. D106, D113, and R120 clamp any positive overswing at the end of the magnetron pulse and absorb any surplus energy from the secondary of the Pulse Transformer. The spark gap (Gap 1) operates at approximately 12kV and provides protection for the Pulse Transformer if the magnetron mistriggers, or if the magnetron heaters become disconnected.

### **Spark Gap Detection Circuit**

The earth return for the Spark Gap is routed through current transformer T104. When the Spark Gap operates the current through T104 generates a positive pulse across R138. This pulse is used to trigger monostable U4A. D124 and D125 clamp the input voltage to the monostable to a safe level. The resulting positive pulse at the "Q" of U4A charges capacitor C125 positively. The voltage at C125 +ve rises from its normal value of 0V towards +12V. This voltage is sampled by the Trigger PCB, and when the voltage rises to +2.5V the Transceiver is switched to standby and an error message is sent to the display.

On long pulse the spark gap has to be triggered for approximately two seconds for the voltage on C125 +ve to reach 2.5V. R143 provides a discharge path for C125, which discharges between monostable pulses such that the voltage on C125 returns to its normal level in approximately four seconds if there is no spark gap activity.

R139 and zener diode D122 provide a 3V bias for the electrolytic capacitor. Zener diode D126 together with D122 restrict the maximum voltage at C125 +ve to 4.5V. R147, R148 and D120 ensure that the voltage at C125 +ve is always positive. These limits are required to protect the circuitry on the Trigger PCB. Low leakage diode D121 prevents C125 discharging through the output of U4A.

## **5.5 Motor Drive Board (X-Band)** (Incorporating the Dynamic Brake facility)

The Motor Drive PCB generates the supply and control signals for the 3-phase electronically commutated DC motor that turns the Scanner Unit. The Motor Drive PCB has the capability of providing High and Low speed operation by link selection on the PCB.

### 5.5.1 Circuit Description (X-Band Motor Drive Board)

The following circuit description is based on Circuit Diagram 65801911 given at Figure 2.31.

The Motor Drive pcb is supplied with +50VDC and +12VDC from the Transceiver power supply (in both Aloft and Bulkhead fits). There is extensive protection provided in case either of the supplies fails. This is necessary because the output driver stage is supplied from the +50VDC side, and the control signals are generated on the +12VDC side. R51, R52 and D13 prevent the slow start voltage across C27 from rising until the +50VDC supply is valid.

Pulling control line 'TU Enable' below 1.5 volts starts the voltage across C27 rising which in turn allows a slow build up of speed up to the maximum set by the speed selection link. The 6 complementary output FET switches (Q7-Q12) which perform the commutation, are protected by a current sensing and limiting circuit, in the event of overload or stall. The current sensing elements are 2 thick film resistors in parallel (R19 & R25). Note that it is possible for the circuit to function with one of these open circuit, however, the maximum load current available will be halved.

A voltage reference of +5V is generated inside the motor control IC (U1) and is available at pin 2 (VREF). This is used to generate the speed control voltage at pin 1 (E/A IN+) via a resistor divider network and speed setting link LK1.

The basic "chopping" frequency of 10KHz is defined by R22 and C15 and appears as a small sinusoidal waveform on pin 25 (RC OSC).

A second +5VDC supply (+V sensor) is generated on-board by voltage regulator U2 and supplies power to the Hall position sensors within the motor, and to the associated pull-up resistors R26,27,28.

Signals from the Hall Sensors in the motor are used to control the commutation sequence, and are also used to provide a degree of speed compensation in high wind load conditions.

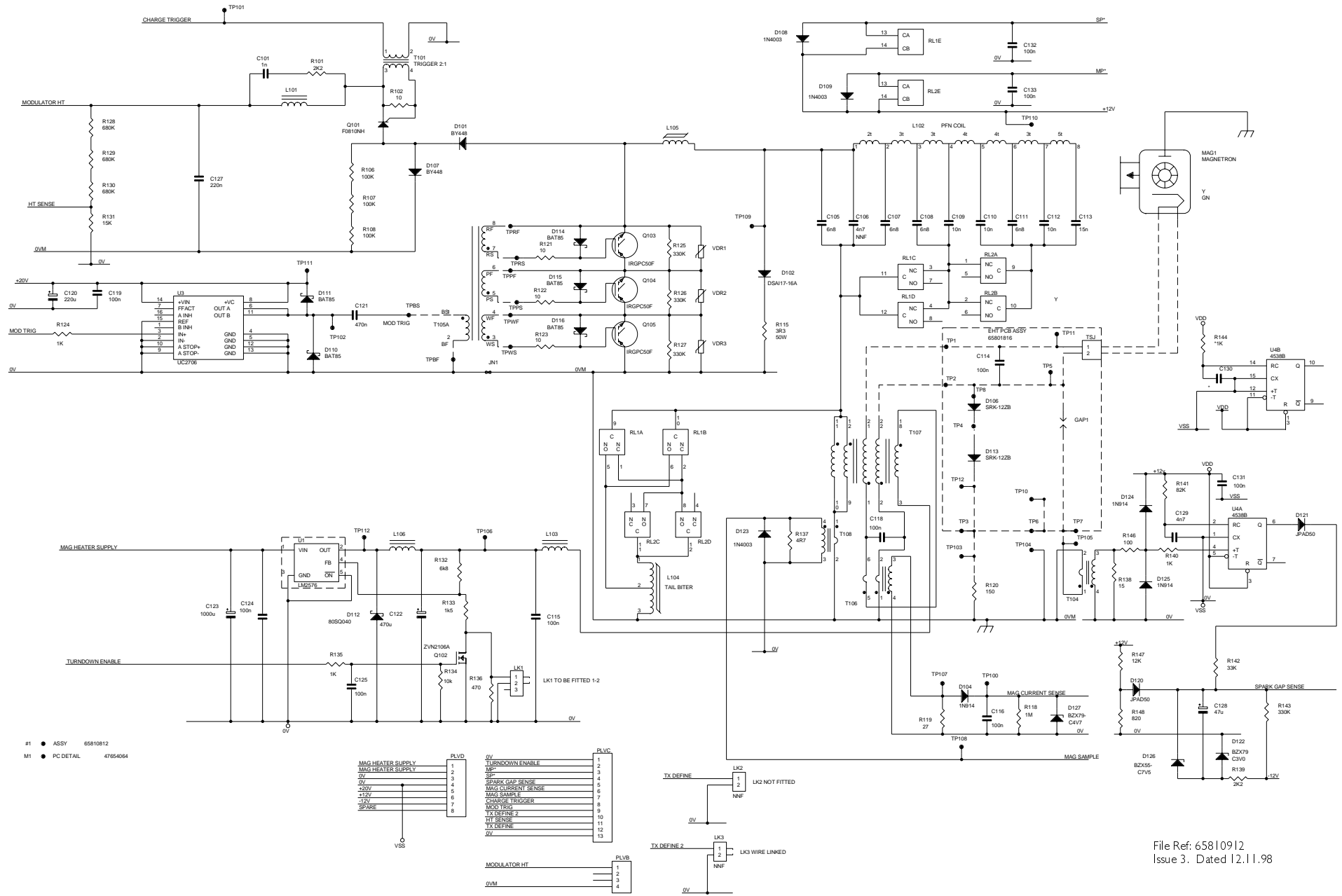
An additional feature of the PCB is a Dynamic Brake which limits the 'windmilling' speed of the Antenna when the radar is turned-off, or is in Standby mode. This circuit is passive and will operate with no supply voltage. The back E.M.F of a windmilling motor turns on Q13 via D7 which then activates power FET Q14. This shunts the motor current via R42 (thick film resistor) to ground. The voltage developed across R42 is sensed by Q16 and will turn off Q14 if the current exceeds approximately 6 Amps. In effect, this forms a fast acting switching load across the motor supply when the motor back E.M.F exceeds the supply voltage by approximately 1V.

### 5.6 Input Boards (X-Band)

The following circuit diagrams are also included.

Circuit Diagram 65801913 - X-Band Masthead Input Board - Figure 2.32

Circuit Diagram 65801920 - X-Band Bulkhead Input Board - Figure 2.33



File Ref: 65810912  
Issue 3. Dated 12.11.98

Figure 2.29 Circuit Diagram 65810912 - X-Band Modulator Board (10kW)

A3 page 2-67/68 Figure 2.29, discard this A4 sheet.



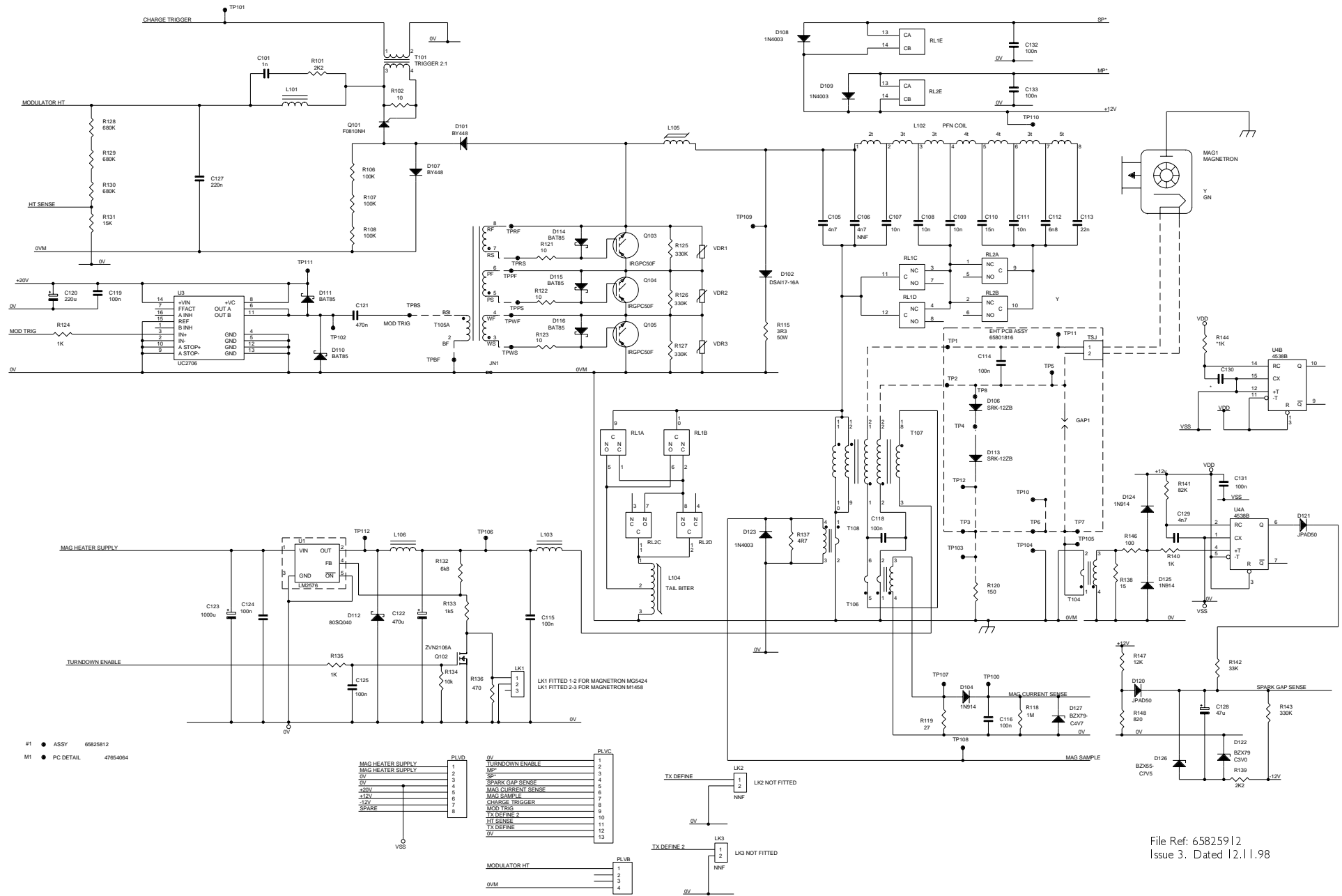


Figure 2.30 Circuit Diagram 65825912 - X-Band Modulator Board (25kW)

A3 page 2-69/70 Figure 2.30, discard this A4 sheet.

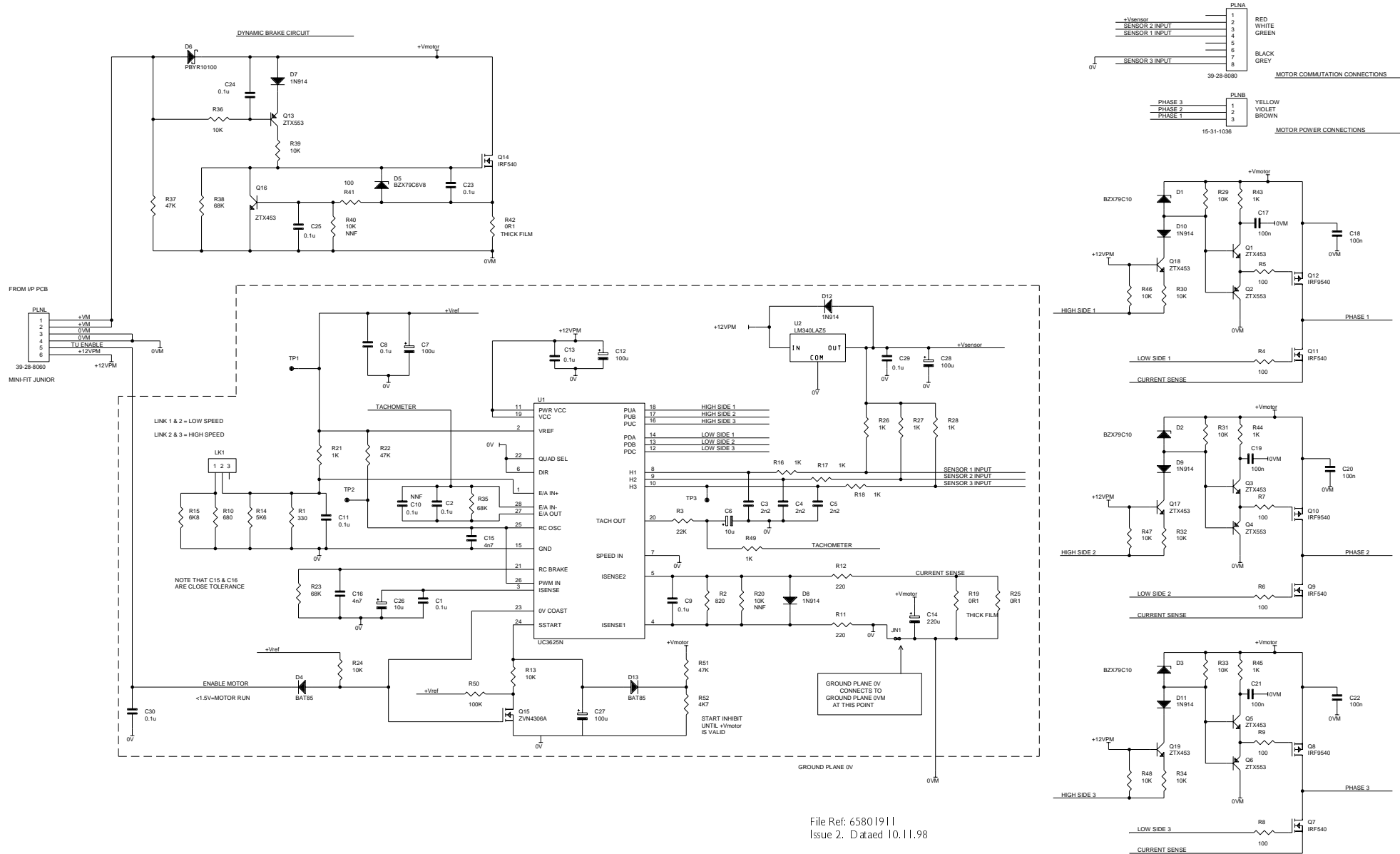


Figure 2.31 Circuit Diagram 65801911 - X-Band Motor Drive Board

A3 page 2-71/72 Figure 2.31, discard this A4 sheet.

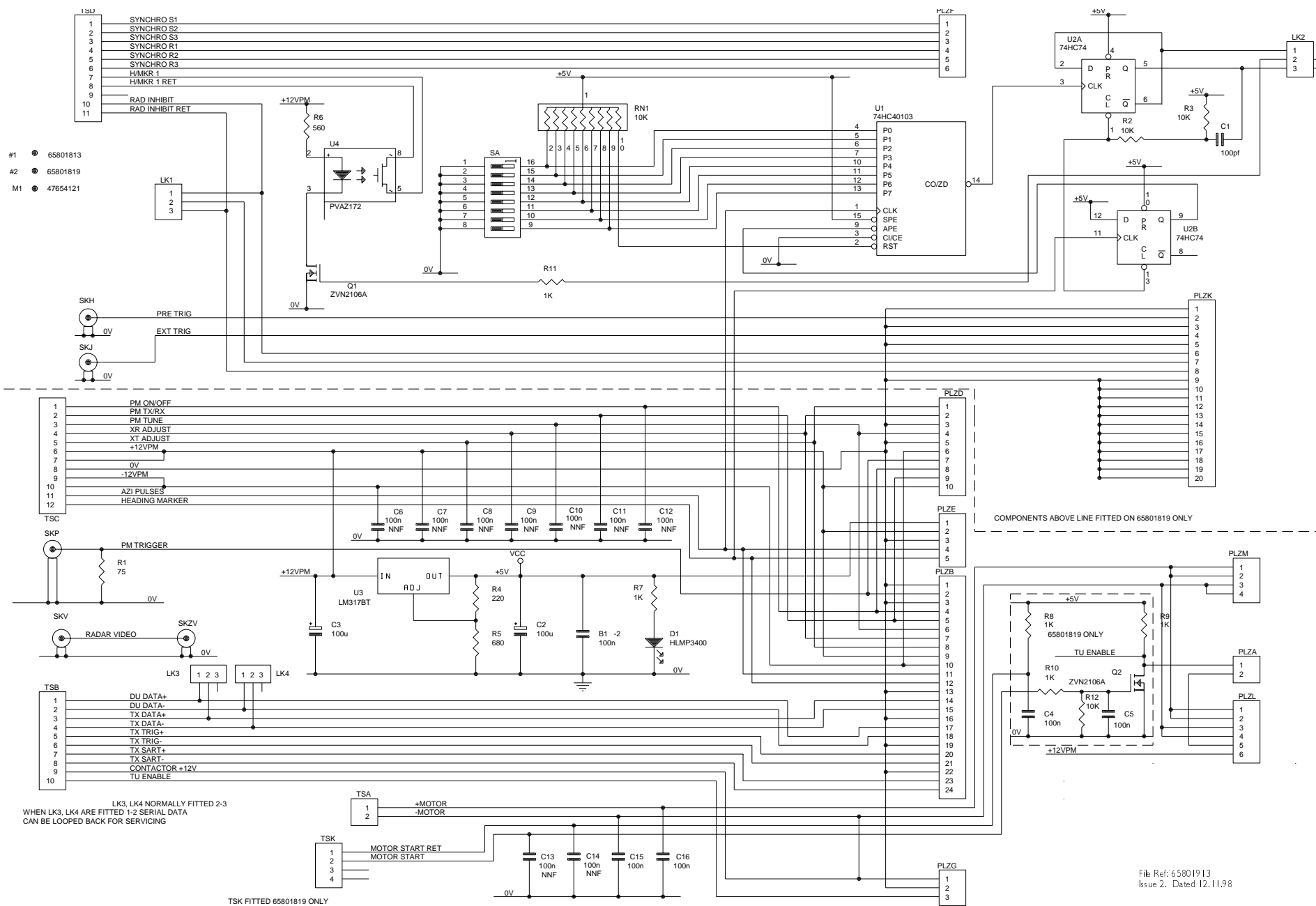
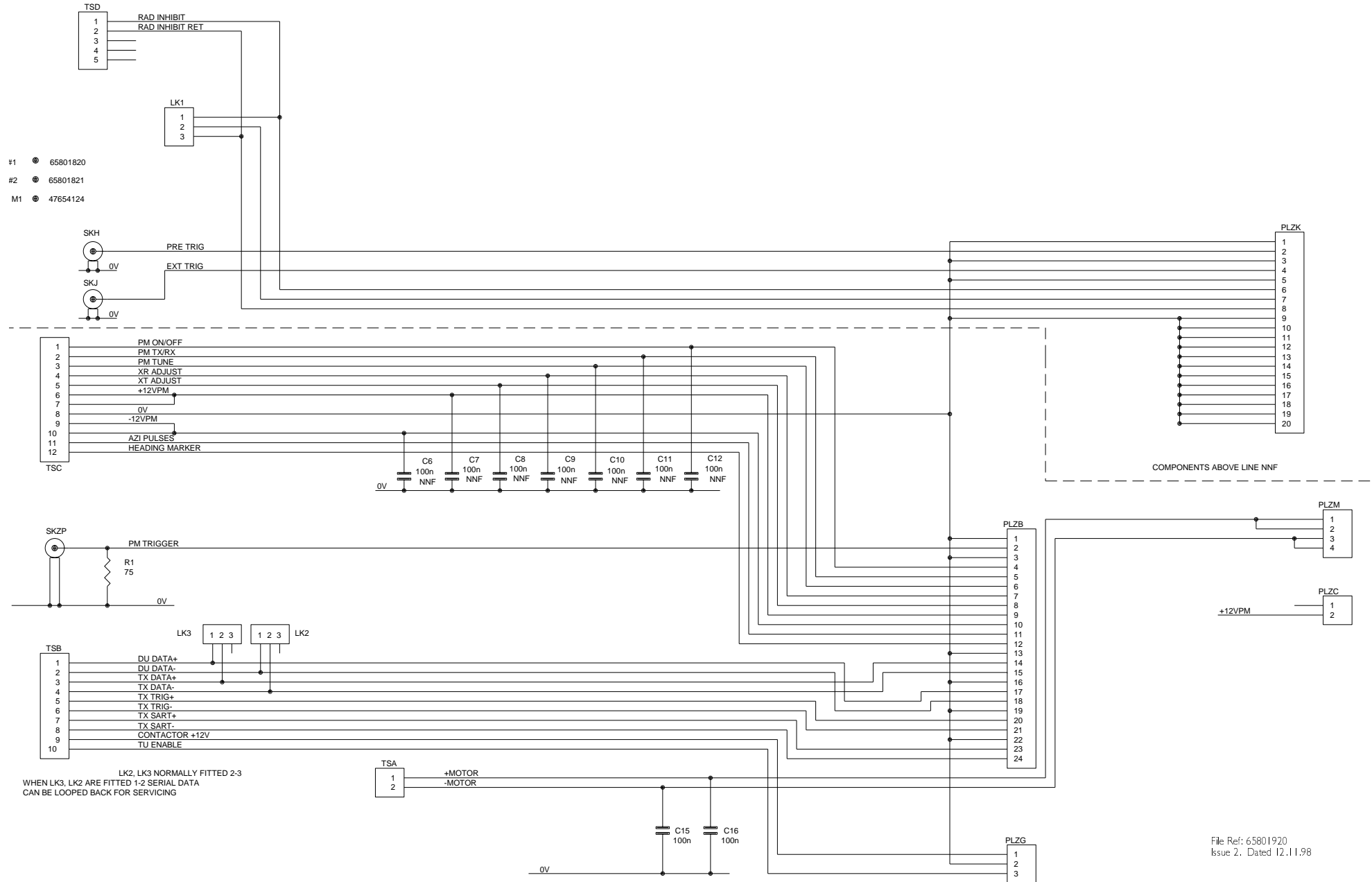


Figure 2.32 Circuit Diagram 65801913 - X-Band Masthead Input Board

A3 page 2-73/74 Figure 2.32, discard this A4 sheet.



File Ref: 65801920  
Issue 2, Dated 12.11.98

Figure 2.33 Circuit Diagram 65801920 - X-Band Bulkhead Input Board

A3 page 2-75/76 Figure 2.33, discard this A4 sheet.



## 5.7 Transceiver DC Power Supply (X-Band)

### 5.7.1 General Information

The power supply unit is of dual converter design that generates the supplies for the X-Band Transceiver. The converter is housed on a single board and is powered by a DC input of between 21.6V and 32V.

The power unit uses a push-pull converter front end to provide regulated high voltage d.c. to a flyback converter providing the modulator HV d.c. +30V and +20V. The push-pull converter supplies  $\pm 12V$ , +5V and motor volts of 50V either directly or via 3 terminal regulators.

The PSU has the following features:-

- Adjustable HT voltage for control of magnetron current via the modulator.
- low and high input voltage protection.
- Reverse polarity protection for the d.c. input.
- Output short circuit protection.
- Slow start for controlled run up.

### 5.7.2 Functional Description (X-Band Transceiver DC Power Supply)

The following functional description is based on the block diagram given at Figure 2.34.

#### Principles of Operation

The PSU takes the form of a d.c. – d.c. converter using a pair of power FETs driven alternately to switch the ship's supply into the primary winding of the power transformer. Voltages induced in the secondary windings are rectified, filtered and the +5V and  $\pm 15V$  are further regulated to provide the d.c. outputs. The push-pull converter also produces +140V for the flyback converter which generates the modulator HV. In addition, this converter produces +30V for tuning and +20V for IGBT drive. 50v is generated for aerial motor rotation.

Stabilisation of the outputs and regulation against variation in the supply voltage are carried out by a regulating pulse width controller. The pulse width is governed by the level of the input voltage and the output load current. Higher input voltage tends to reduce the pulse width whilst higher load currents tend to increase the pulse width. The switching frequency remains constant.

Pulse width control is achieved by using a signal derived from a +15V feedback winding isolated from the output voltages but referenced to the ship's d.c. input. This potted down signal is routed back to the error amplifier within U6. A proportion of the feedback voltage is compared with a stable reference voltage and the output of the error amplifier is compared with a signal representing the slope of primary current in T1.

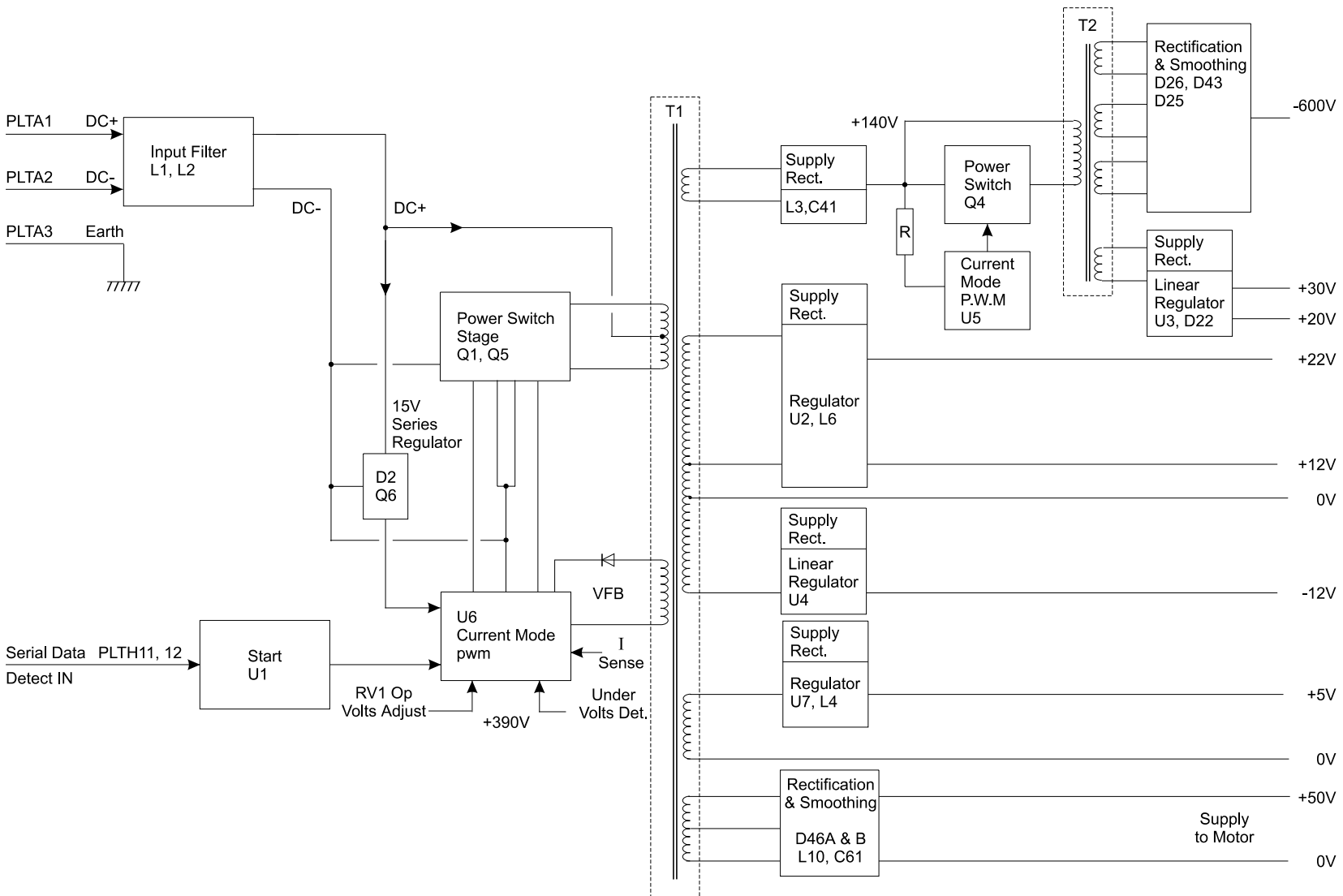


Figure 2.54 Block Diagram - DC Power Supply Board

The output of the comparator is thus a varying pulse width depending on both the primary current and feedback voltage. Input under-voltage protection is achieved by comparing an attenuated version of the input voltage with the reference voltage of U1A. If the supply input drops below approximately 17V d.c. the output of U1A goes low causing the PSU to shut down. When the ship's d.c. returns to within the normal operating range the PSU soft starts.

The input over-voltage protection circuit operates by monitoring the ship's d.c. supply using a zener diode (D7). If the input exceeds approximately 35 volts the controller U6 is shut down. Returning the input voltage to normal limits automatically re-starts the PSU. The current sense transformer (T3) feeds the attenuated primary current signal into both the p.w.m (current mode port) and the overcurrent latch circuit formed by U1C, Q2 etc. The current mode controller (U6) also terminates output pulses should the primary current exceed a preset limit. Thus there are two paths of overcurrent shutdown.

Common mode and differential mode filtering is provided at the input to the PSU. Reverse voltage protection is also provided which if it should occur would blow the input fuse.

Starting the p.s.u. is by detection of the presence of serial data at PLTH by U8. This enables the p.w.m. in U6 via U1B.

### DC Outputs

The power supply outputs the following voltages:-

- variable modulator HT adjustable over the range –550V to –650V.
- +30V tuning
- +20V IGBT drive
- +50V aerial motor
- +16V magnetron heater circuit
- +5V trigger board and  $\pm 12V$  trigger board

### 5.7.3 Circuit Description (X-Band Transceiver DC Power Supply)

The following circuit description is based on Circuit Diagram 65810816 given at Figure 3.35.

#### Input Supply

The ship's d.c. supply enters the PSU via PLTA to the input filter consisting of C1 – C3, L1 and L2. Transient filtering is performed by VDR1 a zinc oxide voltage dependent resistor. The input filter is effective against line to line and line to ground interference. Diode D1, connected across the d.c. input protects the PSU against reverse polarity input. If this should occur the diode will conduct and short out the supply blowing the input fuse. Q6, D2 and D51 form a 15 volt series regulator.

This forms the start up supply to the p.w.m. controller U6. After the PSU has started the supply is derived from the feedback winding via D52.

### **PWM Control Circuitry**

The p.w.m. driver provides two out of phase pulse width modulated waveforms to the gates of the power switching FETs Q1 and Q5. The FETs are turned on alternately for periods of time dependent on the output voltage and load current. T1 primary winding current is sampled via T3 and fed to the pulse by pulse limiting circuit within U6 (pin 4) and overcurrent latch circuit (U1C, Q2). D14-17 rectify the attenuated primary pulse from T3 and supply a voltage proportional to primary current to pin 8 U1C. In comparator U1C a proportion of the reference voltage (0.9V derived from 5.1V) is applied to the non-inverting pin 9 U1C. Should the primary current exceed 0.9V at pin 8 U1C the output of U1C goes low pulling down the base of Q2.

The collector of Q2 rises to the 5.1V ref causing D18 to become illuminated. By positive feedback pin 8 U1C goes further positive which latches U1C. The high signal from Q2 collector is also fed via D18 and R16 to pin 16 U6 to initiate shutdown. The latched overcurrent state can only be reset by interrupting the serial data stream to U8.

At switch off, the current trip latch U1C and Q2 are reset by the low output from U1D. Latching occurs in less than 100ms to minimise the number of fault current pulses handled by the FETs. Each time that the drive waveforms are re-started from either interruption of the serial data or overcurrent operation the slow start current comprising R56, R59 and C55 comes into operation.

### **Over Current Protection**

With current mode regulation, peak current sensing automatically provides flux balancing in push-pull converters and minimises the chance of transformer saturation due to asymmetrical drive. In addition, by limiting the peak swing of the error amplifier an instantaneous peak current limit is provided. By controlling the voltage at LIM (pin 1 U6) the peak current in the primary can be controlled.

The peak-peak current limit circuit is of the hiccup mode with auto-reset. The inter-pulse period is of one to two seconds and should operate prior to the latching overcurrent circuit. The snubber network formed by R6, C10 limit the voltage excursions caused by the interruption of current in T1 by FET turn off and absorb leakage inductance energy. The input capacitors C9, C65, C66 provide pulse to pulse energy for the output stage and ensure that the output stage remains stable under all conditions of load.

The switching aid network (D4, R4, R45, R65 and C6) across Q5 and a similar network across Q1 reduce the drain/source over-voltage transient at turn off.

U6 operates at a fixed frequency of approximately 80kHz set by R57 and C54. An internally generated 500ns blanking pulse is applied to the outputs at the end of each pulse to provide a dead time for recovery of output rectifiers and to ensure the power pulses do not overlap. The oscillator ramp is buffered by Q3 and the signal is mixed with the current sense ramp and applied to pin 4, U6. This ensures stability of the power supply at duty cycles of greater than 50%.

### Under Voltage Protection

Under voltage protection (IP) is provided by U1A. The raw ship's mains (LV DC) to the PSU is sensed by the potential divider formed by R25, RN2C at R24 and is fed to the NI input pin 5 U1A. 5.1V reference is fed to the inverting pin 4 U1A and if the d.c. input falls to less than 1.6V – 1.7V the comparator output pin 2 U1A pulls down LIM pin 1 of U6. This shuts down the PSU until the input d.c. rises back within specification. The PSU starts in its soft start mode.

### Output Voltages from the Push-Pull Converter

The push pull converter produces the following outputs, some of which are used internally and some are outputted via three terminal regulators.

- +140V d.c. for internal use by PSU up converter producing HV for modulator.
- +50V d.c. for aerial turning motor.
- +1.6V d.c. magnetron heater circuit.
- $\pm 1.2V$ , +5V for modulator and trigger board.
- +30V via up converter for tuning.
- +20V via up converter.

Zener diodes and resistors are connected across most outputs from the push-pull converter section to provide critical minimum current flow through the chokes to maintain the correct output voltage at all load conditions.

U7, U4, U2 are three terminal regulators which provide stabilisation and short circuit protection for the +5V  $\pm 1.2V$  rails.

The up converter takes the form of a flyback converter where the +140V rail generated by the push-pull converter is switched to the primary of transformer T2 by the power FET Q4. This FET is driven by the control circuitry within U5. Flyback action takes place during the off state. During the FET 'on' state, energy is stored within the transformer T2. Switching aid networks comprising R44, C37, D27 and C38, D28, R38, R39, R40 serve to limit the flyback voltage appearing across Q4 during the transition period of on to off.

Primary current is sensed via R41 and is fed back to U5 via R60 with C39 filtering switching edges. This feedback provides overcurrent protection under fault conditions and stabilises the PSU under normal load conditions.

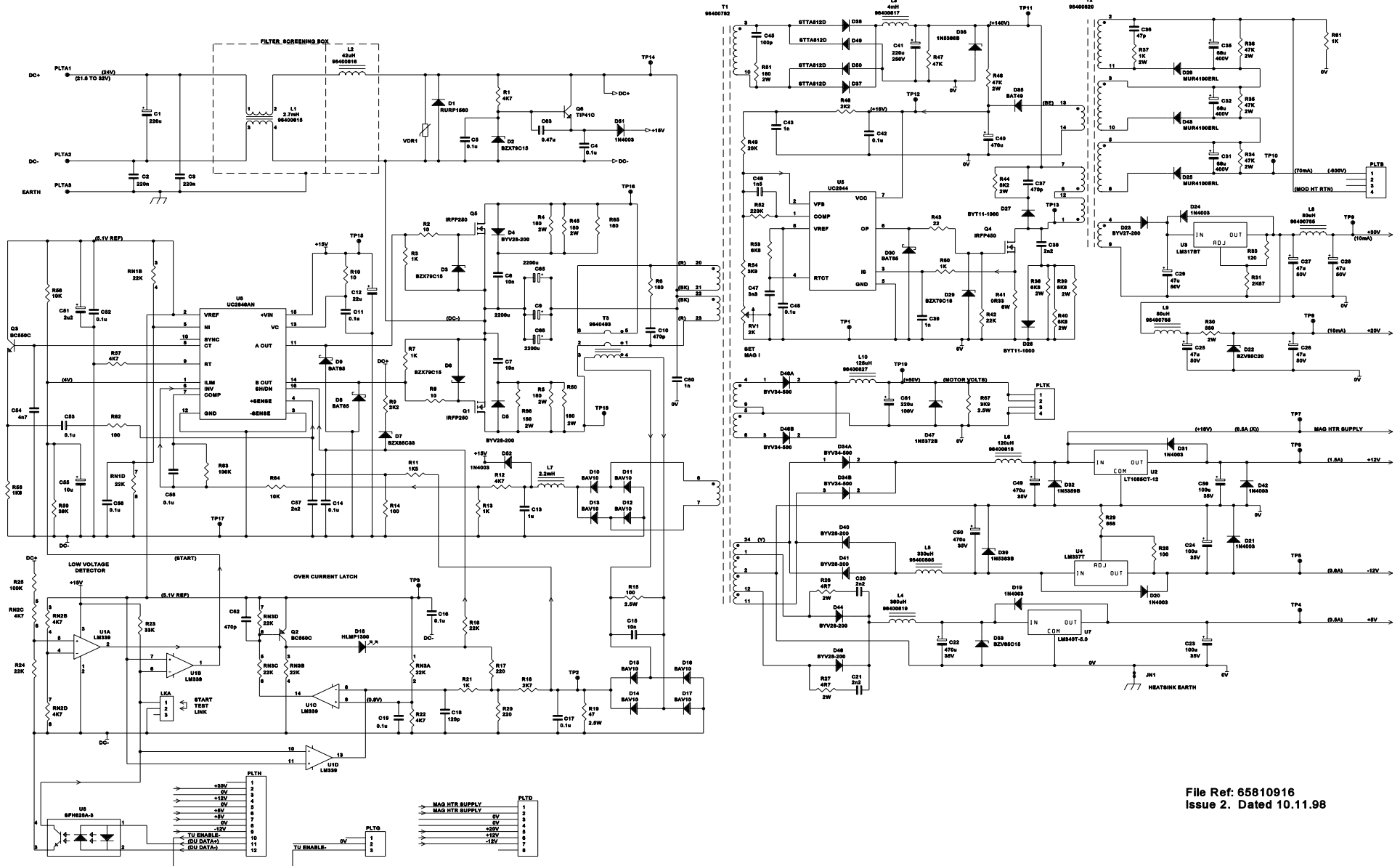
Initial start up voltage is provided from the +140V rail via R46 which charges C40 towards 1.7V. U5 starts when this voltage is achieved and then via voltage feedback action the p.w.m. chip U5 receives power from T2 via D35.

The flyback converter starts approximately 2 seconds after the push-pull converter has powered up due to the charging action of C40 via R46. Should an output over-current fault occur then the up-converter hiccups on/off with approximately 1 second repetition rate until the fault has been rectified.

Voltage feedback also occurs via T2 winding, D35 and potential divider formed by R48, R49, R54 and RV1. RV1 sets the voltage at pin 2 U5 and adjusts the HV output over the range 550V to 650V. Thus the magnetron anode current is adjusted via the modulator. To produce the -600V d.c. HT, three windings on the secondary of T2 each produce 200V and are added together at the output of the rectifier circuits. The 30V circuit is fed via a three terminal regulator used to absorb the varying output of T2 when RV1 is adjusted for various settings of the HT. The 20V rail is stabilised using D22 from the 30V output.

The flyback converter operates at approximately 40kHz.

The motor (aerial supply) is approximately 50V with a starting current capability of up to 5A. The usual running current is from 1-2A. Zener diode D47, together with R67 provide enough critical current load to prevent the output voltage rising above 60V under very light or no load conditions.



File Ref: 65810916  
Issue 2. Dated 10.11.98

Figure 2.35 X-Band Transceiver DC Power Supply Board

A3 page 2-83/84 Figure 2.35, discard this A4 sheet.



## 6 Replacement Spares

Refer to Chapter 6 for a full list of replacement spares.

## 7 Wiring Diagrams

Refer to Ship's Manual 65800010B Chapter 3 for complete system installation diagrams.

The wiring diagrams Included in this section are as follows:

- Figure 2.36 X-Band Turning Unit (Aloft) Schematic
- Figure 2.37 X-Band Turning Unit (Bulkhead) Schematic.
- Figure 2.38 X-Band Transceiver Schematic

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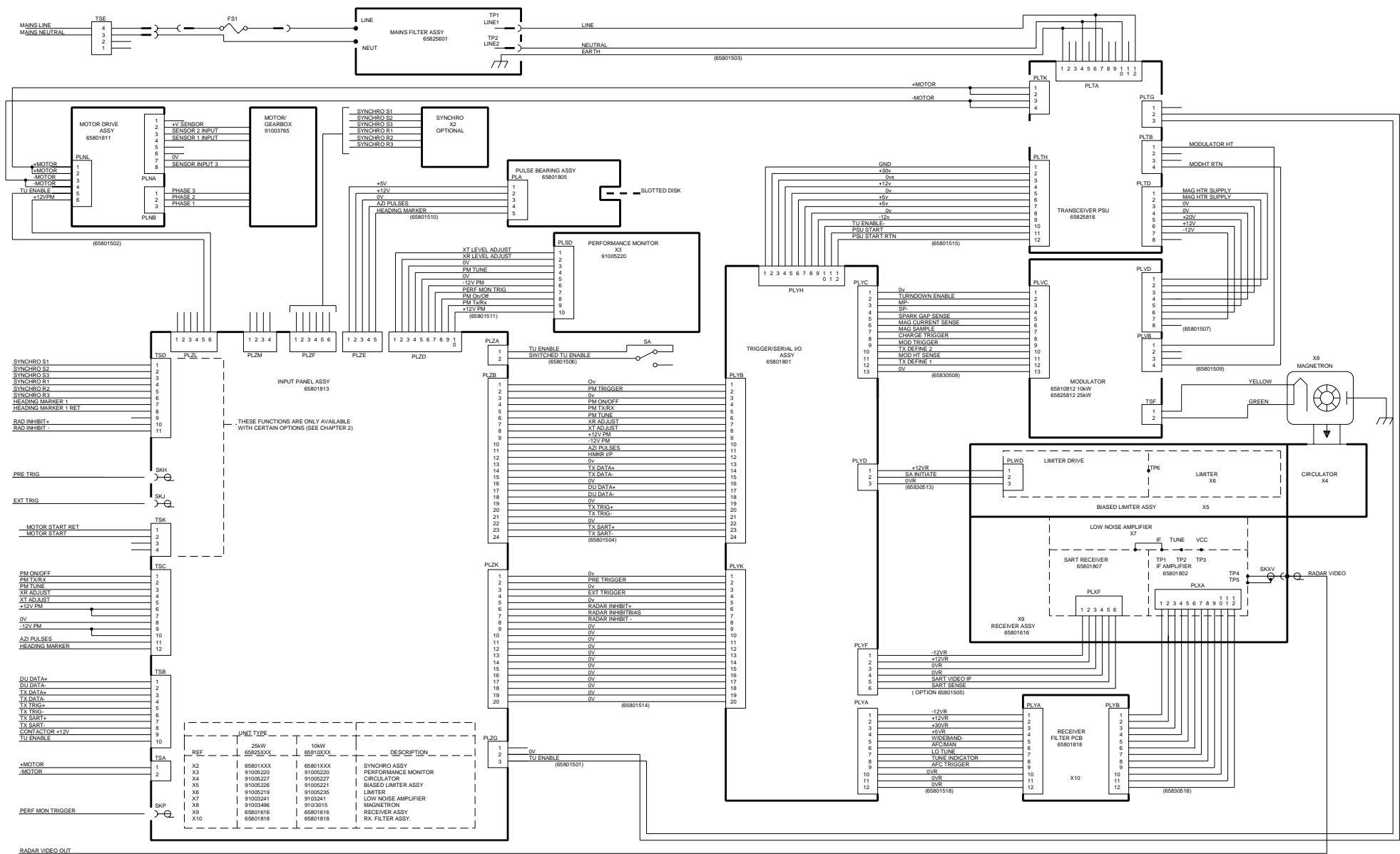


Figure 2.36 X-Band Turning Unit (Aloft) Schematic

A3 page 2-87/88 Figure 2.36, discard this A4 sheet.

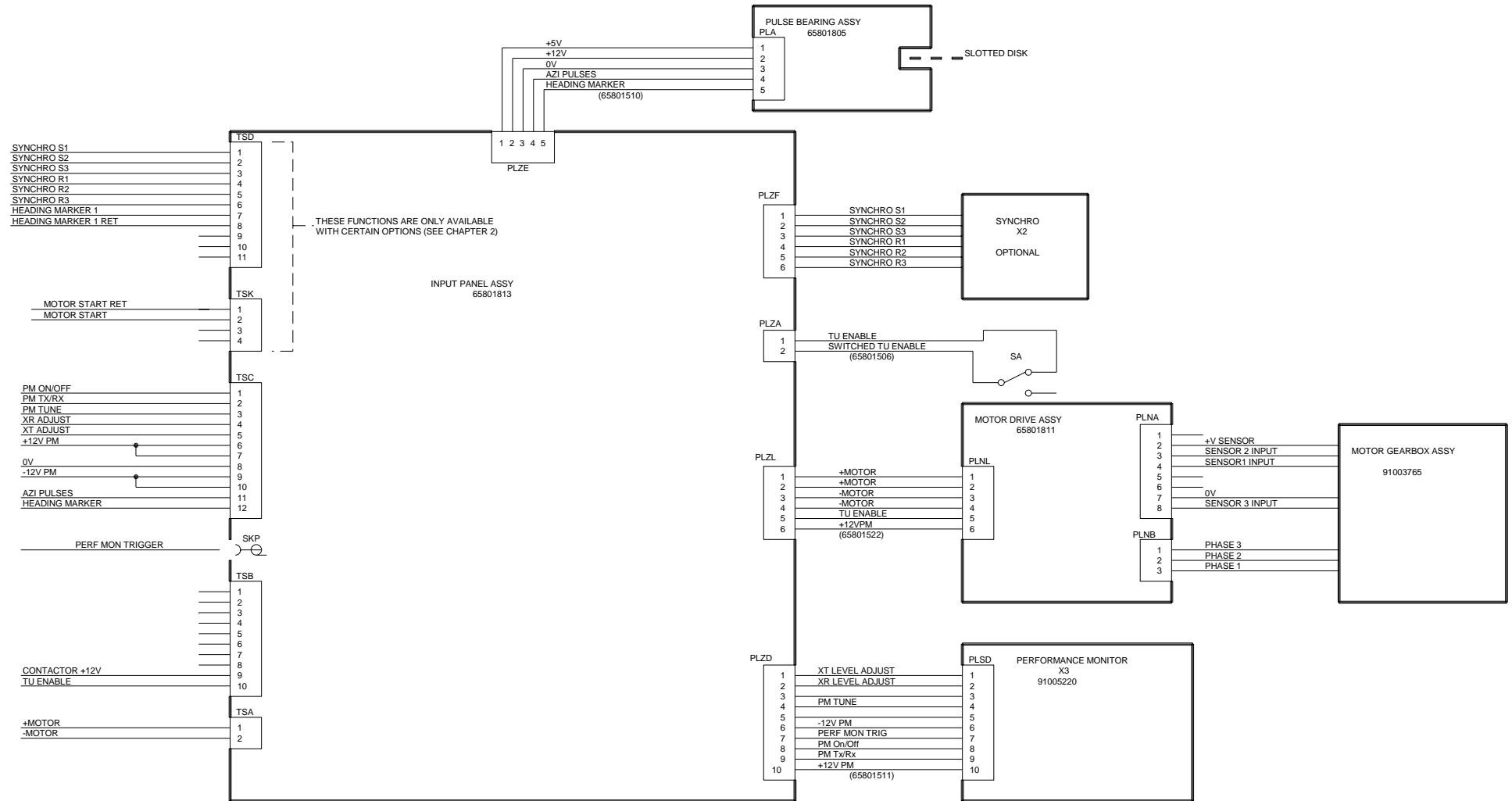


Figure 2.37 X-Band Turning Unit (Bulkhead) Schematic

A3 page 2-89/90 Figure 2.37, discard this A4 sheet.

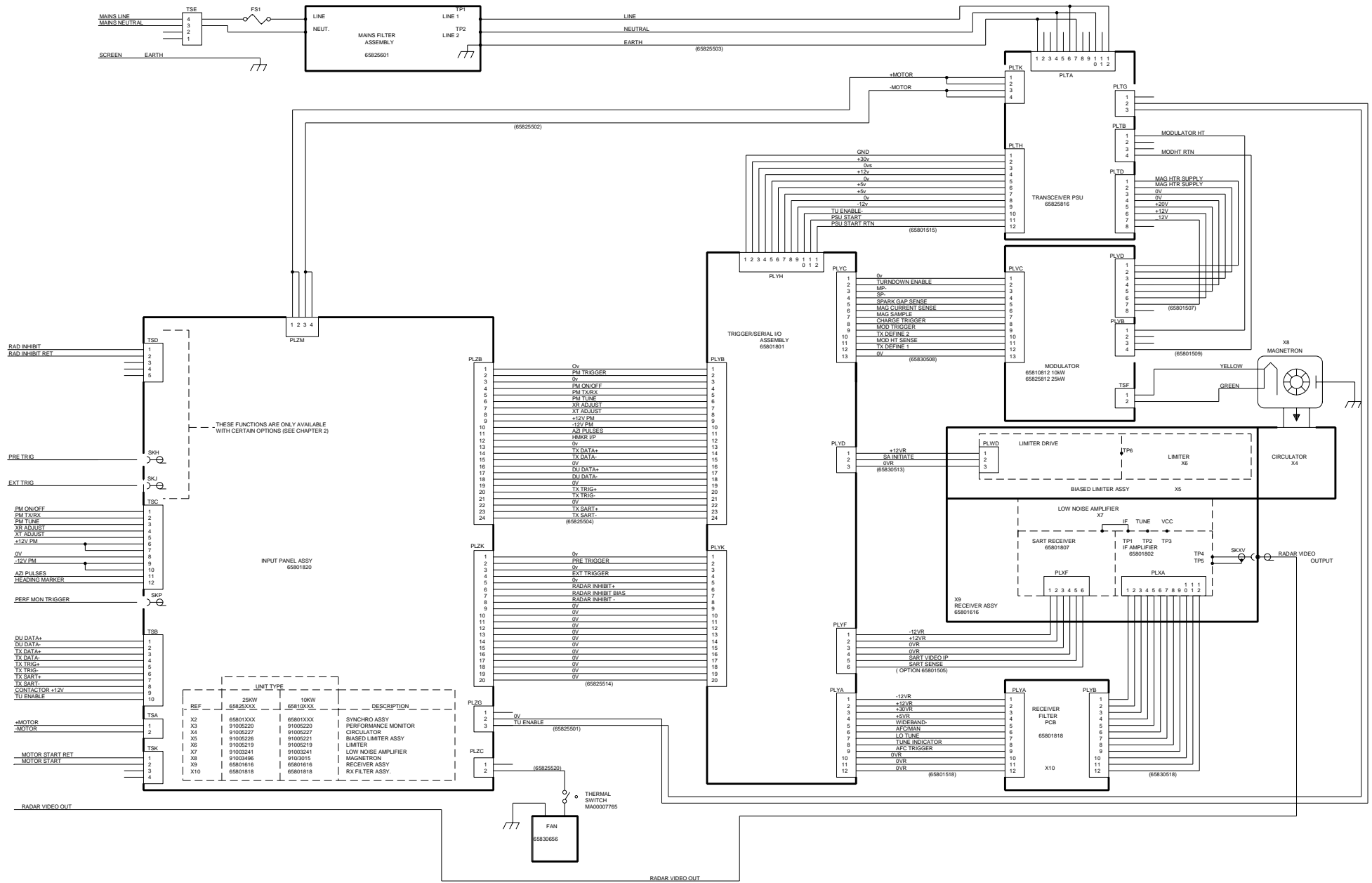


Figure 2.38 X-Band Transceiver Schematic

A3 page 2-91/92 Figure 2.38, discard this A4 sheet.



## 1 General Description

There are three basic types of Display/Monitor Unit as follows:

- 180 Display Unit (High or Medium resolution)
- 250 Display Unit (High or Medium resolution)
- 340 Monitor Unit (Medium resolution)

The 180/250 Display Units comprise a monitor unit and a Processor Electronics Unit (PEU) fitted in a free-standing housing suitable for desk-mount operation, see Figures 3.1 and 3.2.

The separate 340 Monitor Unit is designed for mounting in a split-cabinet or customer specified console, see Figures 3.3 to 3.8.

Refer to Chapter 4 for details of Processor Electronics Units, and to Chapter 5 for details of individual control modules.

## 2 Unit Configurations

### 2.1 General Information

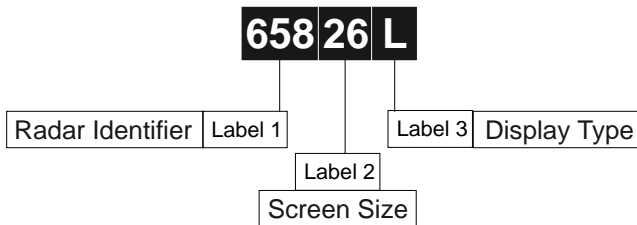
Display monitors are supplied according to the mounting requirement, i.e. Deck, Console (Kit) or Desk mounting.

- Deck - relates to a split-cabinet pedestal mounted display unit.
- Kit - relates to a screened monitor module for fitting into a customer specified console (supplied in kit form).
- Desk - relates to a desk mounted display unit.

The type of mounting (Display Type) is identified in the Monitor Unit's type number as follows.

### 2.2 Monitor Unit Type Numbers

The Monitor Unit type number consists of a five figure number (e.g. 65826) followed by a single letter suffix (e.g. L). A typical complete Monitor Unit Type Number may therefore be: 65826L. A further breakdown of the number is as follows.



Label 1      **BridgeMaster E Identifier (fixed as 658)**

Label 2      **Screen Size**

Label	Screen Diagonal
14	14" (180 series)
21	21" (250 series)
26	26" (340 series)

---

Display Monitor Units and Consoles
Label 3      **Display Type**

<b>Label</b>	<b>Monitor Series</b>	<b>Mounting*</b>	<b>Resolution<sup>#</sup></b>	<b>Buffered Video O/P</b>
<b>F</b>	180/250	Desk	High	No
<b>K</b>	250	Desk	Medium	No
<b>L</b>	340	Deck	Medium	No
<b>N</b>	340	Kit	High	TBA
<b>P</b>	340	Kit	Medium	No
<b>R</b>	180/250	Desk	High	Yes
<b>V</b>	250	Desk	Medium	Yes
<b>W</b>	340	Deck	Medium	Yes
<b>Z</b>	340	Kit	Medium	Yes

\***Deck** relates to the inclusion in pedestal (split-cabinet) mounted display unit.

**Kit** relates to a screened monitor module for fitting into a customer specified console.

**Desk** relates to inclusion in a desk mounted display unit.

<sup>#</sup>All display options are 'interlaced' and have the following resolution.

<b>Resolution</b>	<b>Pixel Grid</b>	<b>Shadow Mask</b>
High 180/250	1365 x 1024	Fine
Medium 250	1365 x 1024	Medium
High 340	1365 x 1024	Fine
Medium 340	1024 x 768	Medium

## 3 Installation and Commissioning

### 3.1 Installation

**Note** - In order to assemble the Display Units from their supplied parts, refer to the documentation supplied with the parts.

- Refer to Figures 3.1 for installing a 180 Display Unit.
- Refer to Figures 3.2 for installing a 250 Display Unit.
- Refer to Figures 3.3 for installing a 340 Split Cabinet.

#### 3.1.1 340 Monitor Module

**Note** - In order to assemble the Split-Cabinet Console from their supplied parts, refer to the documentation supplied with the parts.

- Refer to Figures 3.4 to 3.8 for installing the 340 Monitor into a console.
- Refer to Figure 3.9 for information on interconnecting cables required to connect the 340 Monitor to the Processor Electronics Unit, and to connect the Brilliance Control Module to the Monitor.

### 3.2 Initialisation and Commissioning

The Display Monitor is only part of a complete BridgeMaster E Series Radar, and cannot be operated independently. For details of complete system installations refer to the BridgeMaster E, Ship's Manual 65800010B.

After a complete system has been installed it must be Initialised and Commissioned as detailed in Chapter 4 of the BridgeMaster E, Ship's Manual.

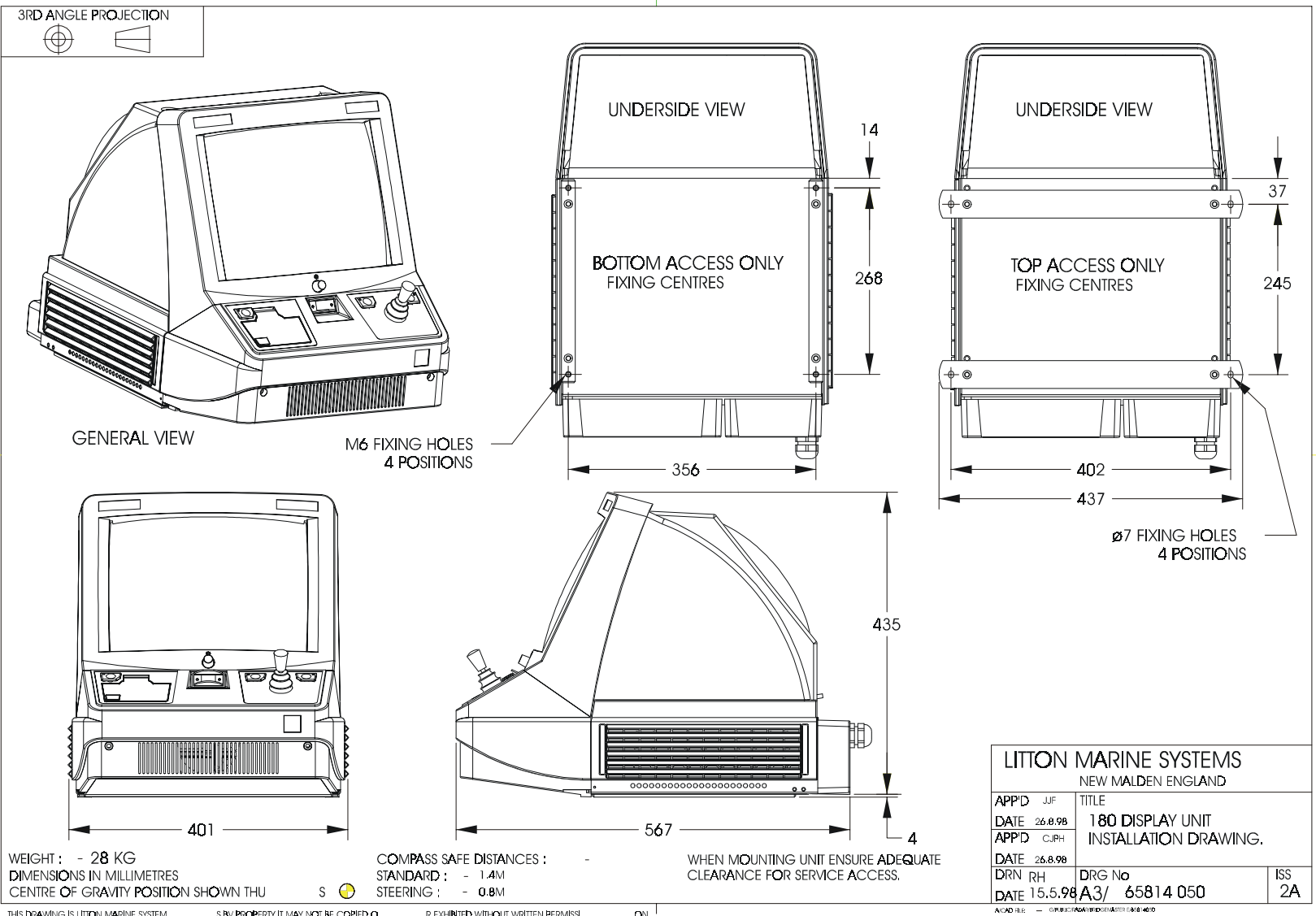


Figure 3.1 - 180 Display Unit Installation Drawing

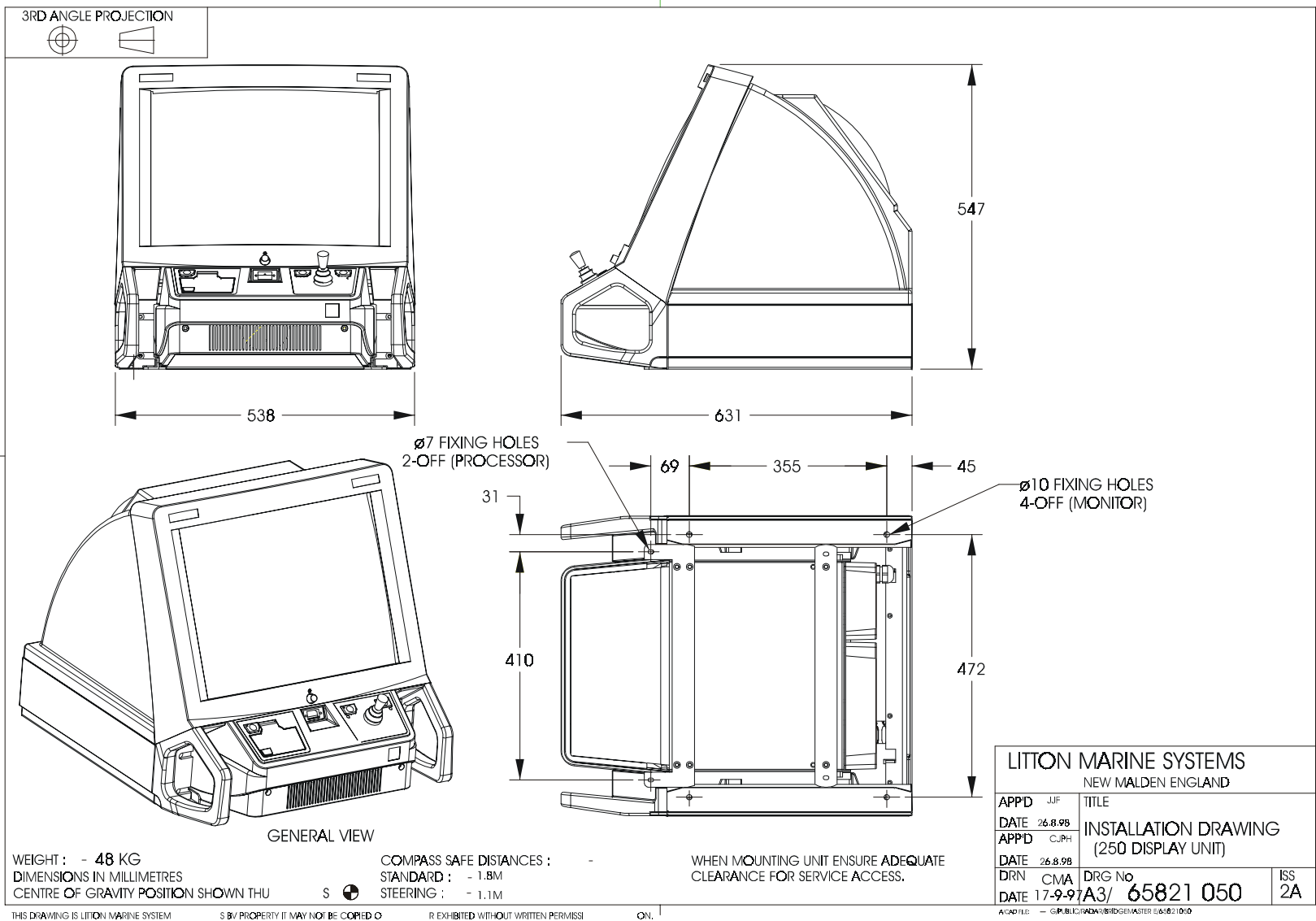


Figure 3.2 - 250 Display Unit Installation Drawing

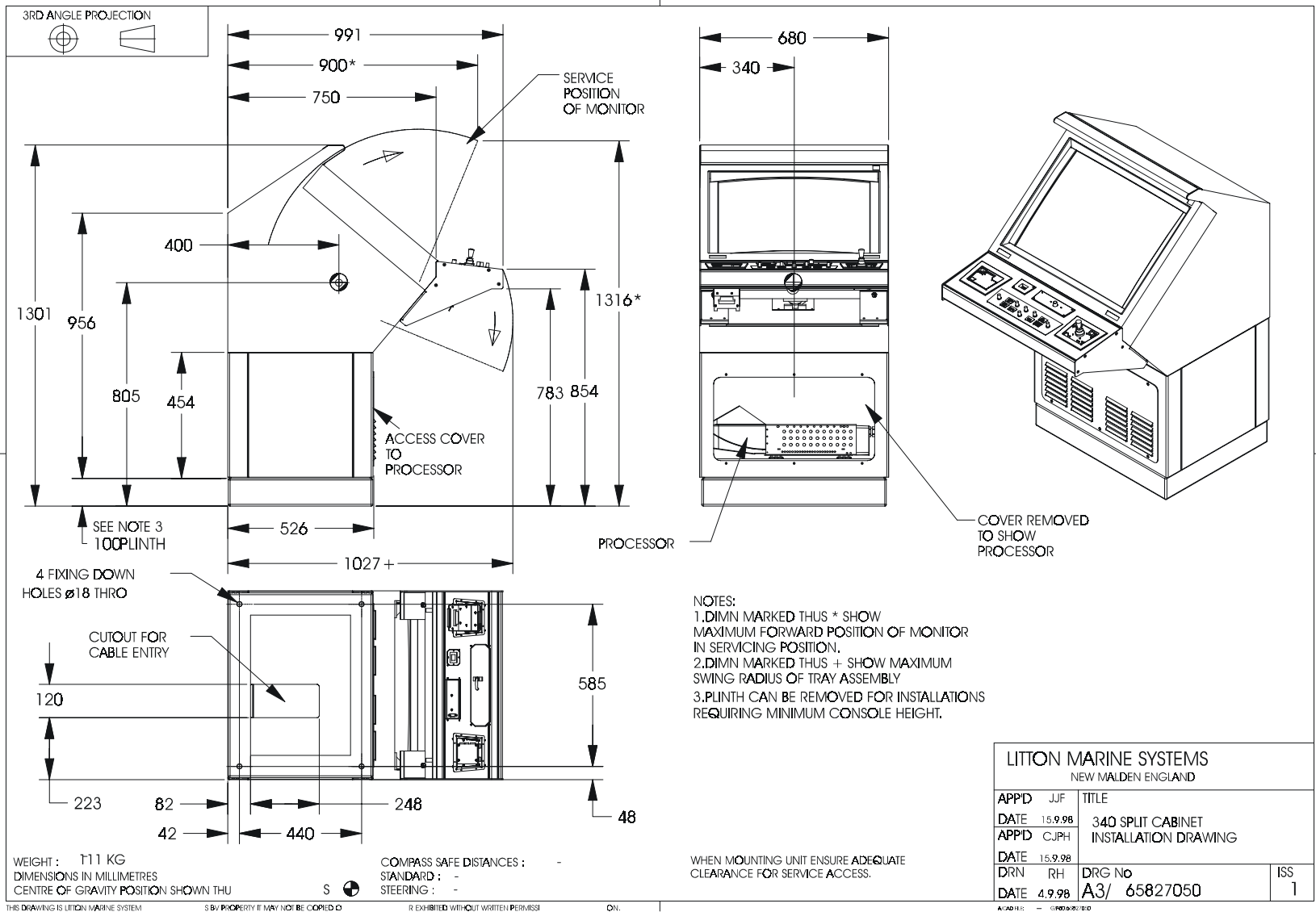


Figure 3.5 - 340 Split Cabinet Installation Drawing

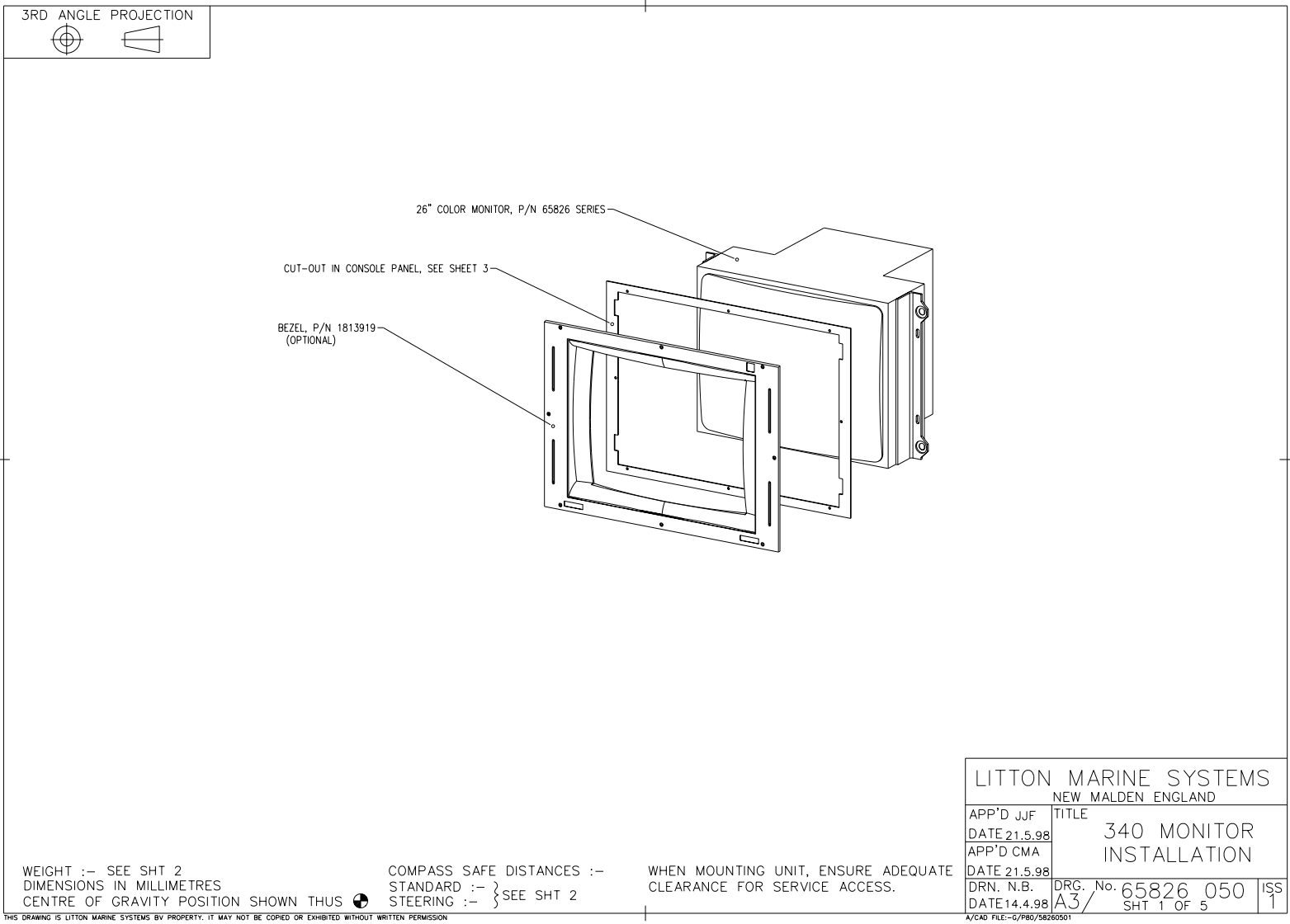


Figure 3.4 - 340 Monitor Installation (Sheet 1 of 5)



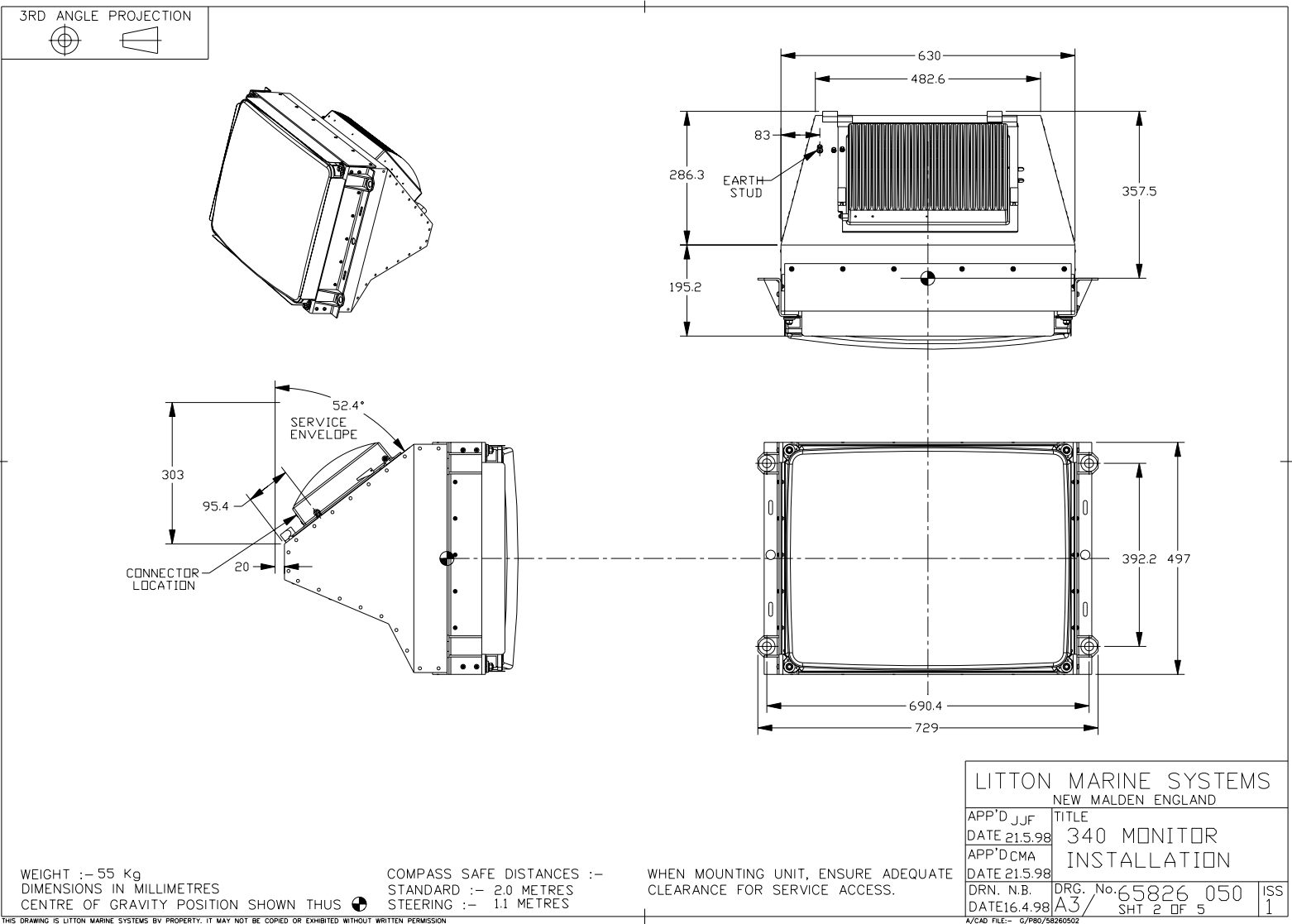


Figure 3.5 - 340 Monitor Installation (Sheet 2 of 5)

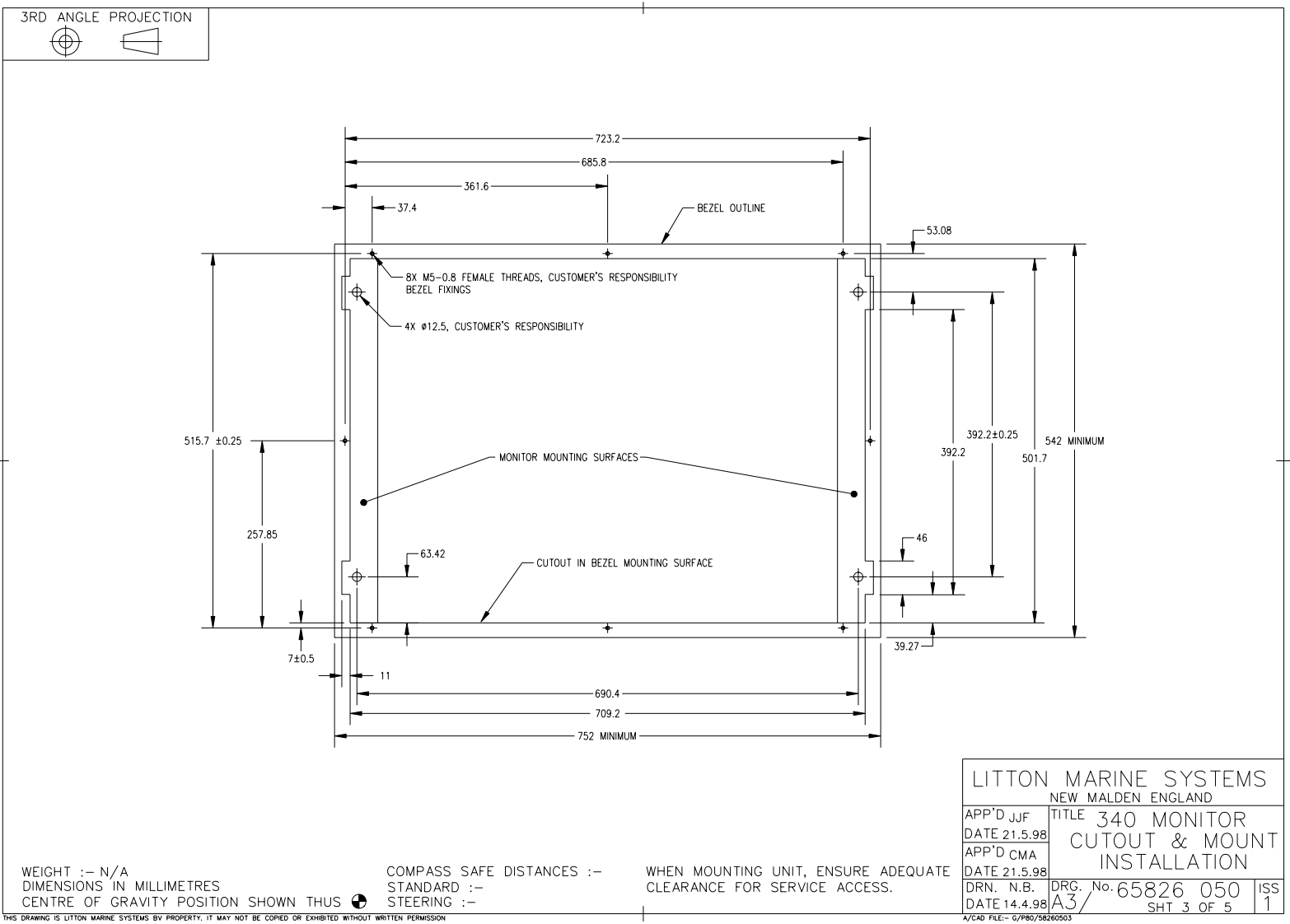


Figure 3.6 - 340 Monitor Installation (Sheet 3 of 5)

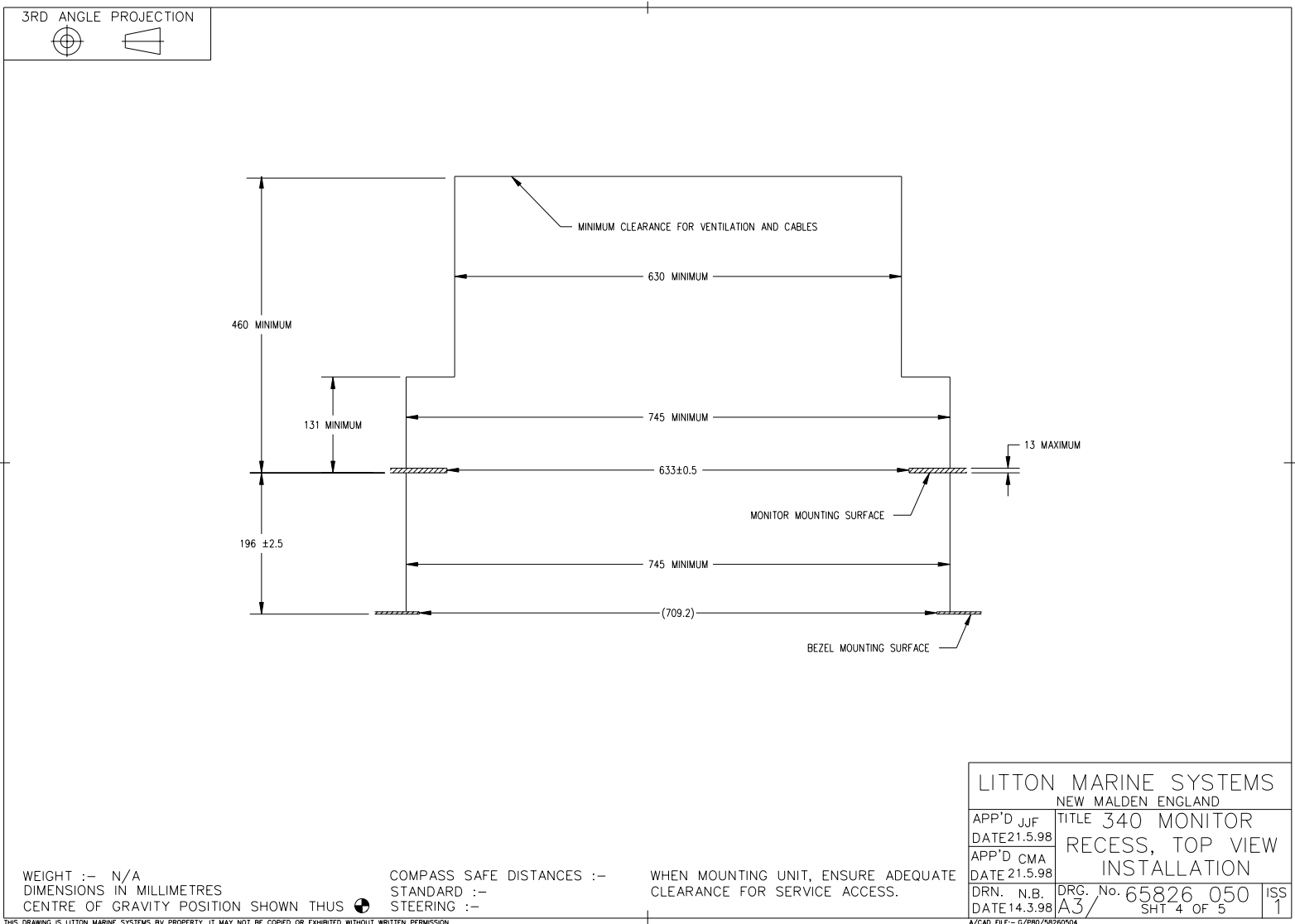


Figure 5.7 - 340 Monitor Installation (Sheet 4 of 5)

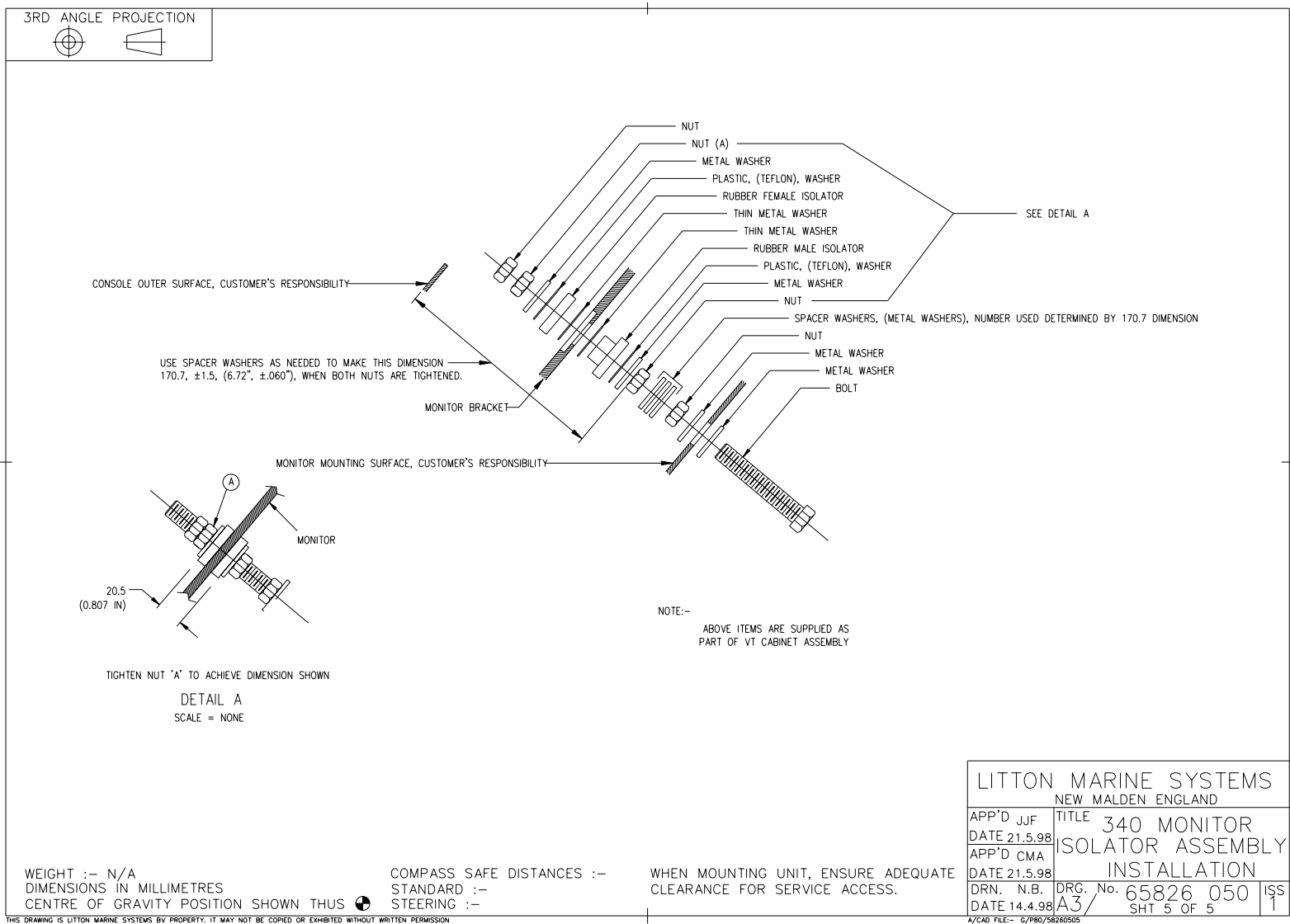


Figure 3.8 - 340 Monitor Installation (Sheet 5 of 5)

## 4 Technical Specification

### 4.1 Display Monitors

#### 4.1.1 BridgeMaster E Display Monitors

Display Monitor Type: Colour Raster Scan, with 4:3 aspect ratio landscape mode picture format

Circle Size/ Resolution	Screen Diagonal (inches)	Radar Circle Diameter (mm)	Pixel Grid Size
180 High	14	180	1365 x 1024
250 Medium	21	250	1365 x 1024
250 High	21	250	1365 x 1024
340 Medium	29	340	1024 x 768

#### 4.1.2 Non-BridgeMaster E Display Monitors

BridgeMaster E Display Monitors fitted with buffered video/sync outputs can be used to drive a suitable Company approved monitor as a secondary display.

A suitable Company approved monitor can also be used as the primary display. In this case, links in the video connection to the monitor are used to select the appropriate pixel grid size, and indicate the screen size to the Processor Electronics Unit.

Video signal characteristics conform to RS343A. A link option in the Processor Electronics Unit allows composite sync to be applied to the R, G and B outputs.

### 4.2 Video Processing

Parameter	Detail
Manual Control	Variable controls for gain, anti-clutter sea and anti-clutter rain.
Anti-clutter Auto	Advanced adaptive rain and sea clutter suppression circuits, applied without manual adjustment.
Enhance (echo stretch)	Operation available by selection on all ranges, with enhancement of targets over entire picture area except for a small area around the radar origin. Special circuitry for identifying weak/fading targets.
Multi-level Video	Radar video digitised at 16 levels. Scan integration employed at 16 levels and displayed at 8 levels on screen.
Picture Persistence/Trails	Medium persistence phosphor simulation with switchable true or relative motion trails, achieved by unique video processing.

### 4.3 Power Supplies

#### 4.3.1 Power Supply (AC)

Parameter	Detail	
Input voltage range	92 - 276V RMS	
Input voltage frequency range	47 to 64 Hz.	
Maximum Input power	Display Units (including Monitor, Processor Unit and Controls)	
	180 Display	230 VA
	250 Display	260 VA
	340 Display	280 VA
Transient protection	Overvoltage transient of up to 40 % above nominal input voltage with maximum duration of one second. Pulse transient of up to $\pm 1200$ V peak, with a rise time of 2 to 10 $\mu$ s and duration up to 20 $\mu$ s.	
Protection facilities	Output short circuit. High and low input voltage. Output overvoltage. Slow start.	
High voltage multiphase operation	Via a suitable transformer.	

#### 4.3.2 Power Supply (DC)

Parameter	Detail	
Input voltage range	22 to 32 V DC	
Maximum Input power	180 Display Unit	230W
	250 Display Unit	260W
	340 Display	280W
Transient Protection	Symmetrical (line-line) 500 V of duration 10 $\mu$ s (100 $\mu$ s rise/fall time). Line to ground 500 V of duration 60 $\mu$ s (1 $\mu$ s rise/fall time)	
Protection Facilities	Output short circuit. High and low input voltage. Slow start.	

## 4.4 Mechanical Specification

### 4.4.1 Weights and Dimensions

Component	Height (mm)	Depth (mm)	Width (mm)	Weight (kg)
180 Display Unit	439	567	401	28
250 Display Unit	547	629	538	48
340 Display Unit -Deck Mounted	1301	991	680	111
340 Monitor Module	497	481	730	55

### 4.4.2 Mounting Options (340 Display)

The radar display components are either supplied in the form of a 340 Deck Mounted Display Unit, which incorporates a 340 Split Cabinet Display Console, or as a kit for fitting into a customer specified console (eg. VT750 console).

## 4.5 Compass Safe Distances

Component	Type No.	Standard	Steering
180 Display Unit	-	1.4 m	0.8 m
250 Display Unit	-	1.8 m	1.1 m
340 Display Unit - Deck Mounted	-	2.7 m	1.6 m
340 Monitor Module	65826 (P, Z)	2.0 m	1.1 m

## 4.6 Environmental Specification

To the requirements of the International Standard for Marine Navigational Equipment CEI/IEC 945 (1988) and Amendment 1 (1992).

## 5 Circuit Diagrams

The following circuit diagrams are included.

Circuit Diagram 65800922 - Display PSU (DC) given at Figure 3.9

Circuit Diagram 65800932 - Display PSU (AC) given at Figure 3.10

Refer to Chapter 4, Figure 4.4 for a basic 180, 250 and 340 Displays block diagram.

## 6 Replacement Spares

Refer to Chapter 6 for a full list of replacement spares.

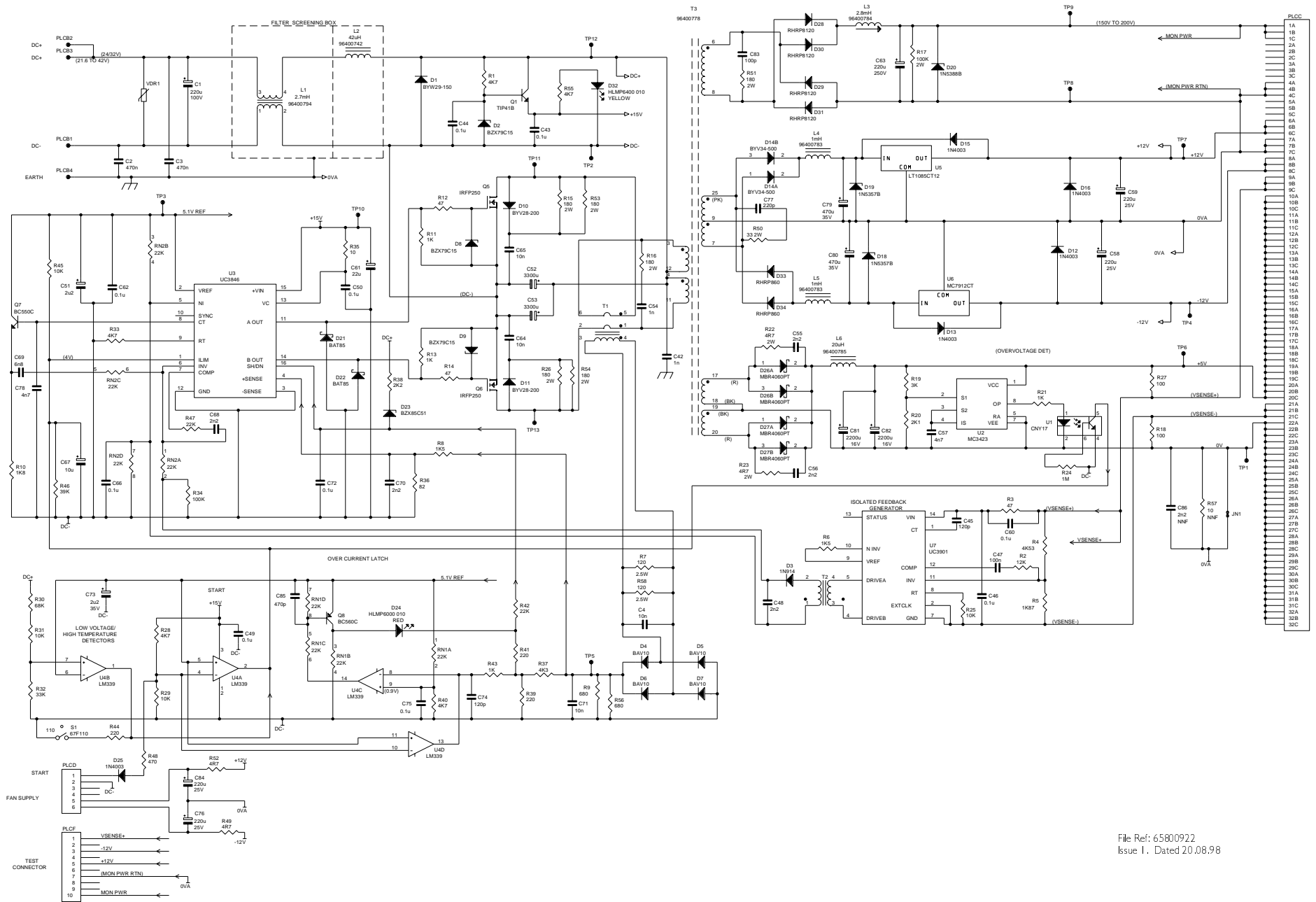
## 7 Wiring Diagrams

Refer to Ship's Manual 65800010B Chapter 3 for complete system installation diagrams.

The wiring diagrams Included in this section are as follows:

- Figure 3.11 Inter-unit Cabling: Non-Integral PEU Front Panel Connections
- Figure 3.12 Kit Display Unit Inter-Module Cabling
- Figure 3.13 Split Cabinet Display Unit Inter-Module Cabling
- Figure 3.14 Integral Display Unit Inter-Module Cabling.





File Ref: 65800922  
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Figure 3.9 Circuit Diagram 65800922 - Display PSU (DC)

A3 page 1-17/18 Figure 1.9, discard this A4 sheet.

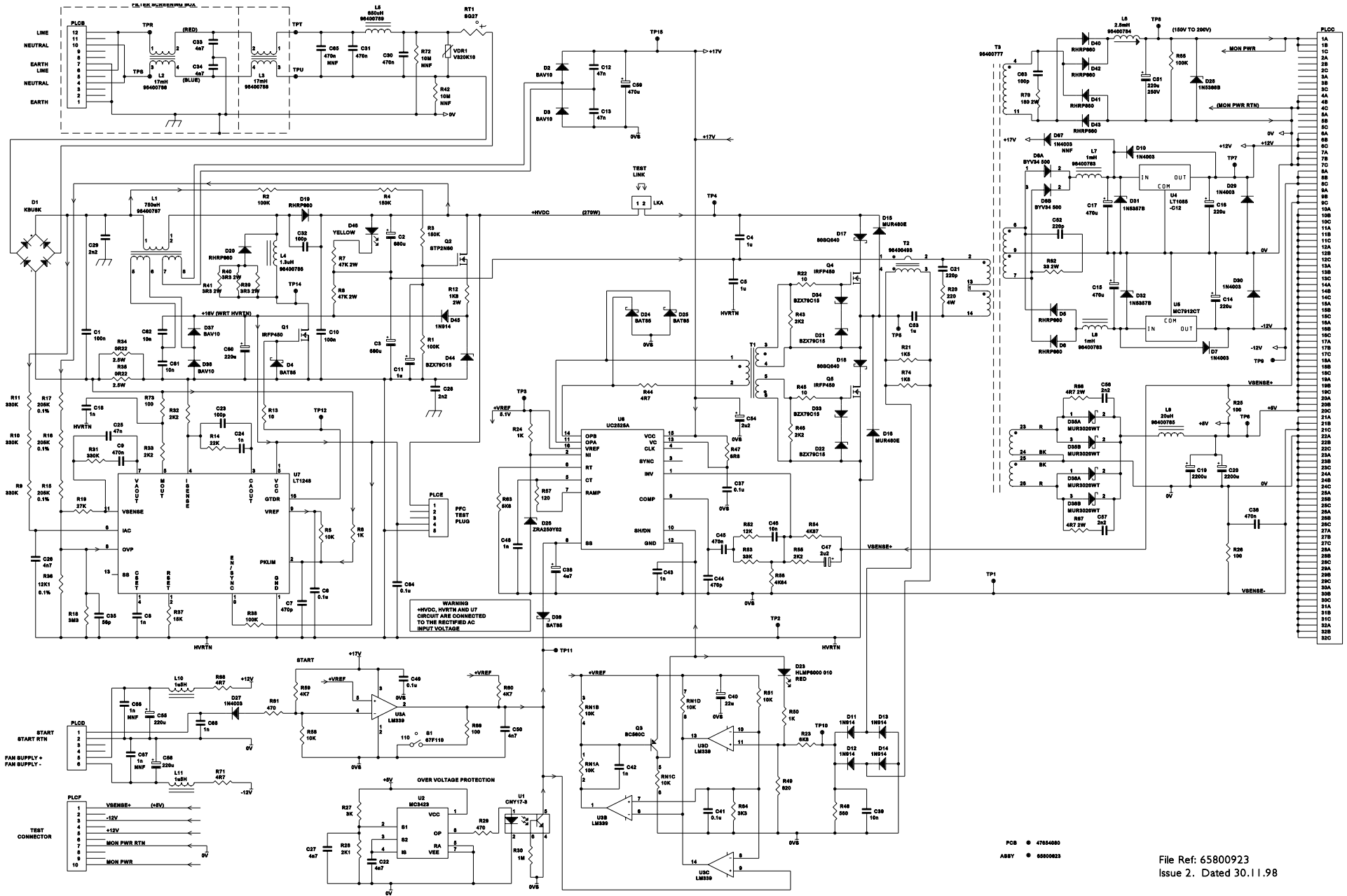
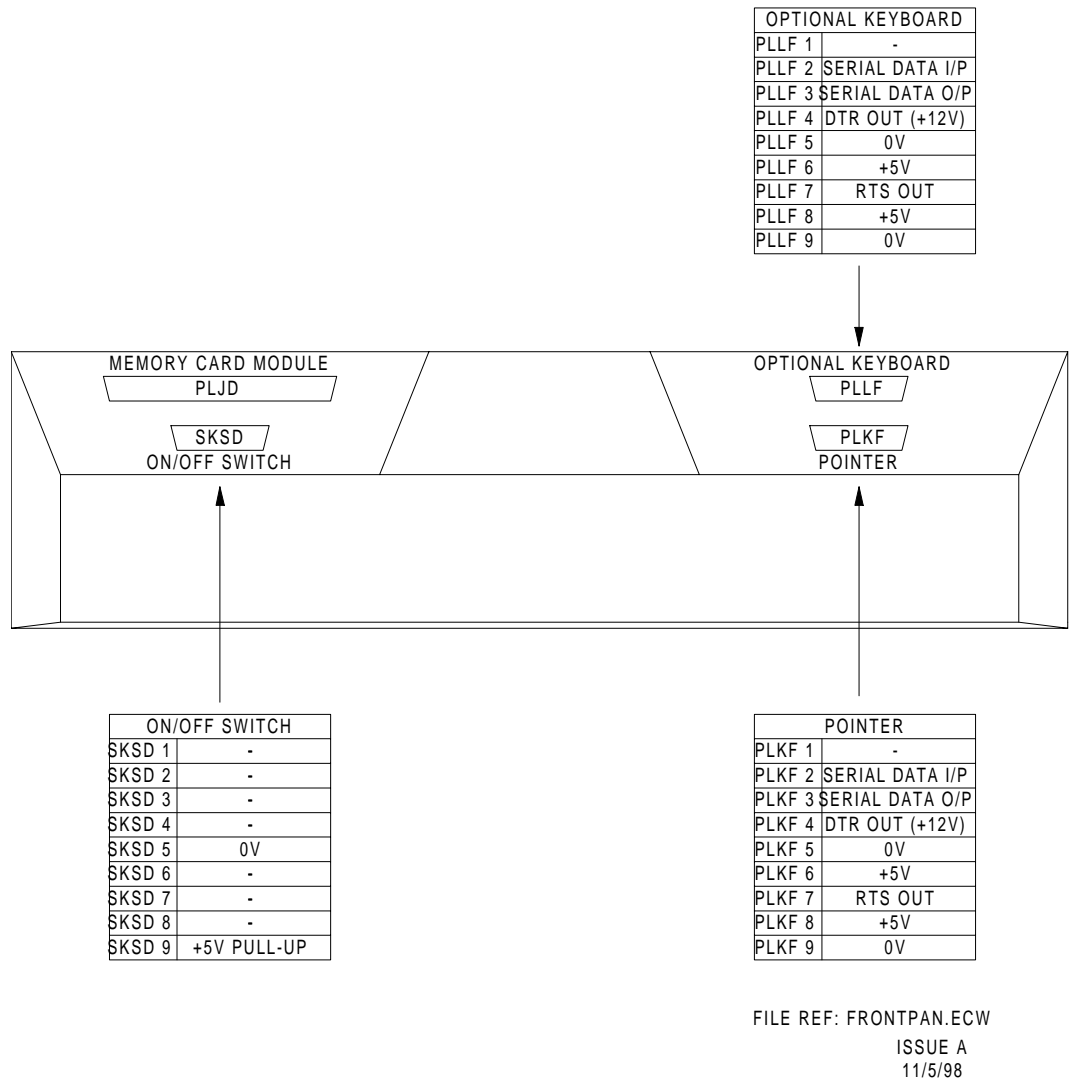


Figure 3.10 Circuit Diagram 65800923 - Display PSU (AC)

A3 page 1-19/20 Figure 1.10, discard this A4 sheet.



**Figure 3.11** - Inter-unit Cabling: Non-Integral PEU Front Panel Connections

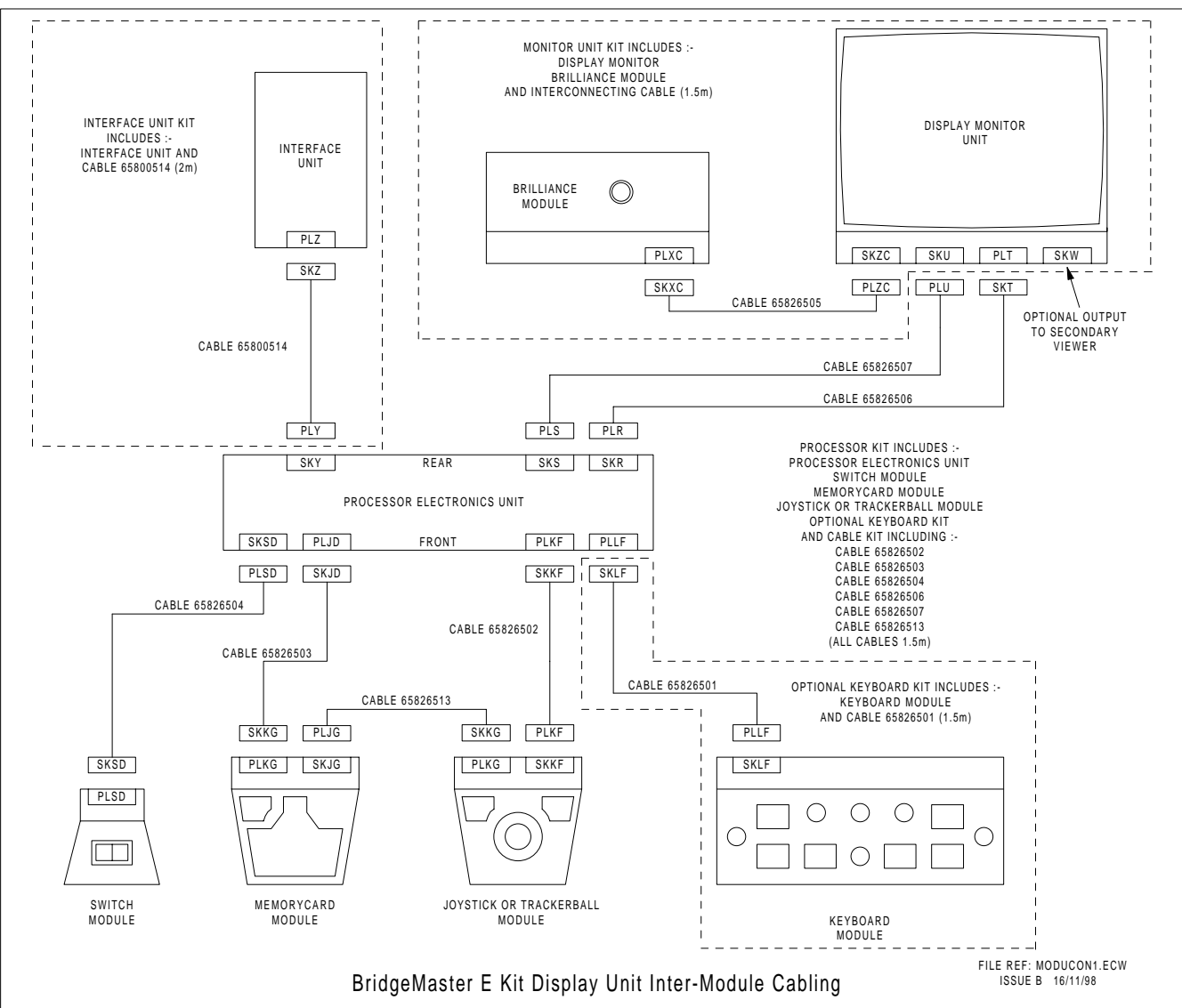
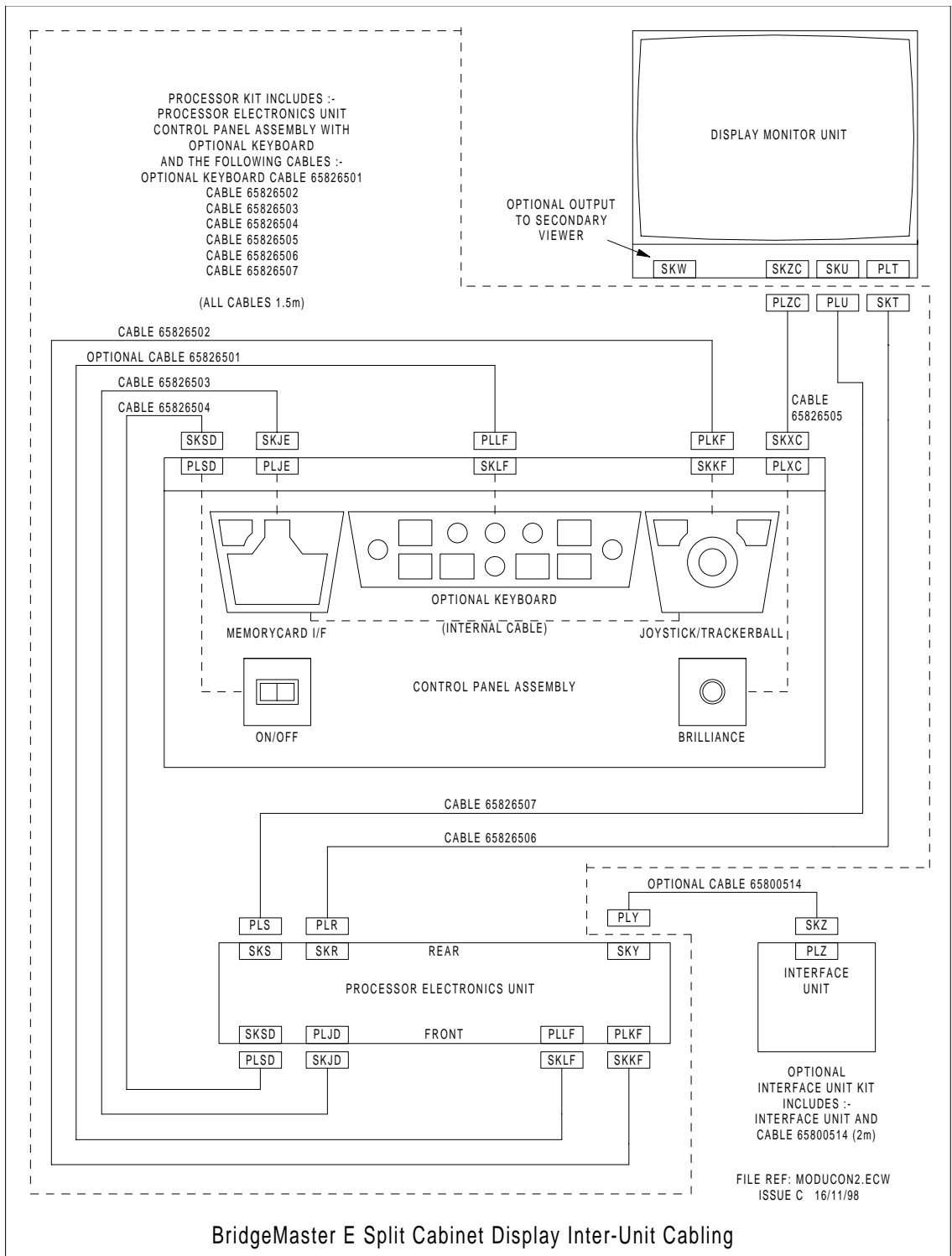


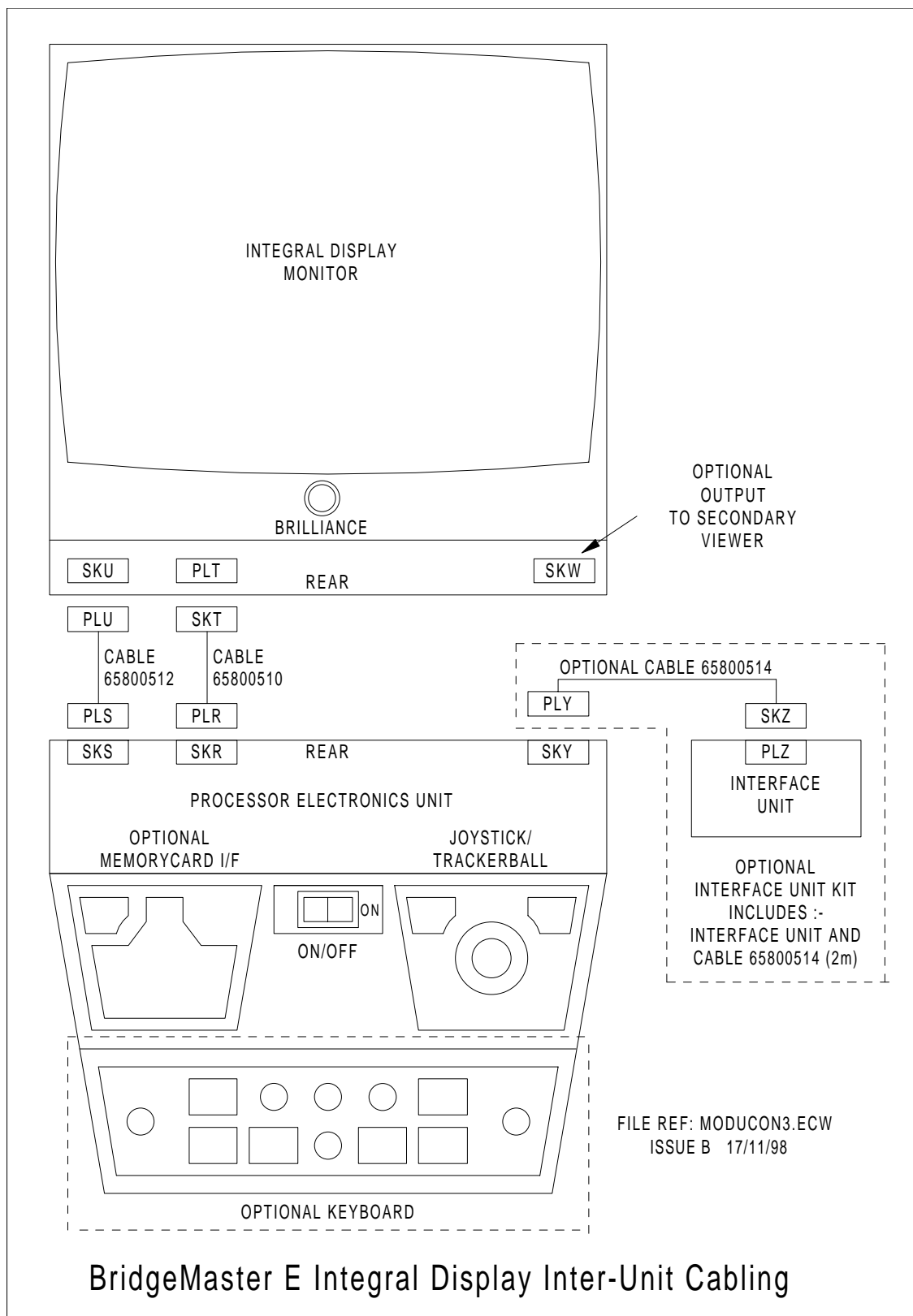
Figure 3.12 - Kit Display Unit Inter-Module Cabling



**Figure 3.13** - Split Cabinet Display Unit Inter-Module Cabling

# Chapter 3

## Display Monitor Units and Consoles



**Figure 3.4** - Integral Display Unit Inter-Module Cabling





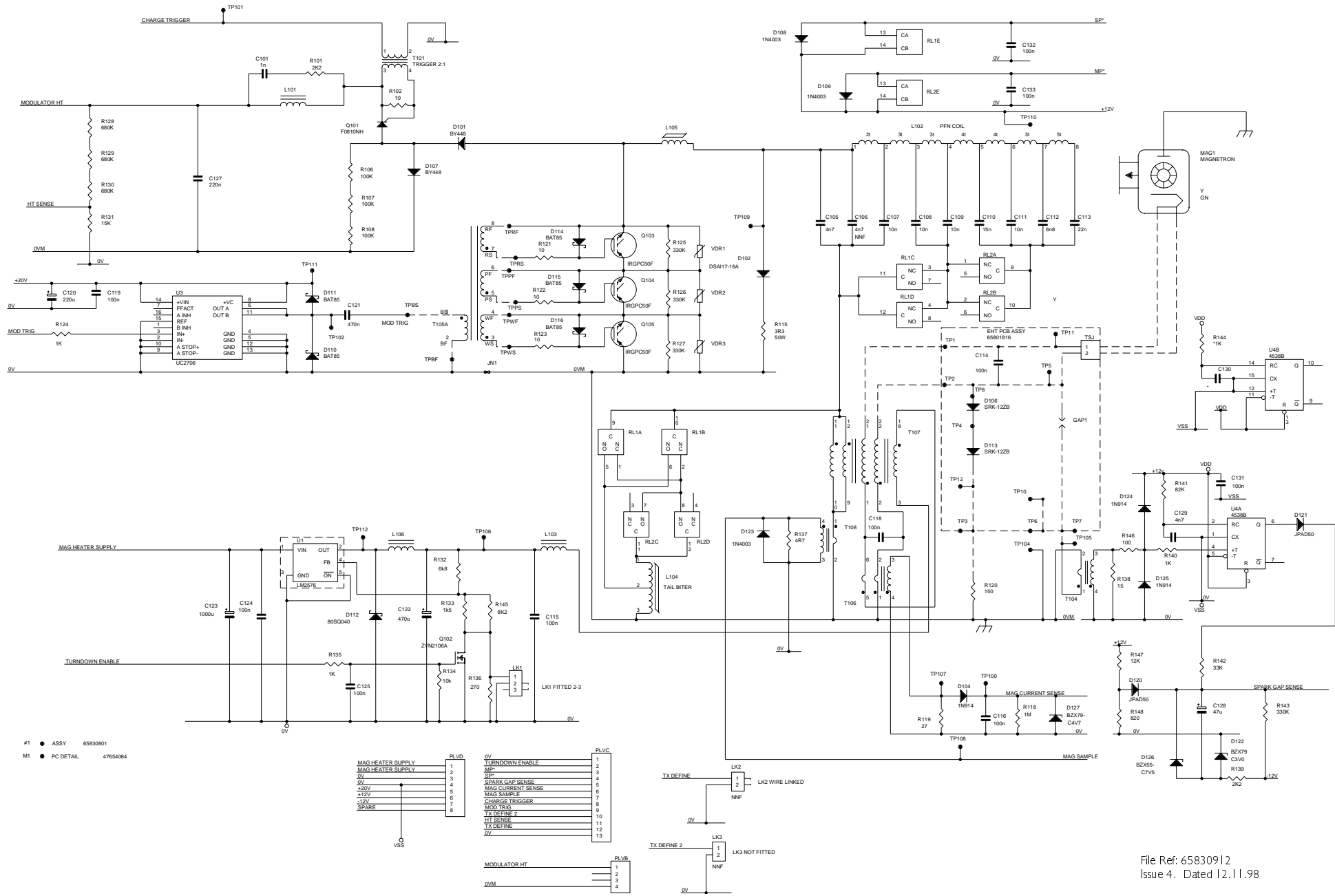


Figure 1.32 Circuit Diagram 65830912 - S-Band Modulator Board (30kW)

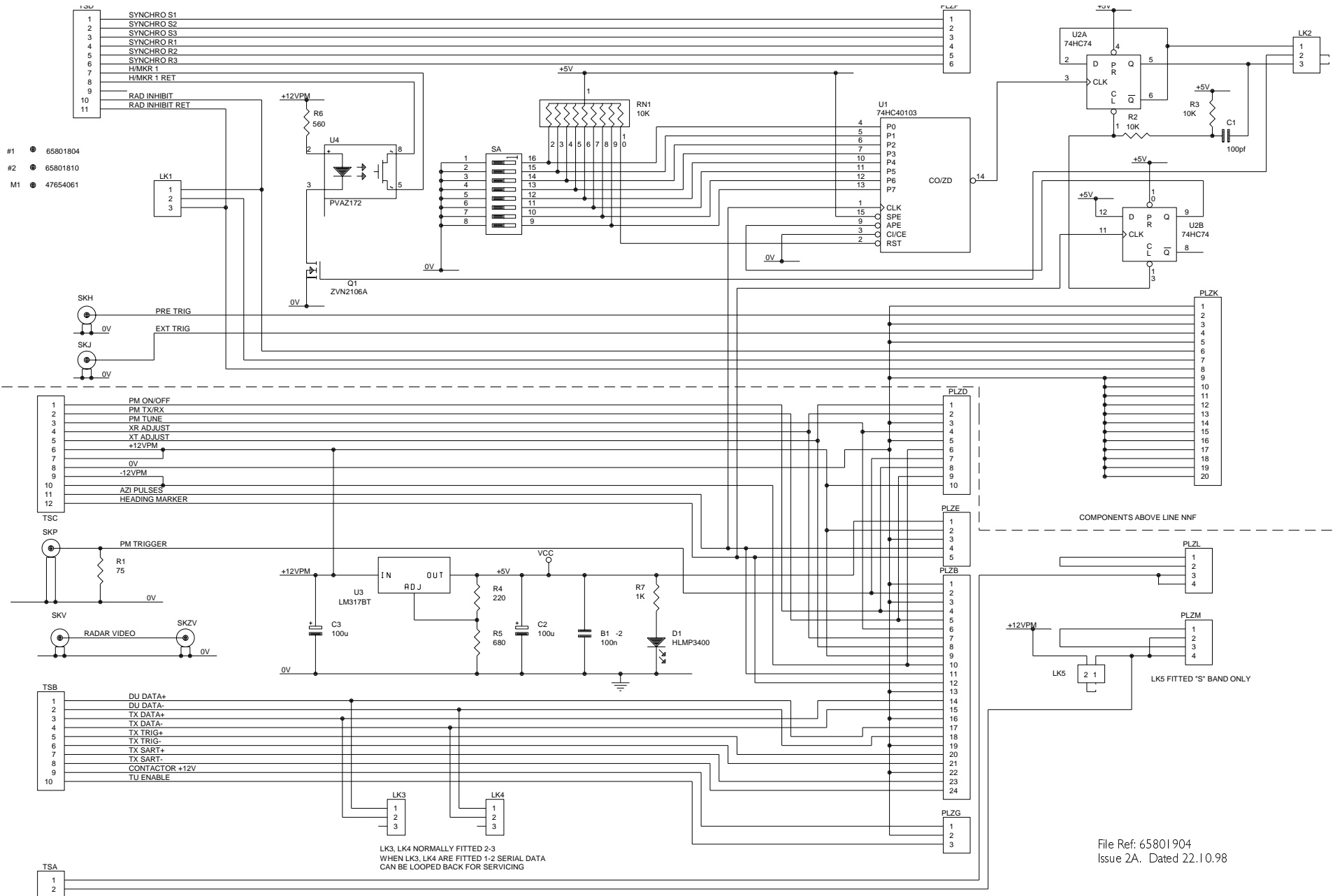


Figure 1.33 Circuit Diagram 65801904 - S-Band Input Board

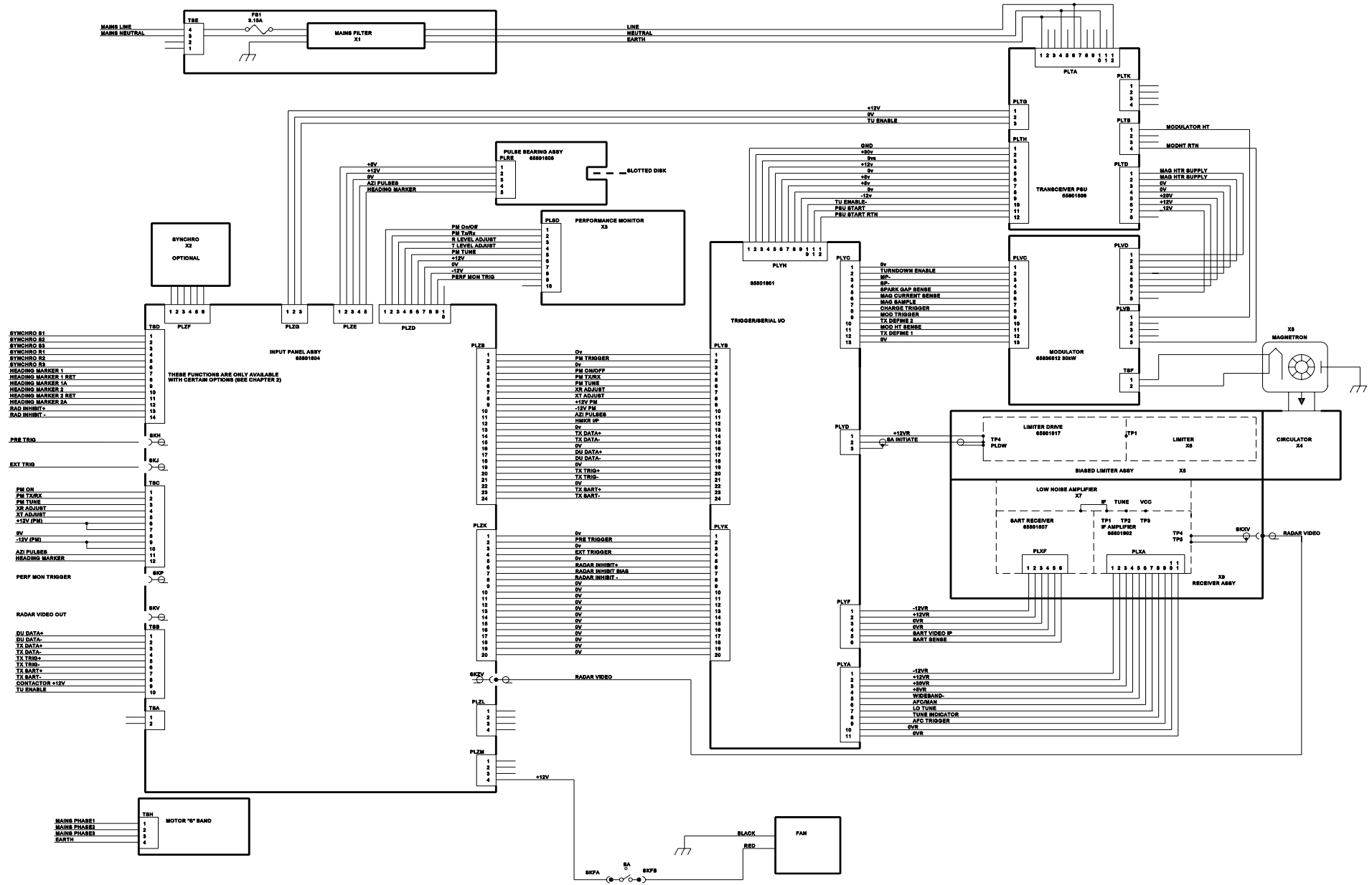


Figure 1-34 S-Band Turning Unit Schematic

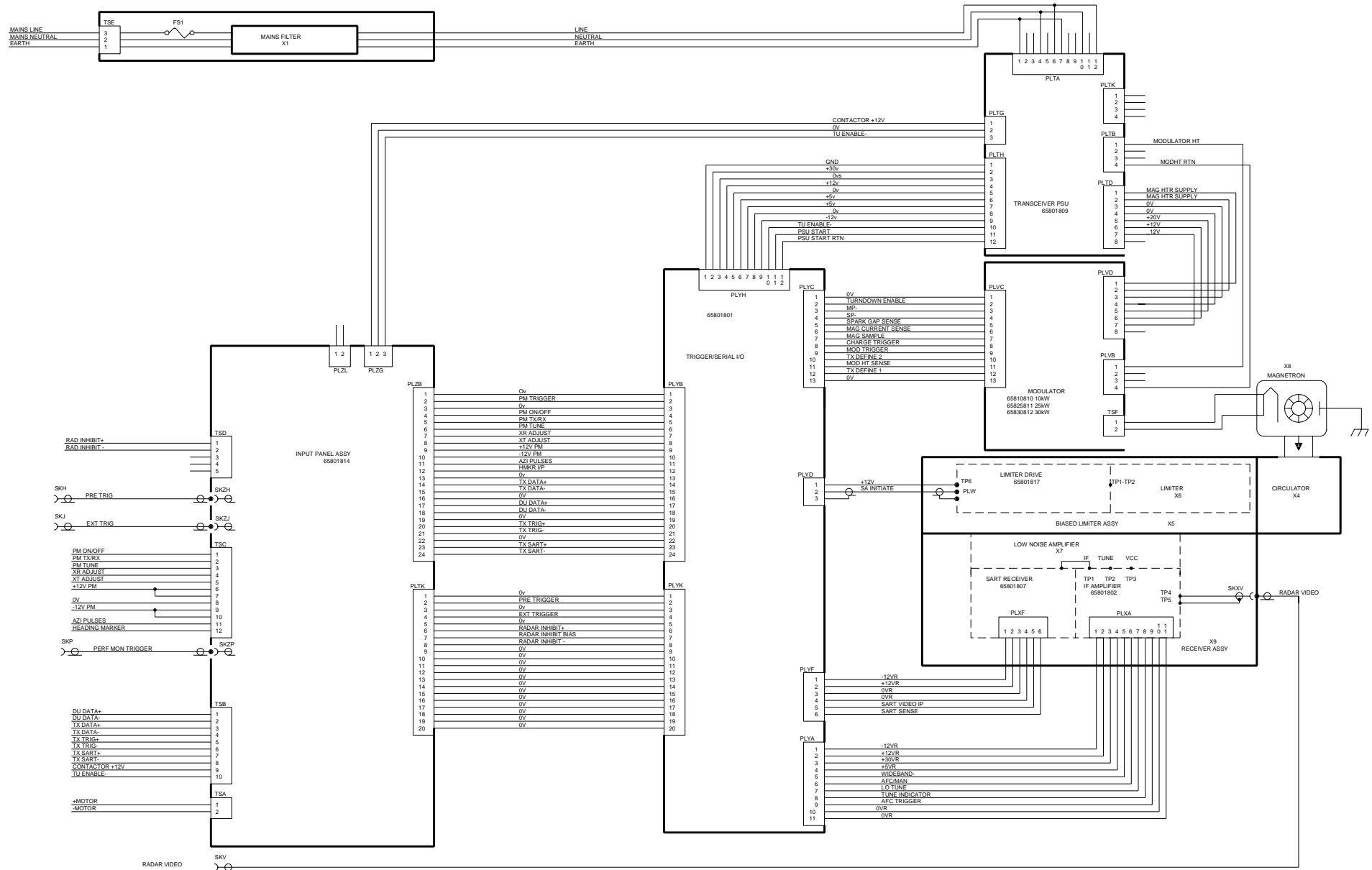


Figure 1.35 S-Band Bulkhead Transceiver Schematic

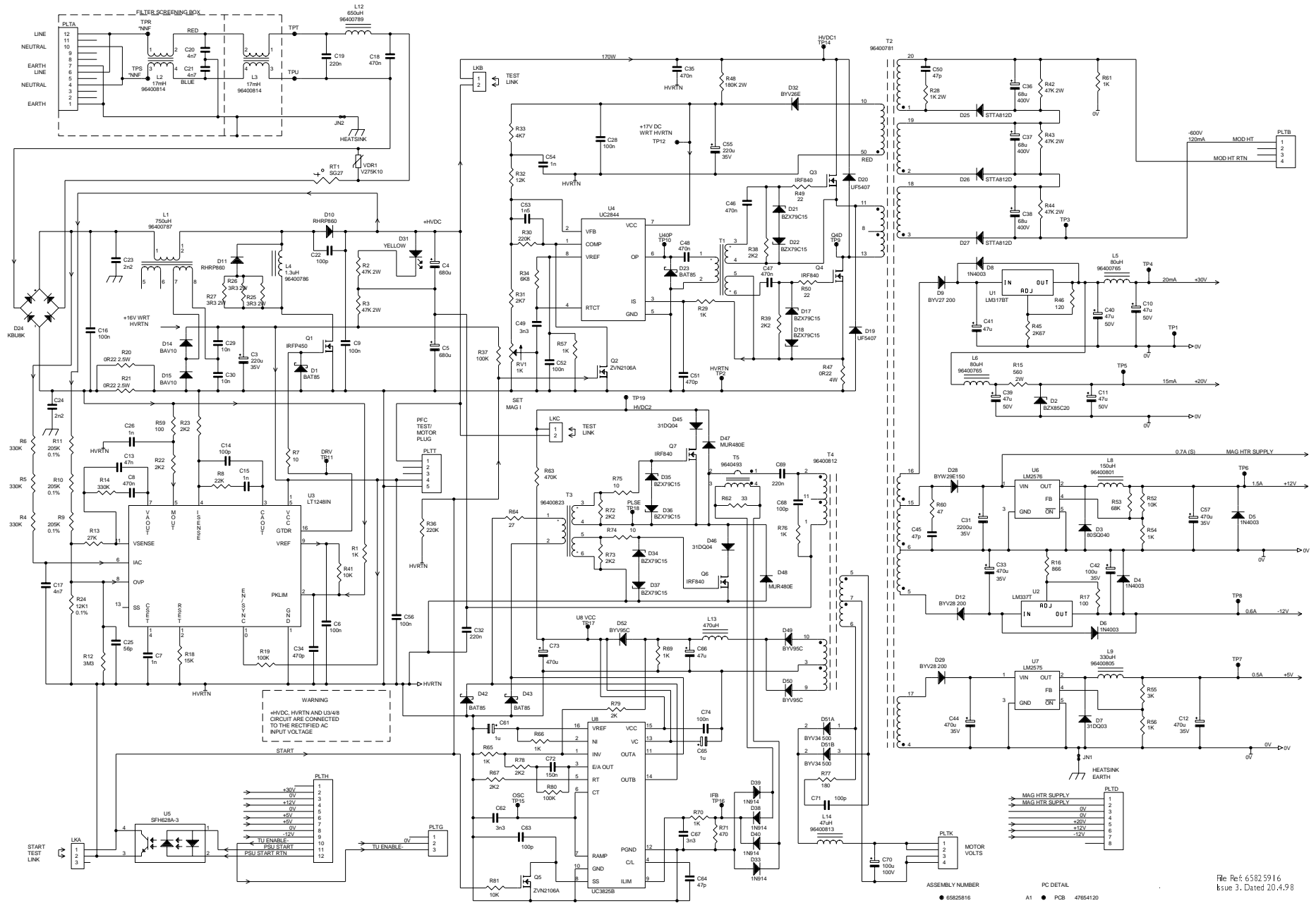
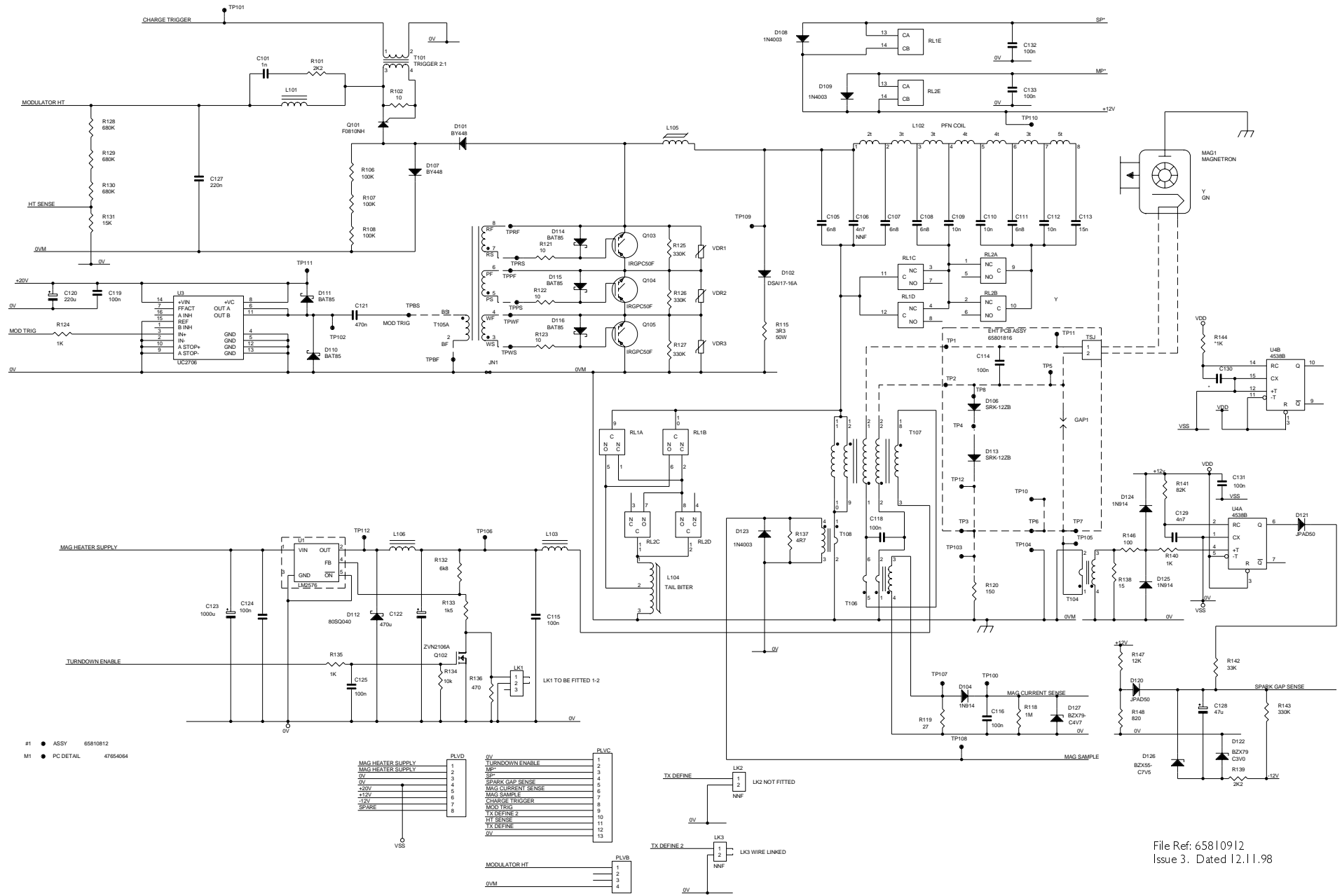
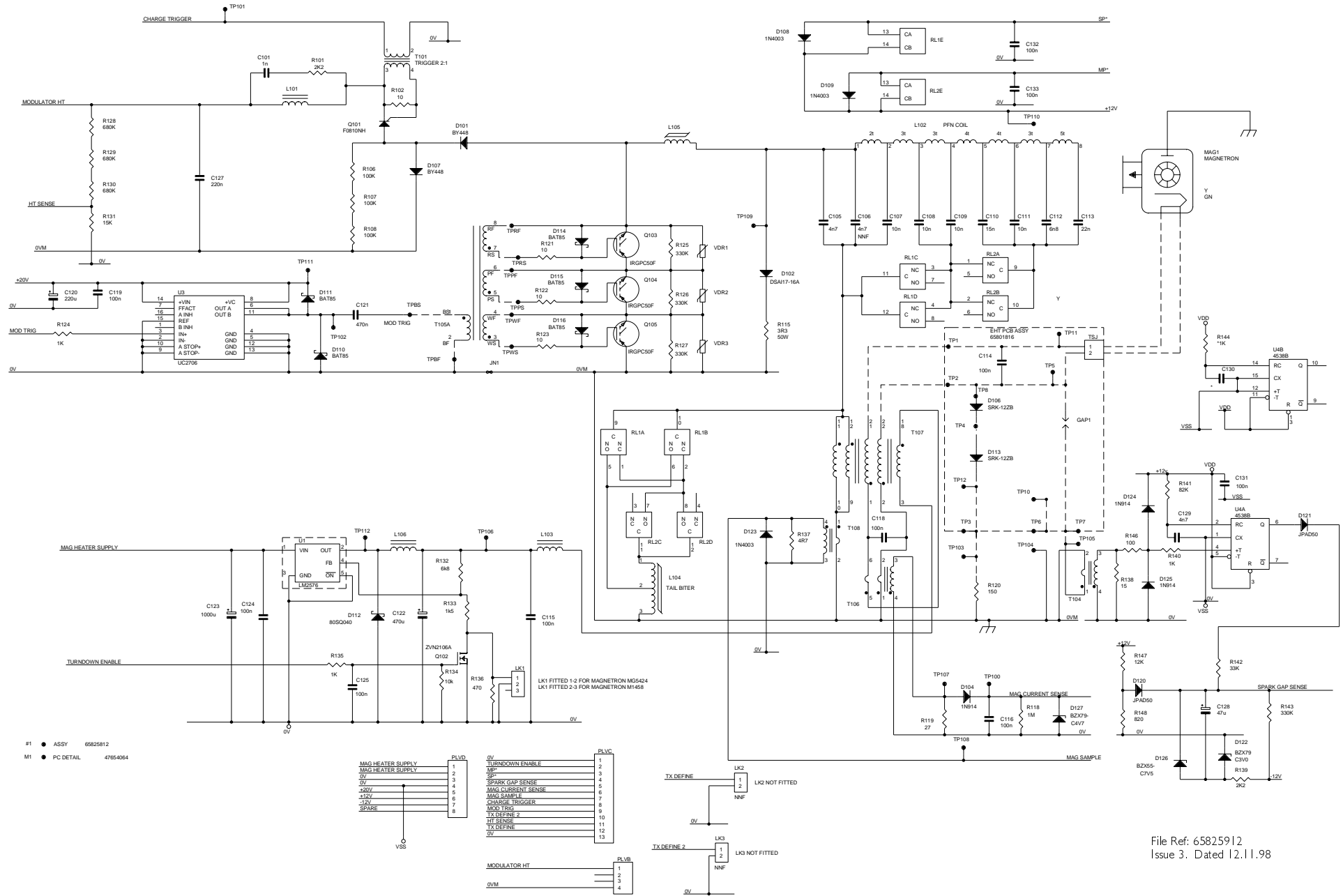


Figure 2.28 Circuit Diagram 65825916 - X-Band Transceiver Power Supply



File Ref: 65810912  
Issue 3. Dated 12.11.98

Figure 2.29 Circuit Diagram 65810912 - X-Band Modulator Board (10kW)



File Ref: 65825912  
Issue 3. Dated 12.11.98

Figure 2.30 Circuit Diagram 65825912 - X-Band Modulator Board (25kW)



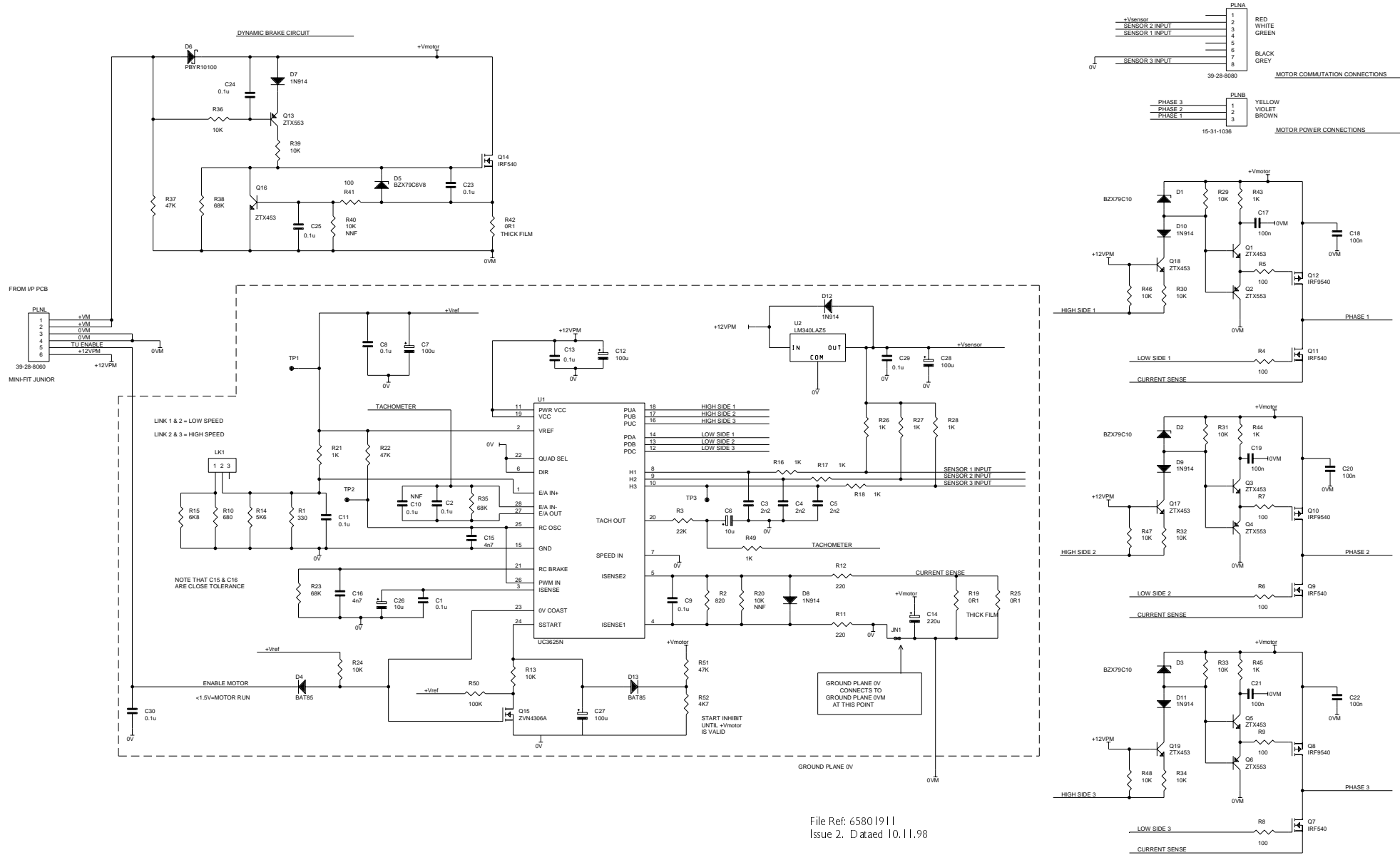


Figure 2.31 Circuit Diagram 65801911 - X-Band Motor Drive Board

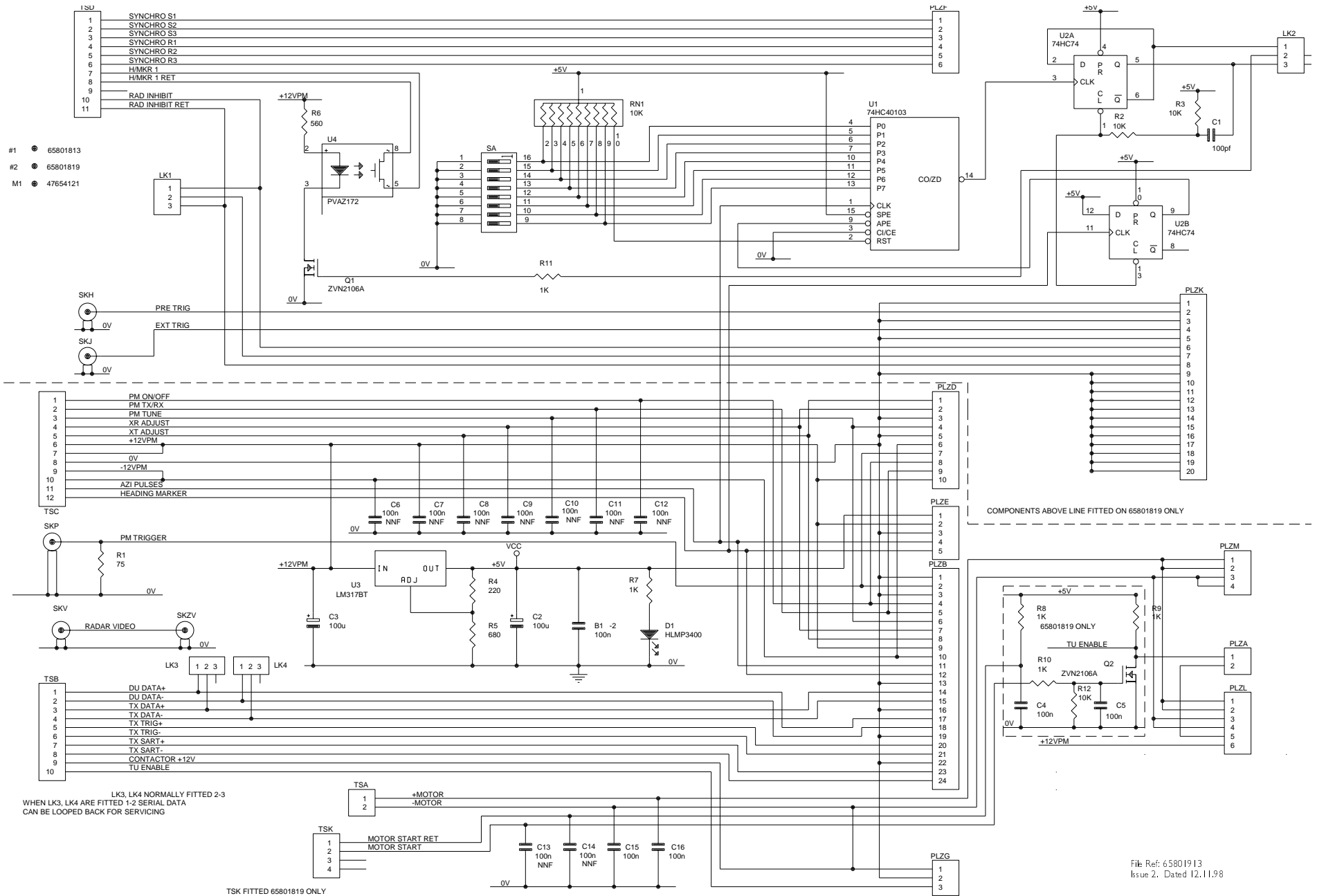
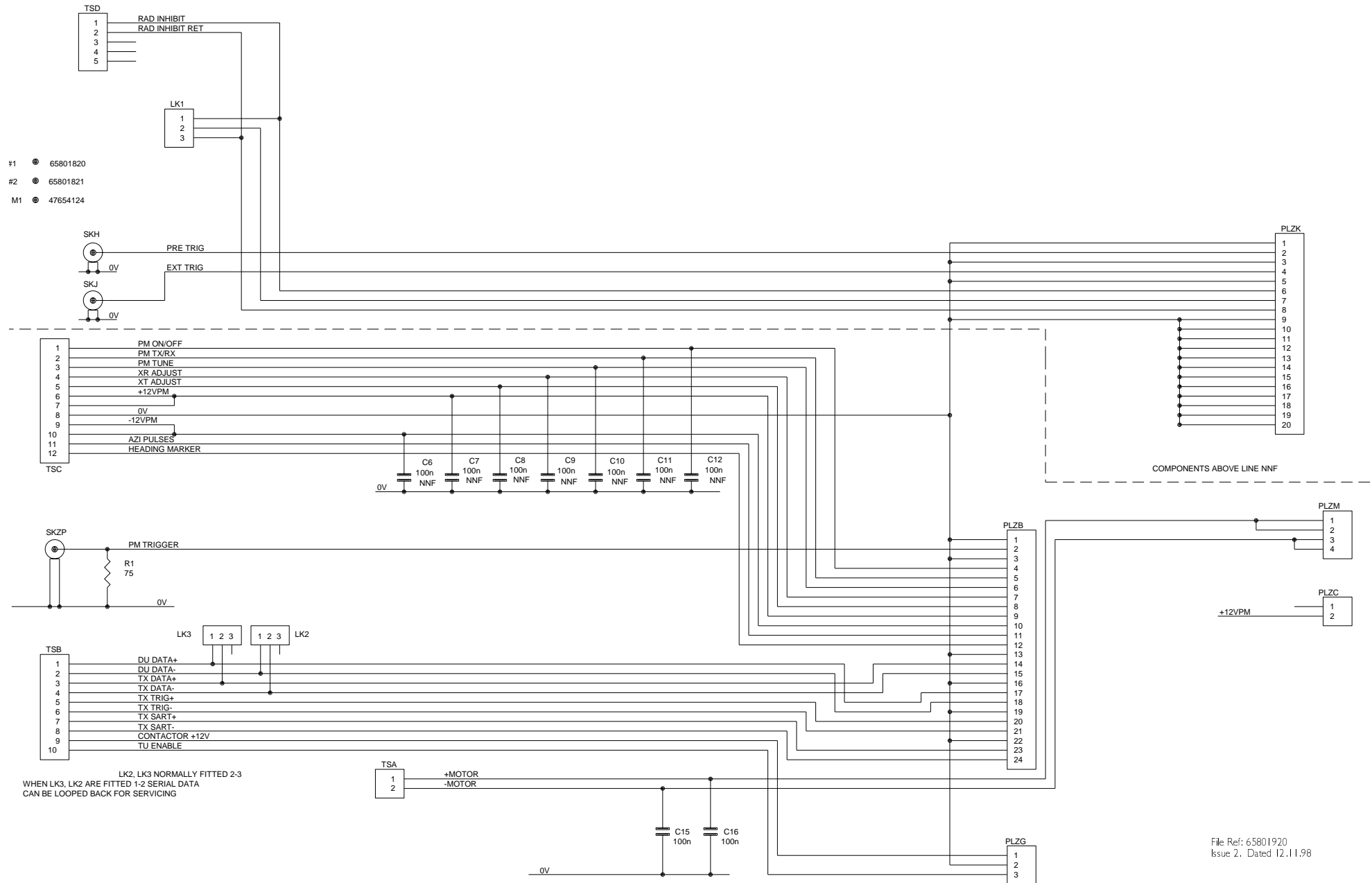
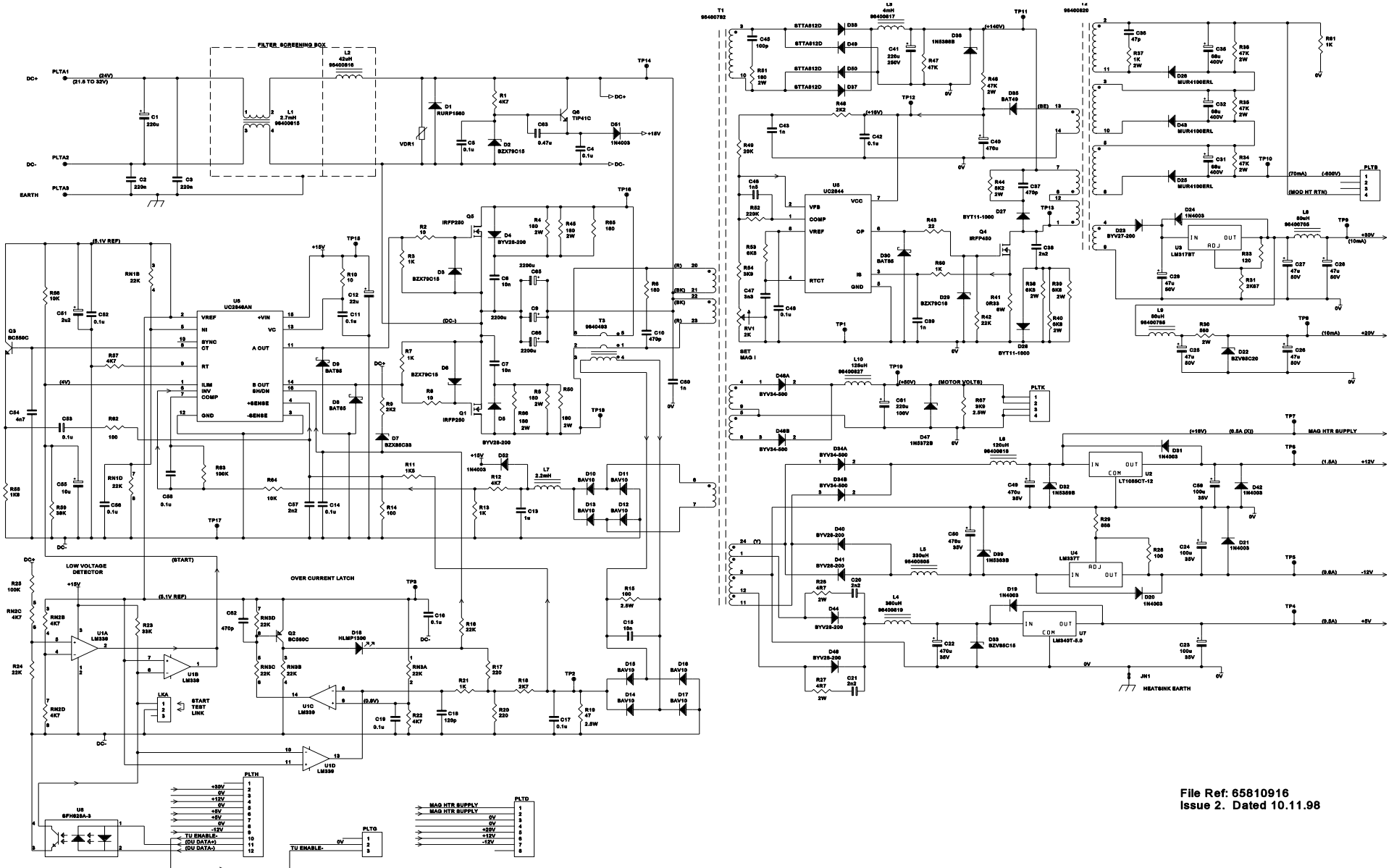


Figure 2.32 Circuit Diagram 65801913 - X-Band Masthead Input Board



File Ref: 65801920  
Issue 2, Dated 12.11.98

Figure 2.33 Circuit Diagram 65801920 - X-Band Bulkhead Input Board



File Ref: 65810916  
Issue 2. Dated 10.11.98

Figure 2.35 X-Band Transceiver DC Power Supply Board

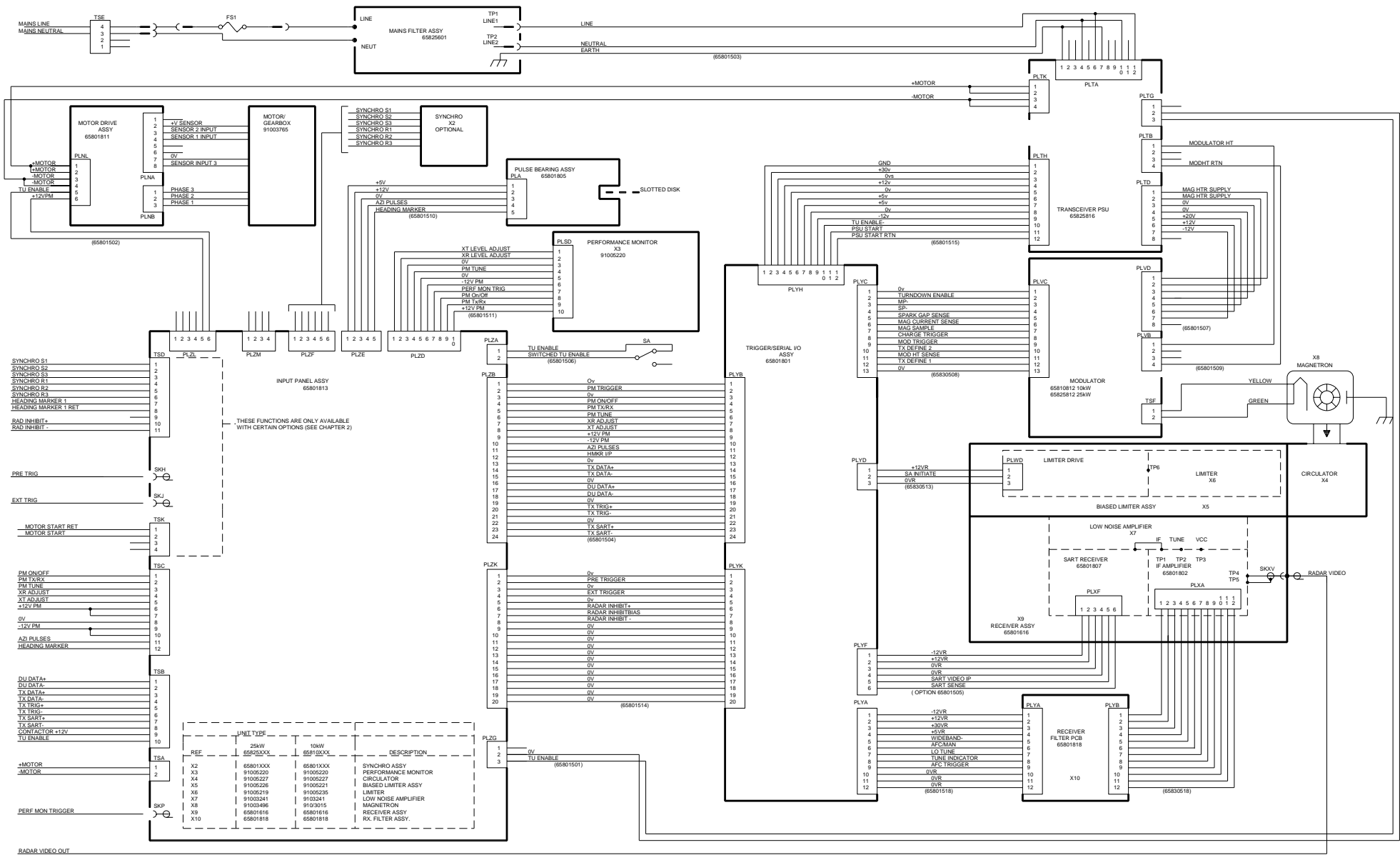


Figure 2.36 X-Band Turning Unit (Aloft) Schematic

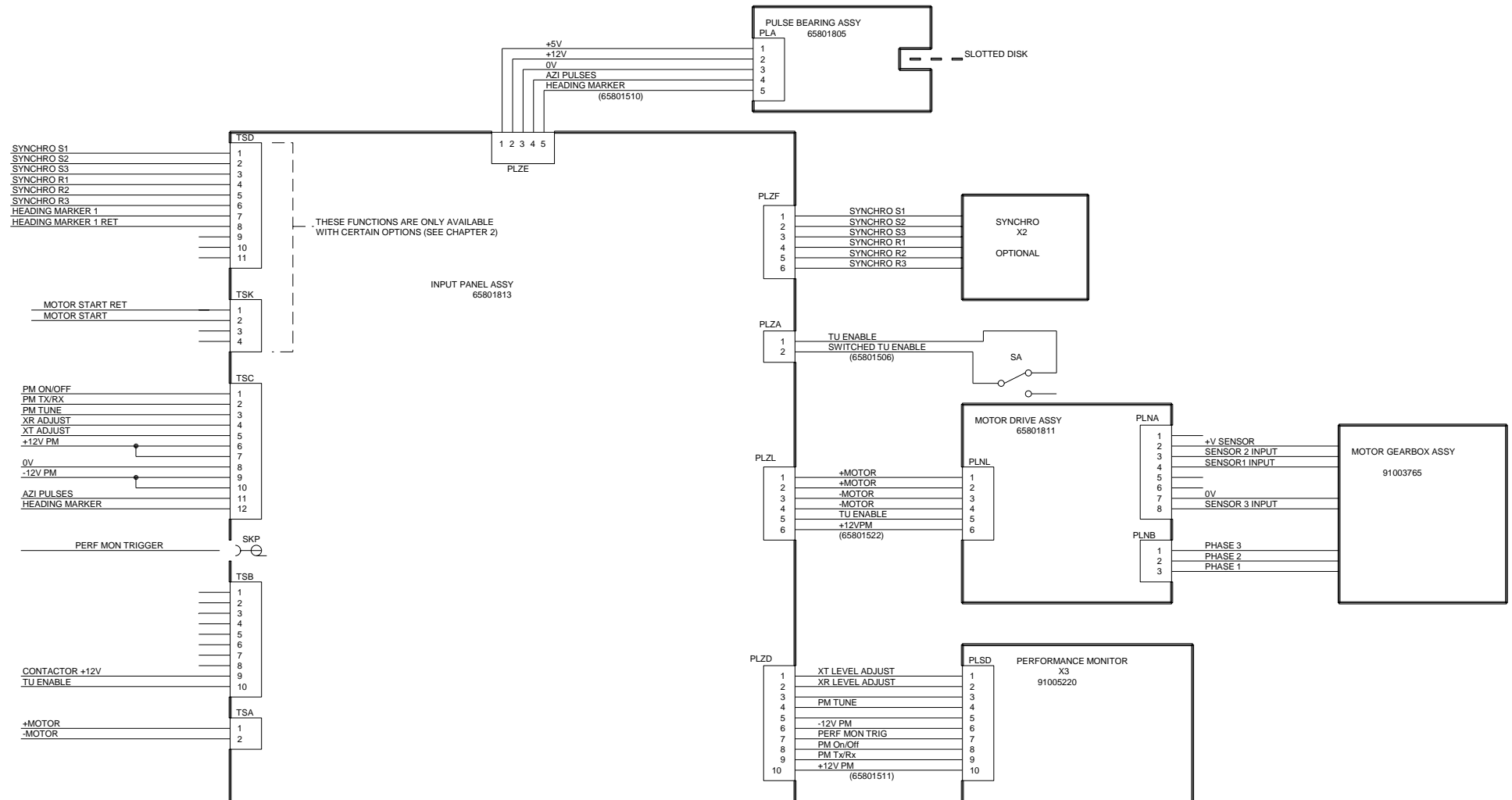


Figure 2.37 X-Band Turning Unit (Bulkhead) Schematic

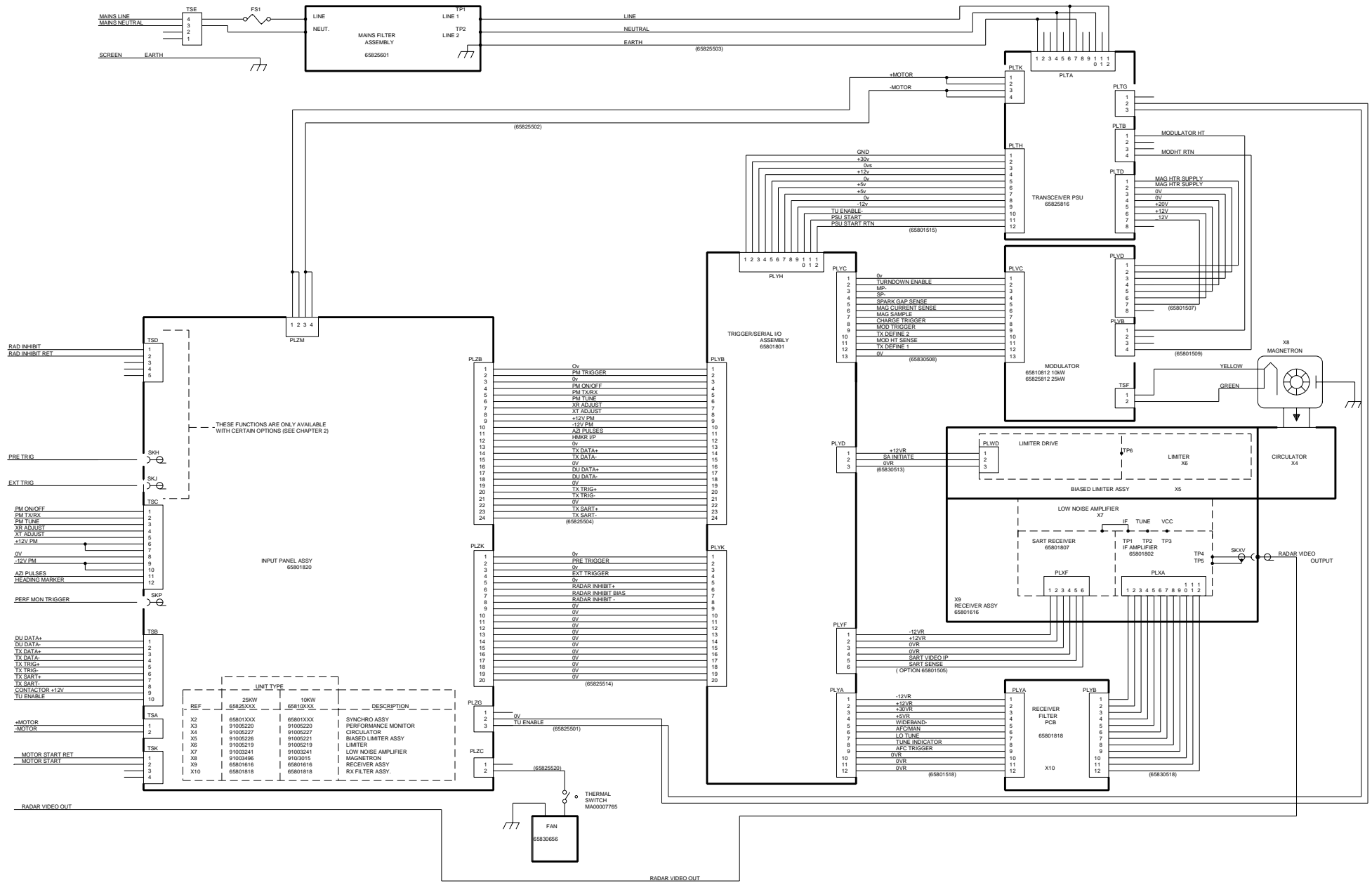
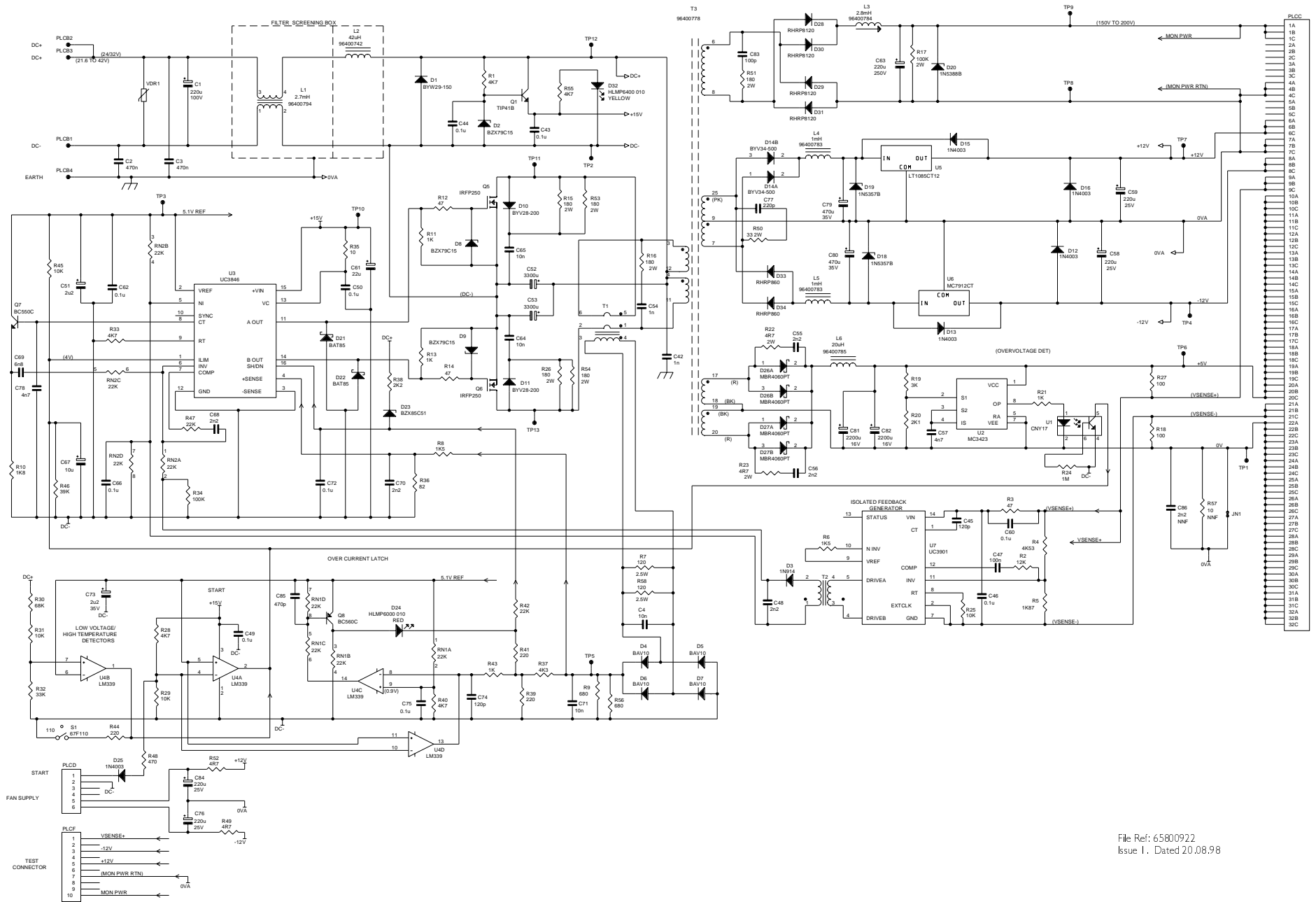


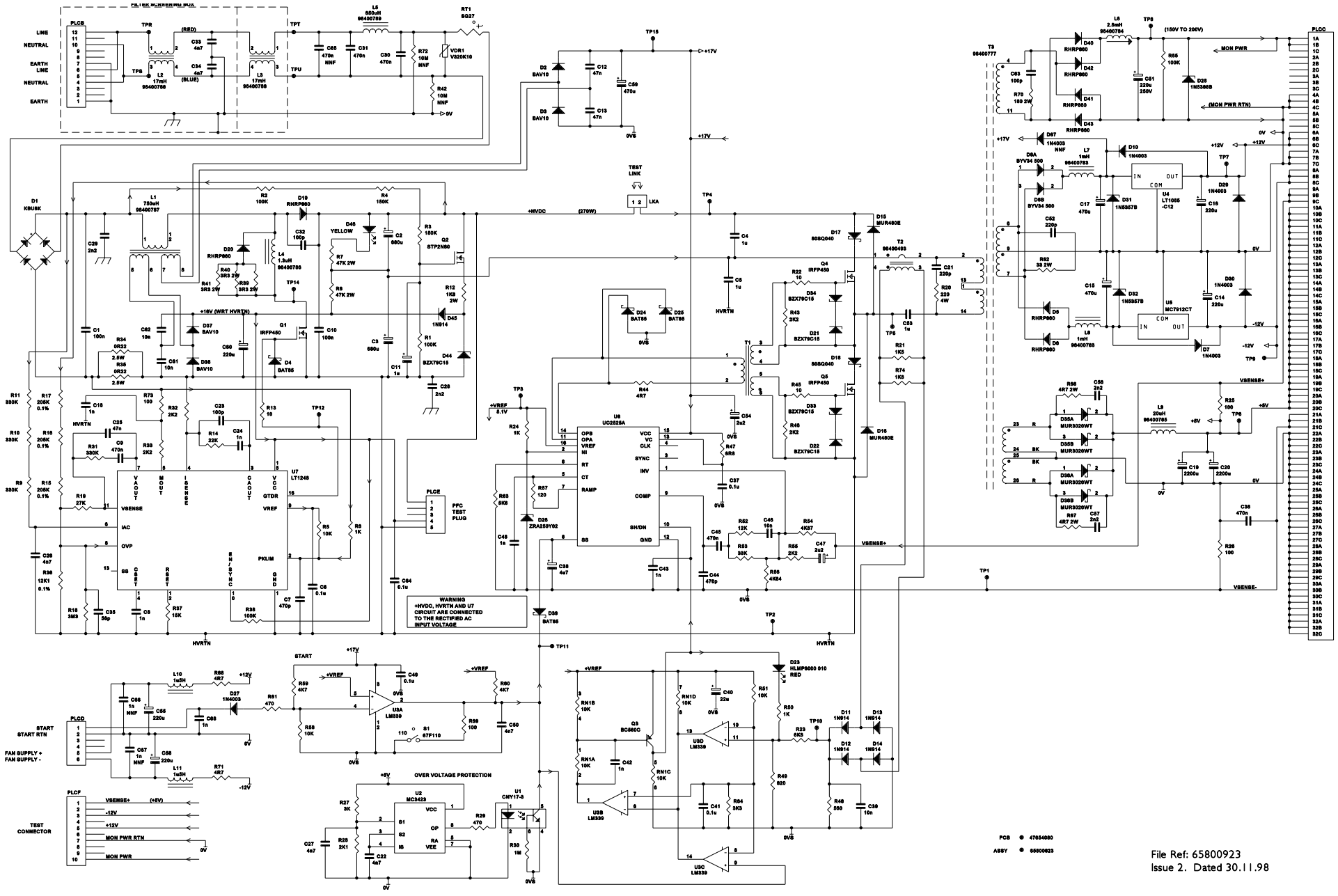
Figure 2.38 X-Band Transceiver Schematic



File Ref: 65800922  
Issue 1. Dated 20.08.98

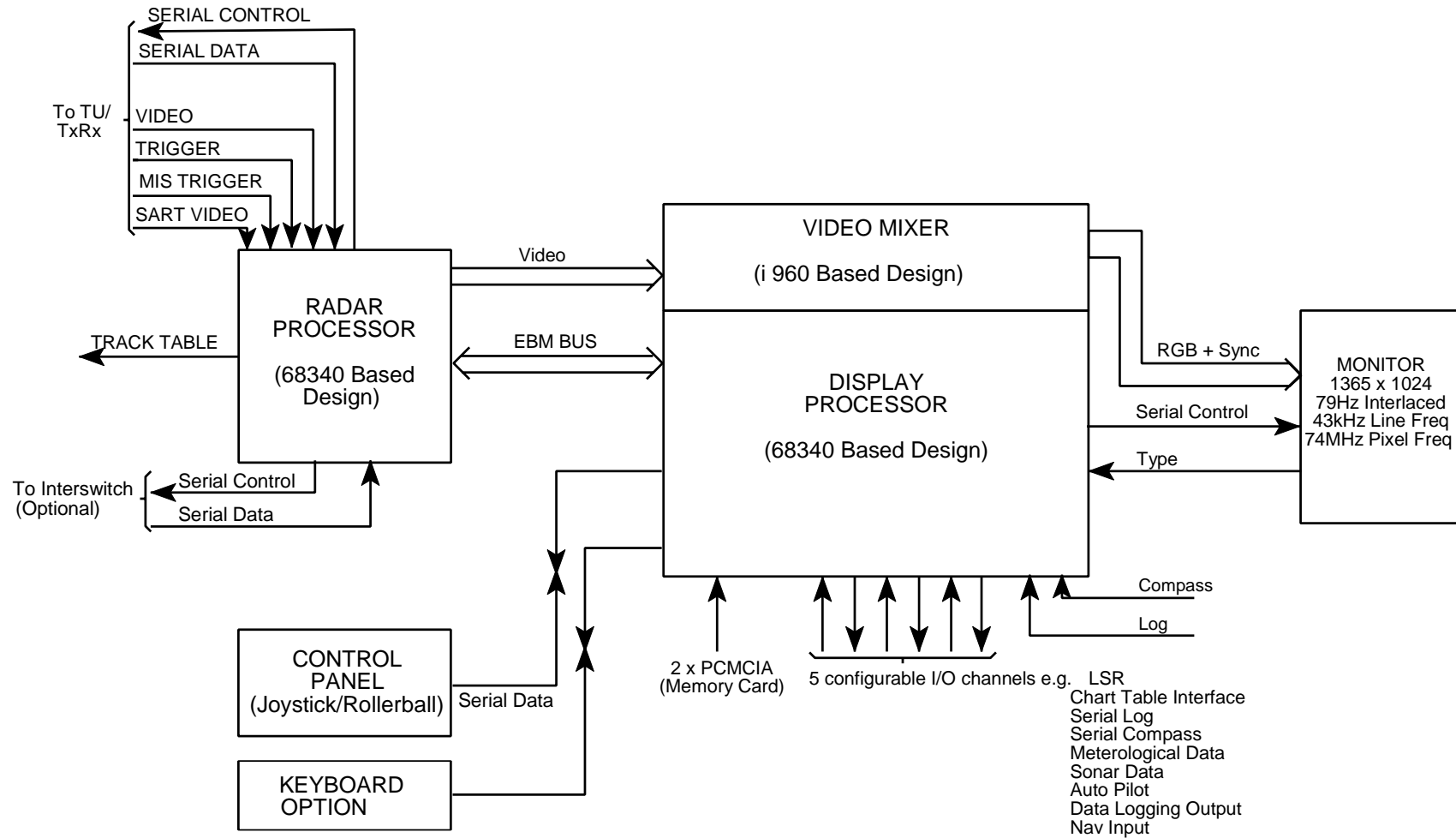
Figure 3.9 Circuit Diagram 65800922 - Display PSU (DC)





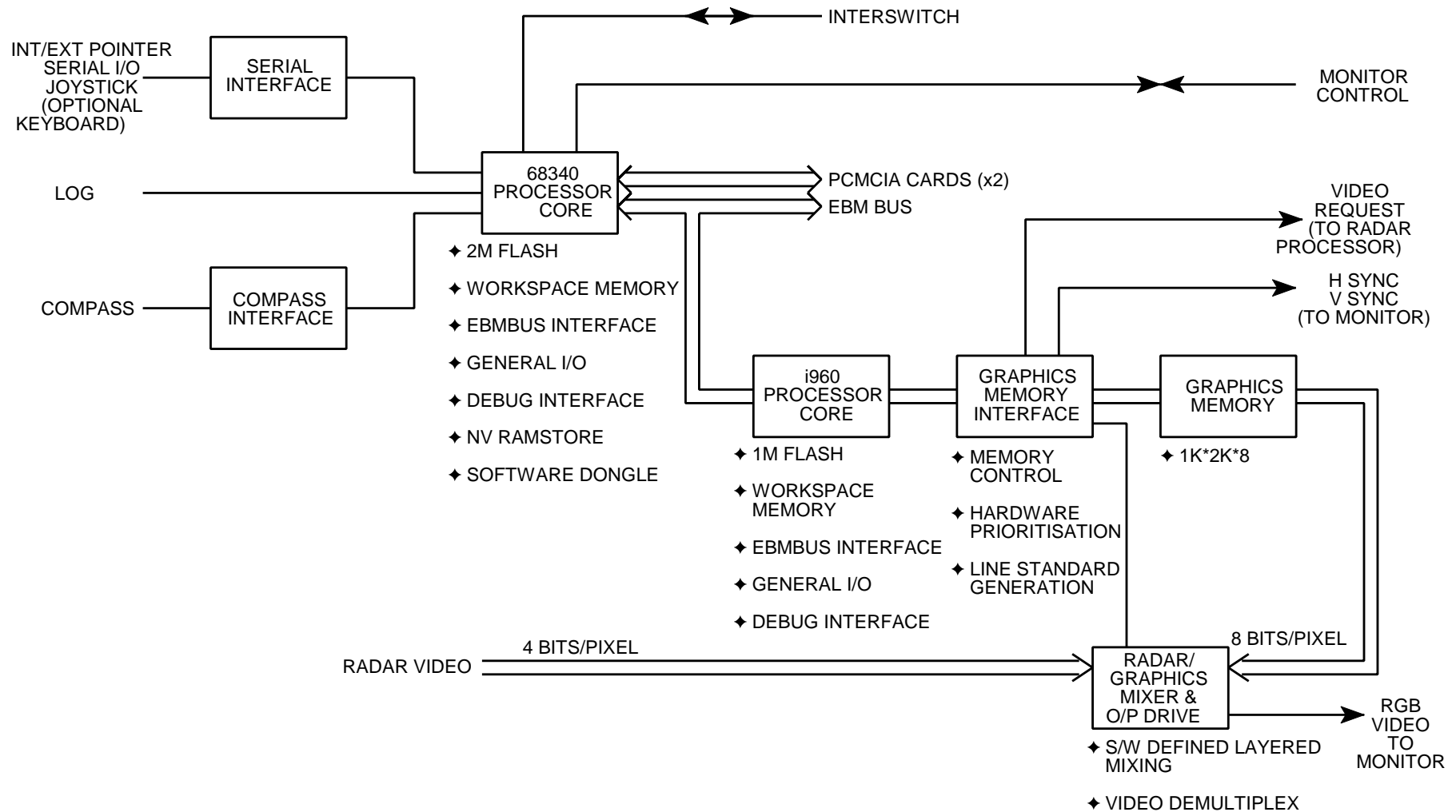
PCB © 4766480  
 ASBY © 6580023  
 File Ref: 6580923  
 Issue 2. Dated 30.11.98

Figure 3.10 Circuit Diagram 6580923 - Display PSU (AC)



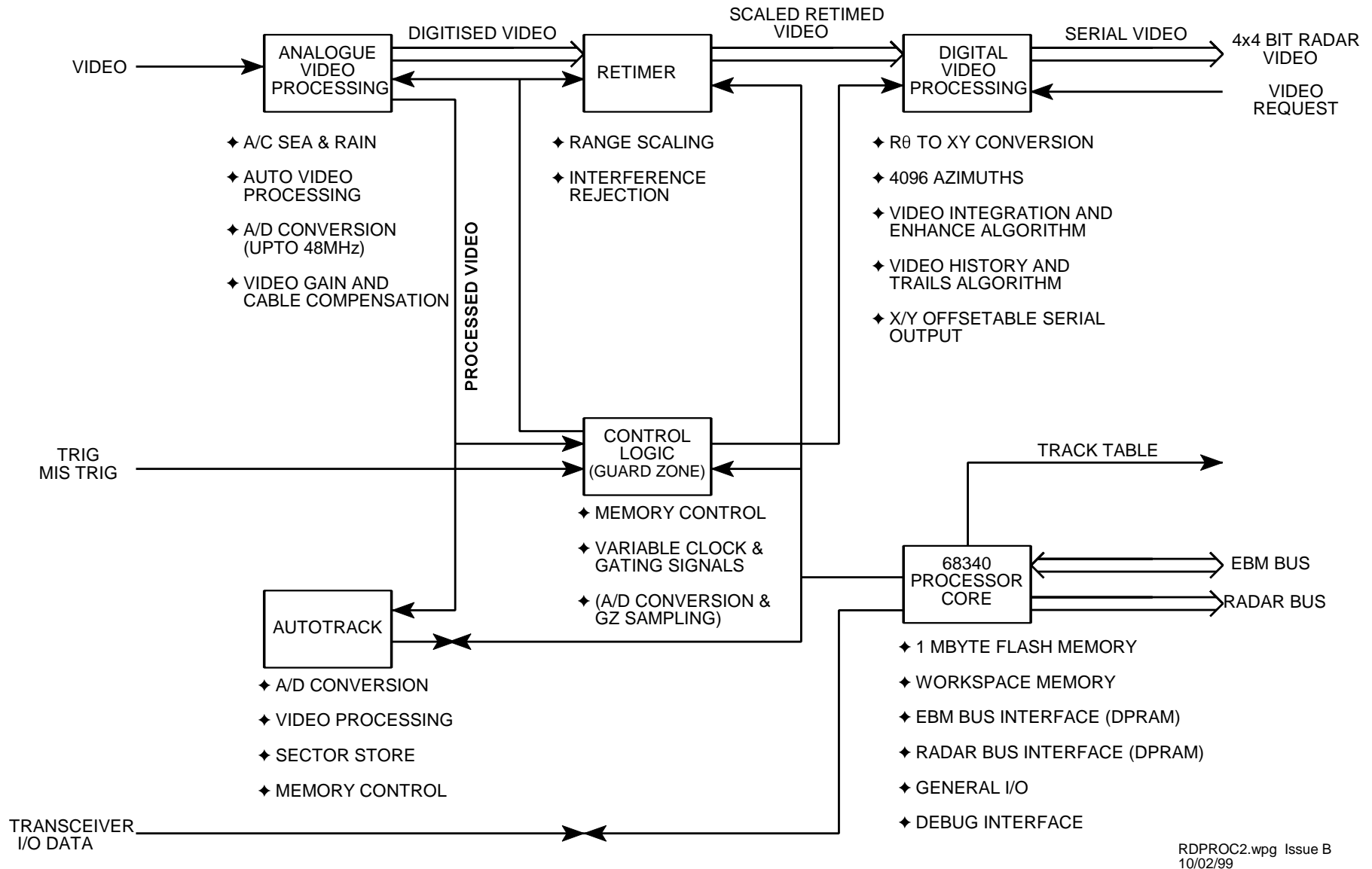
BASIC2.wpg Issue B  
10/02/99

Figure 4.4 Basic 180, 250 and 340 Displays - Block Diagram



DISPROC2.wpg Issue B  
10/02/99

Figure 4.5 Display Processor - Block Diagram



RDPROC2.wpg Issue B  
10/02/99

Figure 4.6 Radar Processor - Block Diagram

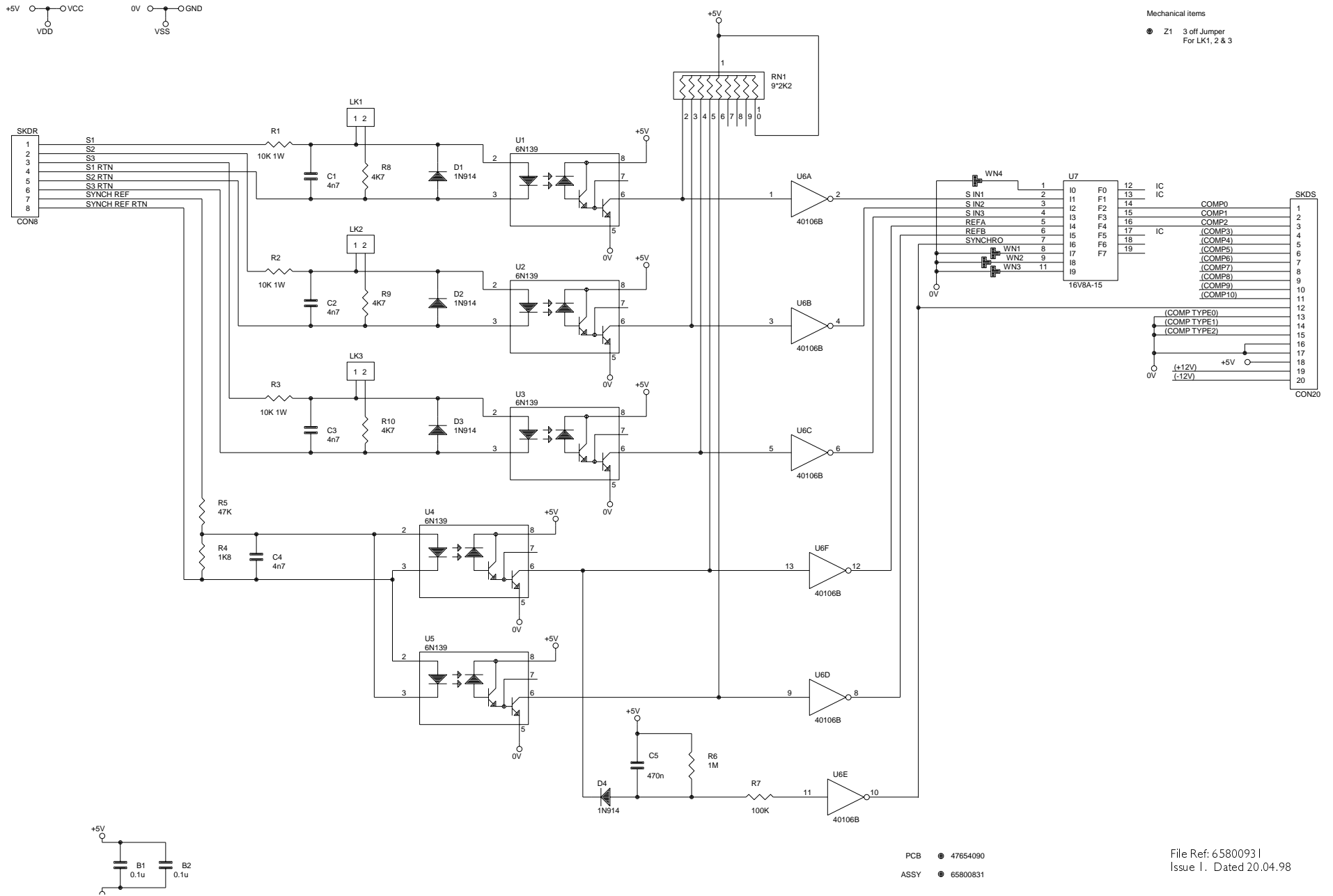
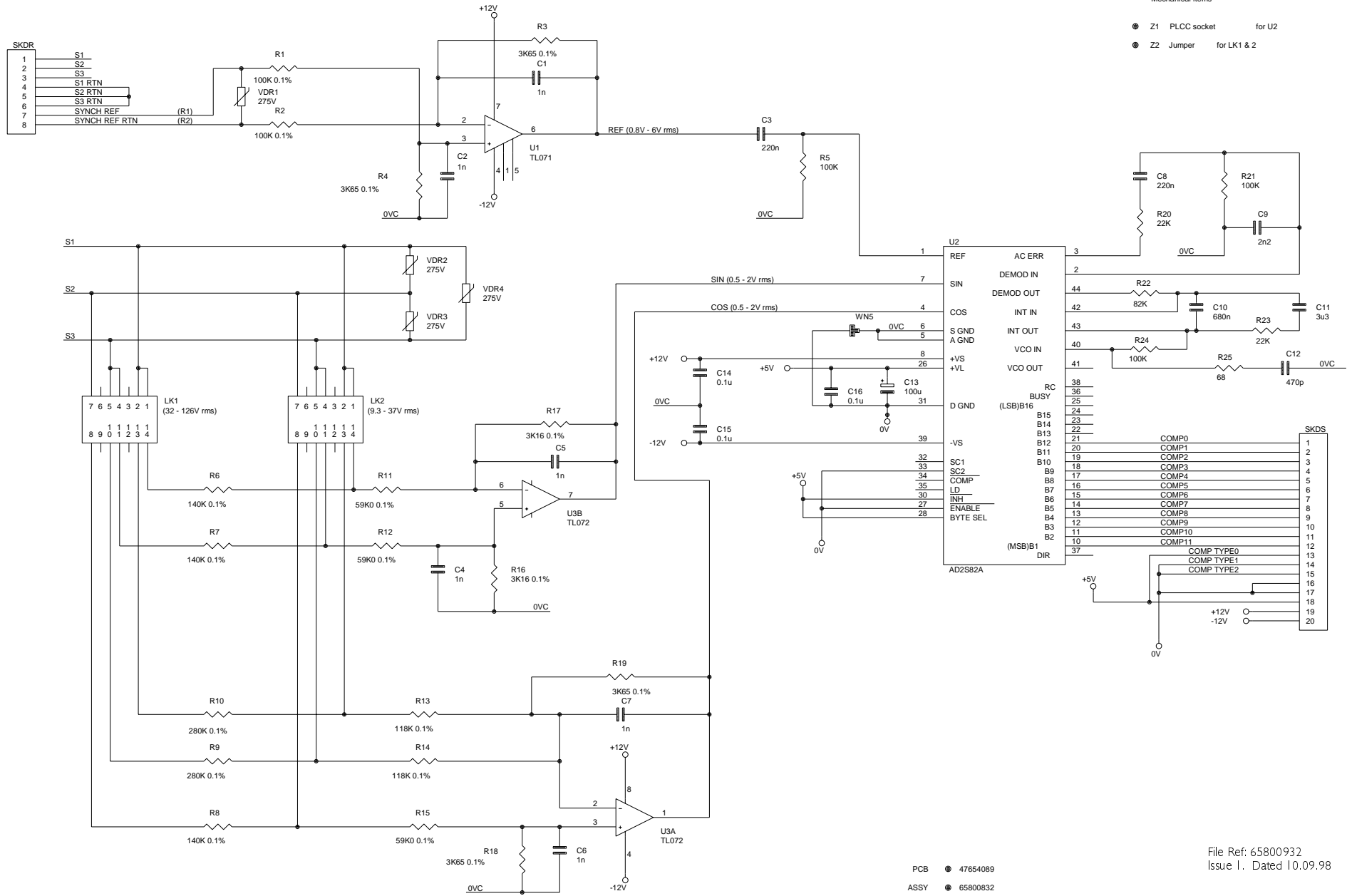


Figure 4.7 Circuit Diagram 6580093 I - Compass Board (Standard)

VCC +5V GND 0V

Mechanical Items

- Z1 PLCC socket for U2
- Z2 Jumper for LK1 & 2



PCB ● 47654089  
 ASSY ● 65800832

File Ref: 65800932  
 Issue 1. Dated 10.09.98

Figure 4.8 Circuit Diagram 65800932 - Compass Board (Synchro)

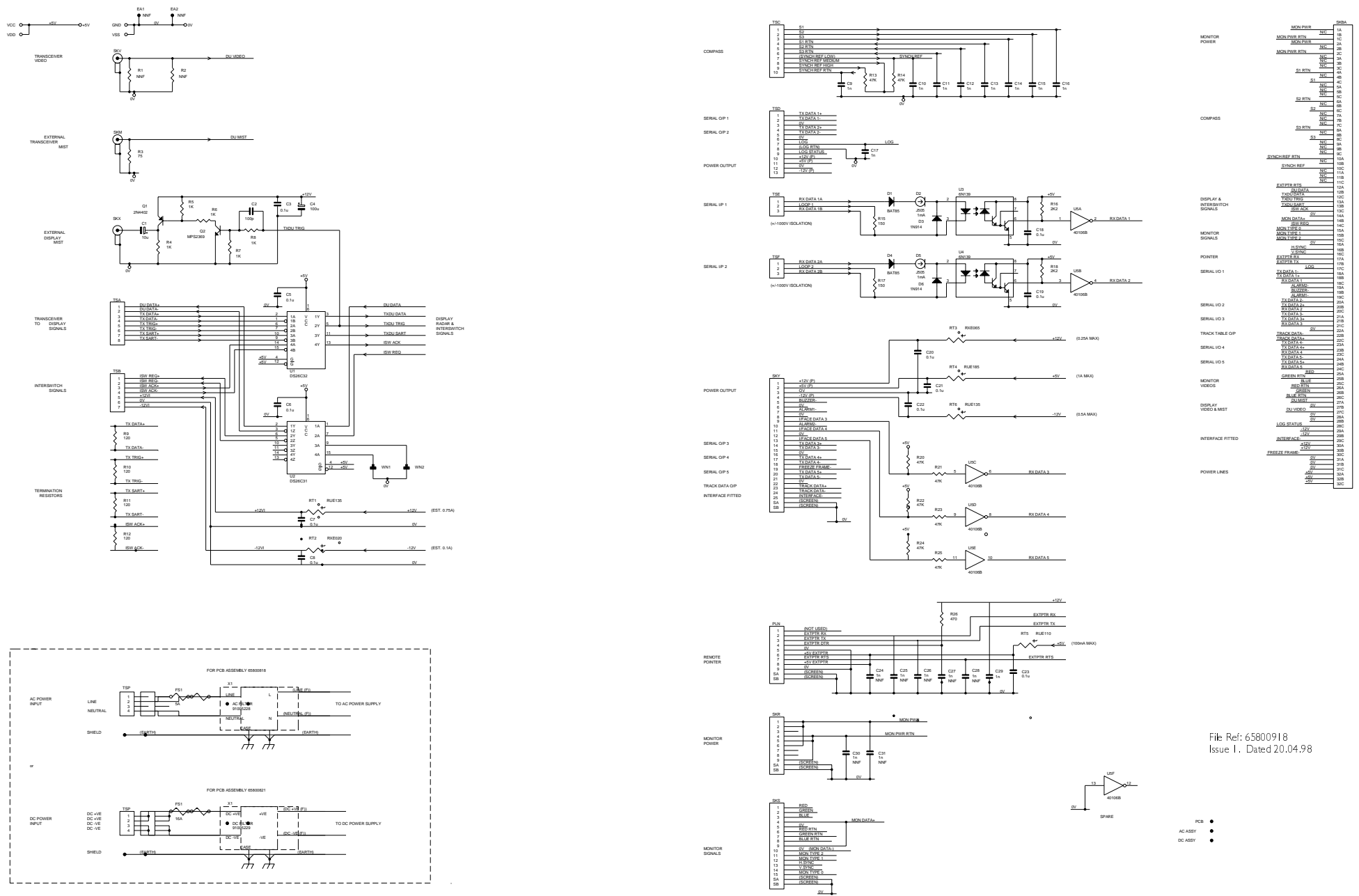


Figure 4.9 Circuit Diagram 65800918 - Input/Output (I/O) Board

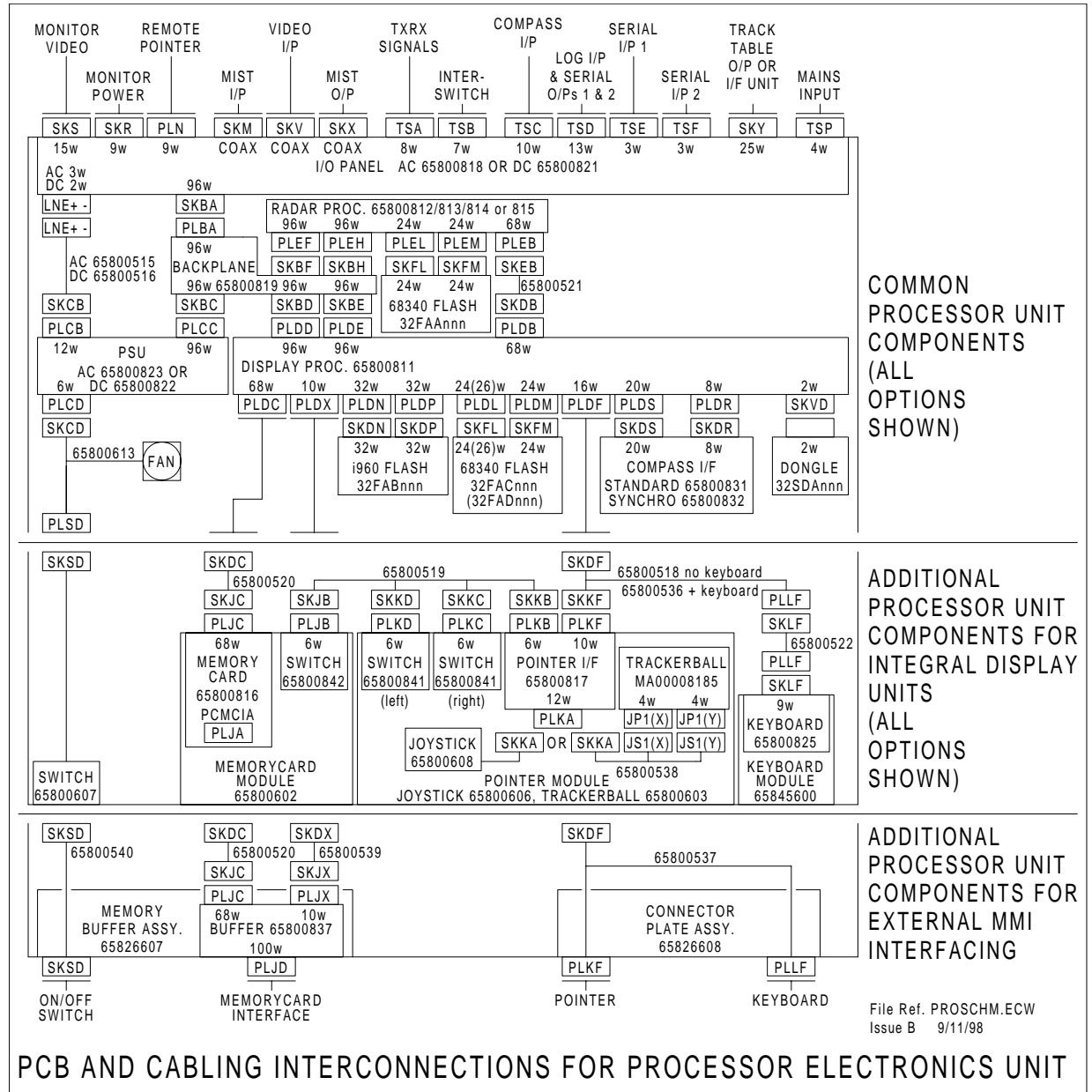


Figure 4.11 Interconnection Diagram - Processor Electronics Unit



## 1 General Description

The Processor Electronics Unit (PEU) is designed to be mounted as part of a general PEU assembly comprising the PEU (an aluminium housing containing a PSU and one or two processor PCBs), an inner moulding, an outer moulding and an optional outer moulding extension.

When used with 180 and 250 display units, the PEU assembly is designed to be mounted as an integral part of the display unit, see Chapter 3 and Figures 4.1 and 4.3.

When used with a 340 split-cabinet or a customer specified console, the PEU assembly is designed to be mounted on a separate support tray which is fitted in the main body of the split cabinet/console, see Chapter 3 and Figure 4.2.

### 1.1 Physical Arrangements

When used with 180 and 250 display units, the inner moulding contains an ON/OFF switch module, joystick/trackerball module and an optional memory card module. The optional outer moulding extension contains an dedicated keyboard. See Figure 4.3.

When used with a 340 split-cabinet or a customer specified console, the control modules usually associated with the inner moulding of the PEU assembly (ON/OFF switch module, joystick/trackerball module and an optional memory card module) are mounted on a separate panel in front of the display monitor. The control modules of the inner moulding are replaced with surface mount connectors which are linked via suitable cables to the remotely located control modules. See Figure 4.2.

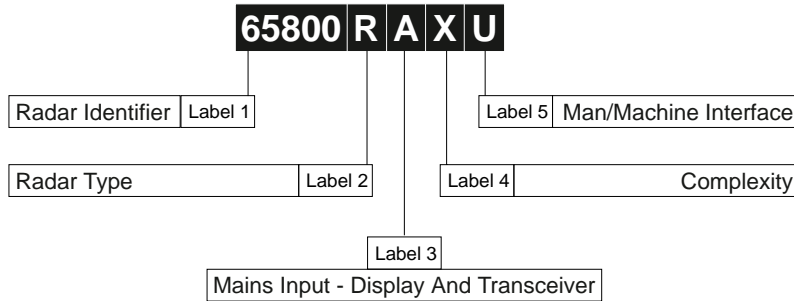
Refer to Chapter 5 for further details of individual control modules.

A number of connectors on the rear panel of the PEU provide for the input and output of the following services, see Figures 4.4. and 4.5:

- TSP - AC or DC Mains Input
- PLN - Remote pointer
- SKY - Interface Connections
- SKR - Monitor Power
- SKS - Monitor Video
- TSE - Serial I/P 1
- TSF - Serial I/P 2
- TSD - Serial O/P 1
- TSA - Transceiver I/O
- TSB - Interswitch Signals
- TSC - Compass Input

## 2 Unit Configurations

The type numbers for Processor Electronics Units are as follows:



Label 1      **BridgeMaster E Identifier** (fixed as **65800**)

Label 2      **Radar Type**

Label	Radar Type
<b>P</b>	Electronic Plotting Aid
<b>T</b>	Automatic Tracking Aid
<b>R</b>	Automatic Radar Plotting Aid

Label 3      **Mains Input** for the Display and Transceiver.

Label	Mains Input
<b>A</b>	110/240Vac, 50/60Hz Single Phase
<b>D</b>	24 - 32Vdc

Label 4      **Complexity**

Label	No of Cards*	RVAP	Compass Type
<b>N</b>	1	No	Standard
<b>R</b>	2	No	Standard
<b>T</b>	2	Yes	Standard
<b>V</b>	2	No	Special
<b>X</b>	2	Yes	Special

\*The number of cards relates to the number of Processor Cards in the Processor Electronics Unit. Two card systems consist of a common Display Processor card and a Radar Processor card.

Label 5 **Man/Machine Interface**

<b>Label</b>	<b>Pointer Type</b>	<b>Keyboard</b>	<b>Mounting/Fit*</b>	<b>Memory Card #</b>
<b>A</b>	Joystick	No	Desk	No
<b>B</b>	Trackerball	No	Desk	No
<b>C</b>	None	No	Desk	No
<b>J</b>	Joystick	No	Desk	Yes
<b>R</b>	Trackerball	No	Desk	Yes
<b>K</b>	Joystick	Yes	Desk	Yes
<b>L</b>	Trackerball	Yes	Desk	Yes
<b>S</b>	Joystick	No	Deck	Yes
<b>T</b>	Trackerball	No	Deck	Yes
<b>Y</b>	Joystick	Yes	Deck	Yes
<b>Z</b>	Trackerball	Yes	Deck	Yes
<b>U</b>	Joystick	No	Kit	Yes
<b>V</b>	Trackerball	No	Kit	Yes
<b>W</b>	Joystick	Yes	Kit	Yes
<b>X</b>	Trackerball	Yes	Kit	Yes

\***Deck** relates to the inclusion in pedestal mounted display unit.

**Kit** relates to a screened monitor module for fitting into a customer specified console.

**Desk** relates to inclusion in a desk mounted display unit.

\*Memory card units are always fitted to consoles, but are not required for all desk mounted displays

## **3 Installation and Commissioning**

### **3.1 Installation**

- Refer to Figures 4.1 and 4.2 for installation of this unit.

***Note** - Particular attention should be given to ensuring adequate connector clearance.*

### **3.2 Initialisation and Commissioning**

The Processor Electronics Unit is only part of a complete BridgeMaster E Series Radar, and cannot be operated independently. For details of complete system installations refer to the BridgeMaster E, Ship's Manual 65800010B.

After a complete system has been installed it must be Initialised and Commissioned as detailed in Chapter 4 of the BridgeMaster E, Ship's Manual.

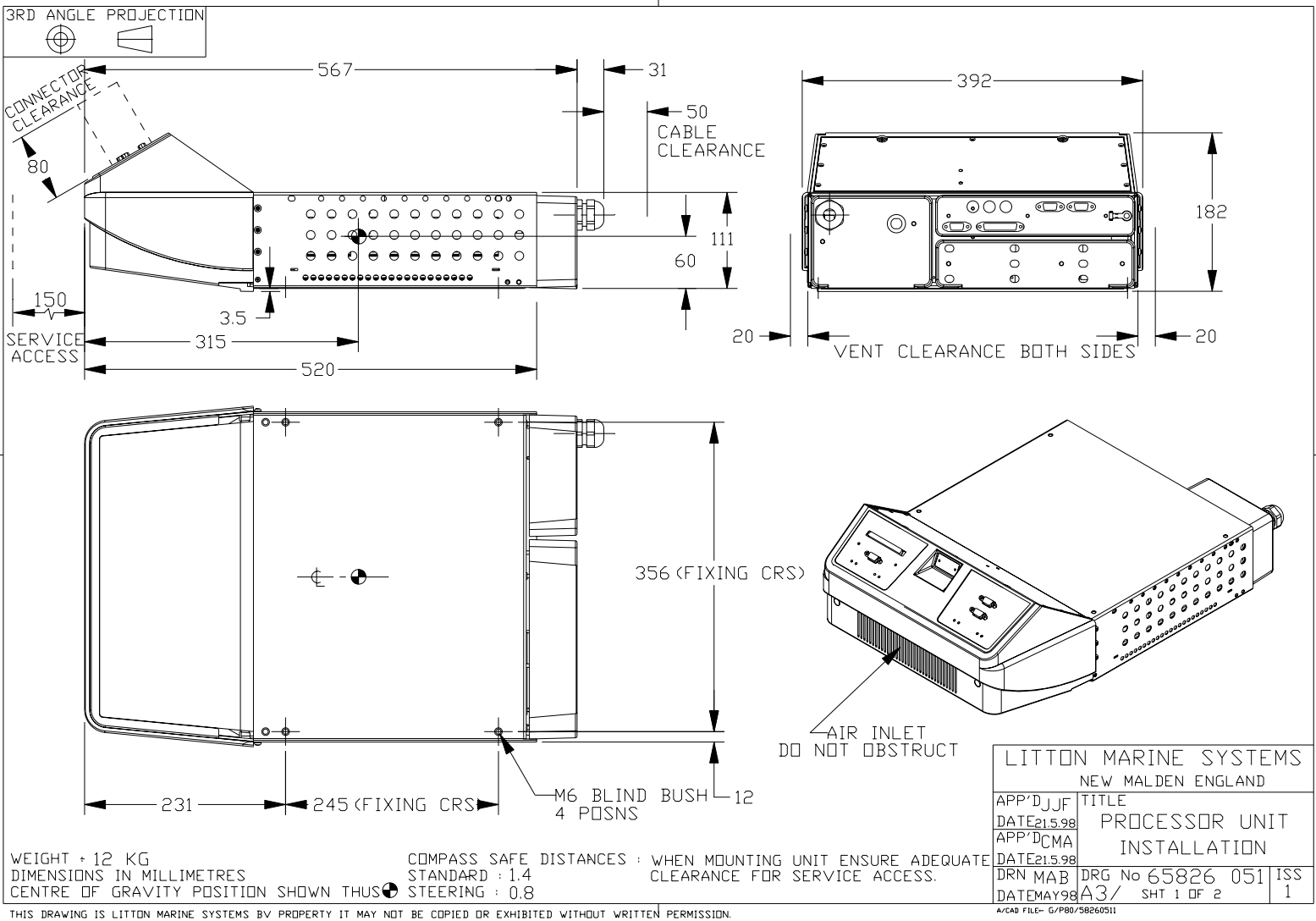


Figure 4.1 - Processor Unit Installation (Sheet 1 of 2)

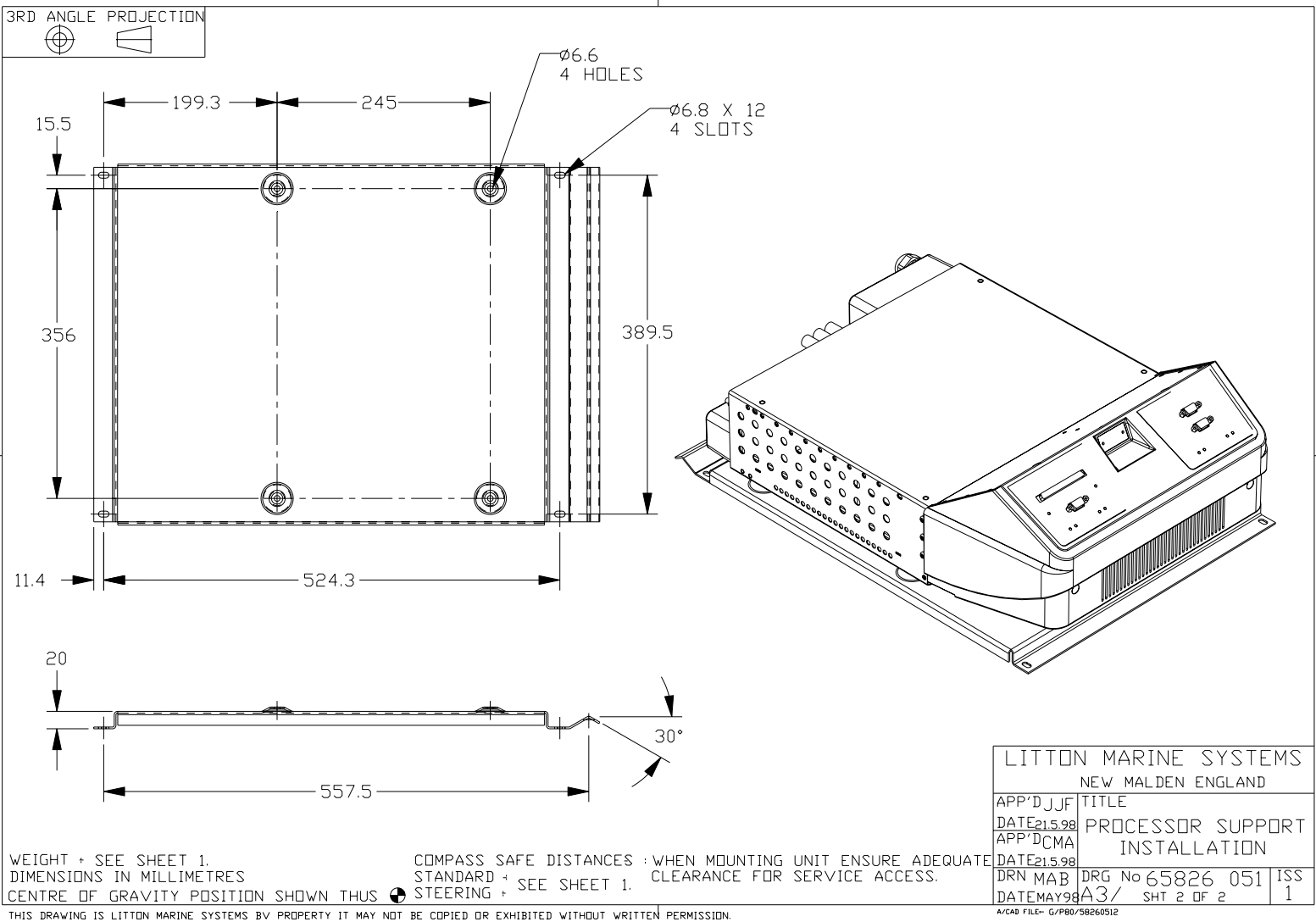


Figure 4.2 - Processor Unit Installation (Sheet 2 of 2)

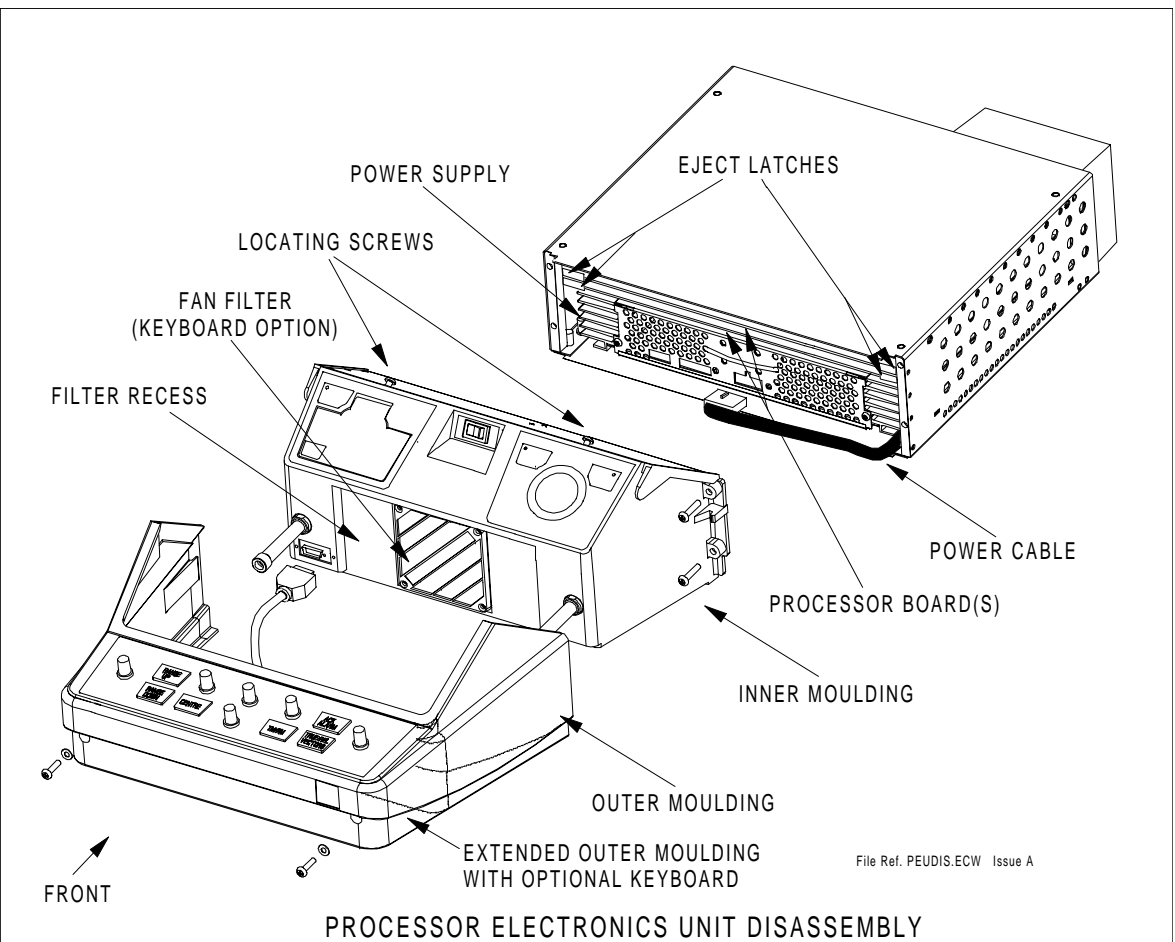


Figure 4.3 - Processor Electronics Unit - Disassembly

## 4 Technical Specification

### 4.1 Power Supplies

#### 4.1.1 Power Supply (AC)

Parameter	Detail	
Input voltage range	92 - 276V RMS	
Input voltage frequency range	47 to 64 Hz.	
Maximum Input power	Display Units (including Monitor, Processor Unit and Controls)	
	180 Display	230 VA
	250 Display	260 VA
	340 Display	280 VA
Transient protection	Overvoltage transient of up to 40 % above nominal input voltage with maximum duration of one second. Pulse transient of up to $\pm 1200$ V peak, with a rise time of 2 to 10 $\mu s$ and duration up to 20 $\mu s$ .	
Protection facilities	Output short circuit. High and low input voltage. Output overvoltage. Slow start.	
High voltage multiphase operation	Via a suitable transformer.	

#### 4.1.2 Power Supply (DC)

Parameter	Detail	
Input voltage range	22 to 32 V DC	
Maximum Input power	180 Display Unit	230W
	250 Display Unit	260W
	340 Display	280W
Transient Protection	Symmetrical (line-line) 500 V of duration 10 $\mu s$ (100 $\mu s$ rise/fall time). Line to ground 500 V of duration 60 $\mu s$ (1 $\mu s$ rise/fall time)	
Protection Facilities	Output short circuit. High and low input voltage. Slow start.	



## 4.2 Mechanical Specification

### 4.2.1 Weights and Dimensions

Component	Height (mm)	Depth (mm)	Width (mm)	Weight (kg)
Processor Electronics Unit	182	567	392	12

## 4.3 Compass Safe Distances

Component	Type No.	Standard	Steering
Processor Electronics Unit	65800	1.3 m	0.8 m
Brilliance Module	65826657	0.3 m	0.3 m
Memory Card Module	65826655	0.3 m	0.3 m
On-Off Switch Module	65826656	0.3 m	0.3 m
Joystick Module	65826658	0.3 m	0.3 m
Trackerball Module	65826654	0.3 m	0.3 m
Keyboard	65845050	0.5 m	0.3 m

## 4.4 Environmental Specification

To the requirements of the International Standard for Marine Navigational Equipment CEI/IEC 945 (1988) and Amendment 1 (1992).

## 5 Technical Description

The technical description of the Processor Electronics Unit is presented as a series of block diagrams which illustrate the basic functions as follows.

Basic 180, 250 and 340 Displays - Block Diagram given at Figure 4.4

Display Processor - Block Diagram given at Figure 4.5

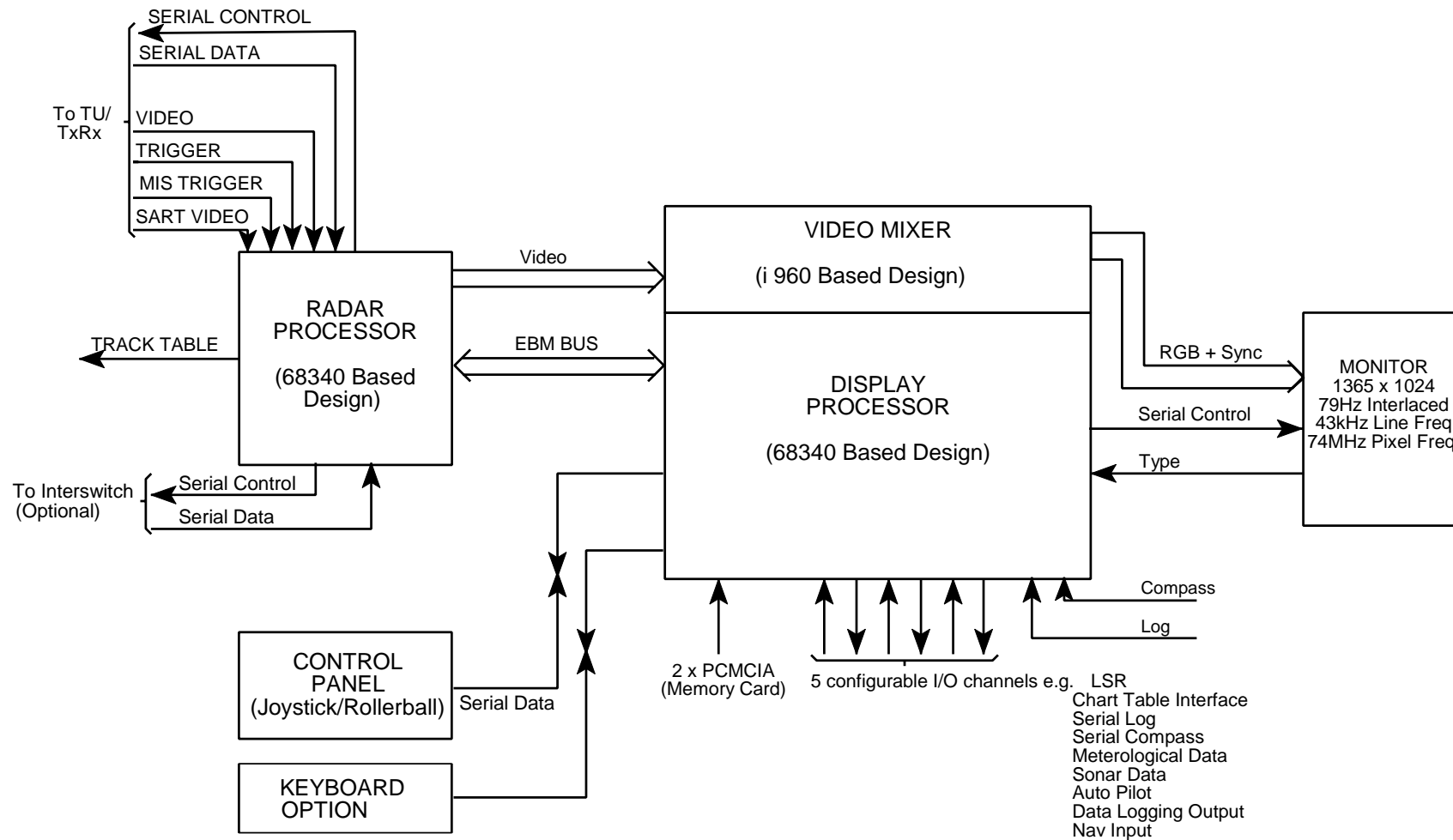
Radar Processor - Block Diagram given at Figure 4.6

The following circuit diagrams are also included.

Circuit Diagram 65800931 - Compass Board (Standard) given at Figure 4.7

Circuit Diagram 65800932 - Compass Board (Synchro) given at Figure 4.8

Circuit Diagram 65800918 - Input/Output (I/O) Board given at Figure 4.9



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10/02/99

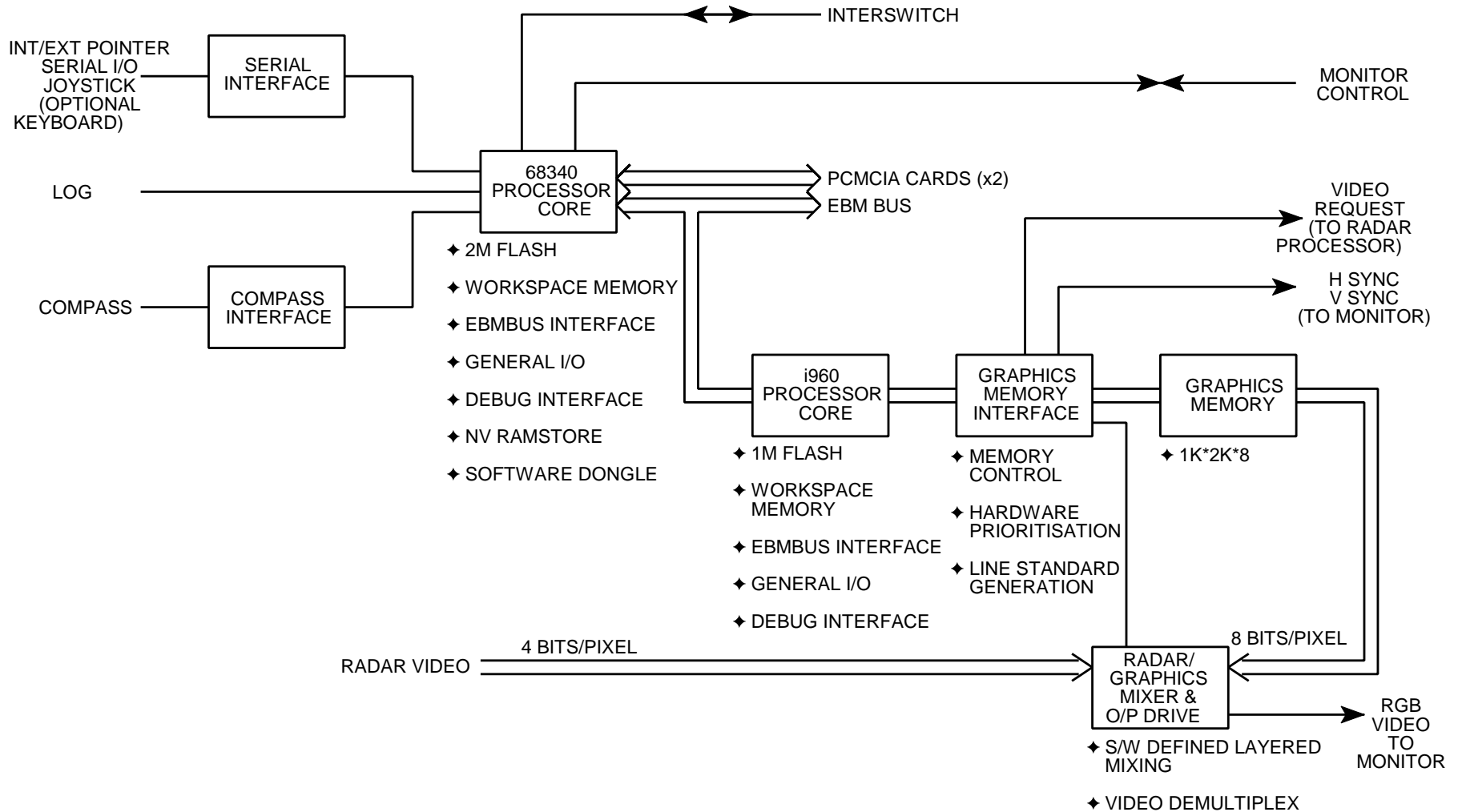
Figure 4.4 Basic 180, 250 and 340 Displays - Block Diagram

# Chapter 4

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## Processor Electronics Units

A3 page 4-1 1/12 Figure 4.4, discard this A4 sheet.



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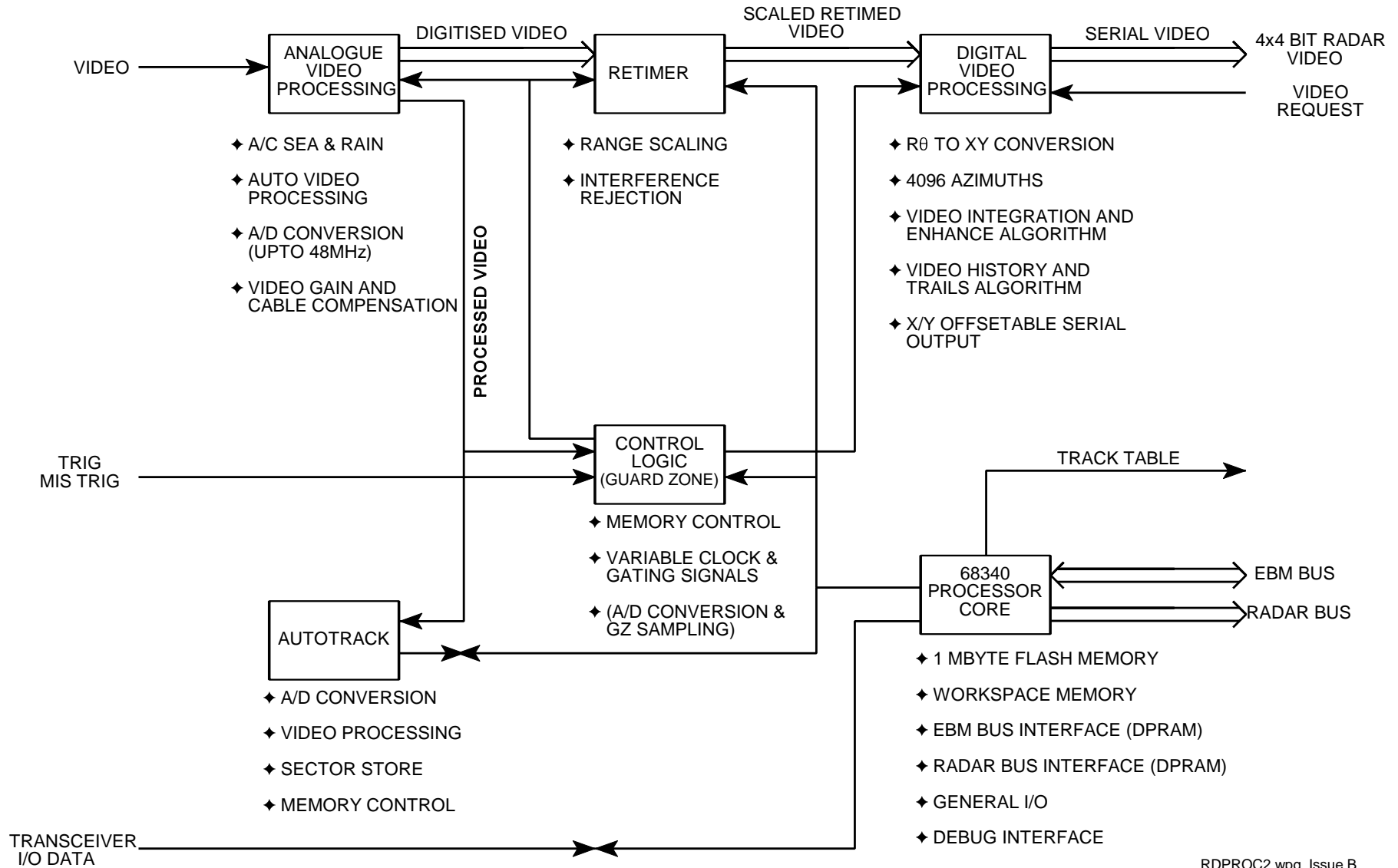
Figure 4.5 Display Processor - Block Diagram

# Chapter 4

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## Processor Electronics Units

A3 page 4-13/14 Figure 4.5, discard this A4 sheet.



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Figure 4.6 Radar Processor - Block Diagram

# Chapter 4

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## Processor Electronics Units

A3 page 4-15/16 Figure 4.6, discard this A4 sheet.



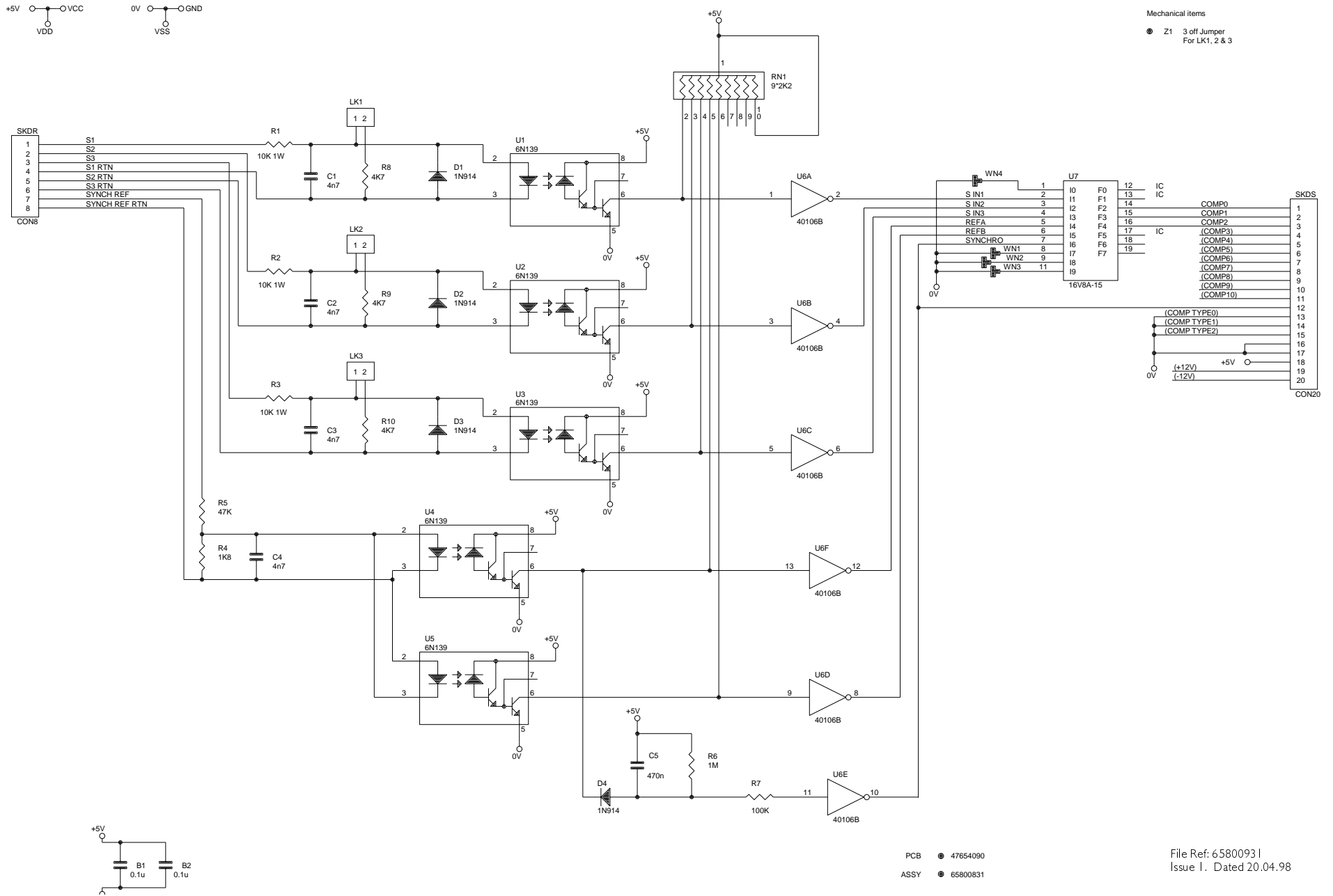


Figure 4.7 Circuit Diagram 65800931 - Compass Board (Standard)

# Chapter 4

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## Processor Electronics Units

A3 page 4-17/18 Figure 4.7, discard this A4 sheet.



VCC ○+5V GND ○0V

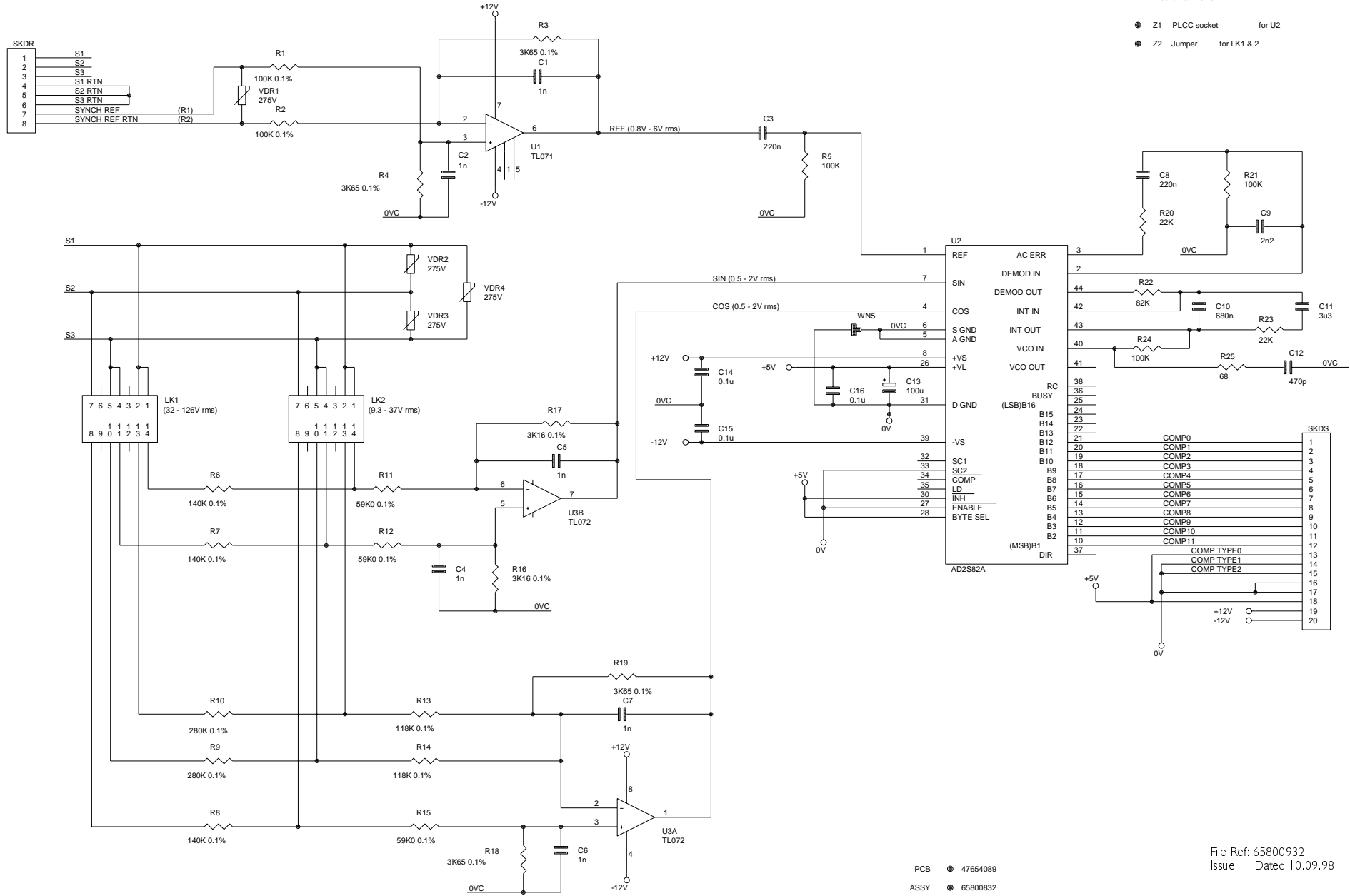


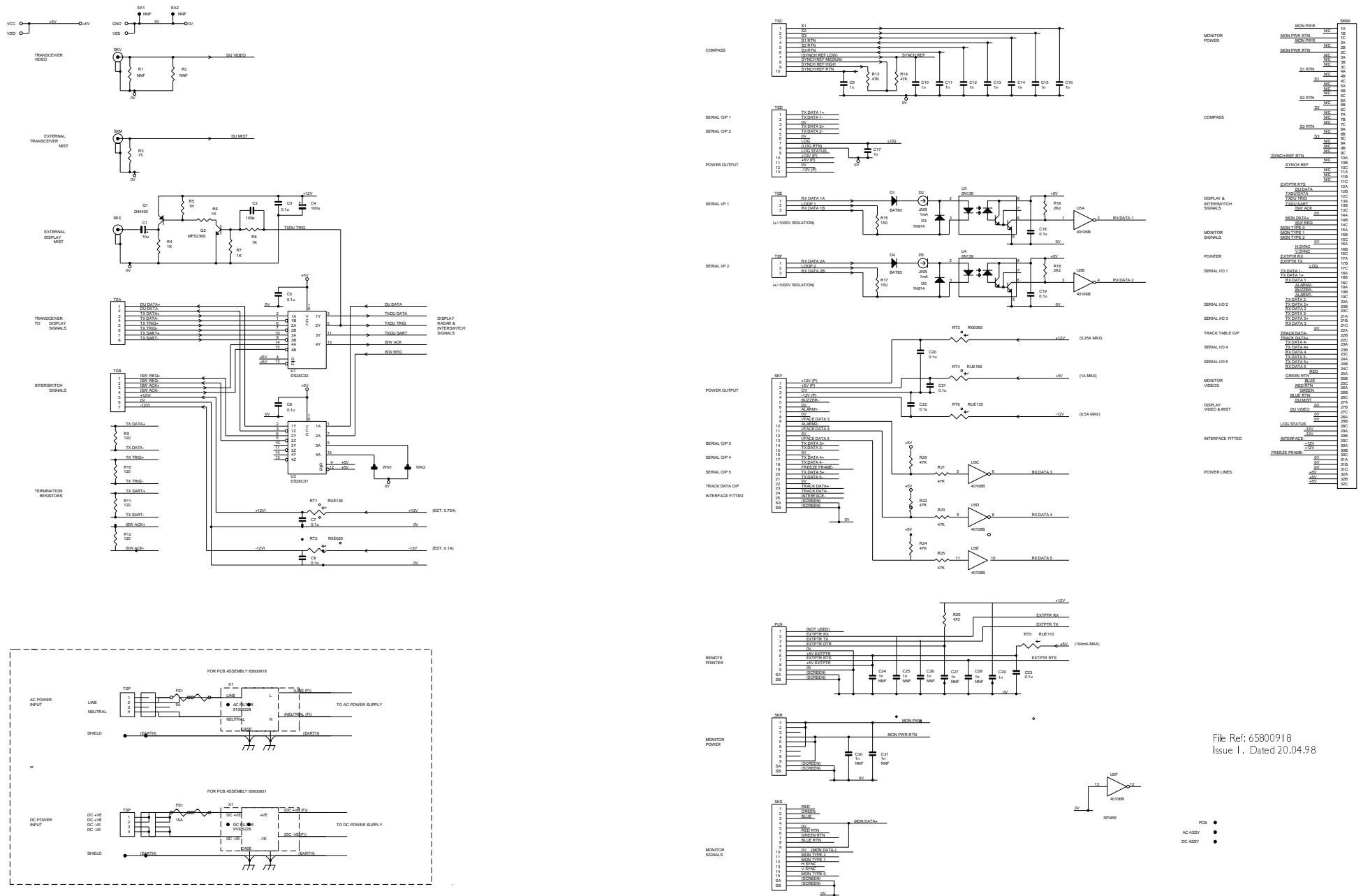
Figure 4.8 Circuit Diagram 65800932 - Compass Board (Synchro)

# Chapter 4

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## Processor Electronics Units

A3 page 4-19/20 Figure 4.8, discard this A4 sheet.



File Ref: 65800918  
Issue 1, Dated 20.04.98

Figure 4.9 Circuit Diagram 65800918 - Input/Output (I/O) Board

# Chapter 4

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## Processor Electronics Units

A3 page 4-21/22 Figure 4.9, discard this A4 sheet.

## 6 Replacement Spares

Refer to Chapter 6 for a full list of replacement spares.

## 7 Wiring Diagrams

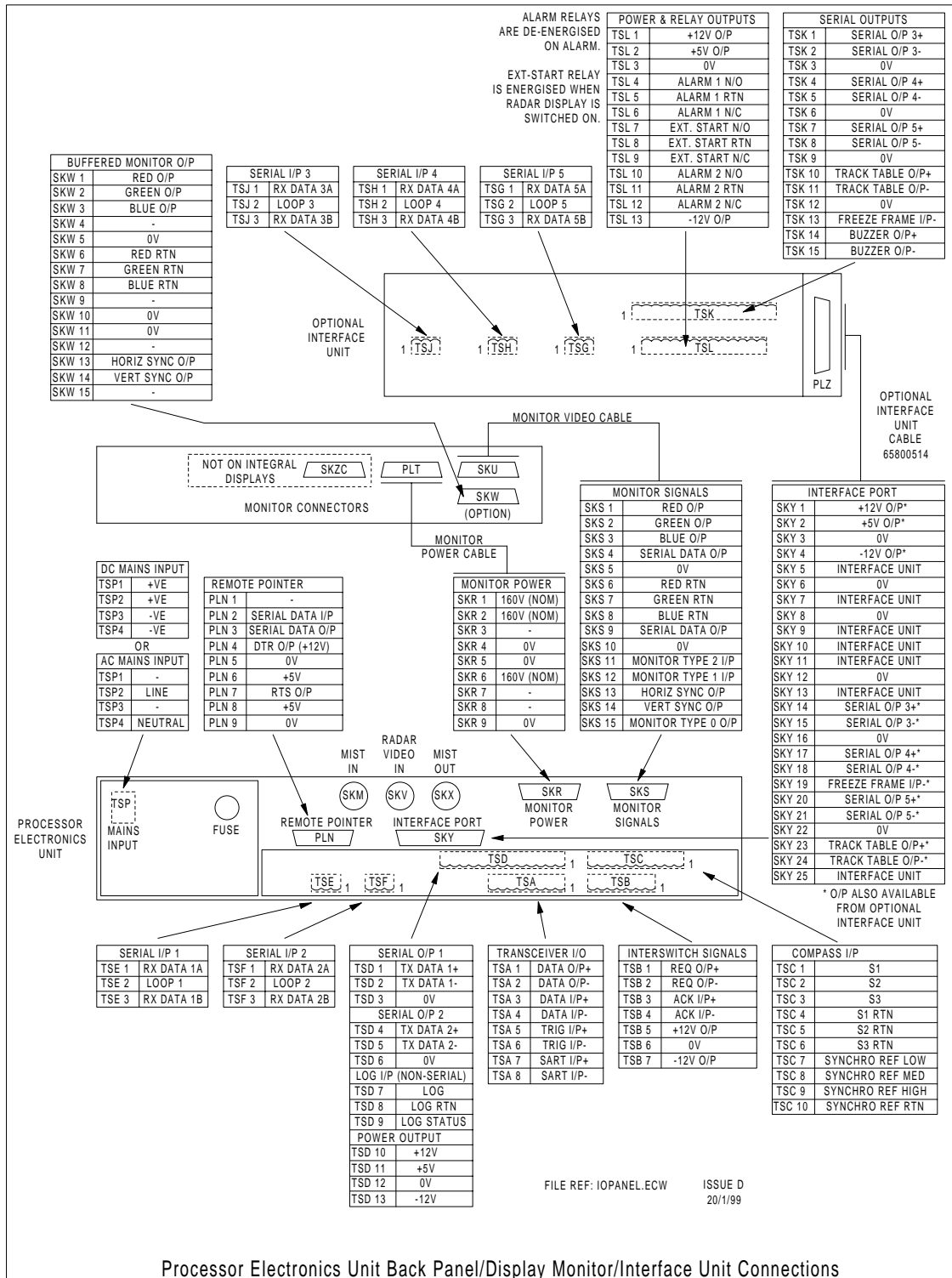
Refer to Ship's Manual 65800010B Chapter 3 for complete system installation diagrams.

The wiring diagrams Included in this section are as follows:

- Figure 4.4 Inter-unit Cabling:  
Processor Electronics Unit Rear Panel/Interface Unit Connections
- Figure 4.5 Interconnection Diagram - Processor Electronics Unit

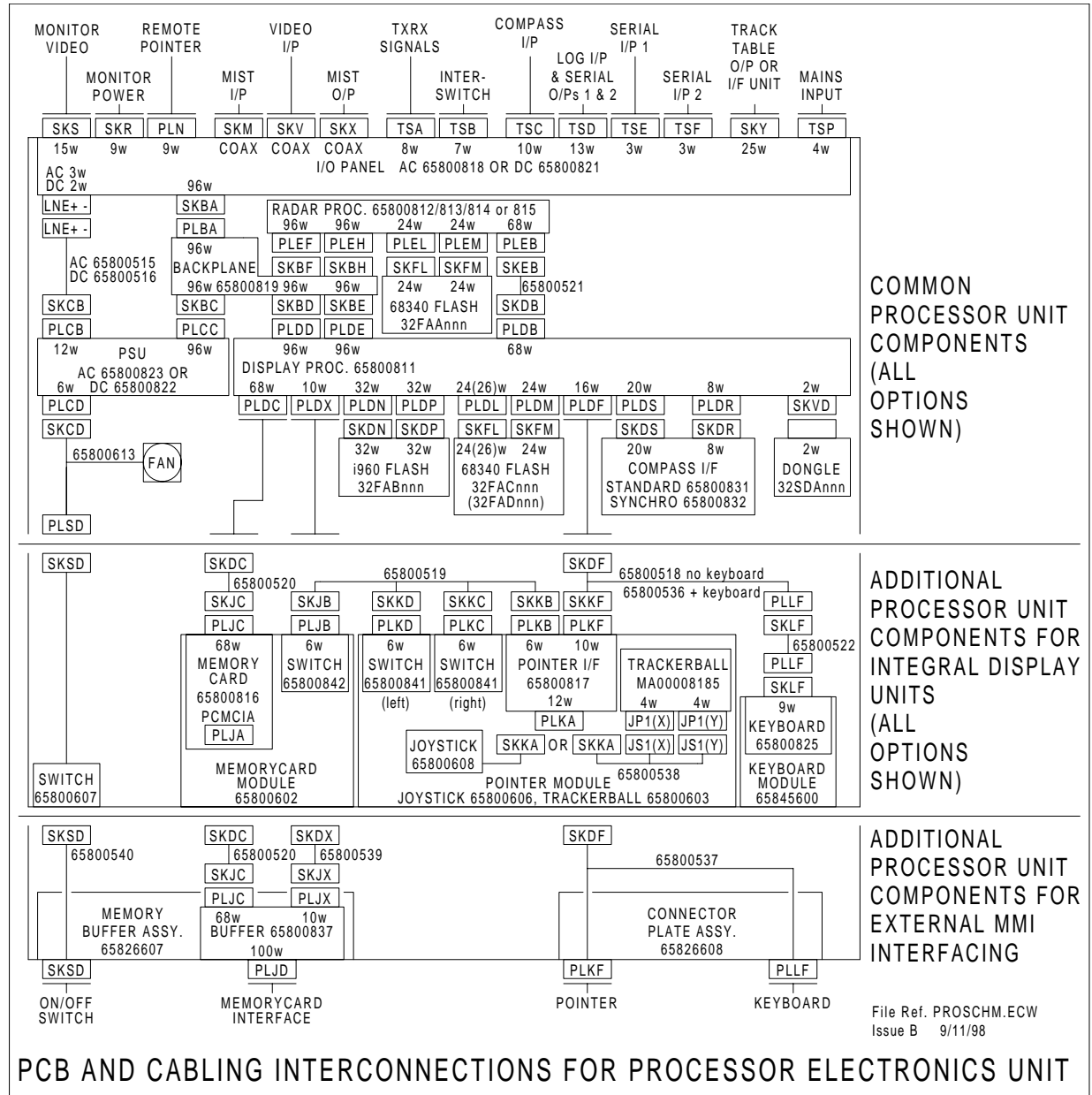
# Chapter 4

## Processor Electronics Units



**Figure 4.10** - Inter-unit Cabling:  
Processor Electronics Unit Rear Panel/Interface Unit Connections





COMMON PROCESSOR UNIT COMPONENTS (ALL OPTIONS SHOWN)

ADDITIONAL PROCESSOR UNIT COMPONENTS FOR INTEGRAL DISPLAY UNITS (ALL OPTIONS SHOWN)

ADDITIONAL PROCESSOR UNIT COMPONENTS FOR EXTERNAL MMI INTERFACING

File Ref. PROSCHM.ECW Issue B 9/11/98

PCB AND CABLING INTERCONNECTIONS FOR PROCESSOR ELECTRONICS UNIT

Figure 4.11 Interconnection Diagram - Processor Electronics Unit

# Chapter 4

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## Processor Electronics Units

A3 page 4-25/26 Figure 4.11, discard this A4 sheet.

## 1 General Description

Individual control modules are designed to be mounted as part of the Processor Electronics Unit for desk mounted monitor displays (see Chapter 4), or on a separate panel when used in a split-cabinet or customer specified console, see Chapters 2 and 3.

A simple control panel is configured from the following modules:

- ON/OFF Switch module
- Pointer module (joystick or trackerball)
- Memory Card module (optional)
- Brilliance Control module

An extended control panel will include a keyboard module.

Refer to Figures 5.1 to 5.5 for details of individual control modules.

### 1.1 Control Functions

The control offered by each module is as follows:

#### 1.1.1 ON/OFF Control Module

Used to control power to the radar display (Monitor and Processor Electronics Unit).

#### 1.1.2 Pointer Module

Joystick/Trackerball:

Used to move the screen cursor within the radar picture, and to position the arrowed cursor over menu items. It is also used to control primary operational functions of the radar, such as clutter and gain.

Left/Right Push Button Keys:

The left key is used to select (turn ON or OFF) the option over which the screen cursor is placed. The right key is used where appropriate to reveal an options menu for the selected facility, or to cancel a selection.

#### 1.1.3 Memory Card Module

Memory Cards:

The memory card module will accept one or two memory cards which are used for the storage and retrieval of data such as map information.

Duplicate Left key:

This key is available when a memory card unit is fitted. Its operation is identical to that of the left key described above. However, its location within the control panel allows for two handed operation.

### 1.1.4 Brilliance Control Module

A rotary control used for controlling the brilliance of the radar's display monitor.

### 1.1.5 Keyboard

The dedicated keyboard contains a number of rotary controls and push buttons which are used for direct selection and control of specific radar parameters.

Rotary Analogue Controls: Used to control primary operational functions of the radar, such as clutter and gain.

- Gain
- Anti-clutter Rain
- Anti-clutter Sea
- EBL I
- VRM I
- Panel Brightness

Push Button Keys: Used to select the various secondary functions of the radar.

- Range Up
- Range Down
- Centre
- TM/RM
- True/Relative Vectors
- Acknowledge Alarms

## **2 Installation and Commissioning**

### **2.1 Installation**

Individual control modules are mounted as part of the Processor Electronics Unit assembly or on a separate panel when used in a split-cabinet or customer specified console, see Chapters 2 and 3.

- Refer to Figures 5.1 to 5.5 for installing the Keyboard, ON/OFF Switch, Pointer, Memory Card and Brilliance modules. The pointer module installation drawing (Figure 5.3) is applicable to both Trackerball and Joystick pointer modules.
- Refer to Figure 5.6 for information on interconnecting cables required to connect the modules to the Processor Electronics Unit, and the 340 Monitor.
- All items required for securing the modules are supplied with the units.

### **2.2 Initialisation and Commissioning**

The control modules and keyboard are only part of a complete BridgeMaster E Series Radar, and cannot be operated independantly. For details of complete system installations refer to the BridgeMaster E, Ship's Manual 65800010B.

After a complete system has been installed it must be Initialised and Commissioned as detailed in Chapter 4 of the BridgeMaster E, Ship's Manual.

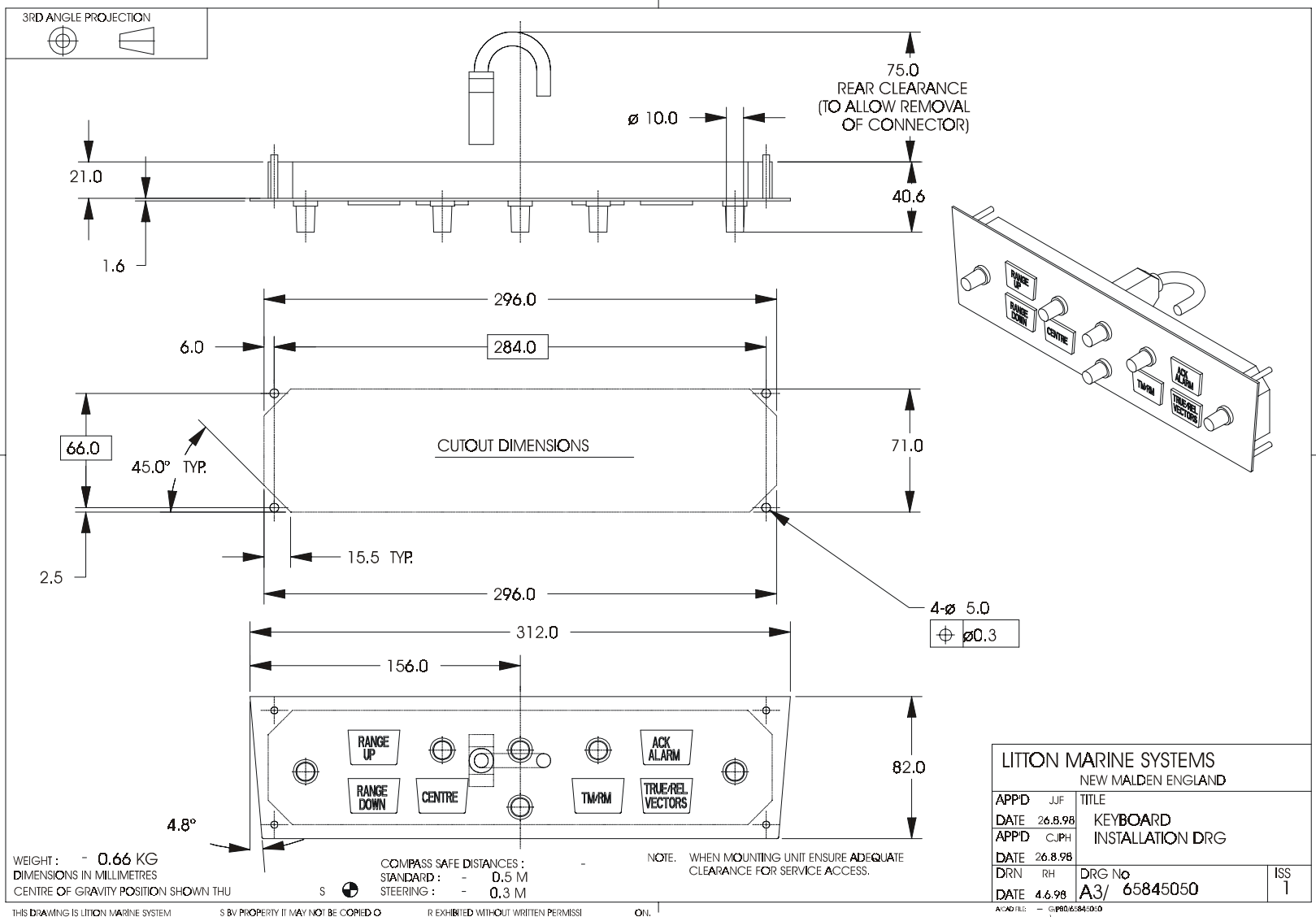


Figure 5.1 - Keyboard Installation Drawing

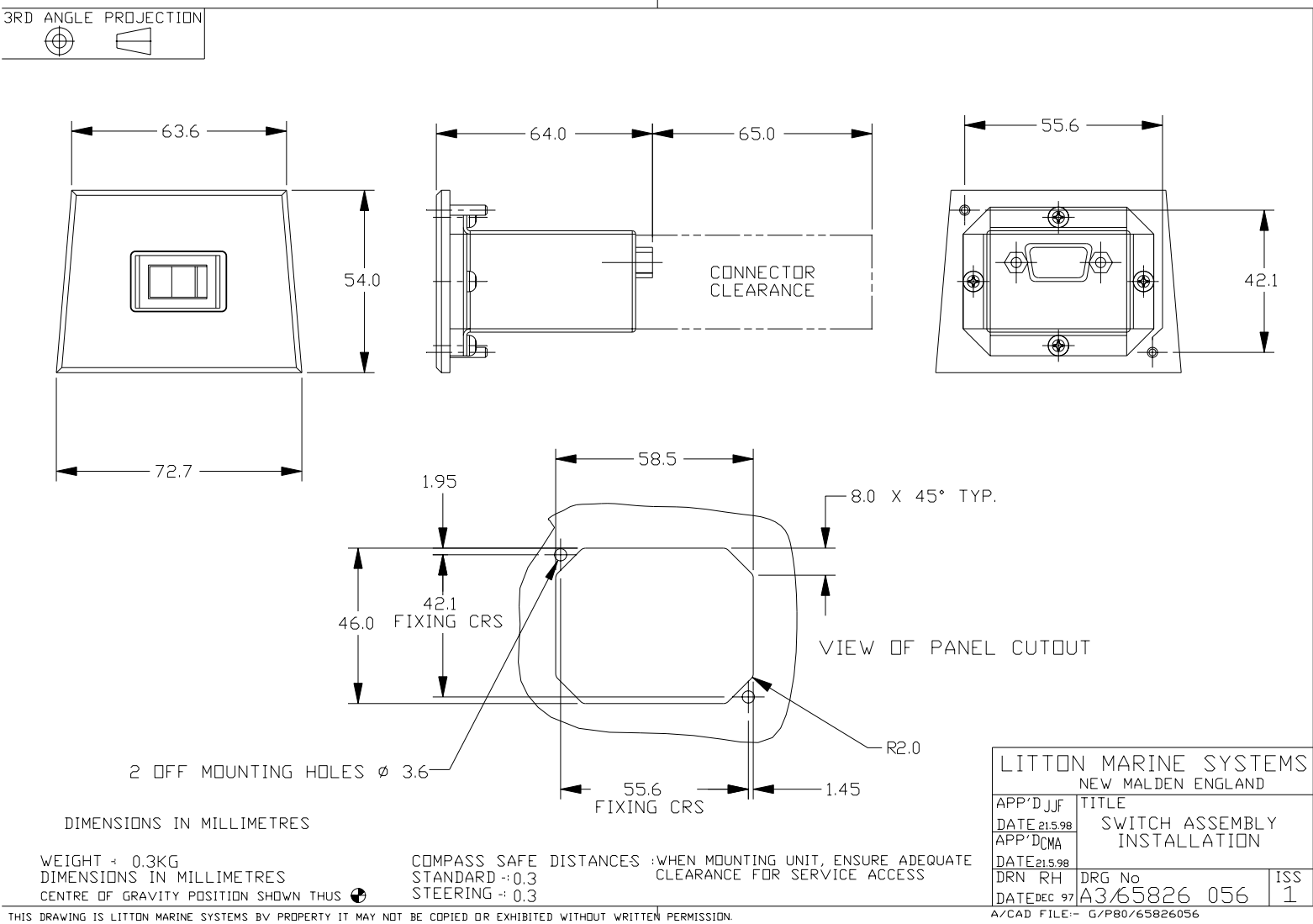


Figure 5.2 - ON/OFF Switch Module Installation

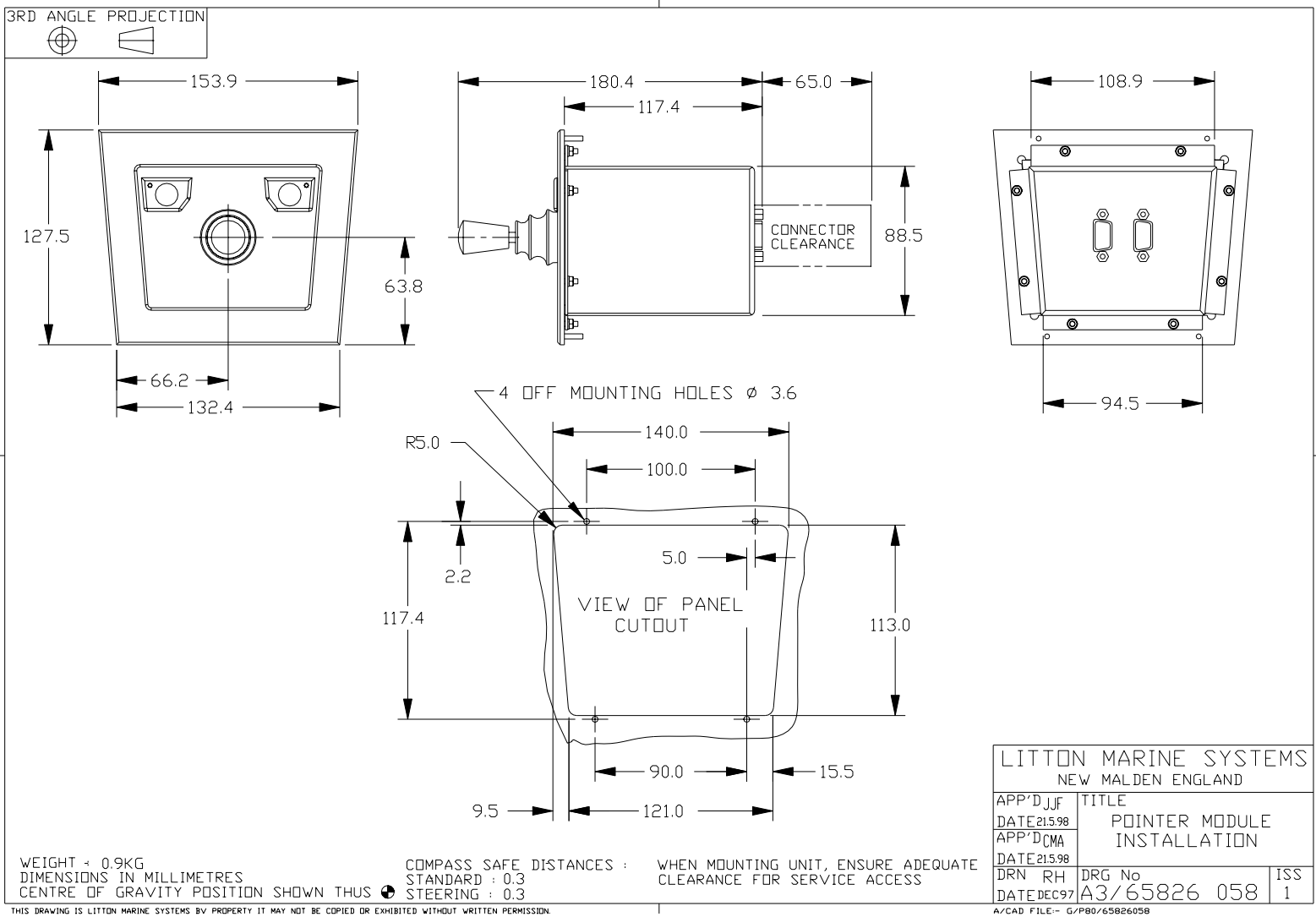


Figure 5.3 - Pointer Module (Joystick/trackerball) Installation



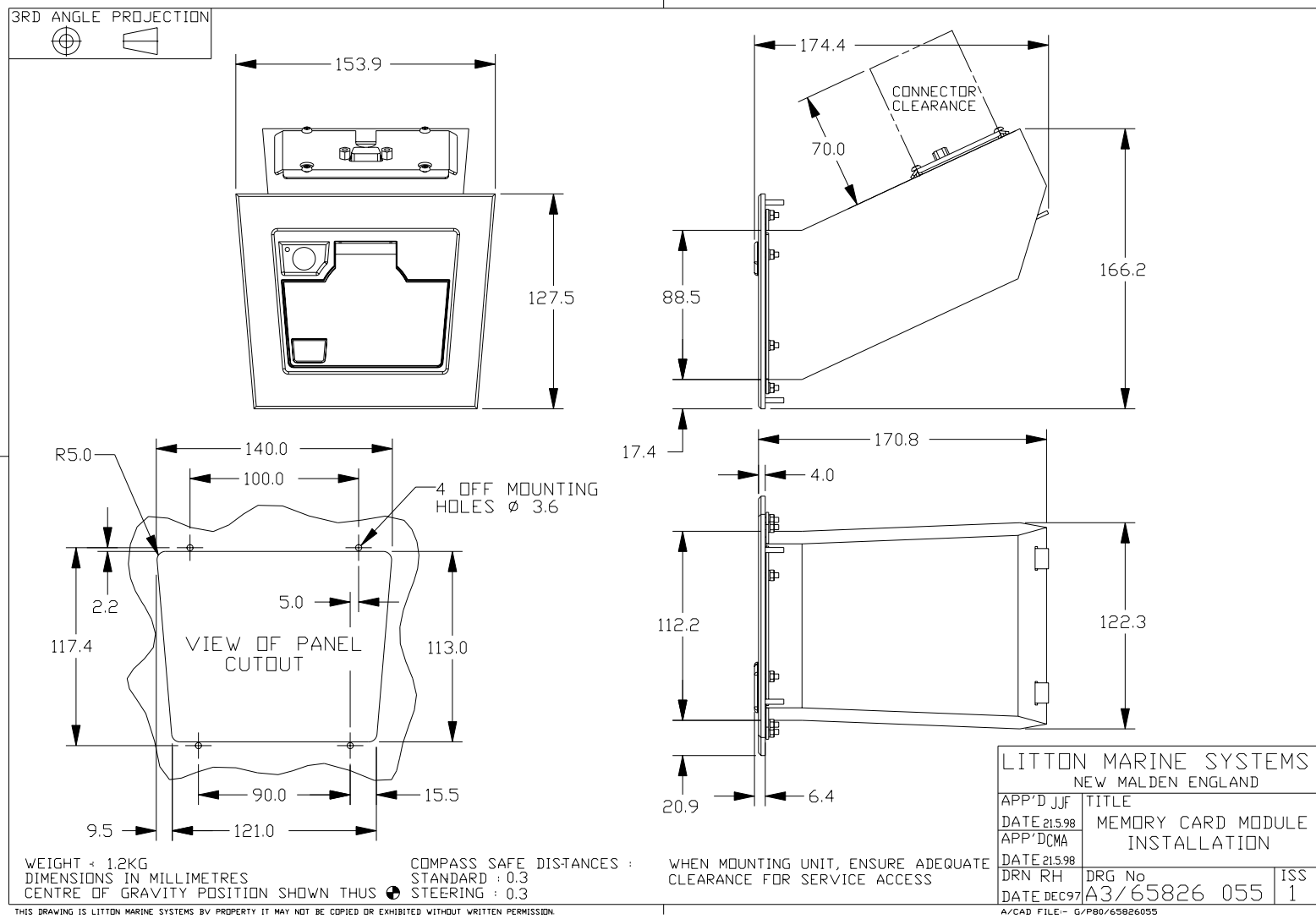


Figure 5.4 - Memory Card Module Installation

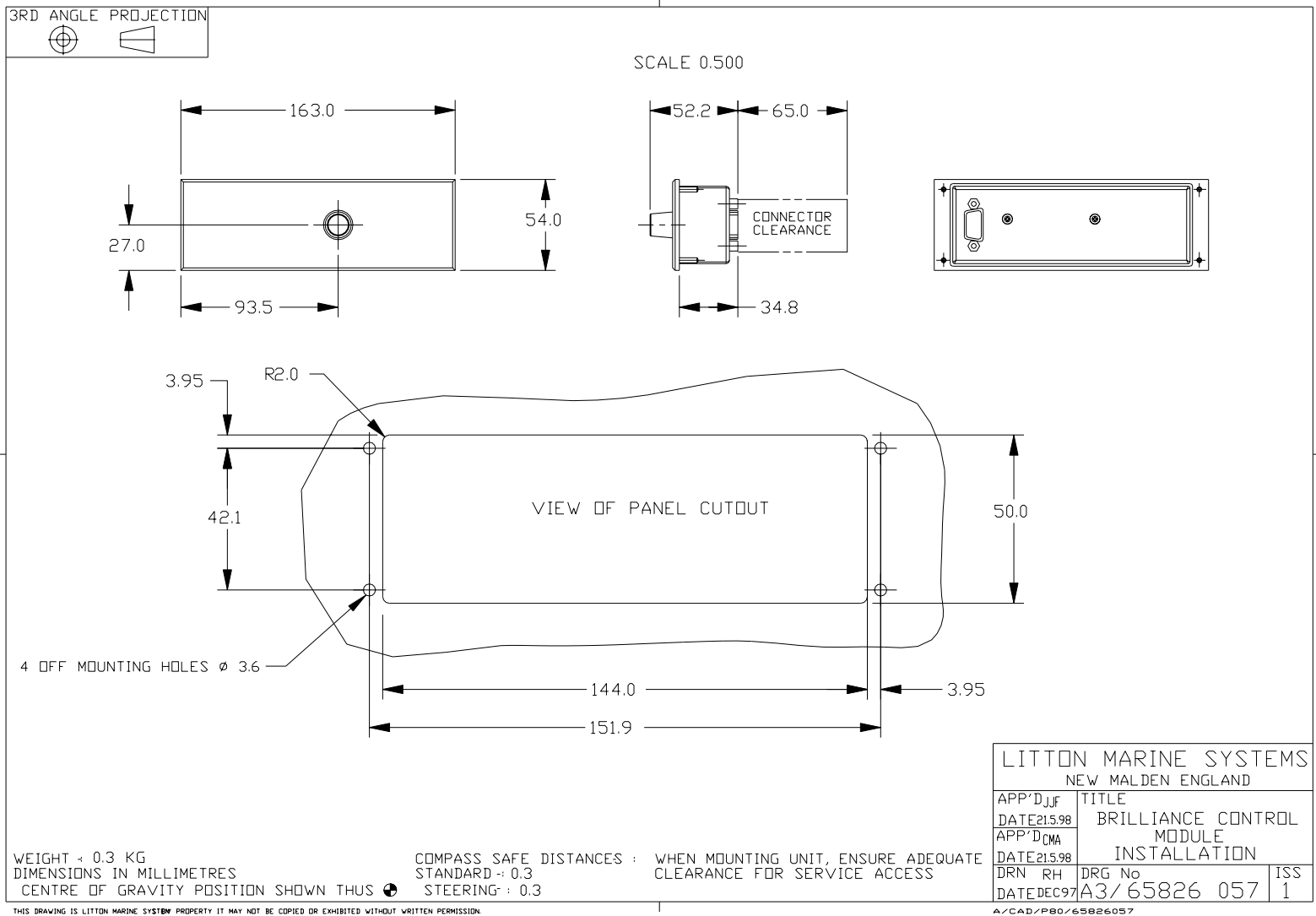


Figure 5.5 - Brilliance Control Module Installation

## 3 Technical Specification

### 3.1 Weights and Dimensions

Component	Height (mm)	Depth (mm)	Width (mm)	Weight (kg)
Brilliance Module	54	52.2	163	0.3
Memory Card Module	166.2	174.4	153.9	1.2
On-Off Switch Module	54	64	72.7	0.3
Joystick Module	127.5	180.4	153.9	0.9
Trackerball Module	127.5	130.3	153.9	1.1
Keyboard	82	40.6	296	0.66

### 3.2 Compass Safe Distances

Component	Type No.	Standard	Steering
Brilliance Module	65826657	0.3 m	0.3 m
Memory Card Module	65826655	0.3 m	0.3 m
On-Off Switch Module	65826656	0.3 m	0.3 m
Joystick Module	65826658	0.3 m	0.3 m
Trackerball Module	65826654	0.3 m	0.3 m
Keyboard	65845050	0.5 m	0.3 m

### 3.3 Environmental Specification

To the requirements of the International Standard for Marine Navigational Equipment CEI/IEC 945 (1988) and Amendment 1 (1992).

## 4 Replacement Spares

Refer to Chapter 6 for a full list of replacement spares.

## 5 Wiring Diagrams

Refer to Ship's Manual 65800010B Chapter 3 for complete system installation diagrams.

The wiring diagrams Included in this section are as follows:

Figure 5.6 Kit Display Unit Inter-Module Cabling Connections

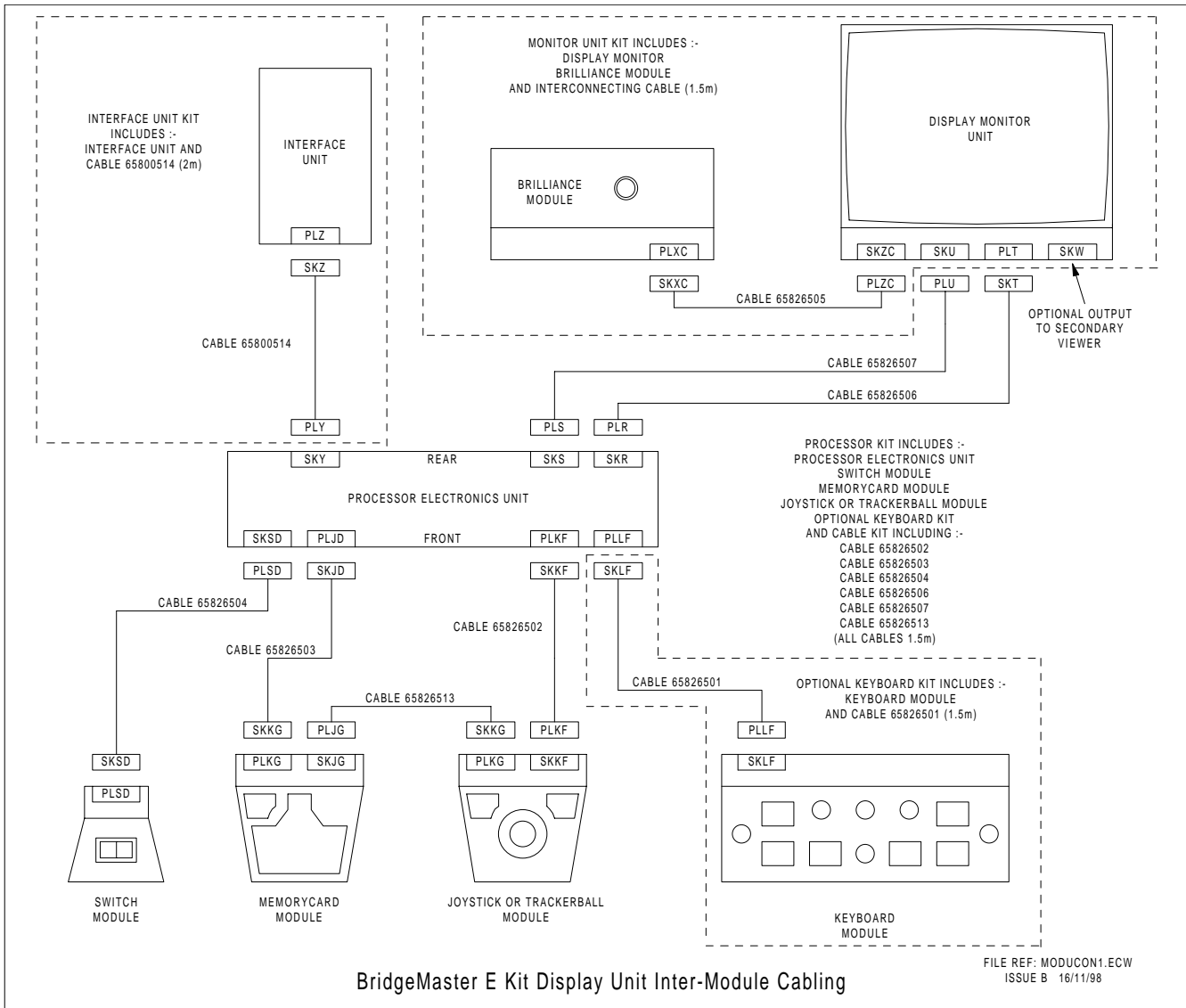


Figure 5.6 - Kit Display Unit Inter-Module Cabling

## 1 Fault Reporting

Fault diagnosis to component level is not possible without the use of specialised test equipment.

The majority of the PCBs are assembled using surface mount techniques.

Service repair is therefore by module (PCB) replacement only.

The module may be covered by the Service Exchange scheme.

### 1.1 Contact

If a unit exhibits a fault, please contact your supplier or local dealer, or if on International trade, contact:

Litton Marine Systems B.V.	Telephone: +(44) (0) 181 329 2400
SERVICE CONTROL	Or +(44) (0) 181 329 2000
Burlington House	
118 Burlington Road	Fax: +(44) (0) 181 329 2458
New Malden	
Surrey KT3 4NR	Telex: 261545 RACDECCA G
England.	

For general non-urgent enquiries, the following e-mail addresses are also available:

gmk01@nml.litton-marine.com & rjp02@nml.litton-marine.com

It is recommended that any e-mails are sent to both of the above addresses.

### 1.2 Information Required for Service

Please give the following details when reporting a fault:

1. Name of vessel (Satcom or Fax number if fitted).
2. Equipment type, including prefix and suffix letters.
3. Software status (version number).
4. Next port of call, ETA and ship's agents.
5. Fault description (with as much detail as possible).
6. Contact name.

## 2 Fault Identification and Isolation

Refer to the following associated manuals for assistance in identifying and isolating System faults.

65601012	BridgeMaster II S-Band Supplement (Hybrid Systems) Additionally covers DCU and Scanner Control Unit faults.	- Chapter 6
65601013	BridgeMaster II X-Band Supplement (Hybrid Systems) Additionally covers DCU faults.	- Chapter 6
65800011	Ship's Technical Manual (Additional information for S-Band and X-Band systems)	
65800012	Ancillary Units and Radar Systems Manual Covers DCU, TCU, 2- & 6-way Interswitch, Serial Interface Unit.	

## 2.1 Display Unit

Flow charts for the isolation of Display Unit faults are given on the following pages. Flow Charts 1 & 2 cover the situation where there is no picture, and Flow Chart 3, where there is a picture but there are other faults.

The Flow Charts should be read in conjunction with the following notes.

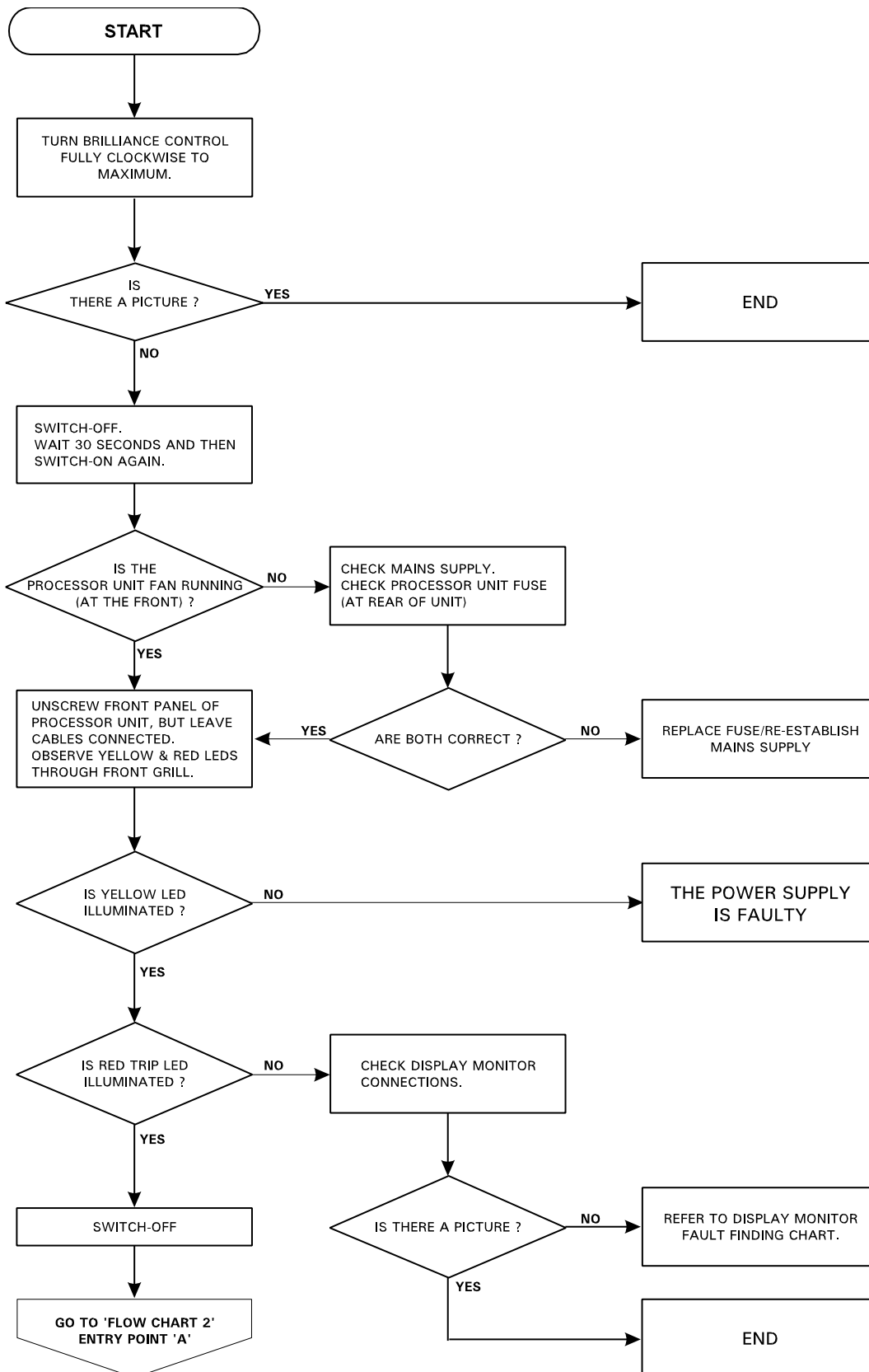
### Notes

1. *The YELLOW LED, indicating power supply active, is located approximately 100 mm from the right hand side of the power supply, towards the rear of the PSU. It can be viewed through the front grill of the PSU.*
2. *The RED LED, indicating power supply trip, is located approximately 125 mm from the right hand side of the power supply, towards the rear of the PSU. It can be viewed through the front grill of the PSU.*
3. *The DISPLAY EHT SUPPLY has a thermal trip circuit. Following the removal of an overload, it self resets after 15 seconds.*
4. *The DISPLAY POWER SUPPLY has a thermal trip that shuts down the power supply if the heatsink temperature exceeds 110°C. This thermal trip will not activate the PSU RED TRIP LED. The YELLOW LED is similarly not affected. The PSU will self reset when the heatsink cools to approximately 90°C.*
5. *Use the following table to help with decisions on DISPLAY FLOW CHART 3.*

Decision	Answers	Example Symptoms
Is the display distorted ?	Digital Distortion	Broken or missing text, misaligned text.
	Analogue Distortion	Non-circular range rings.
Are the colours correct ?	Incorrect Colours	Different colours shown from those set.
	Discolouration	Set colours vary.
Where is the fault ?	Within Radar Picture	Missing targets, no gain, strange patterns.
	Text and Synthetics	Missing text, non-function of menus, strange patterns.

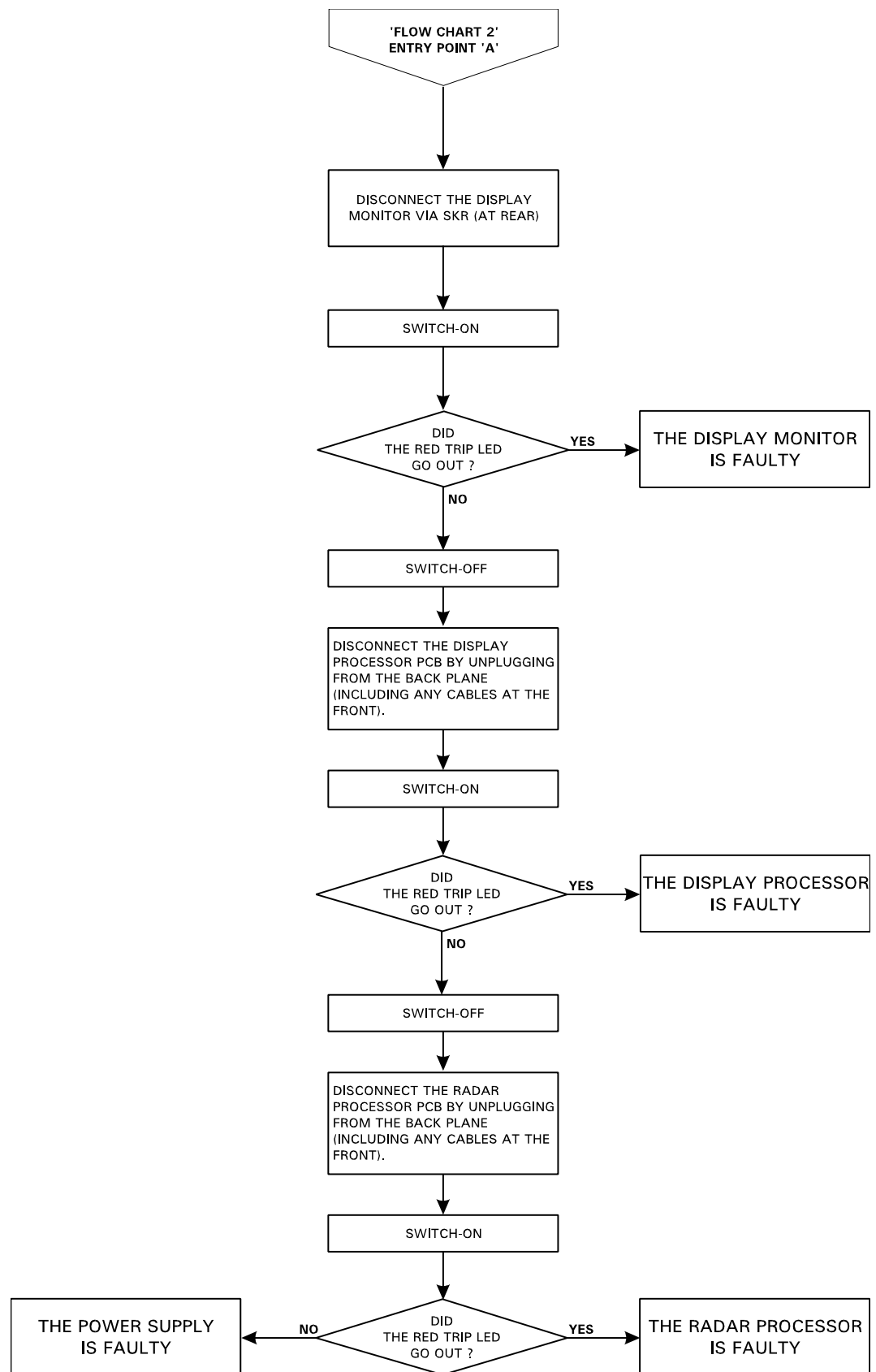
Fault Finding and First Line Servicing

**FLOW CHART 1 - DISPLAY UNIT FAULTS (No Picture)**



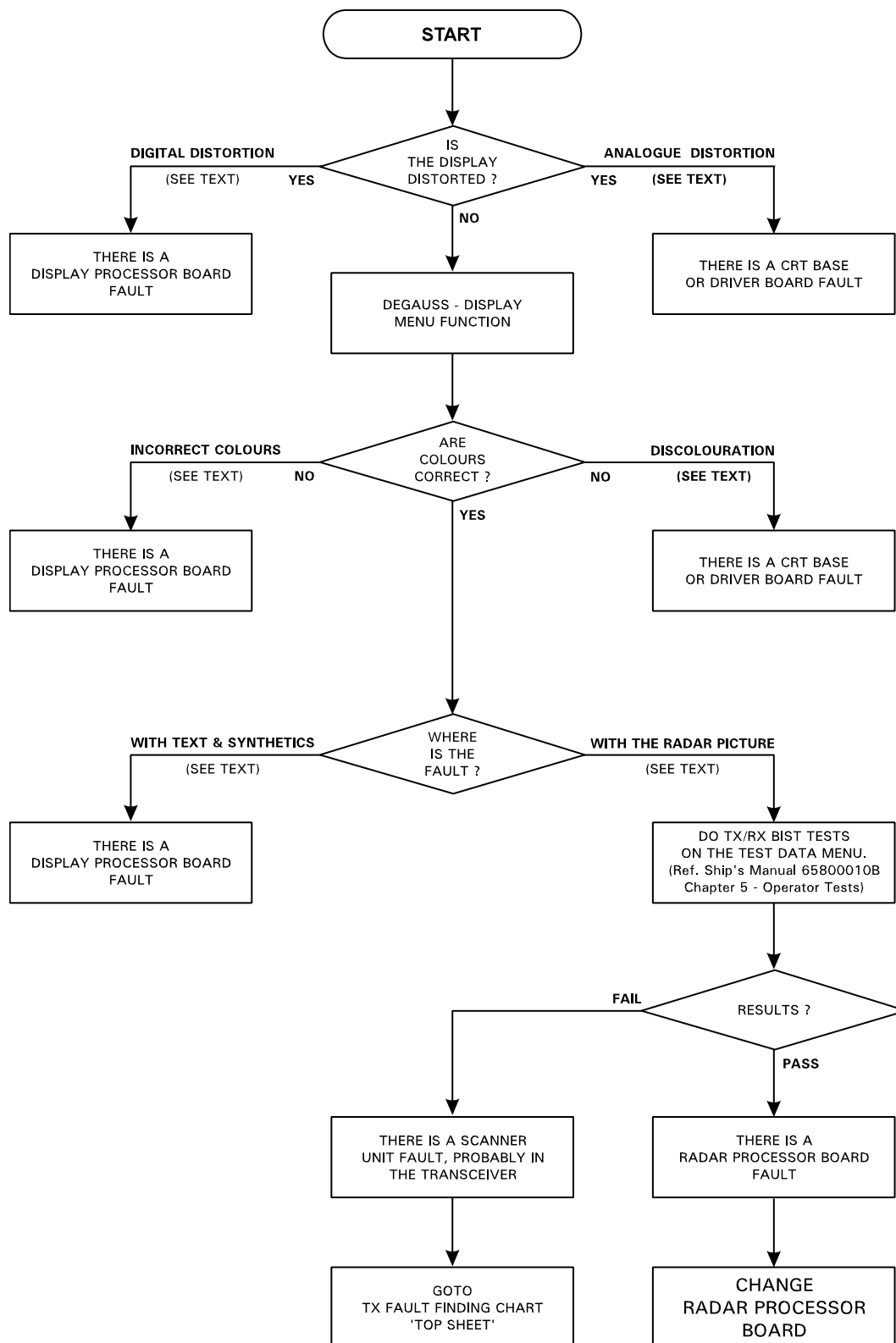


**FLOW CHART 2 - DISPLAY UNIT FAULTS (No Picture)**



Fault Finding and First Line Servicing

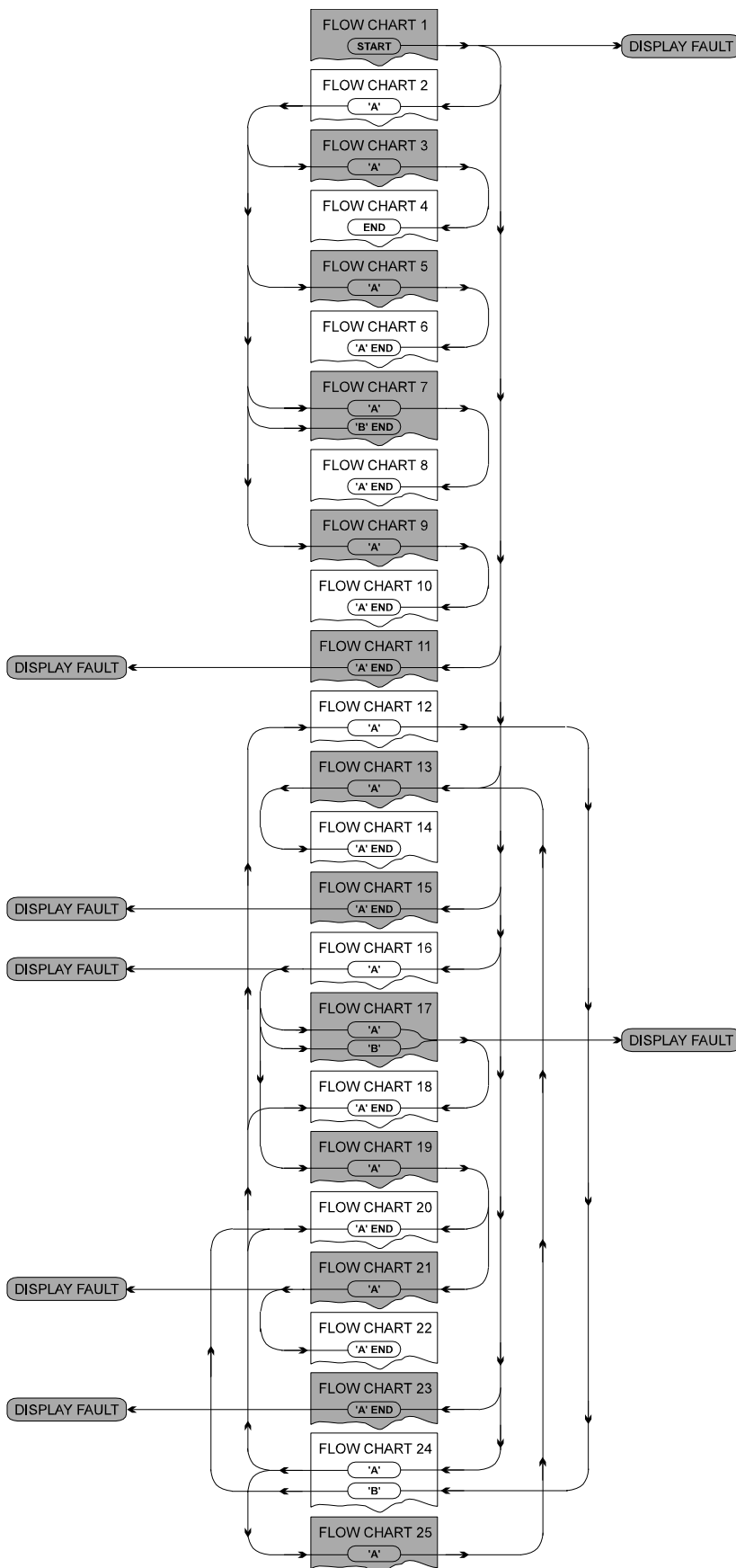
**FLOW CHART 3 - DISPLAY UNIT FAULTS (With Picture)**



## **2.2 S-Band Scanner Unit**

Flow charts for isolating faults on S-Band Scanner Units are given on the following pages. The lead sheet shows the overall flow through individual Flow Charts 1 to 25.

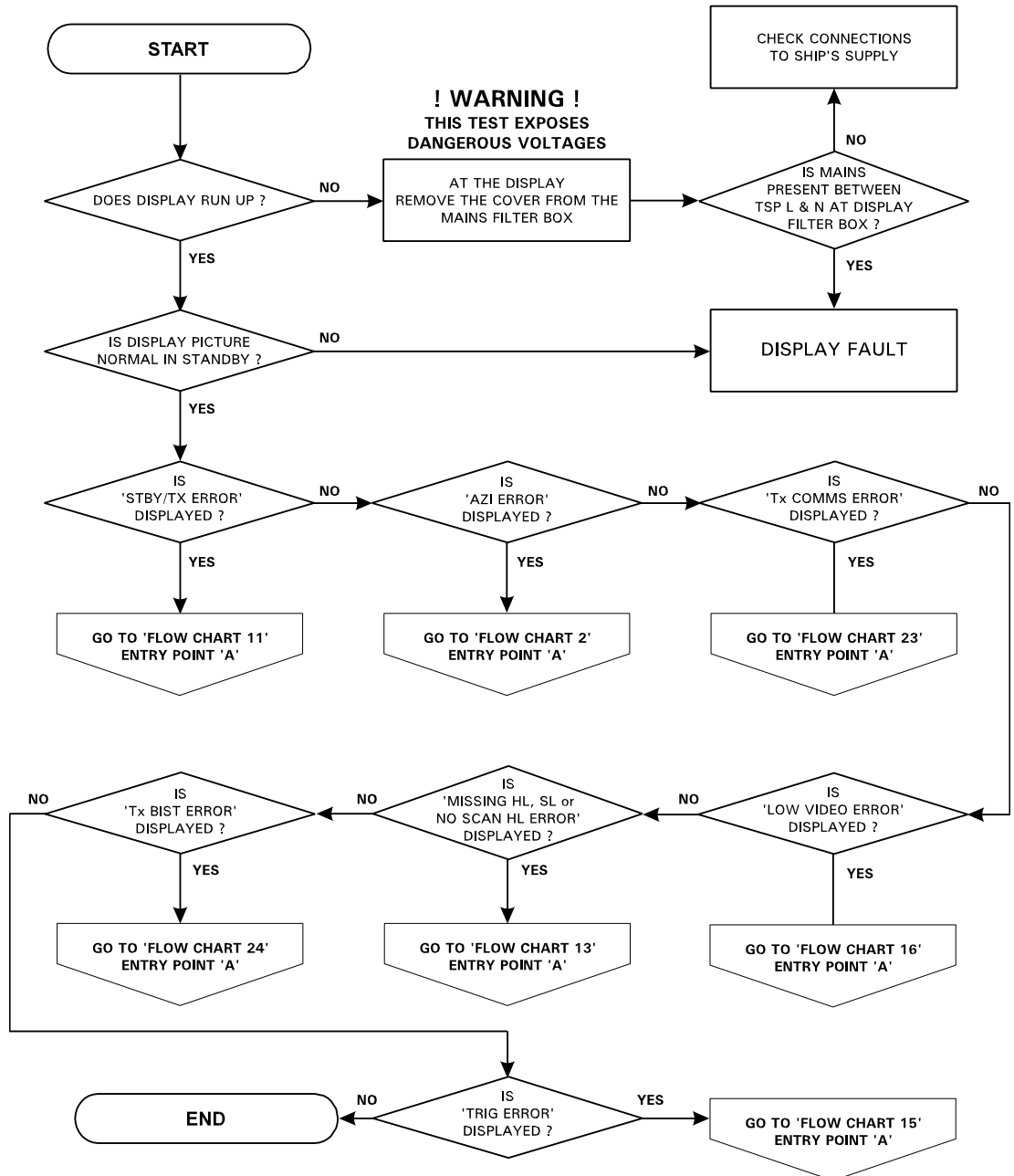
**OVERALL FLOW CHART - S-BAND SCANNER FAULTS**



**FLOW CHART 1 - S-BAND SCANNER FAULTS**

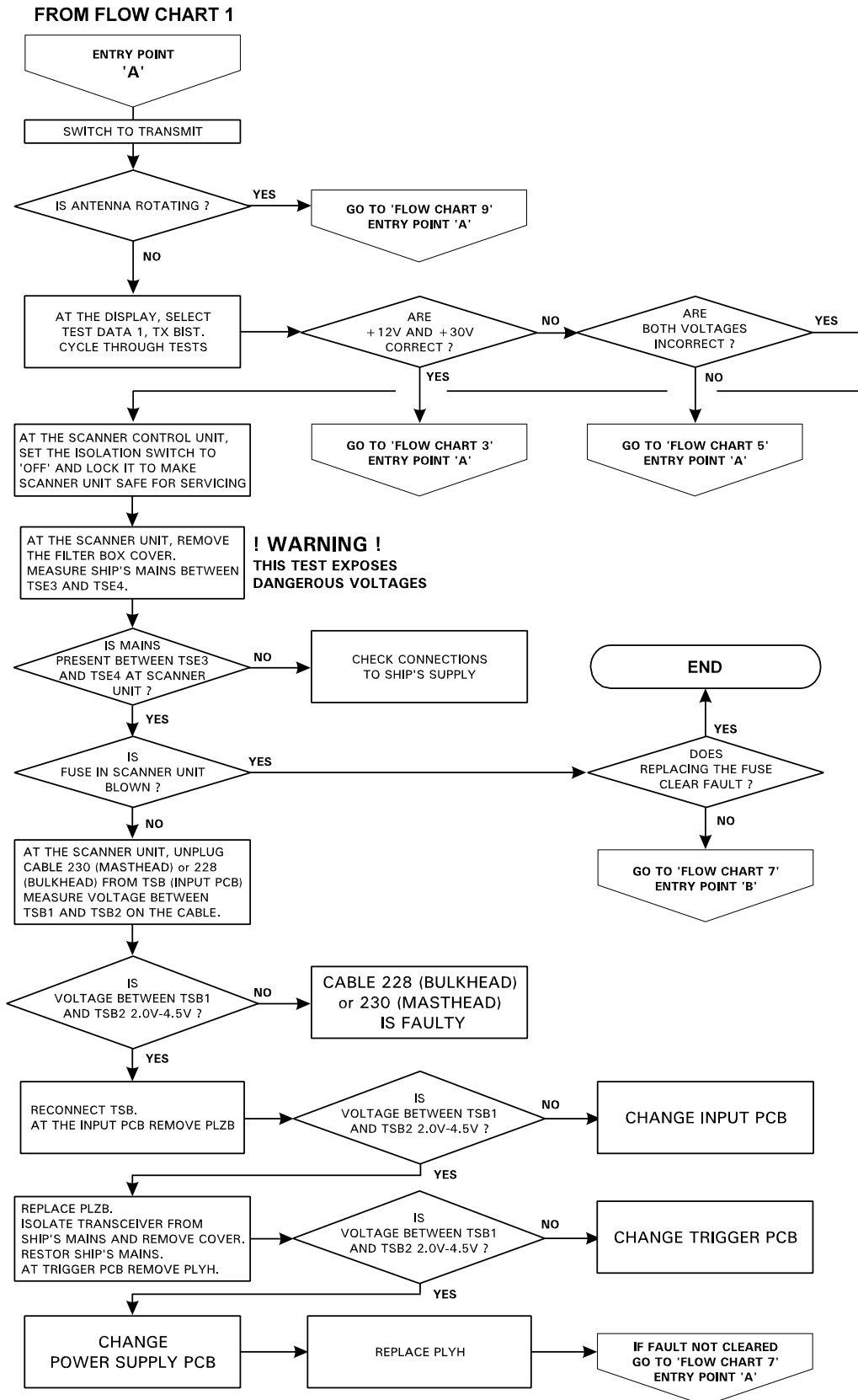
**! WARNING !**

WHEN THE COVERS ARE REMOVED FROM THE EQUIPMENT, DANGEROUS VOLTAGES ARE EXPOSED. ONLY QUALIFIED PERSONS SHOULD WORK ON THE EQUIPMENT WHEN POWER IS APPLIED. ALWAYS ISOLATE THE TURNING UNIT FROM THE SHIP'S SUPPLY BEFORE WORKING ON IT. ALWAYS ISOLATE THE TRANSCEIVER FROM THE SHIP'S SUPPLY WHILE REMOVING OR REPLACING THE TRANSCEIVER COVER

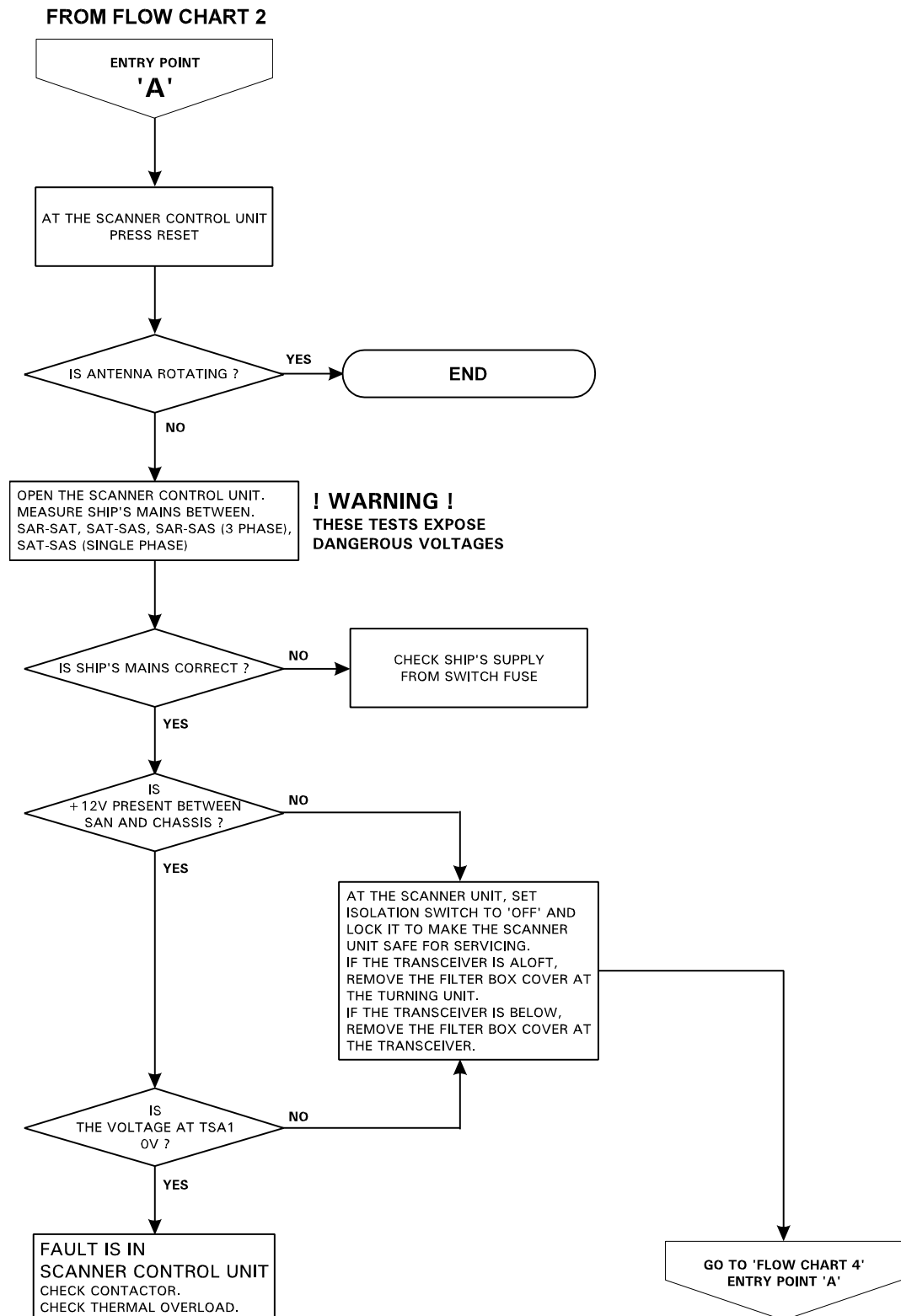


Fault Finding and First Line Servicing

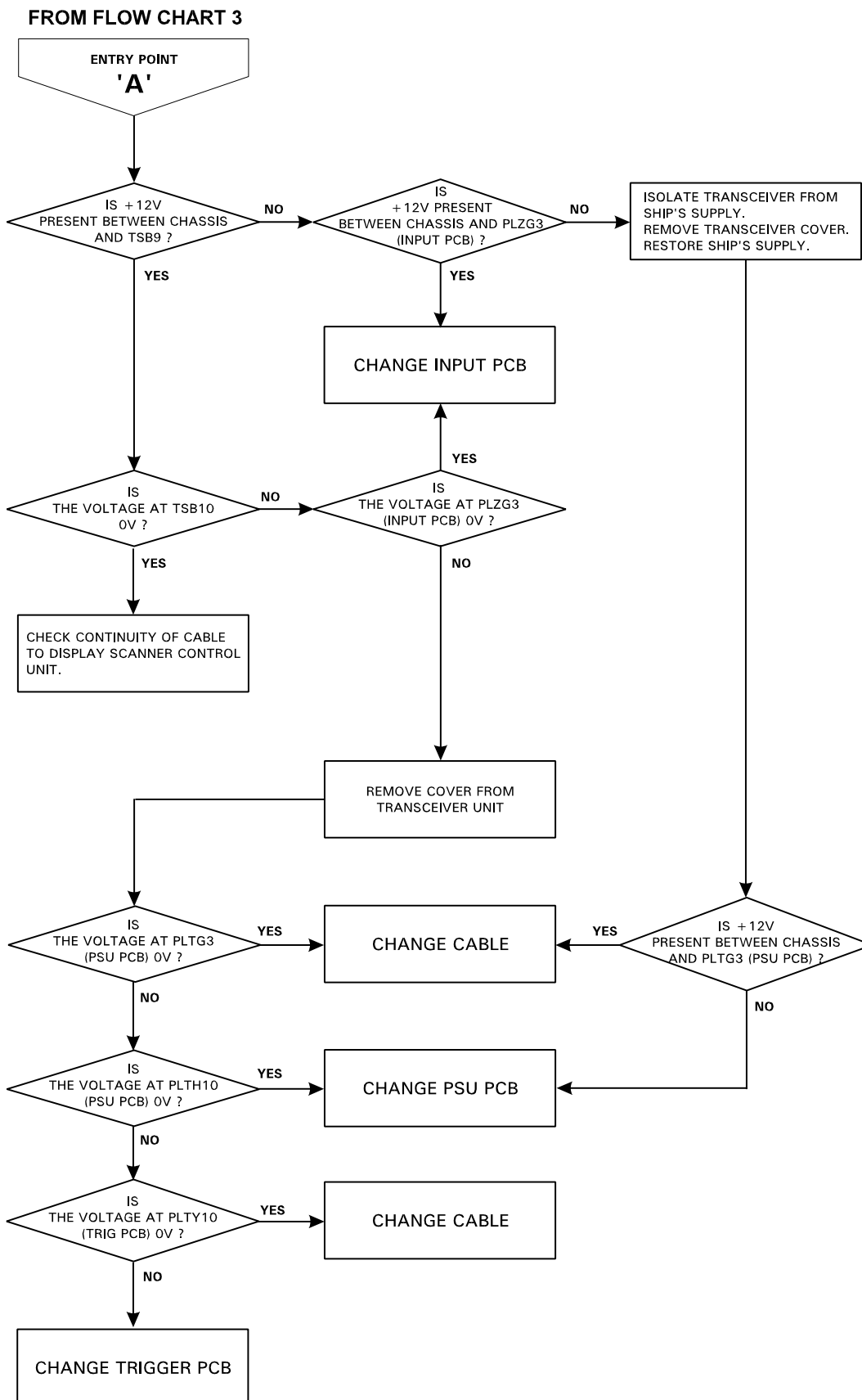
**FLOW CHART 2 - S-BAND SCANNER FAULTS**  
 ('AZI ERROR' Displayed)



**FLOW CHART 3 - S-BAND SCANNER FAULTS**

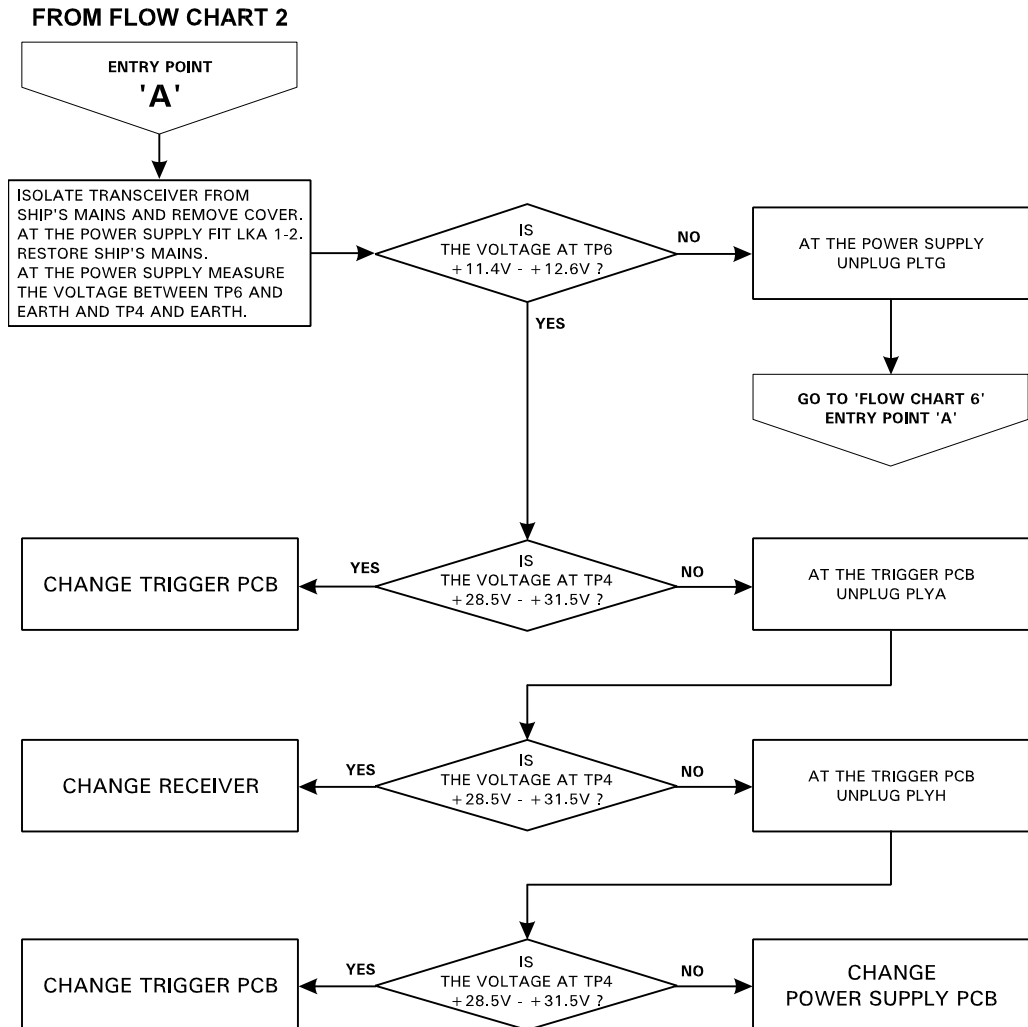


**FLOW CHART 4 - S-BAND SCANNER FAULTS**

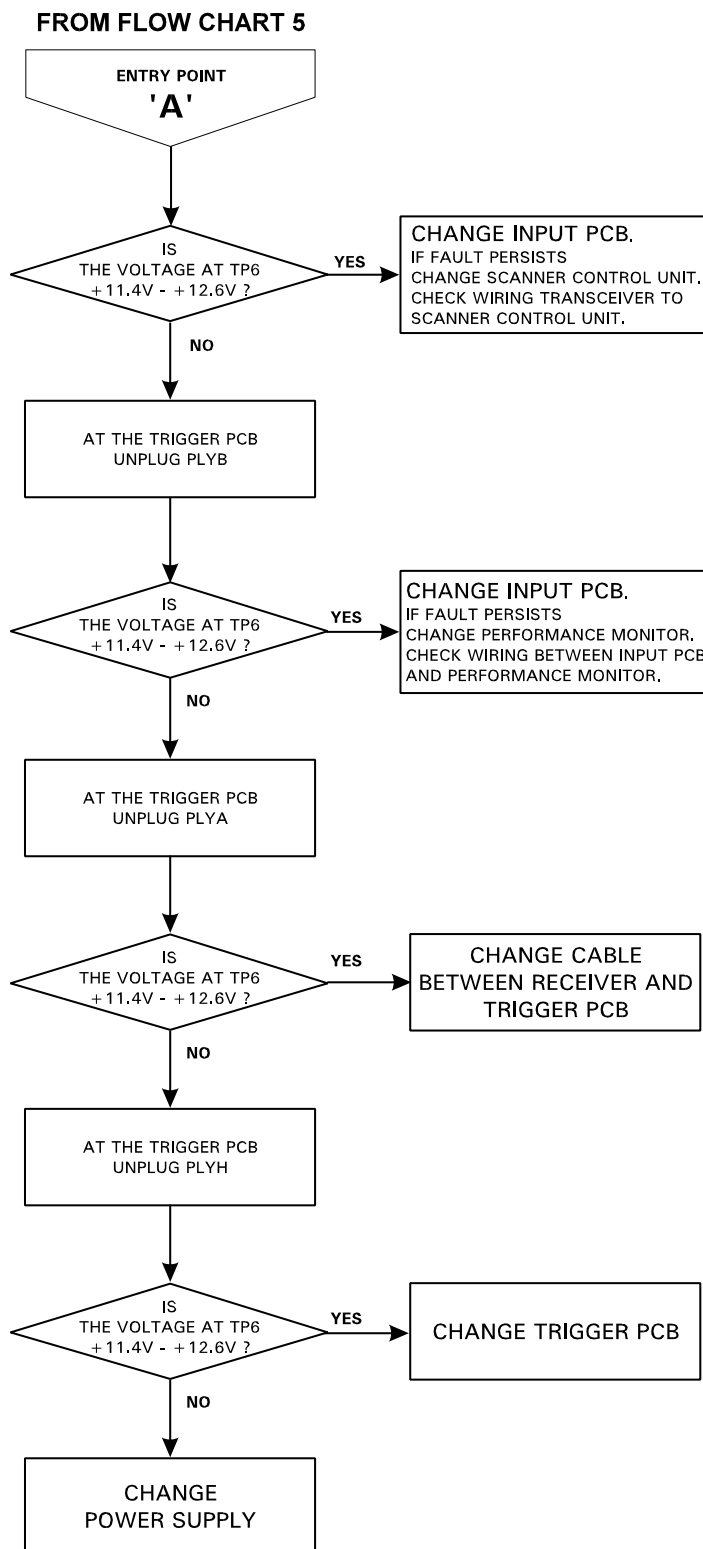




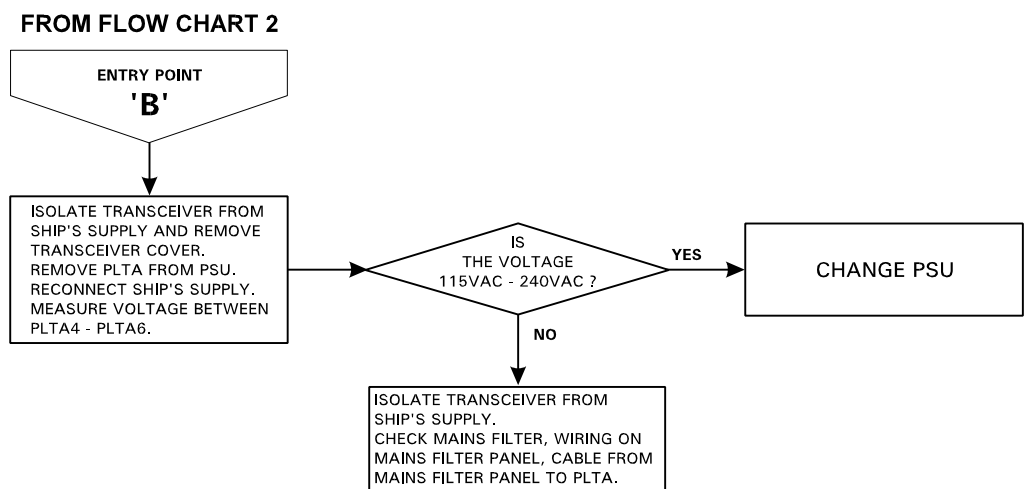
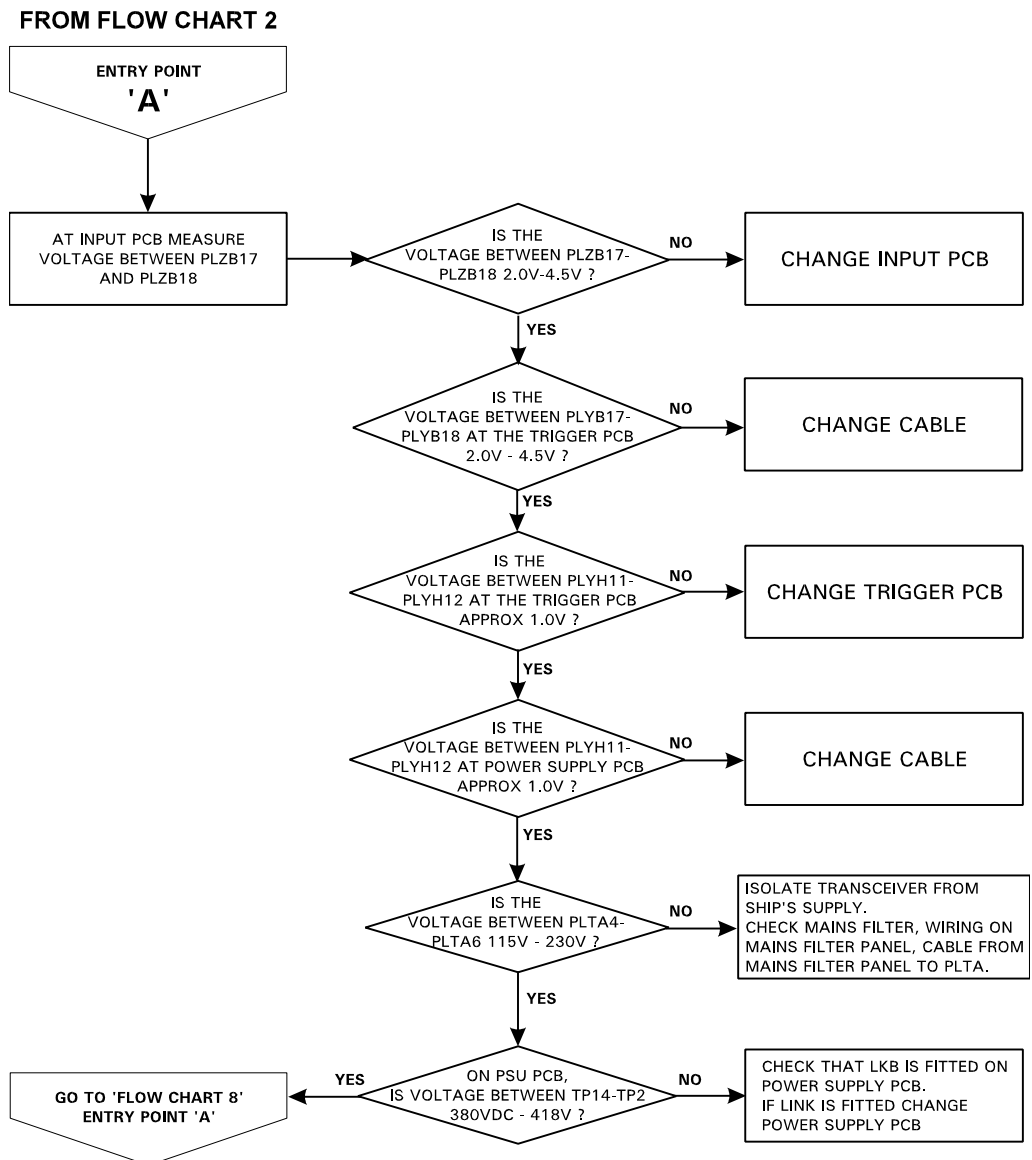
**FLOW CHART 5 - S-BAND SCANNER FAULTS**



## Fault Finding and First Line Servicing

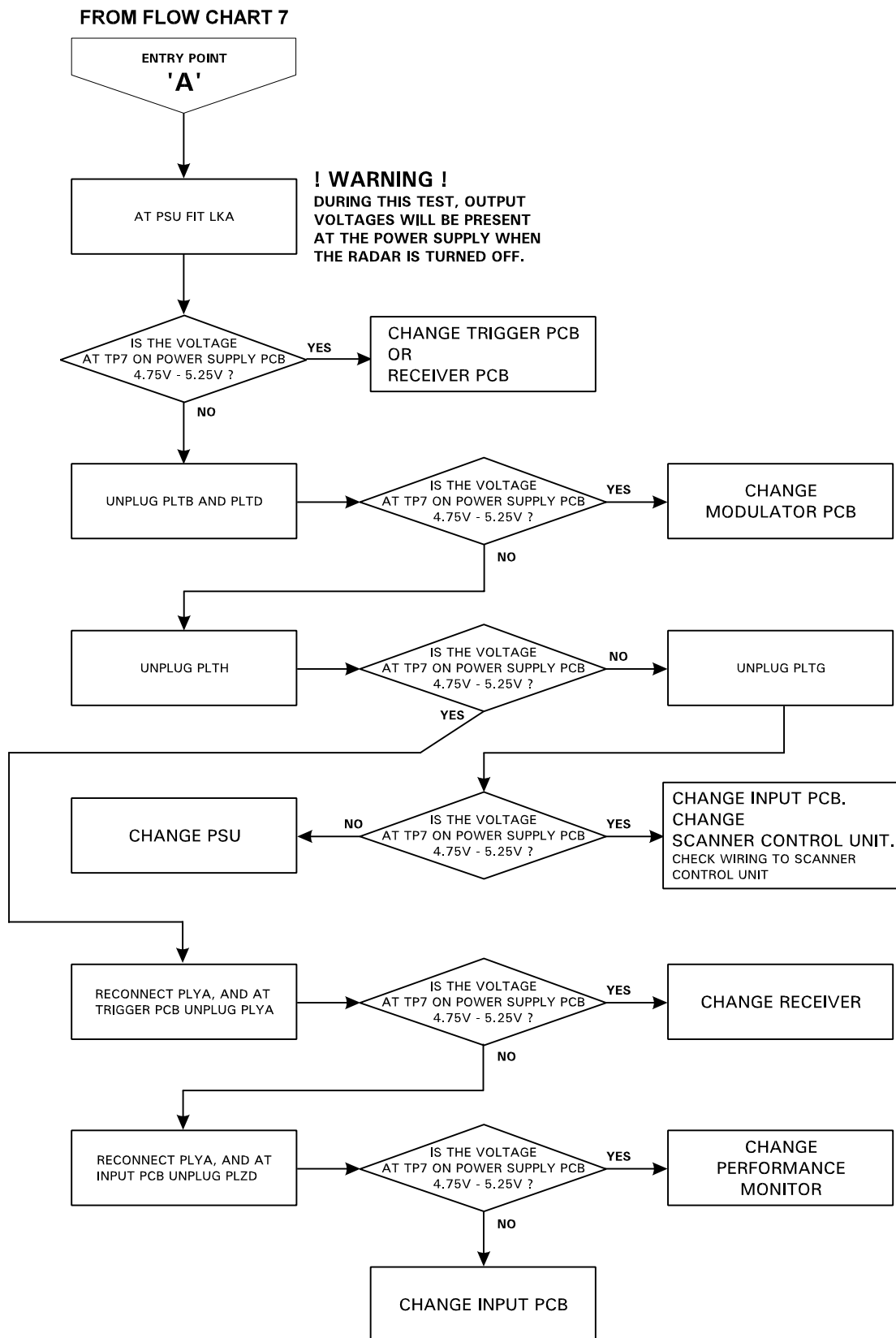
**FLOW CHART 6 - S-BAND SCANNER FAULTS**

**FLOW CHART 7 - S-BAND SCANNER FAULTS**

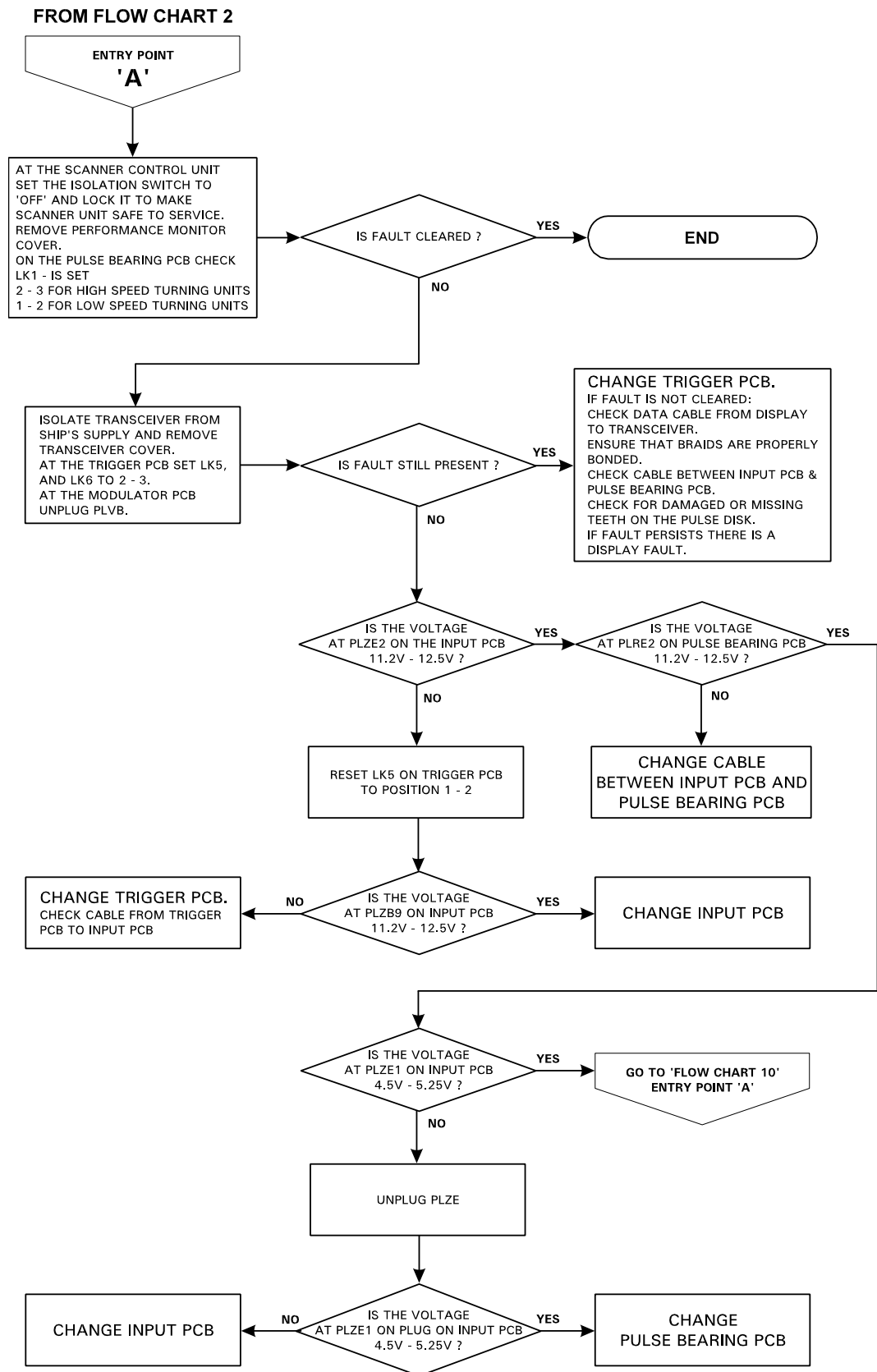


Fault Finding and First Line Servicing

**FLOW CHART 8 - S-BAND SCANNER FAULTS**

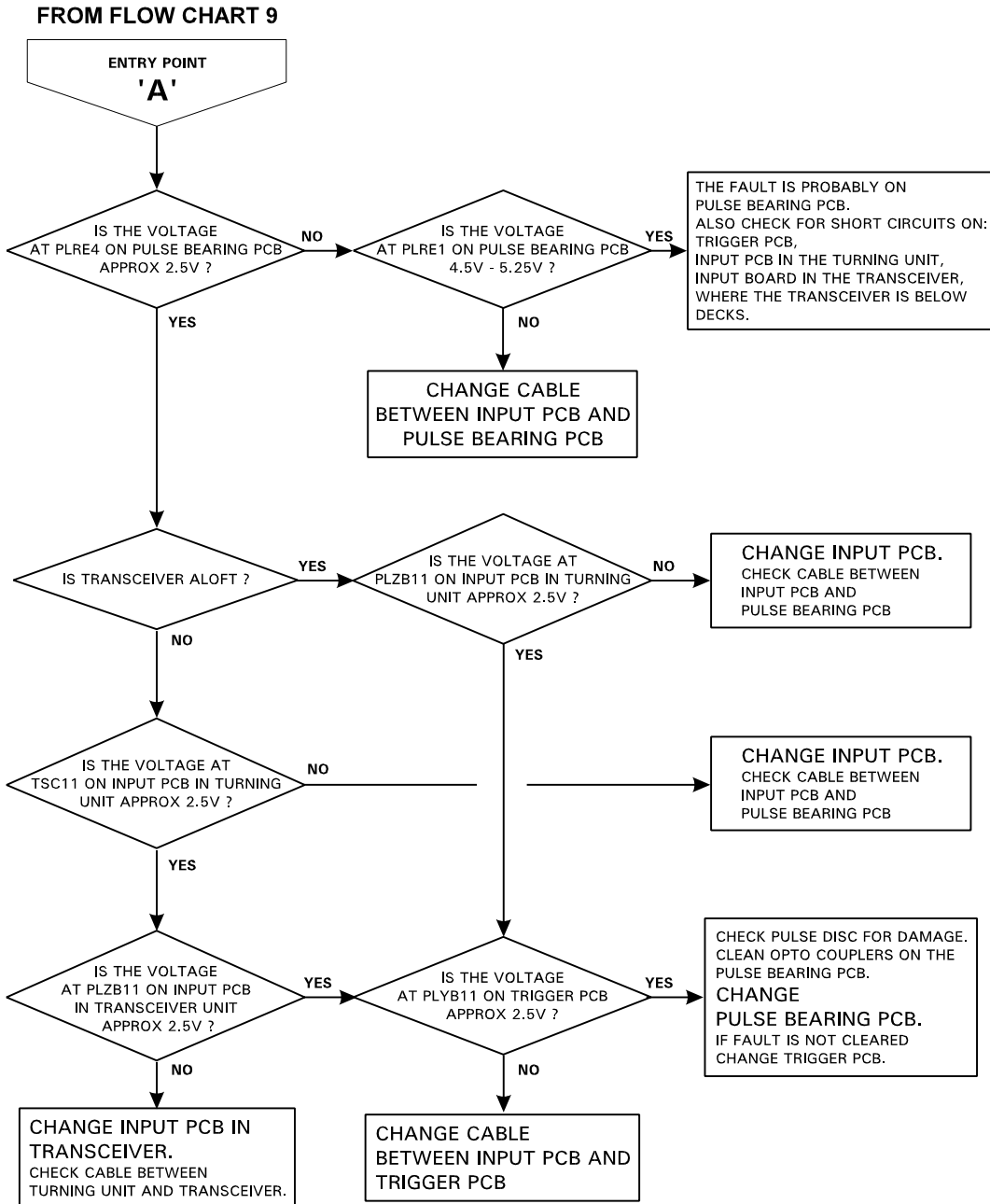


**FLOW CHART 9 - S-BAND SCANNER FAULTS**

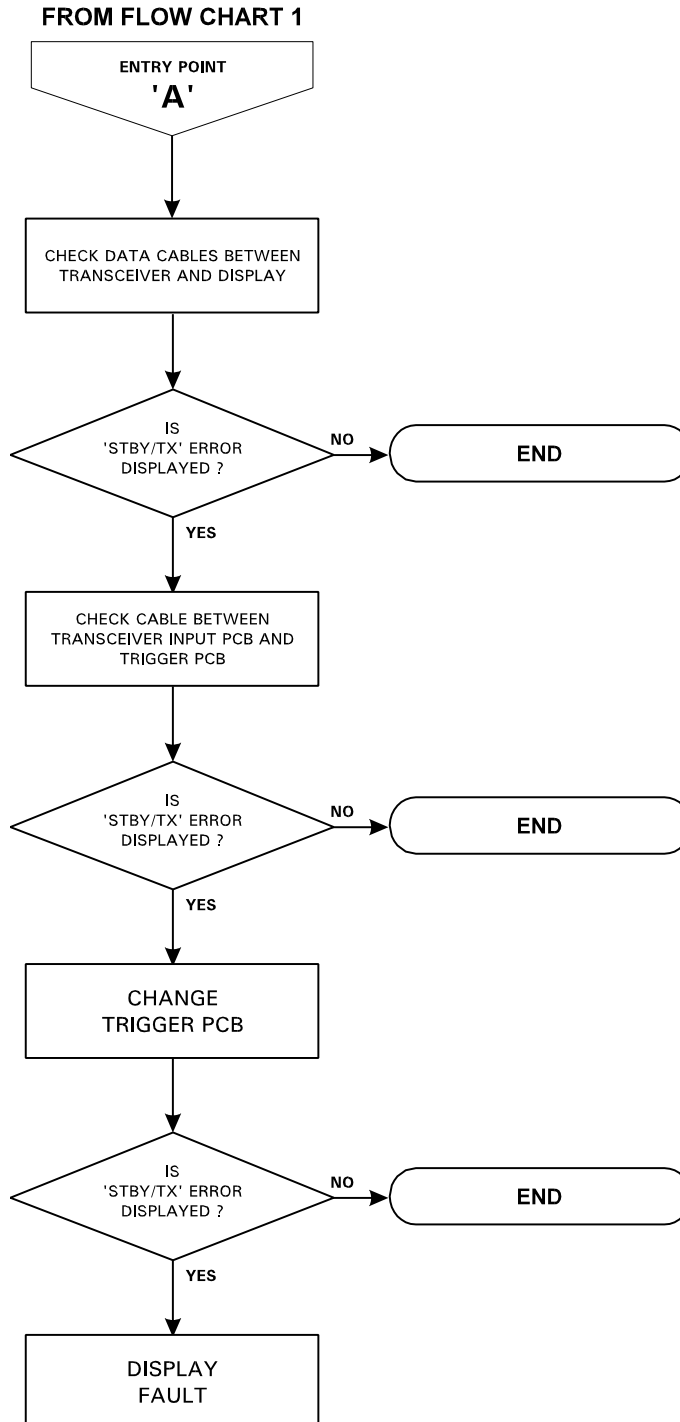


Fault Finding and First Line Servicing

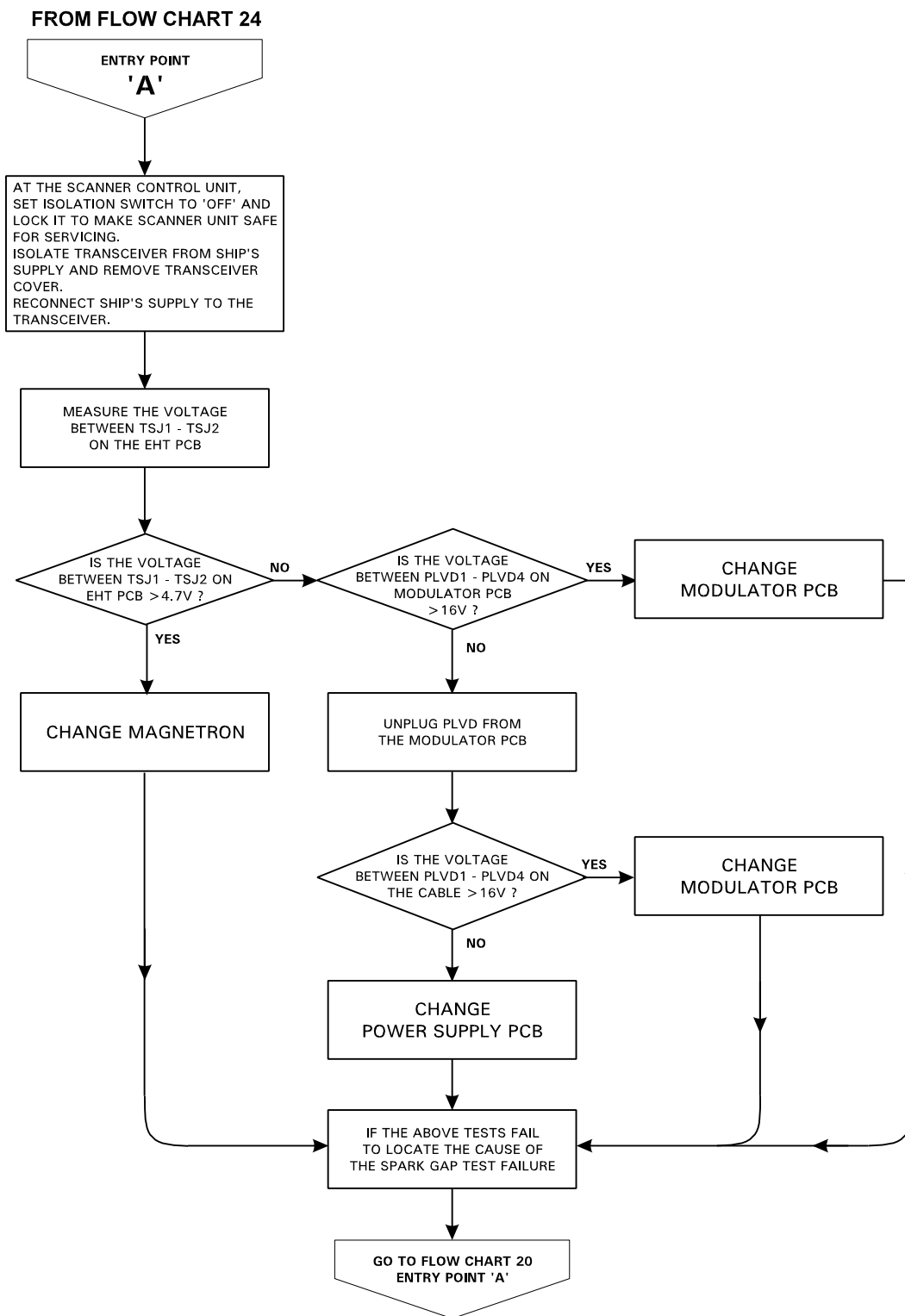
**FLOW CHART 10 - S-BAND SCANNER FAULTS**



**FLOW CHART 11 - S-BAND SCANNER FAULTS  
(‘STBY/TX ERROR’ Displayed)**



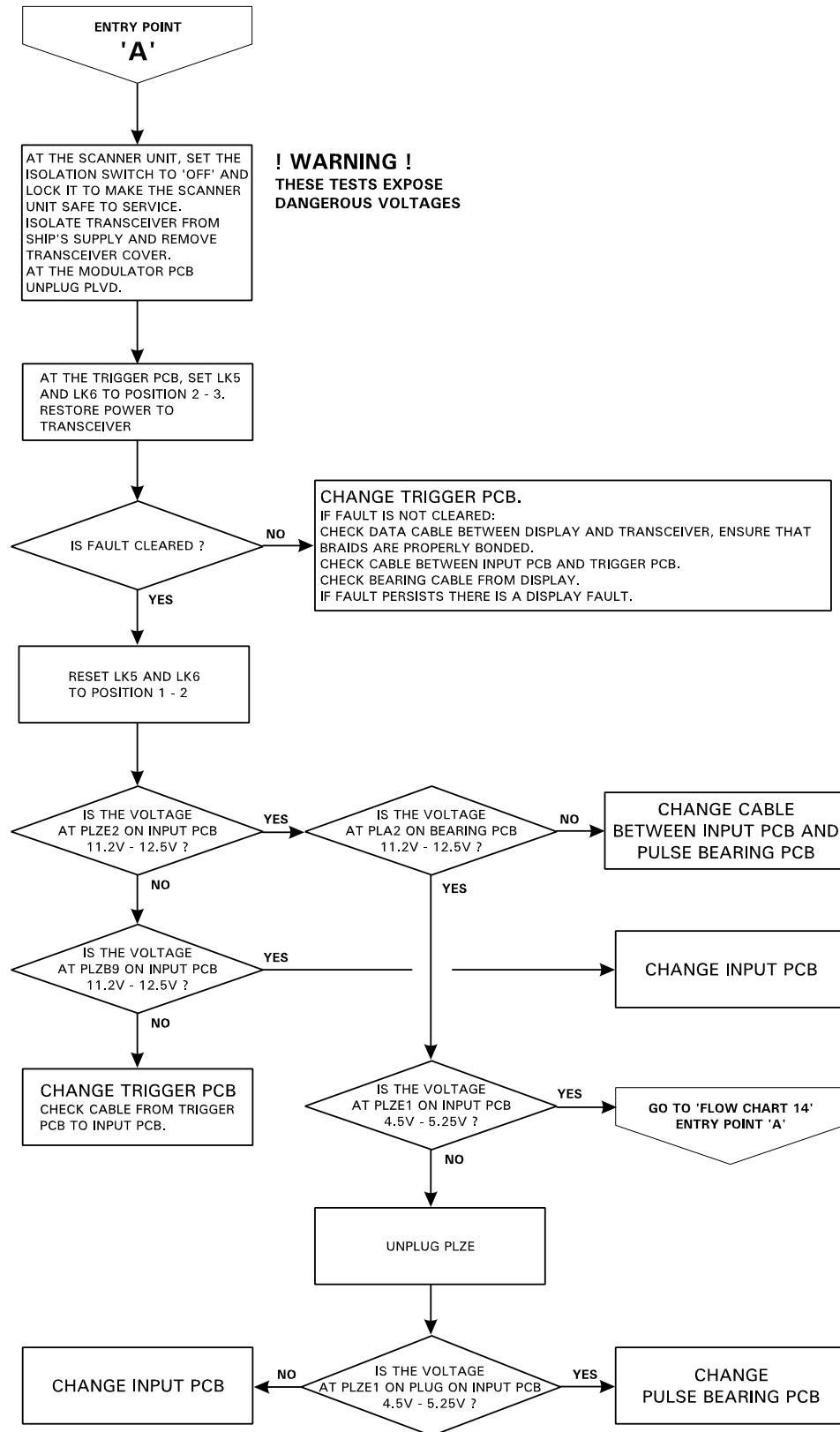
**FLOW CHART 12 - S-BAND SCANNER FAULTS  
 ('SPARK GAP TEST' Failure)**





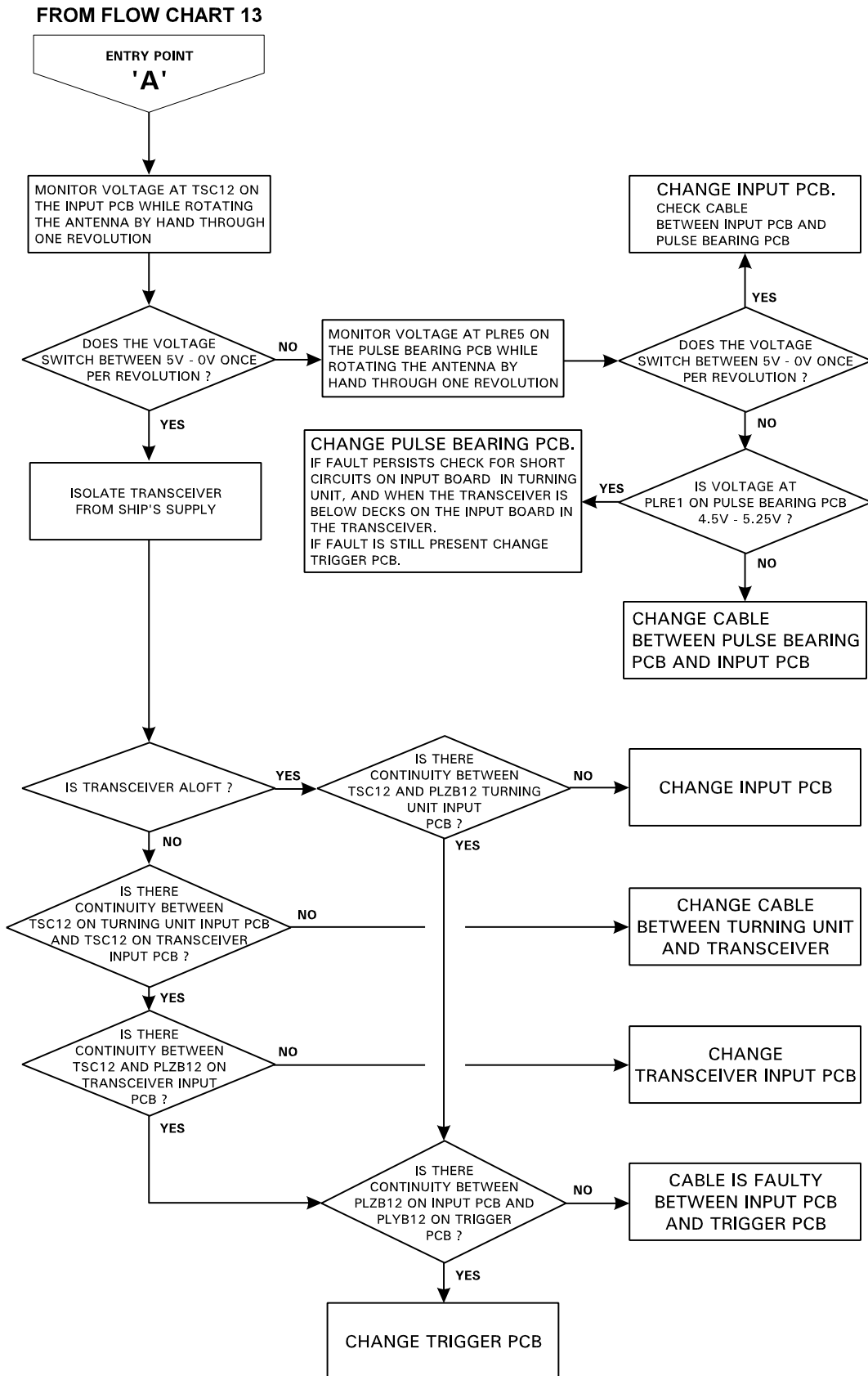
**FLOW CHART 13 - S-BAND SCANNER FAULTS  
(‘MISSING HMKR ERROR’ Displayed)**

FROM FLOW CHART 1 OR 25

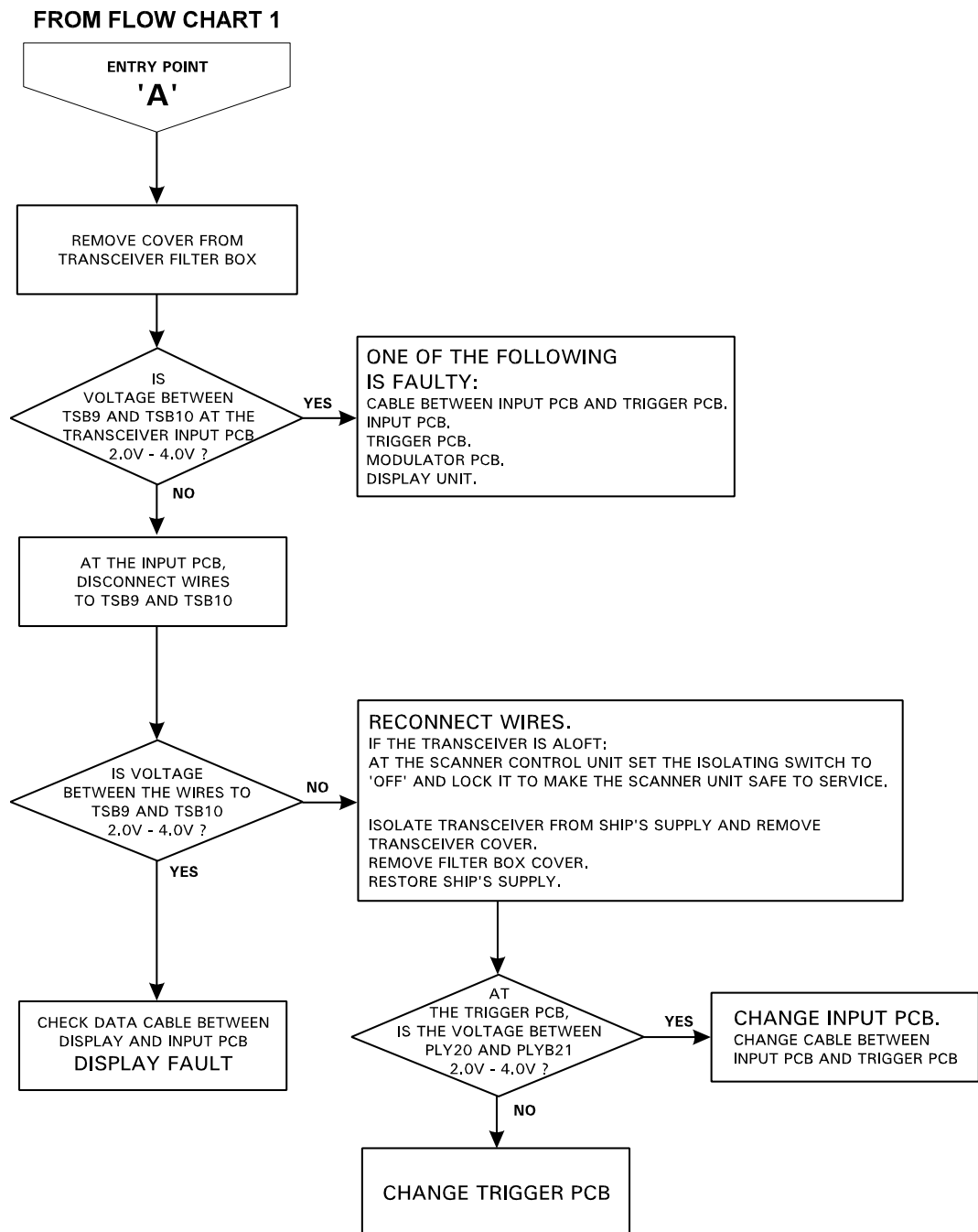


Fault Finding and First Line Servicing

**FLOW CHART 14 - S-BAND SCANNER FAULTS**

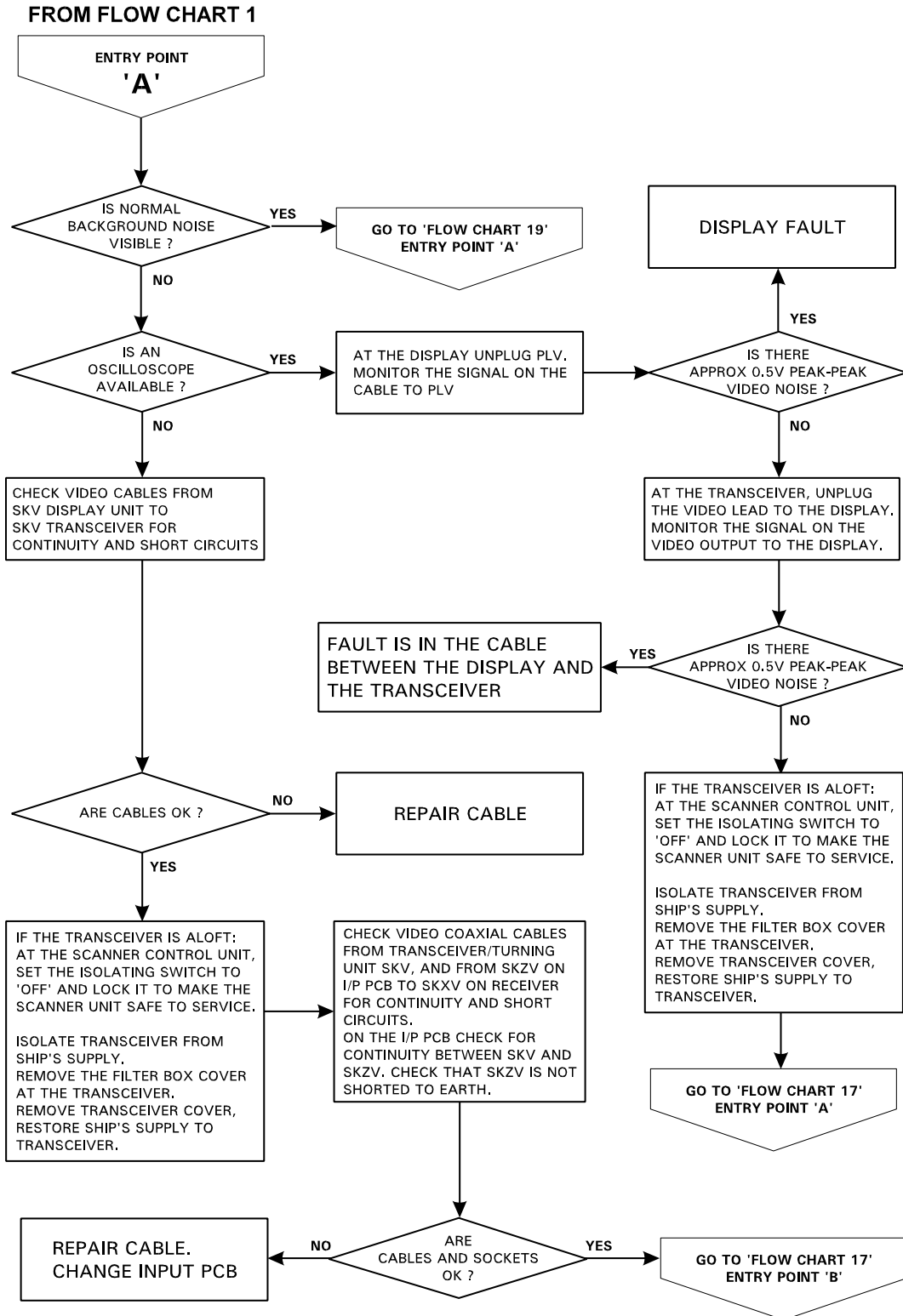


**FLOW CHART 15 - S-BAND SCANNER FAULTS  
(‘TRIGGER ERROR’ Displayed)**

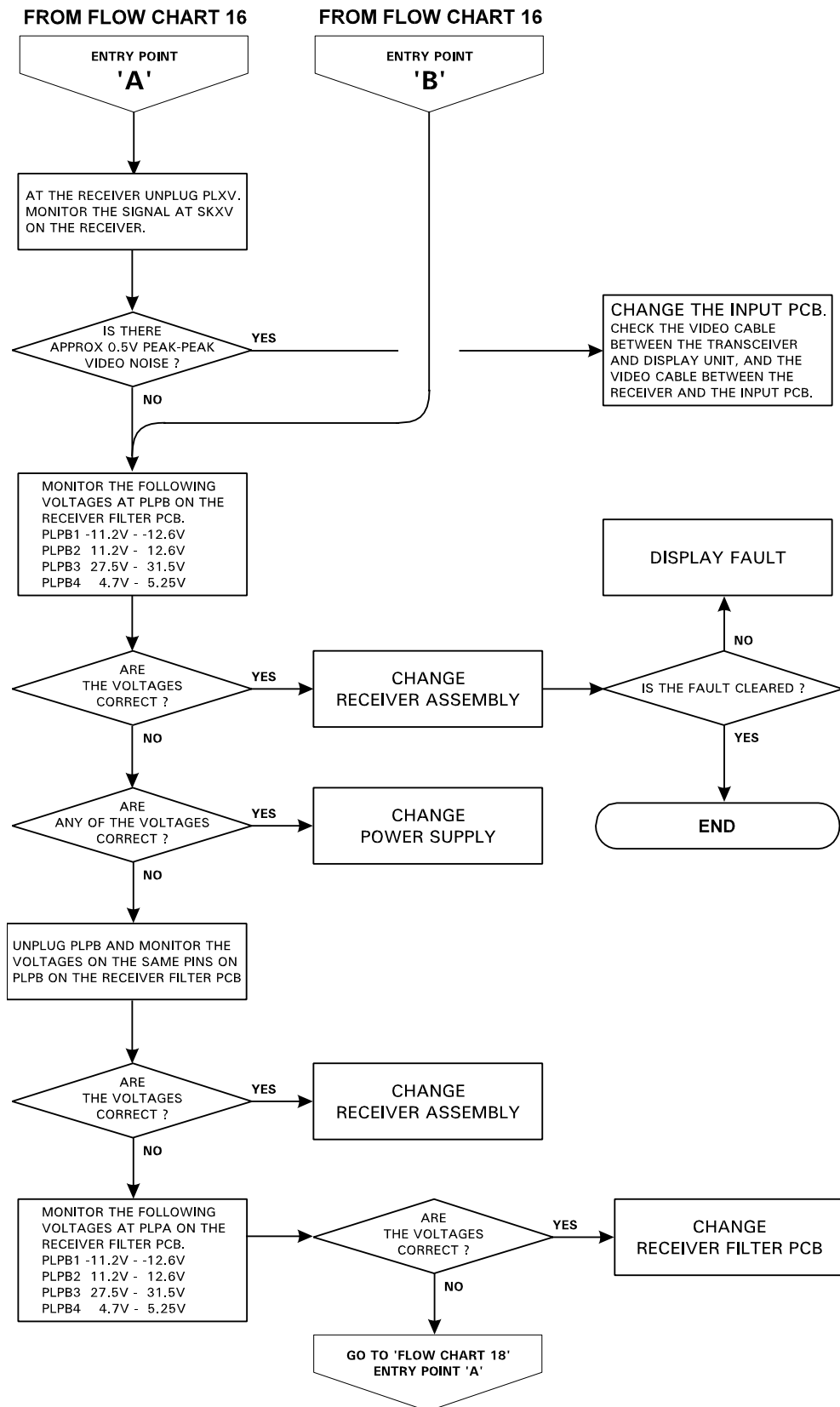


Fault Finding and First Line Servicing

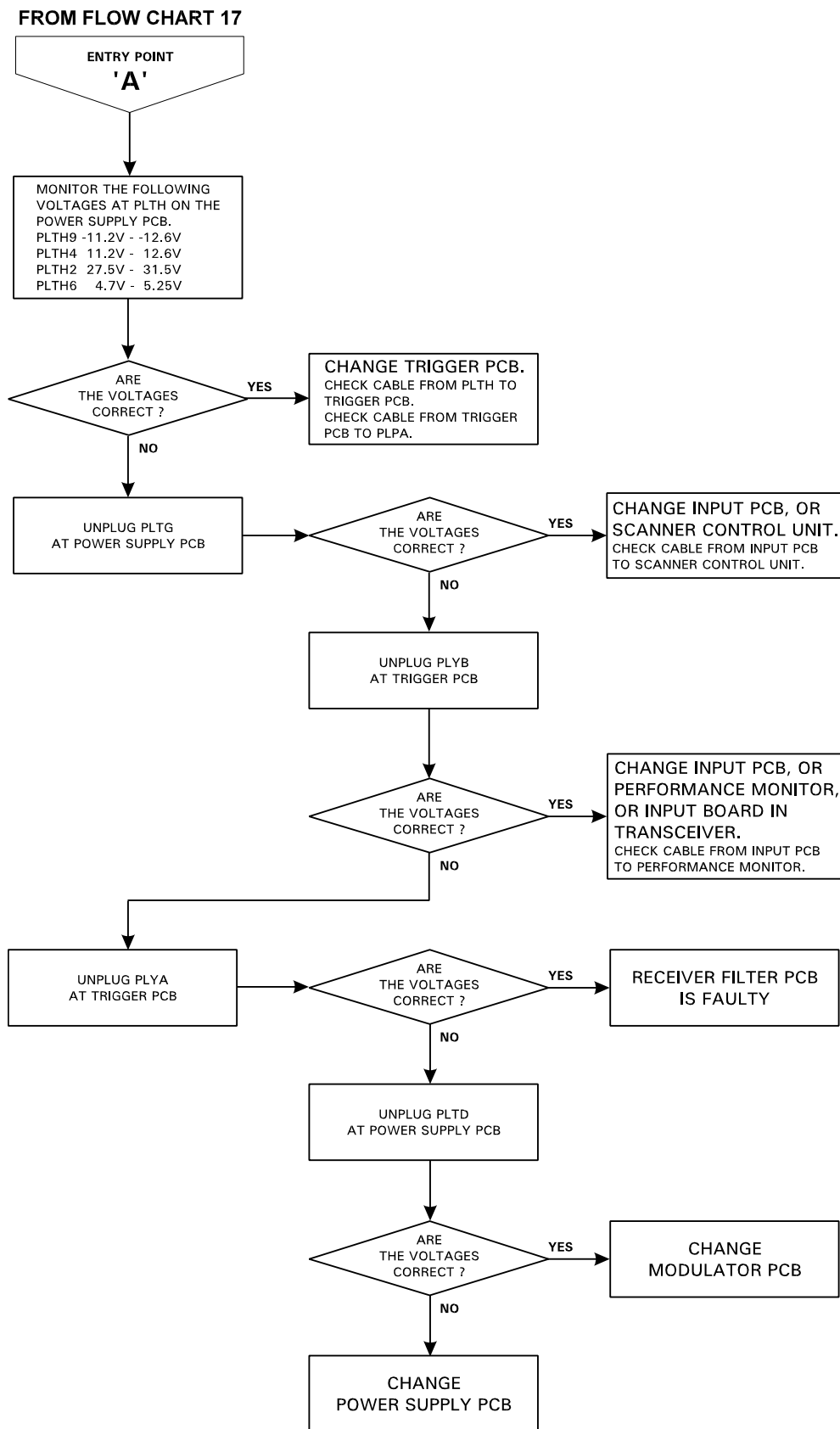
**FLOW CHART 16 - S-BAND SCANNER FAULTS**  
 ('TX ERROR'/'LOW VIDEO ERROR' Displayed)



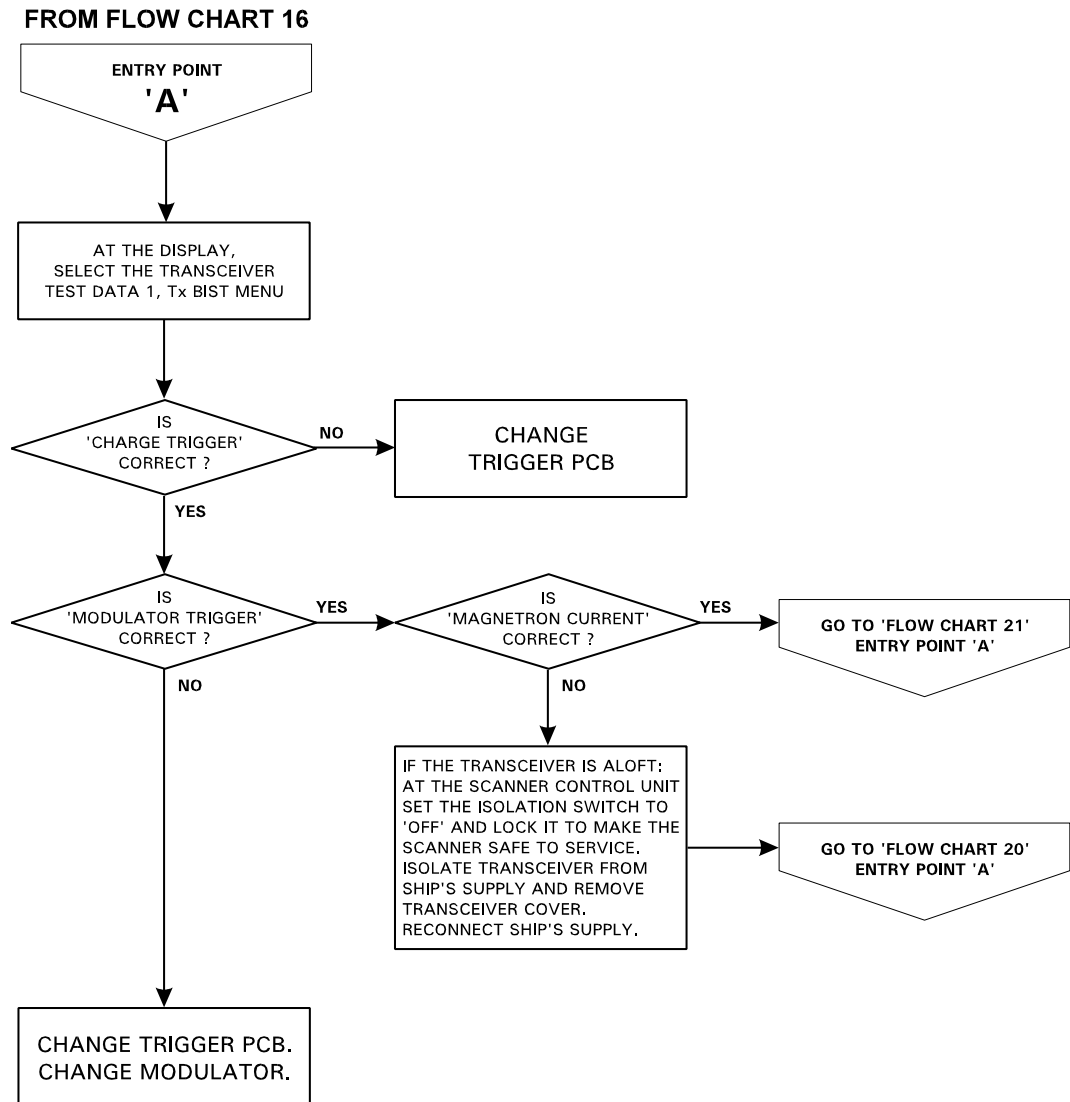
**FLOW CHART 17 - S-BAND SCANNER FAULTS**



**FLOW CHART 18 - S-BAND SCANNER FAULTS**

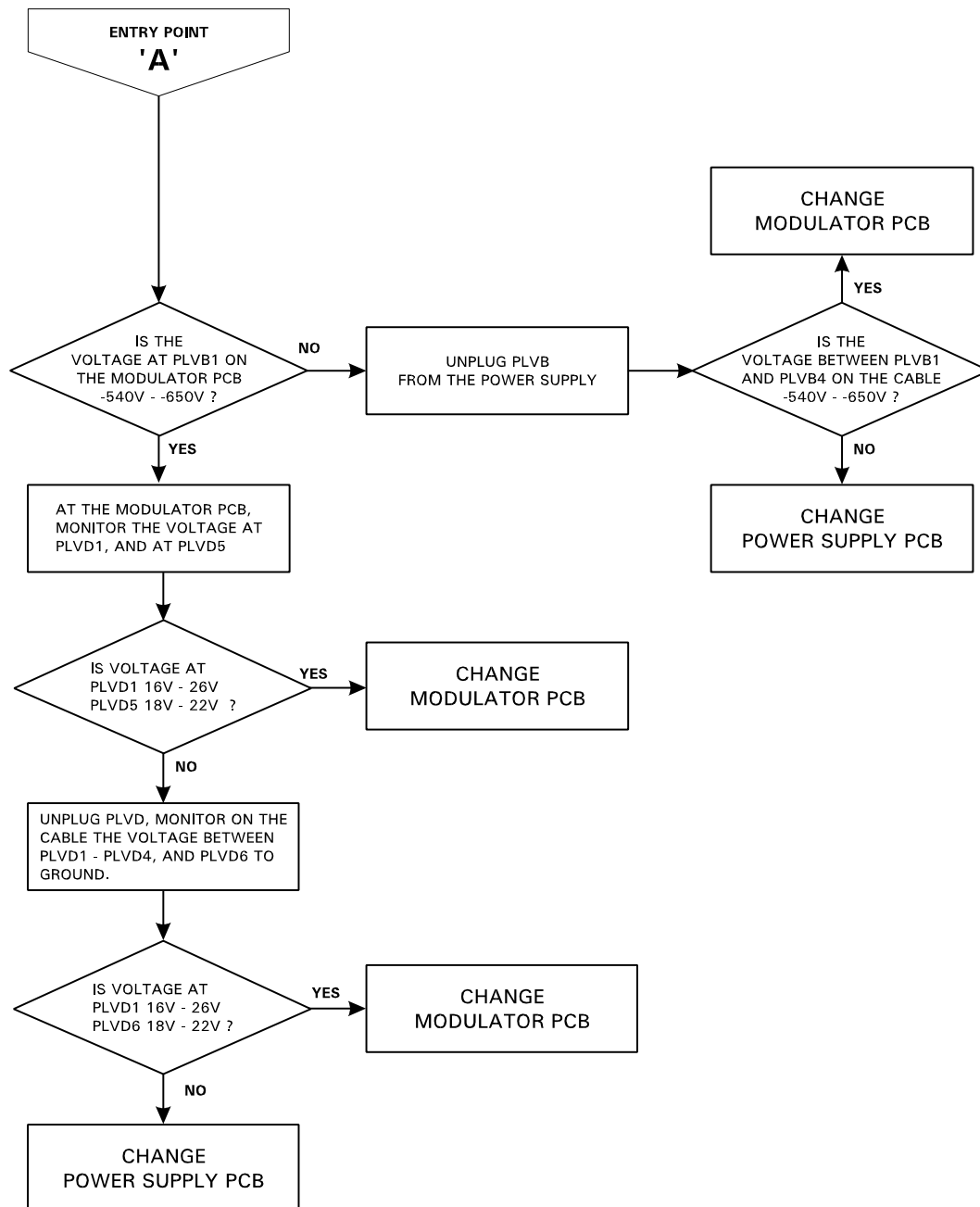


**FLOW CHART 19 - S-BAND SCANNER FAULTS  
(‘LOW VIDEO ERROR’ Displayed)**



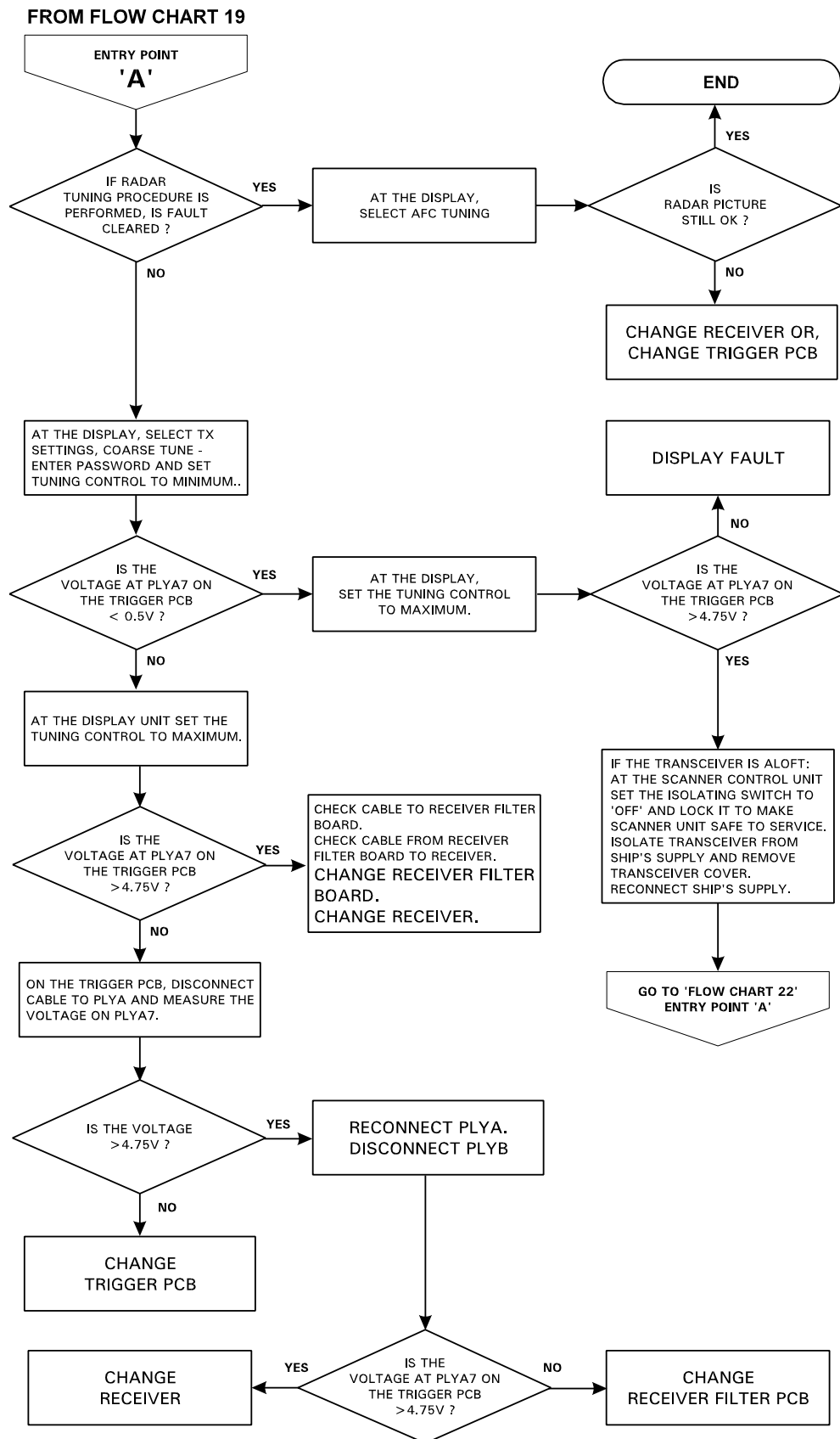
**FLOW CHART 20 - S-BAND SCANNER FAULTS**

FROM FLOW CHART 19 OR 24

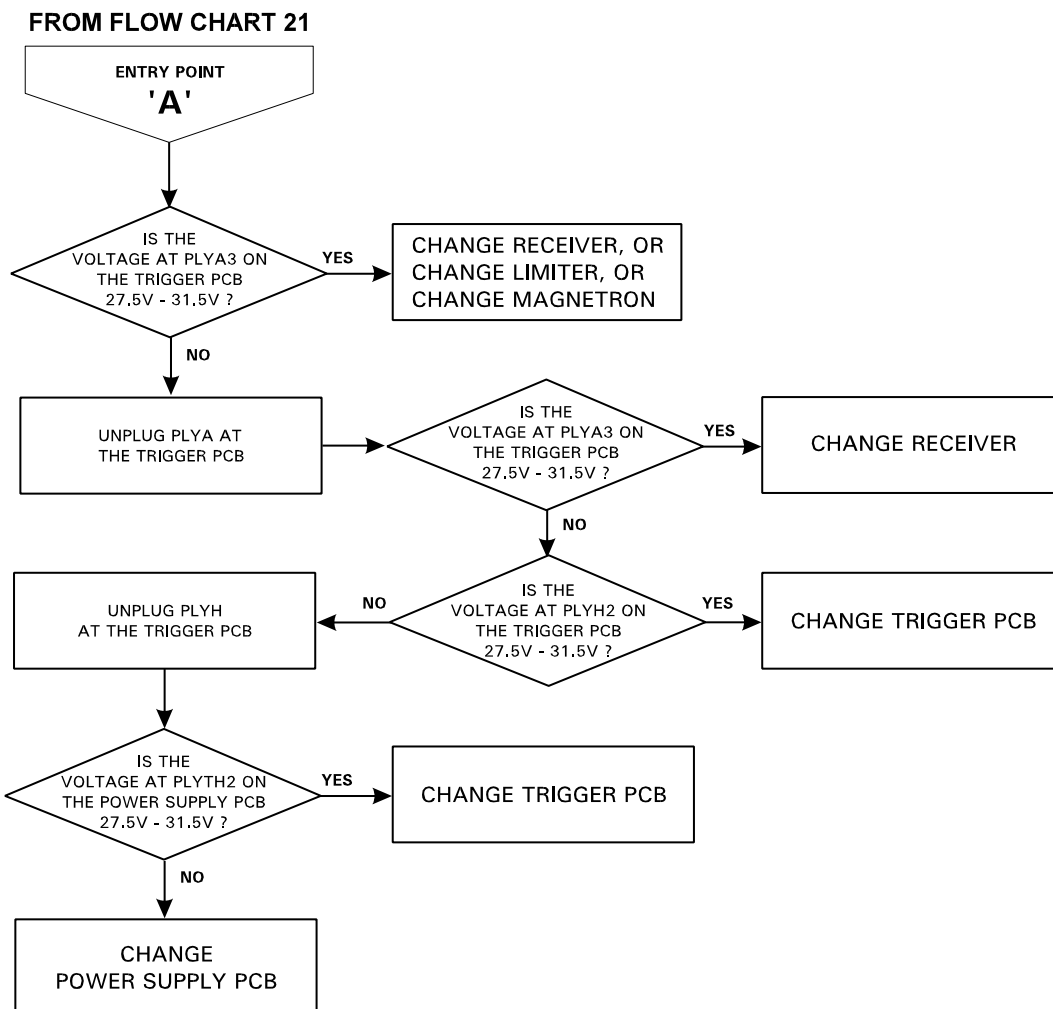




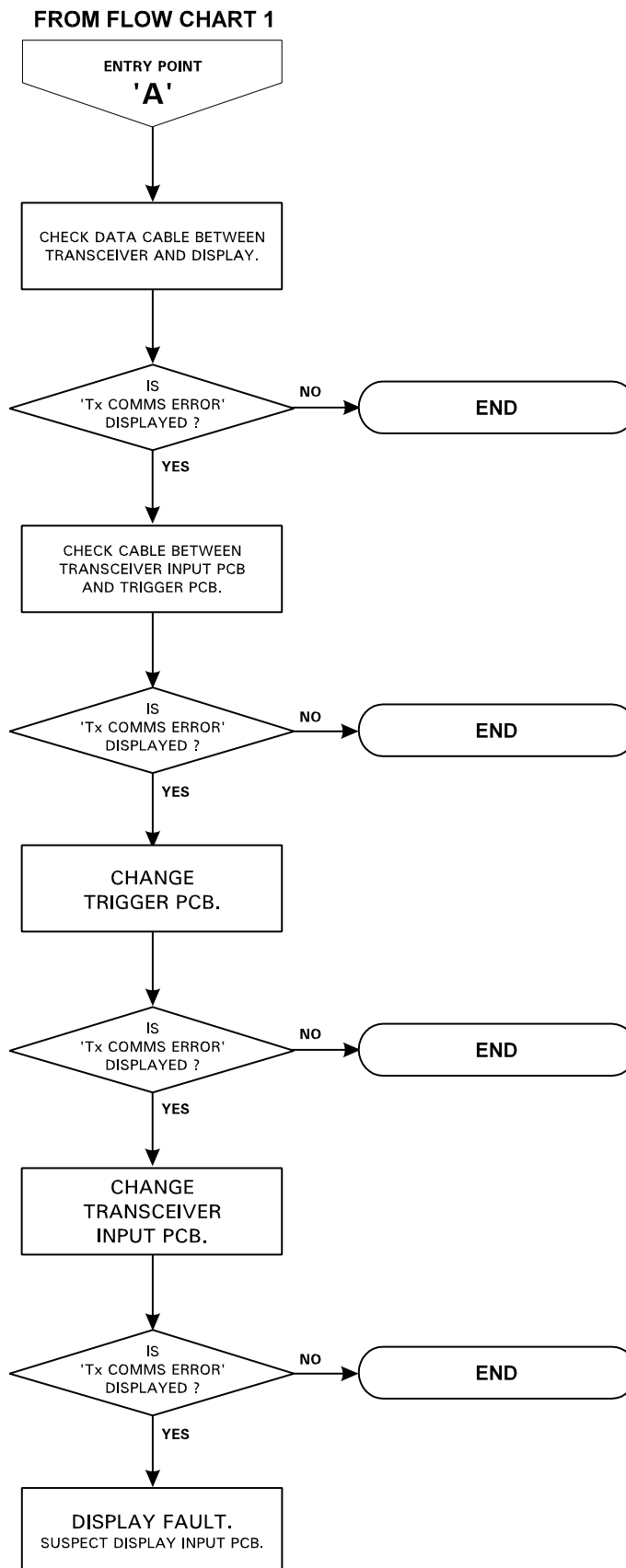
**FLOW CHART 21 - S-BAND SCANNER FAULTS**



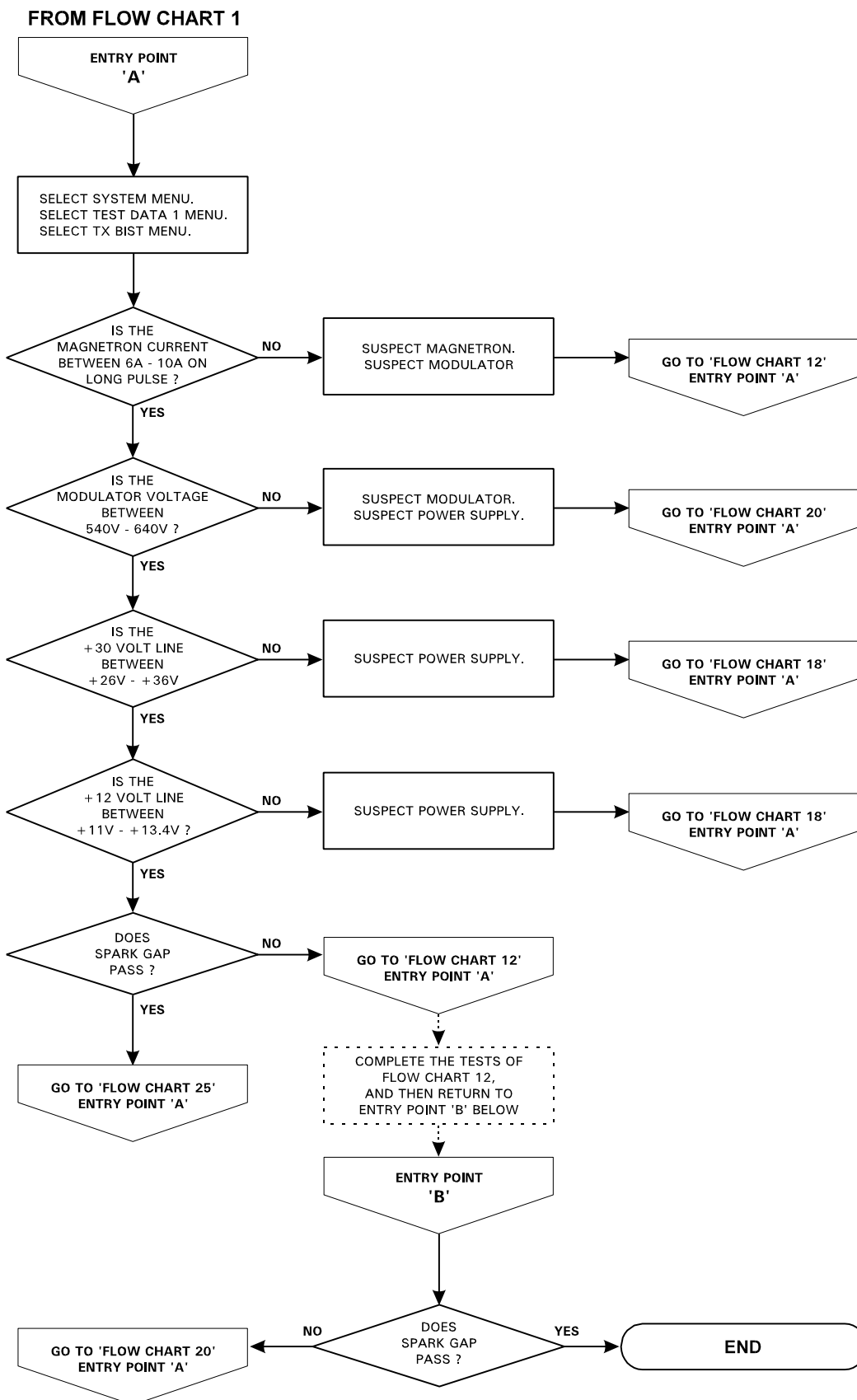
**FLOW CHART 22 - S-BAND SCANNER FAULTS**



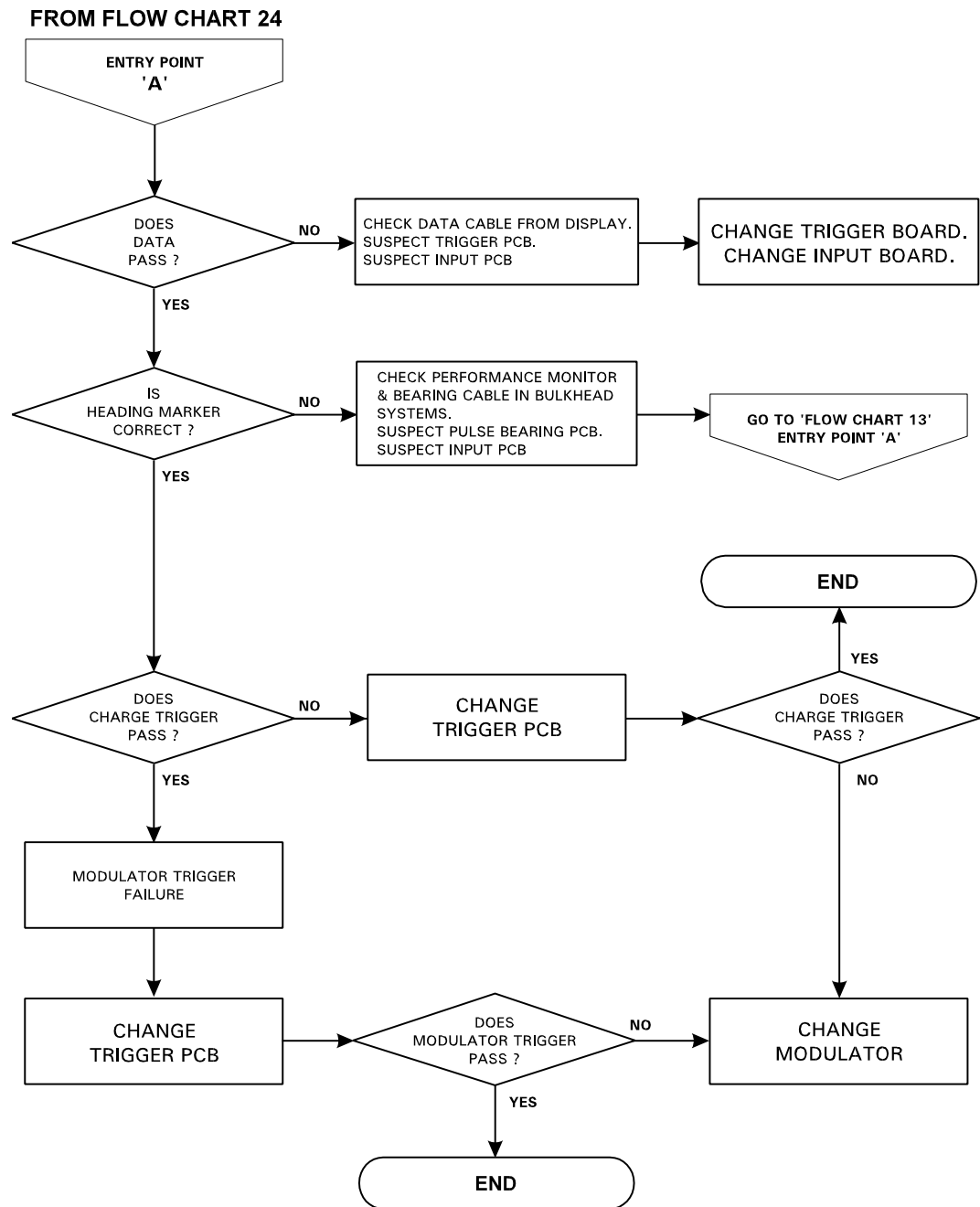
**FLOW CHART 23 - S-BAND SCANNER FAULTS  
(‘TX COMMS ERROR’ Displayed)**



**FLOW CHART 24 - S-BAND SCANNER FAULTS**  
 ('TX BIST ERROR' Displayed)



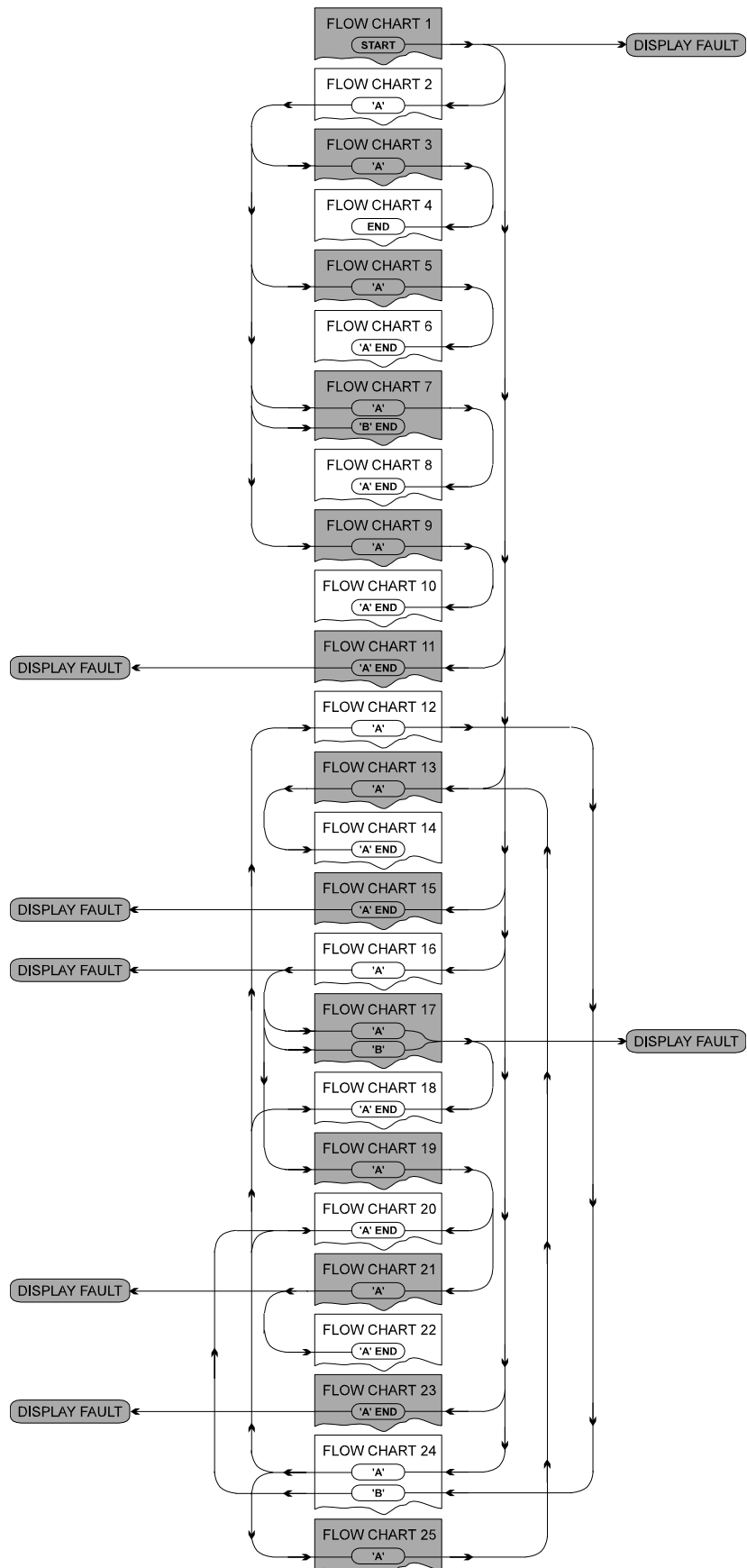
**FLOW CHART 25 - S-BAND SCANNER FAULTS**



## 2.3 X-Band Scanner Unit

Flow charts for isolating faults on X-Band Scanner Units are given on the following pages. The lead sheet shows the overall flow through individual Flow Charts 1 to 25.

**OVERALL FLOW CHART - X-BAND SCANNER FAULTS**

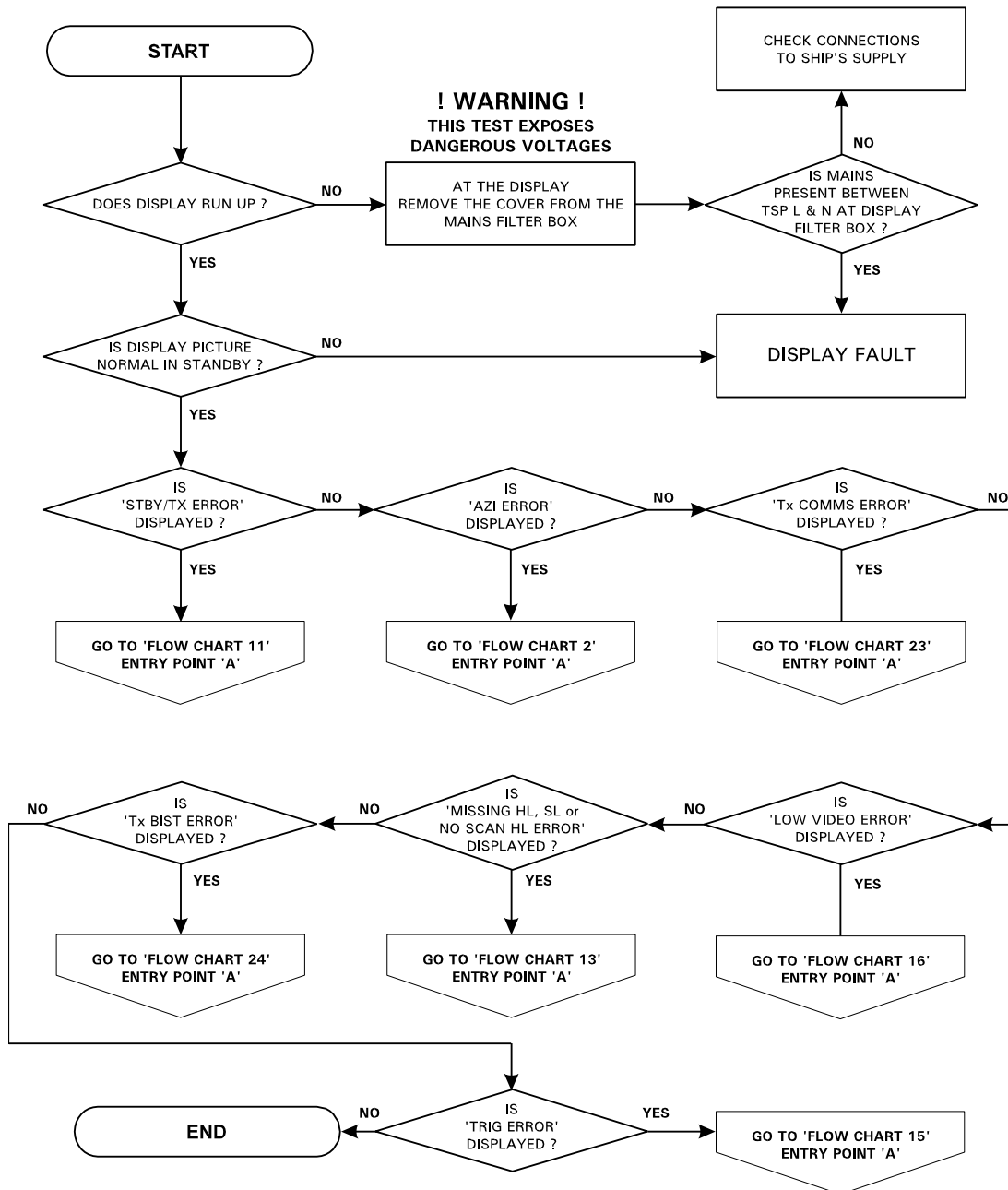


Fault Finding and First Line Servicing

**FLOW CHART 1 - X-BAND SCANNER FAULTS**

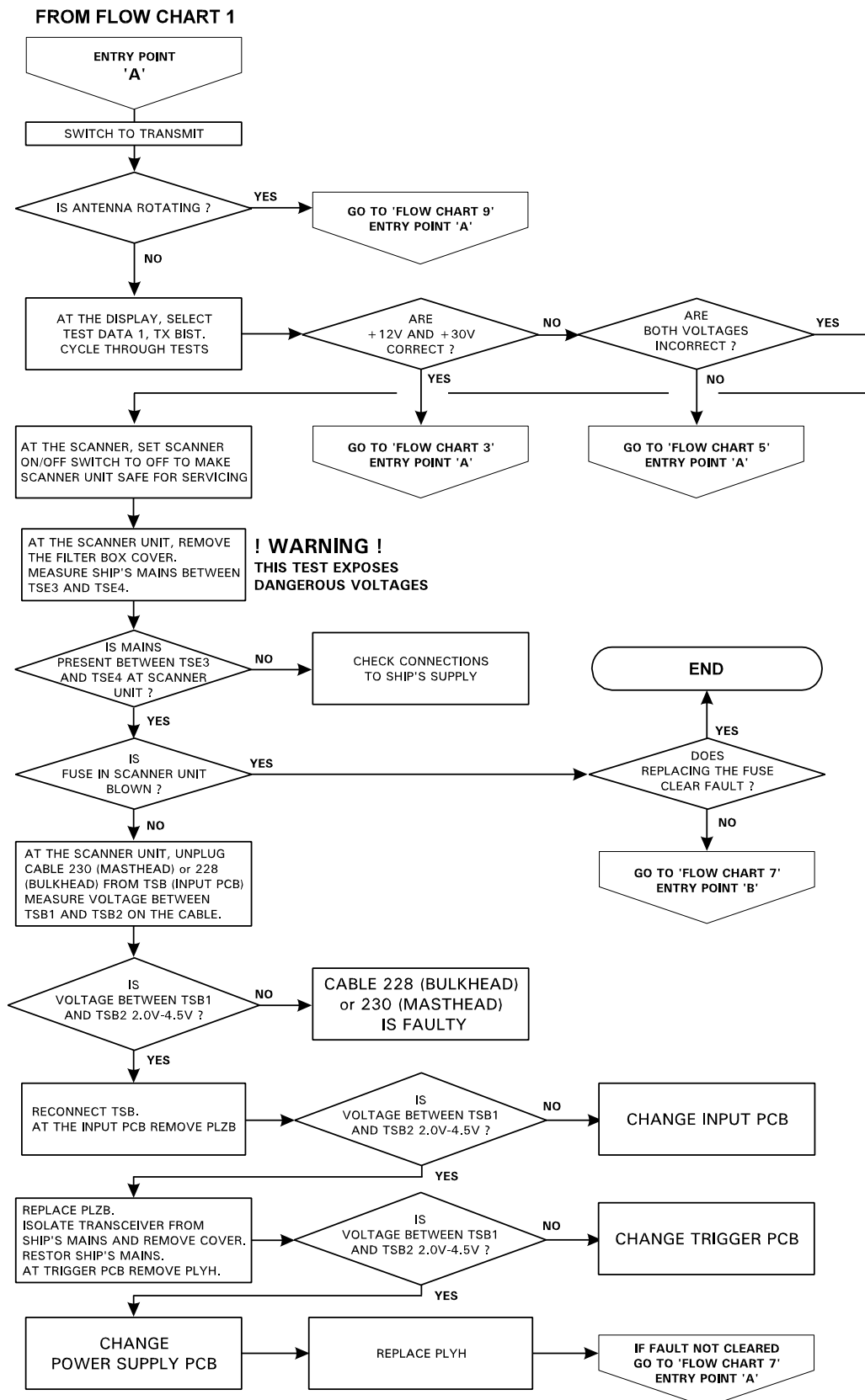
**! WARNING !**

WHEN THE COVERS ARE REMOVED FROM THE EQUIPMENT, DANGEROUS VOLTAGES ARE EXPOSED. ONLY QUALIFIED PERSONS SHOULD WORK ON THE EQUIPMENT WHEN POWER IS APPLIED. ALWAYS ISOLATE THE TURNING UNIT FROM THE SHIP'S SUPPLY BEFORE WORKING ON IT. ALWAYS ISOLATE THE TRANSCEIVER FROM THE SHIP'S SUPPLY WHILE REMOVING OR REPLACING THE TRANSCEIVER COVER



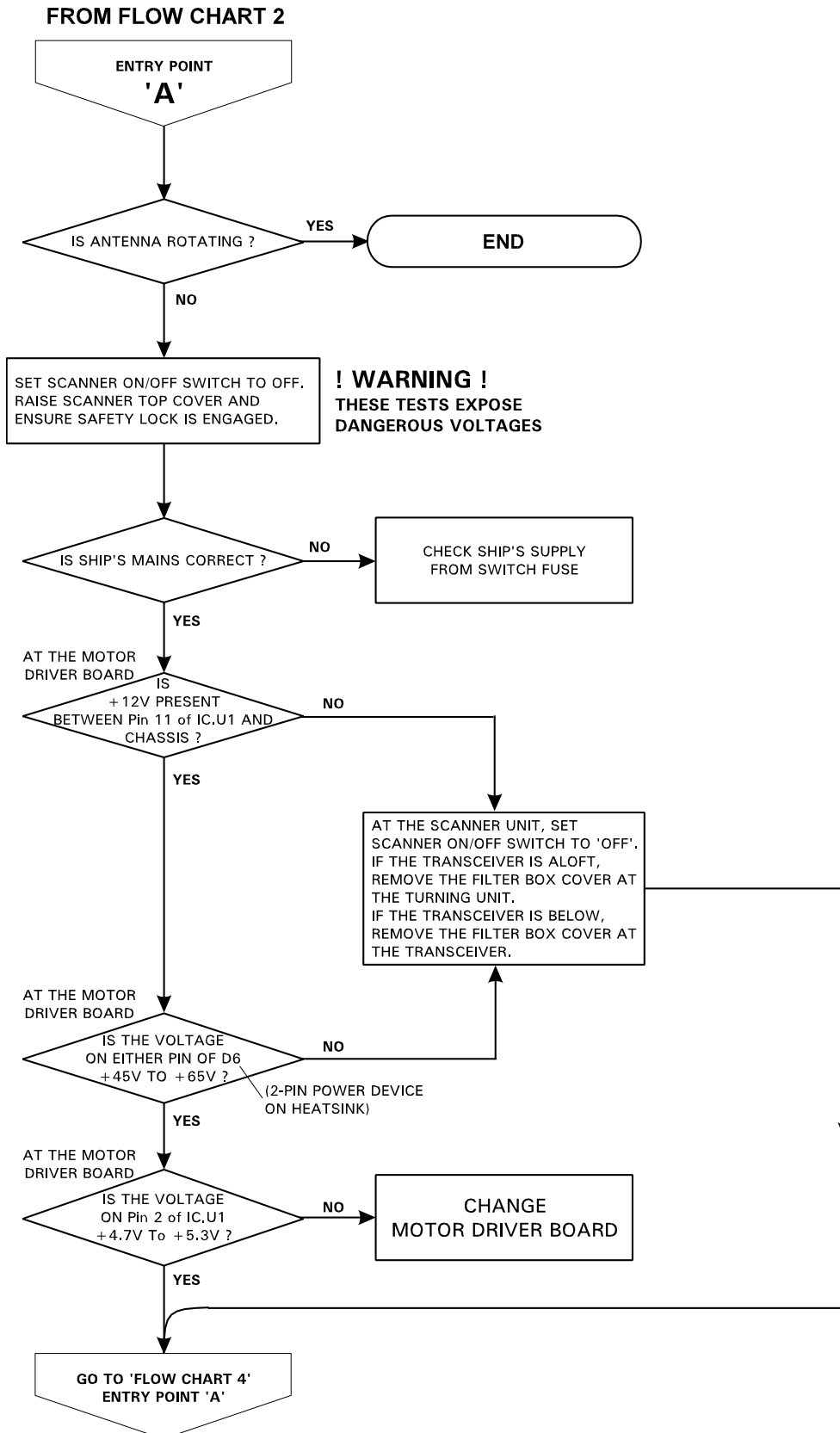


**FLOW CHART 2 - X-BAND SCANNER FAULTS  
(‘AZI ERROR’ Displayed)**

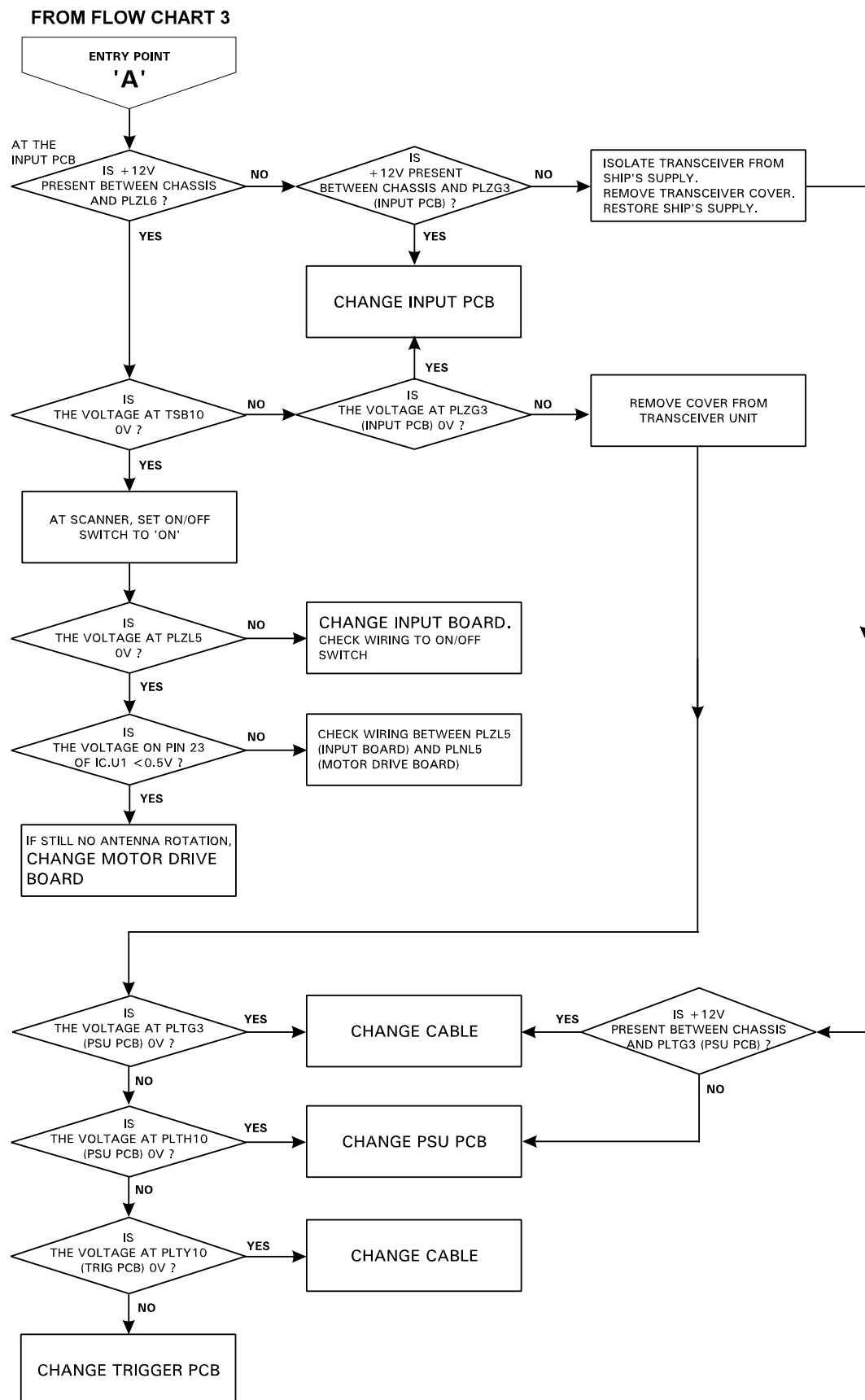


Fault Finding and First Line Servicing

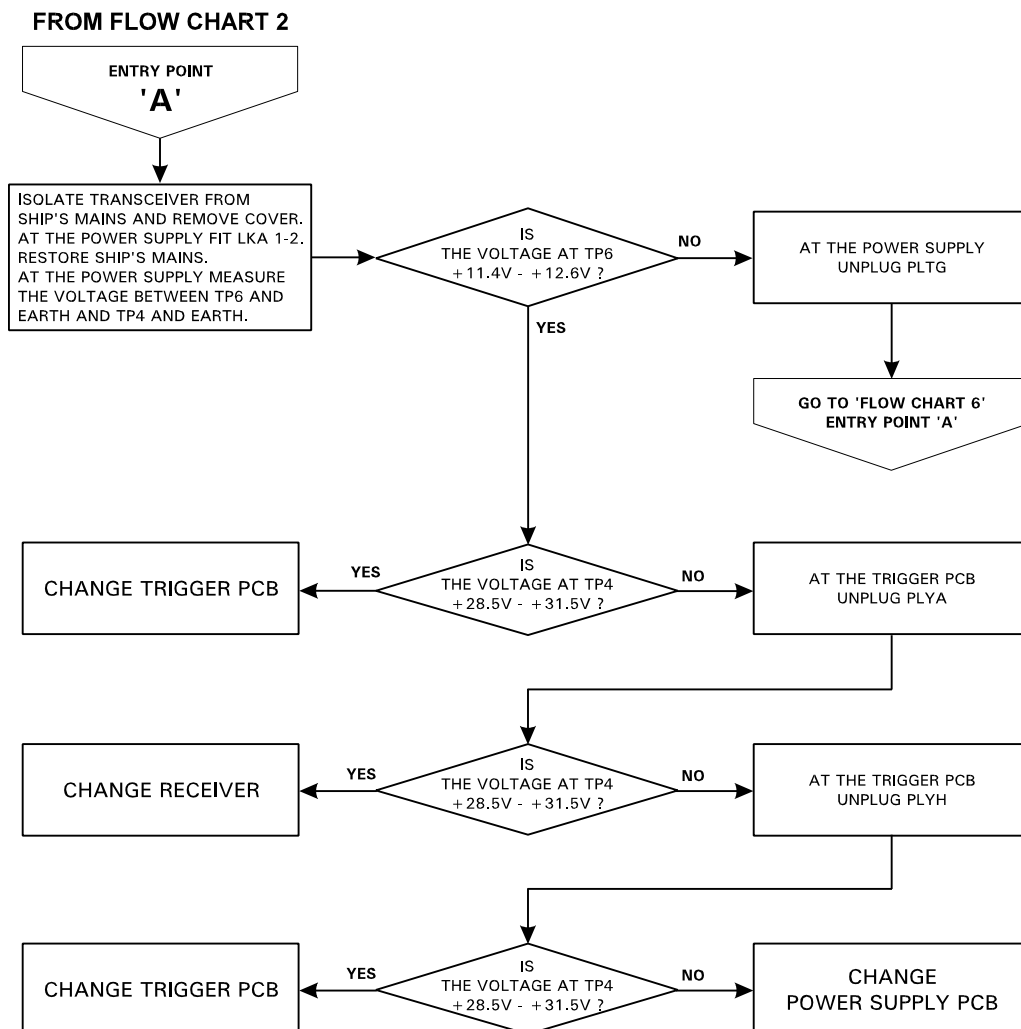
**FLOW CHART 3 - X-BAND SCANNER FAULTS**



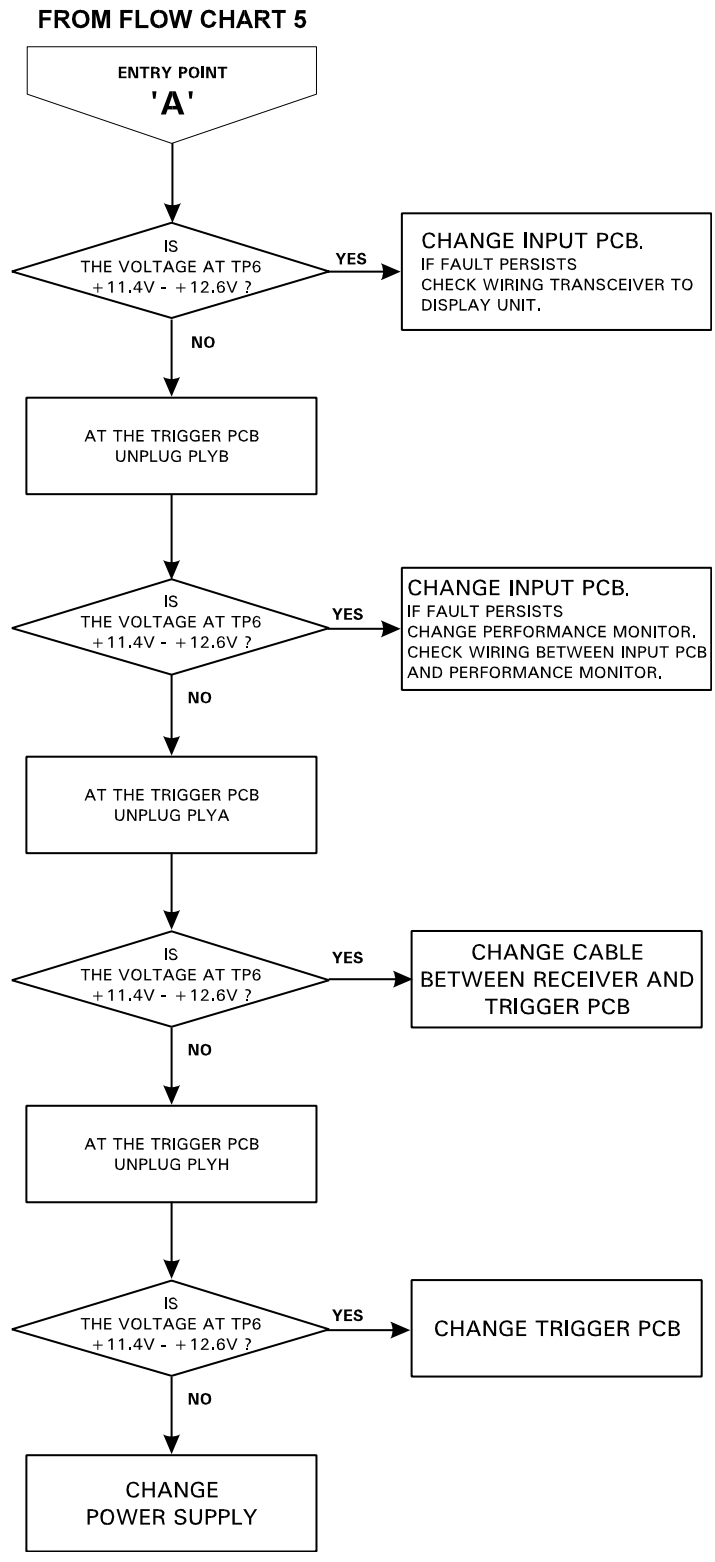
**FLOW CHART 4 - X-BAND SCANNER FAULTS**



**FLOW CHART 5 - X-BAND SCANNER FAULTS**

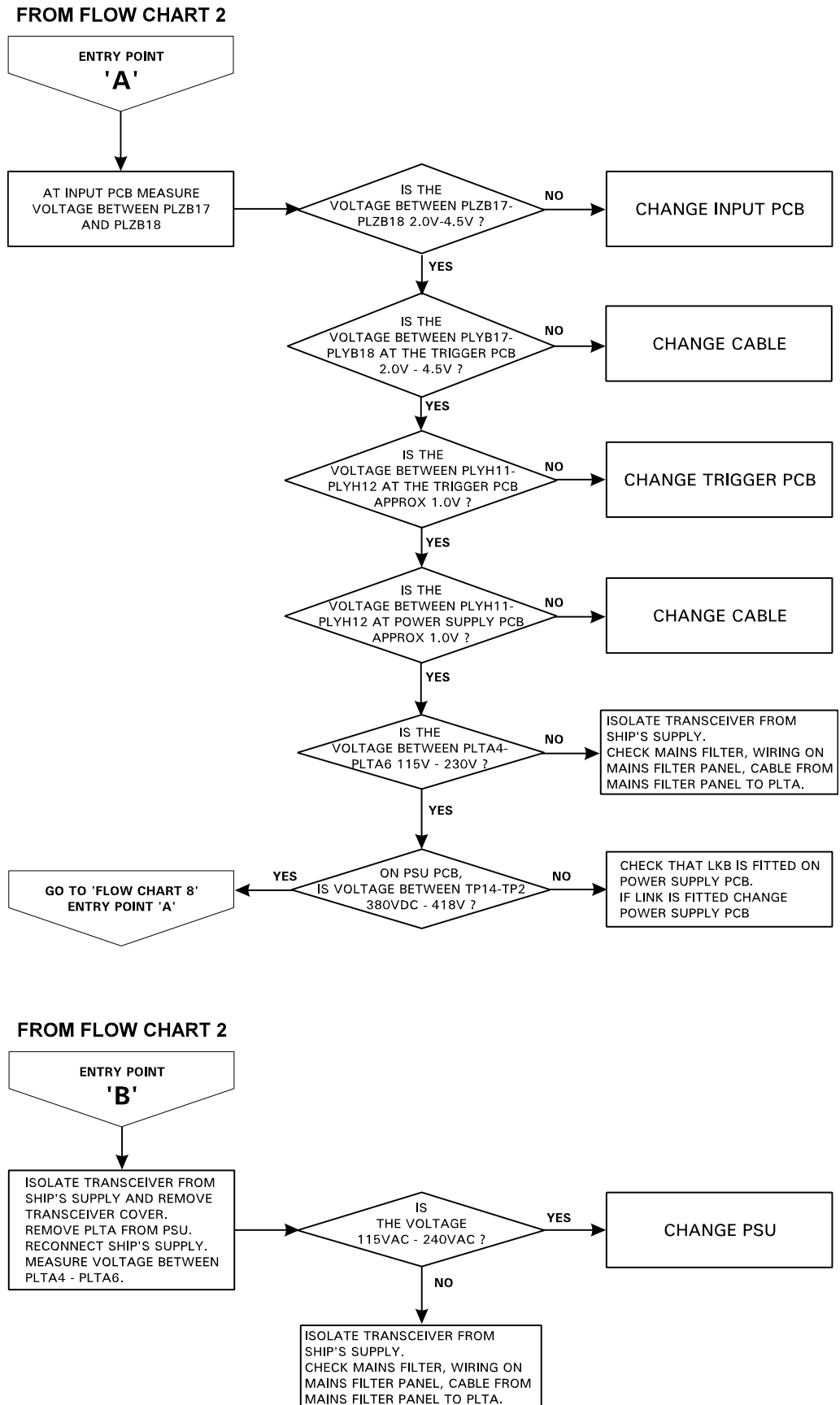


**FLOW CHART 6 - X-BAND SCANNER FAULTS**

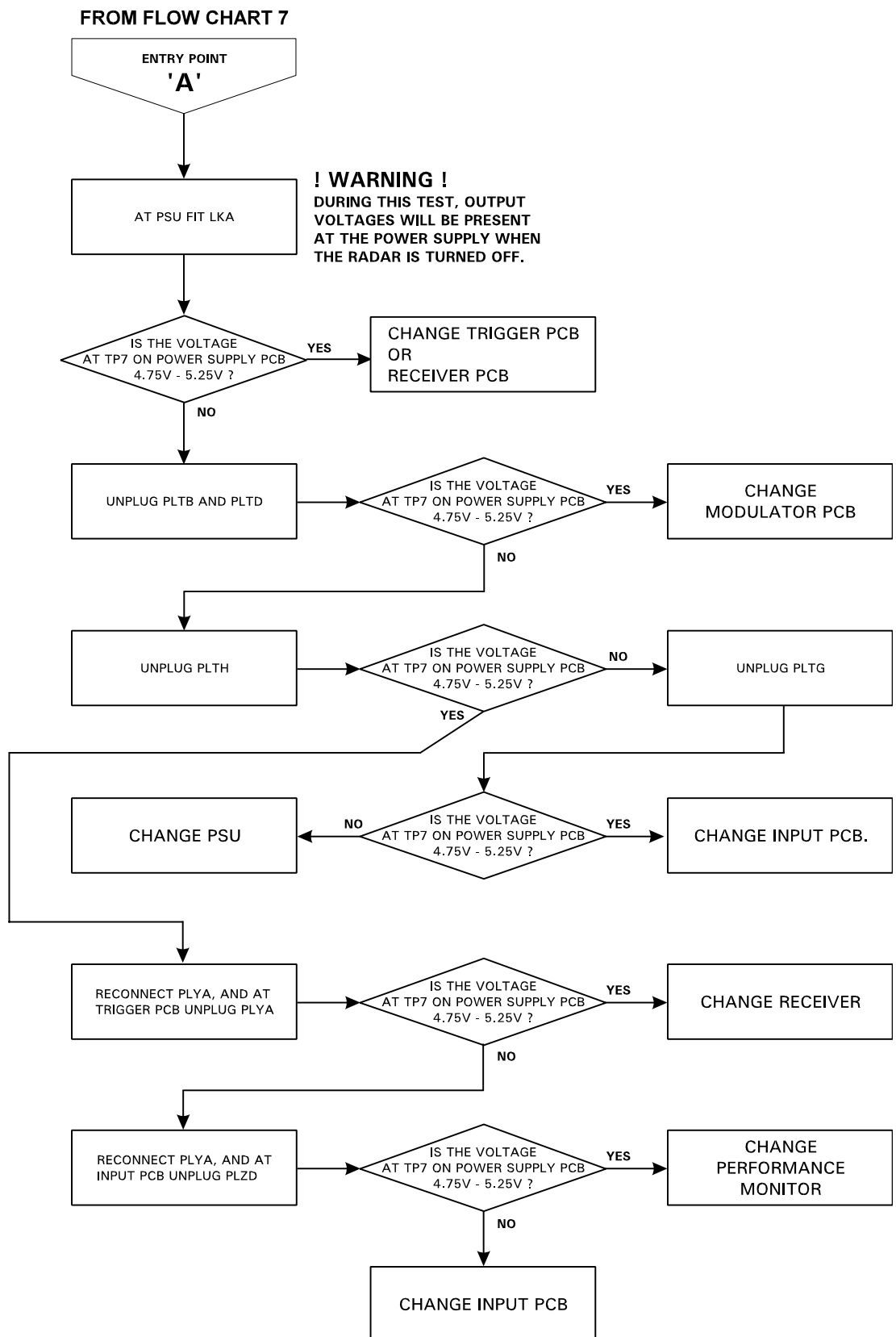


Fault Finding and First Line Servicing

**FLOW CHART 7 - X-BAND SCANNER FAULTS**

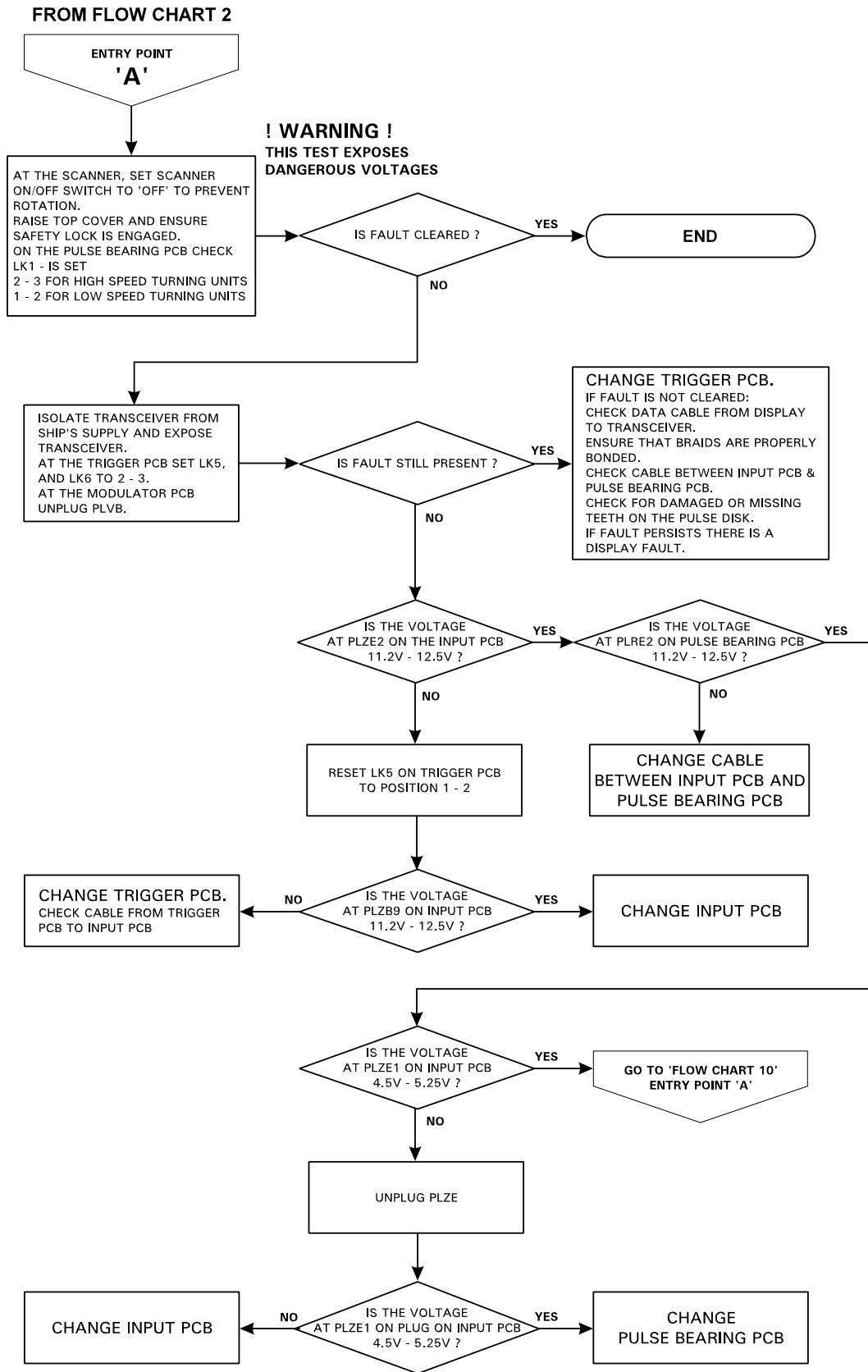


**FLOW CHART 8 - X-BAND SCANNER FAULTS**



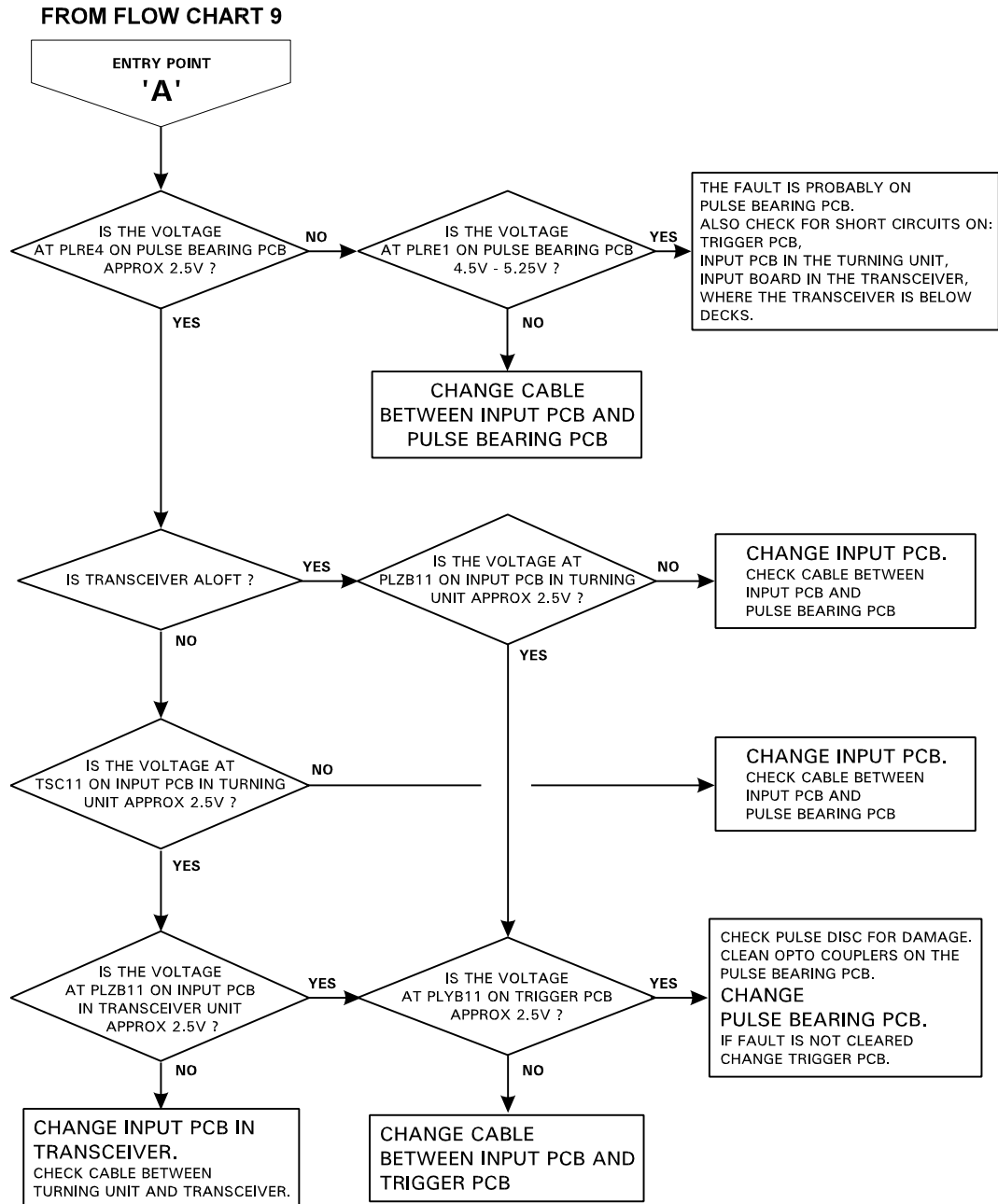
Fault Finding and First Line Servicing

**FLOW CHART 9 - X-BAND SCANNER FAULTS**



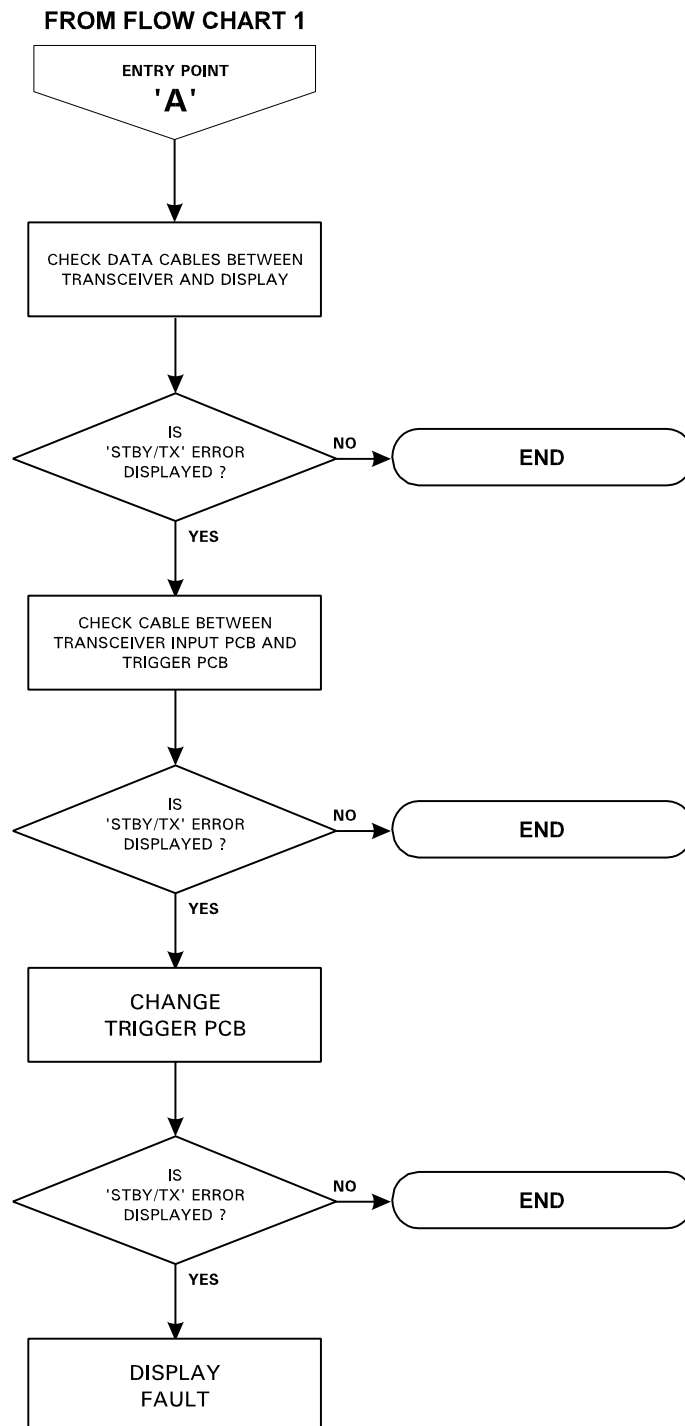


**FLOW CHART 10 - X-BAND SCANNER FAULTS**

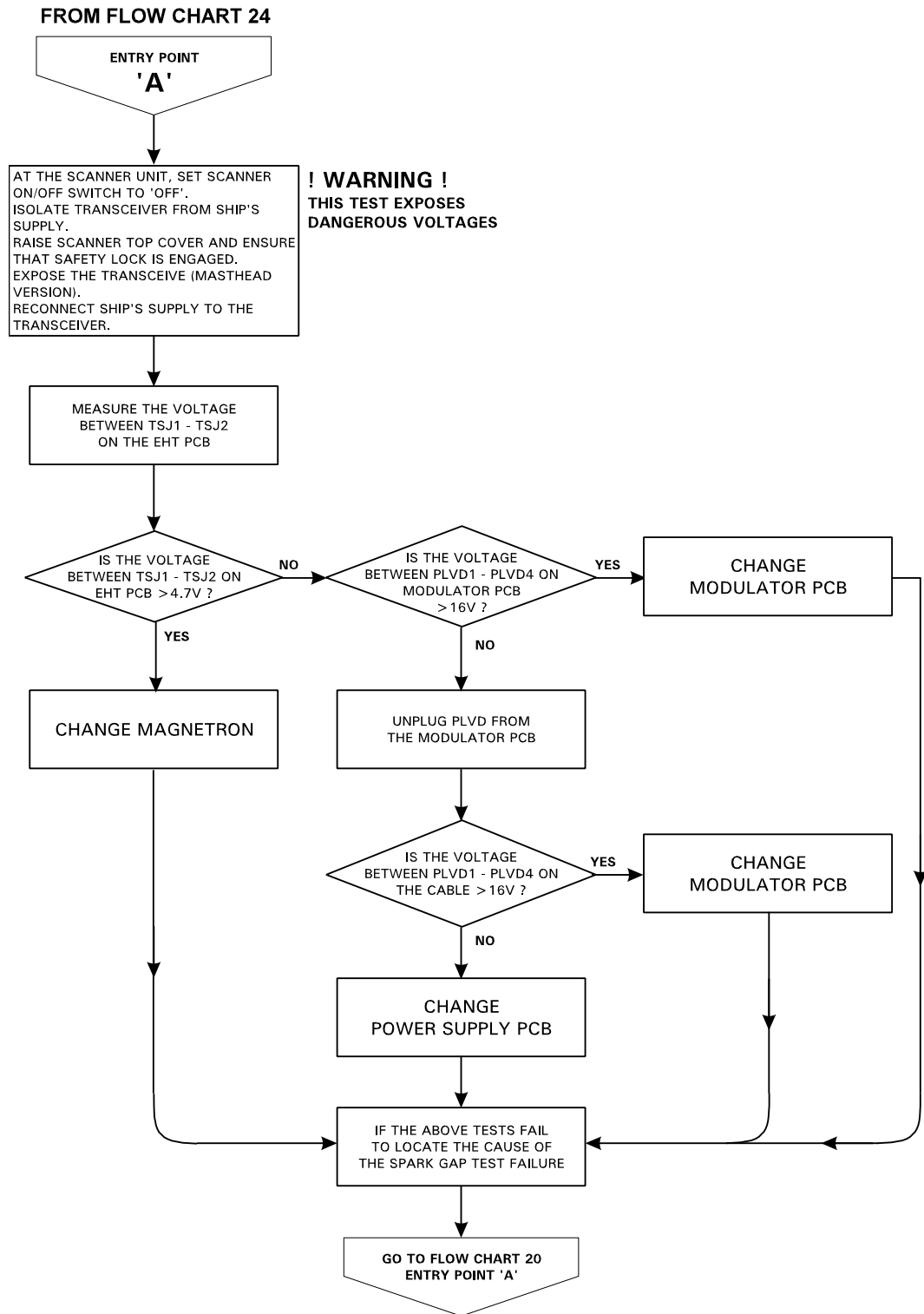


Fault Finding and First Line Servicing

**FLOW CHART 11 - X-BAND SCANNER FAULTS**  
(**'STBY/TX ERROR'** Displayed)



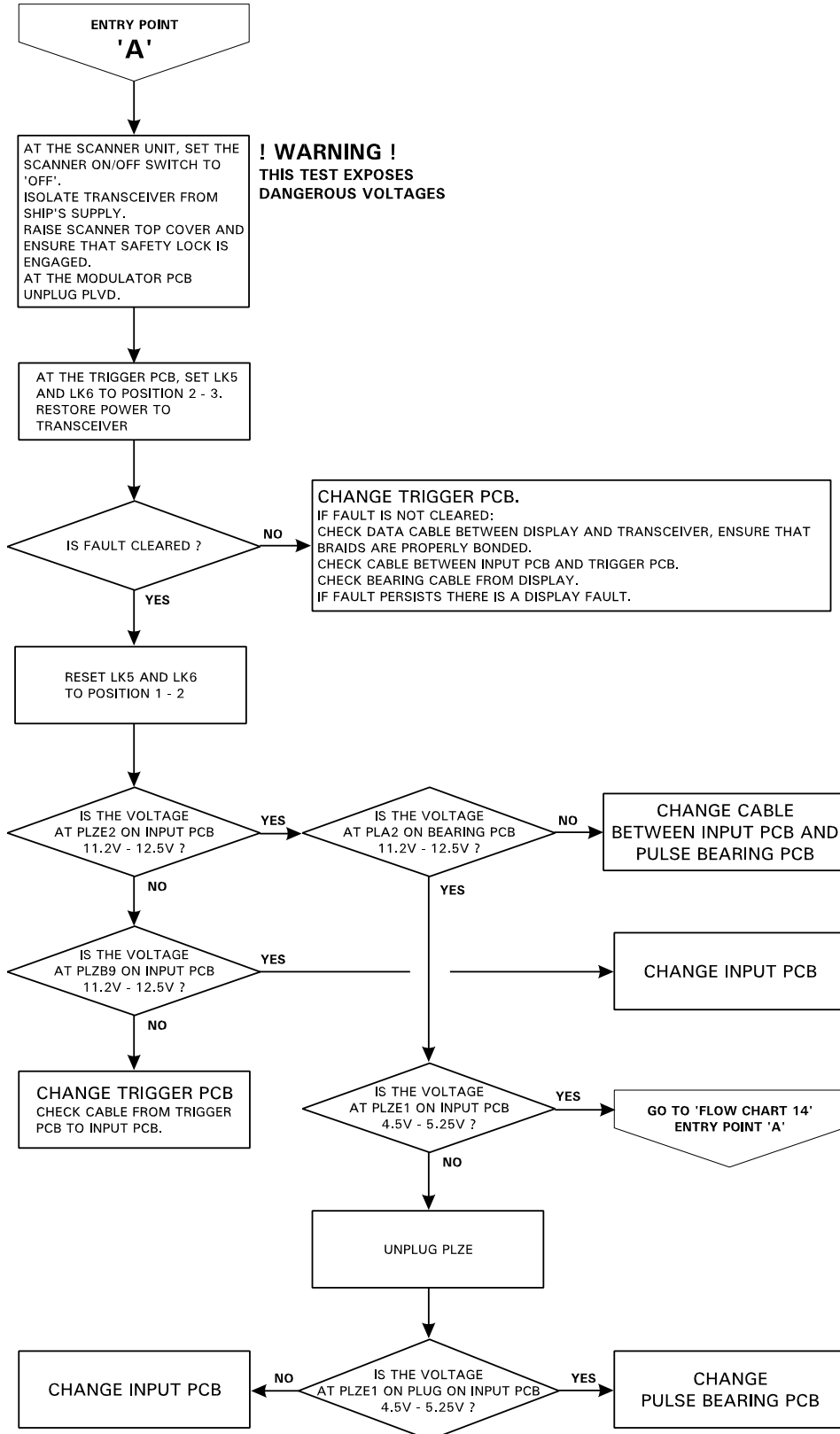
**FLOW CHART 12 - X-BAND SCANNER FAULTS  
('SPARK GAP TEST' Failure)**



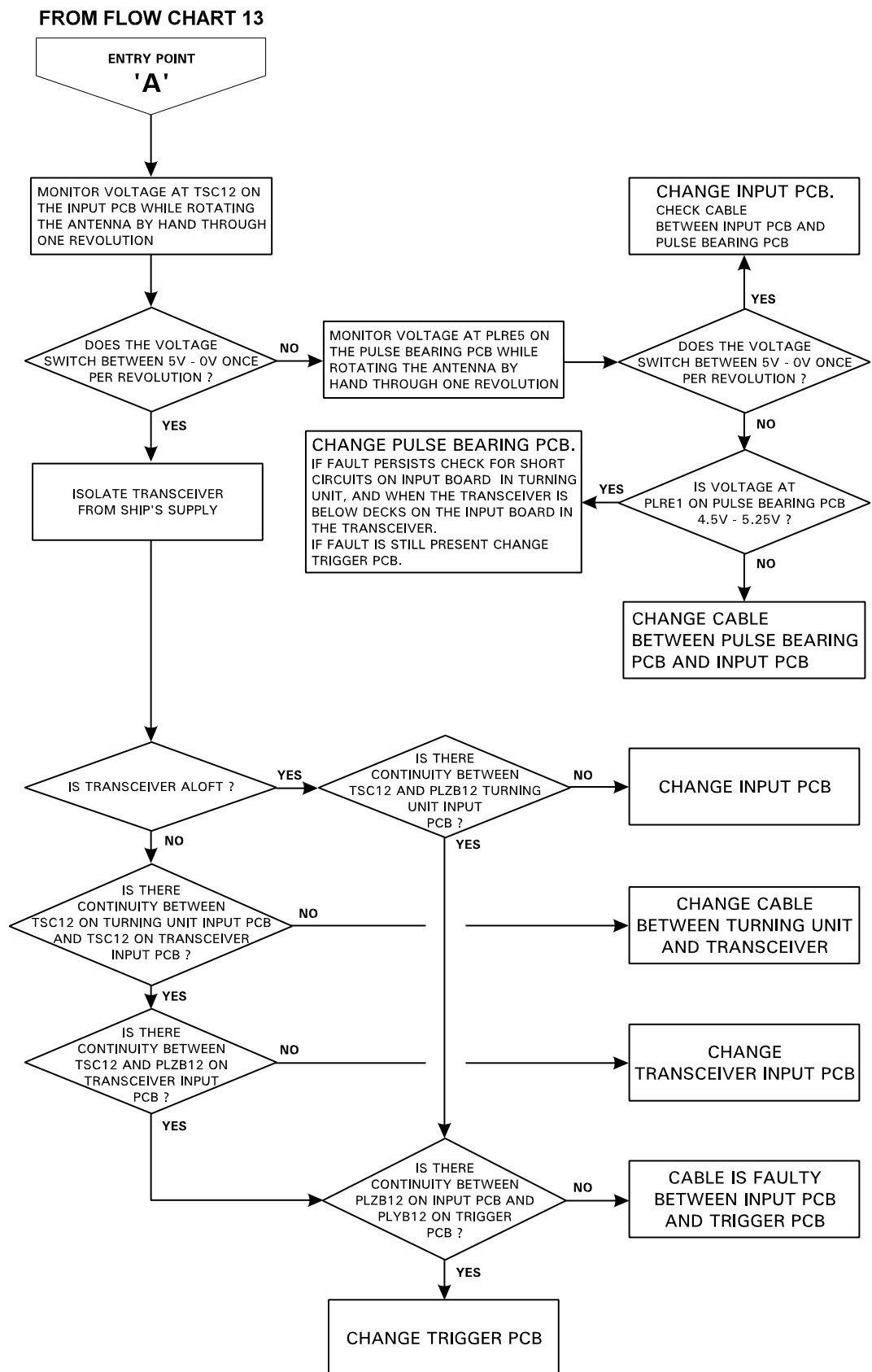
Fault Finding and First Line Servicing

**FLOW CHART 13 - X-BAND SCANNER FAULTS  
( 'MISSING HMKR ERROR' Displayed )**

FROM FLOW CHART 1 OR 25

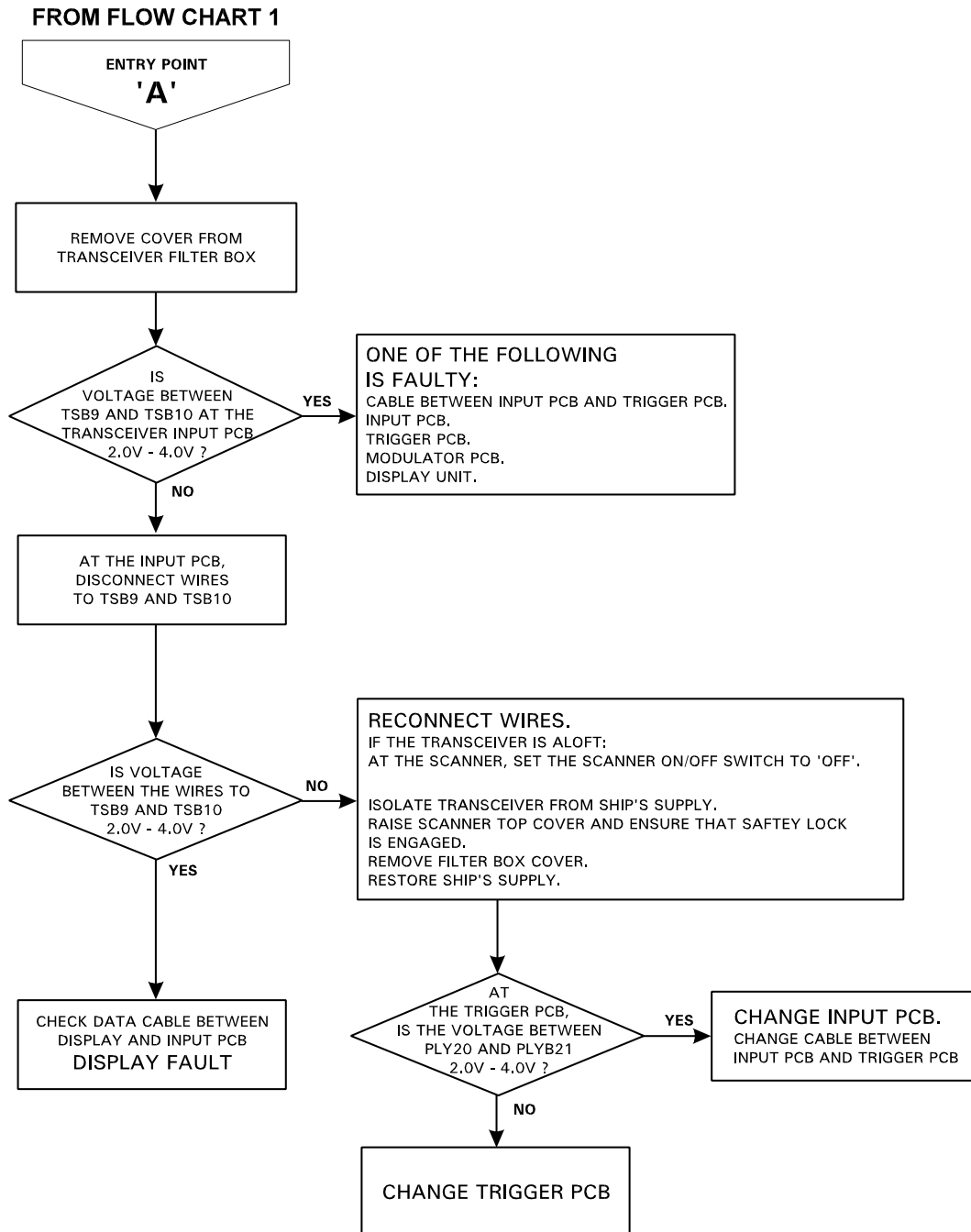


**FLOW CHART 14 - X-BAND SCANNER FAULTS**

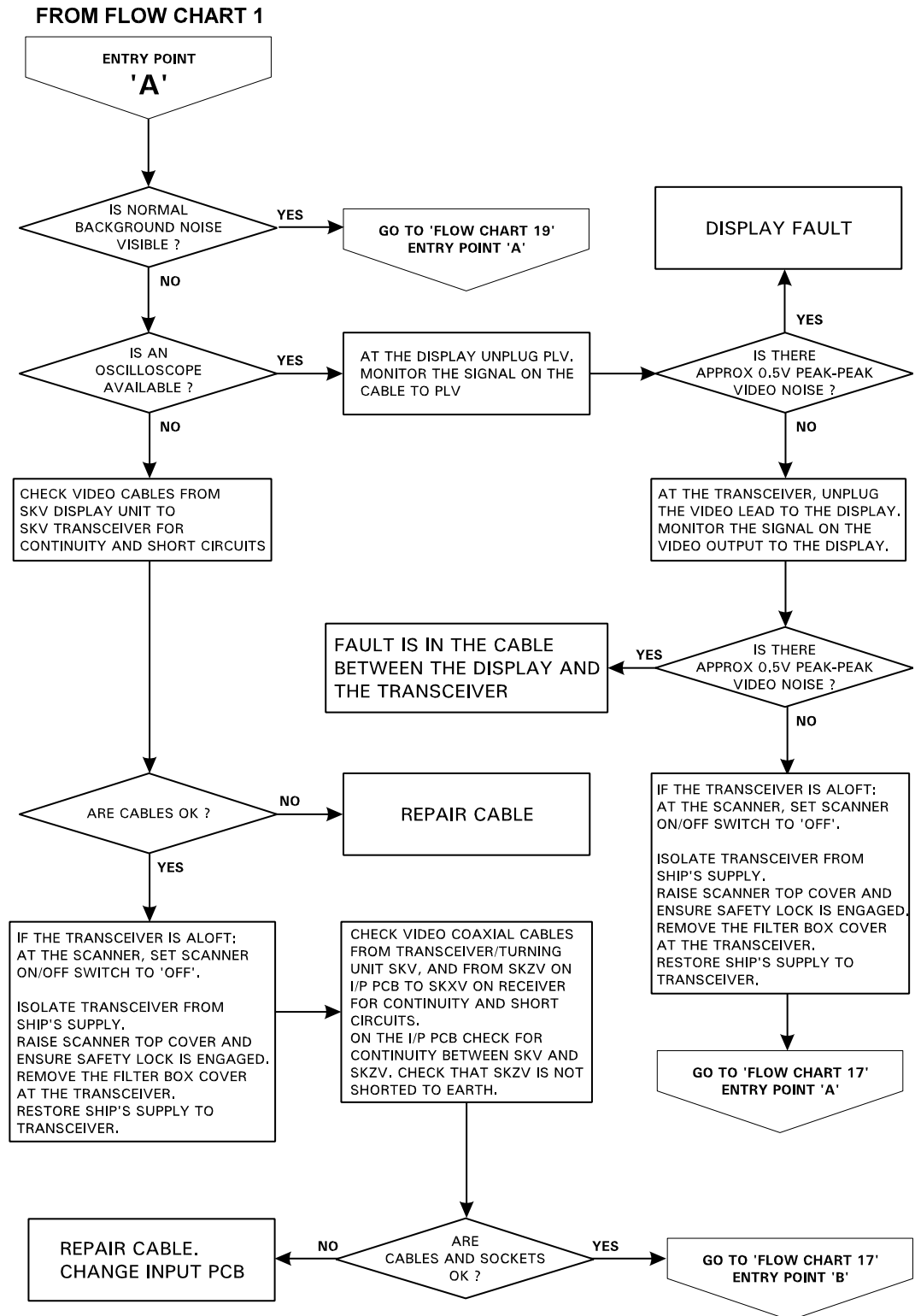


Fault Finding and First Line Servicing

**FLOW CHART 15 - X-BAND SCANNER FAULTS**  
 ('TRIGGER ERROR' Displayed)

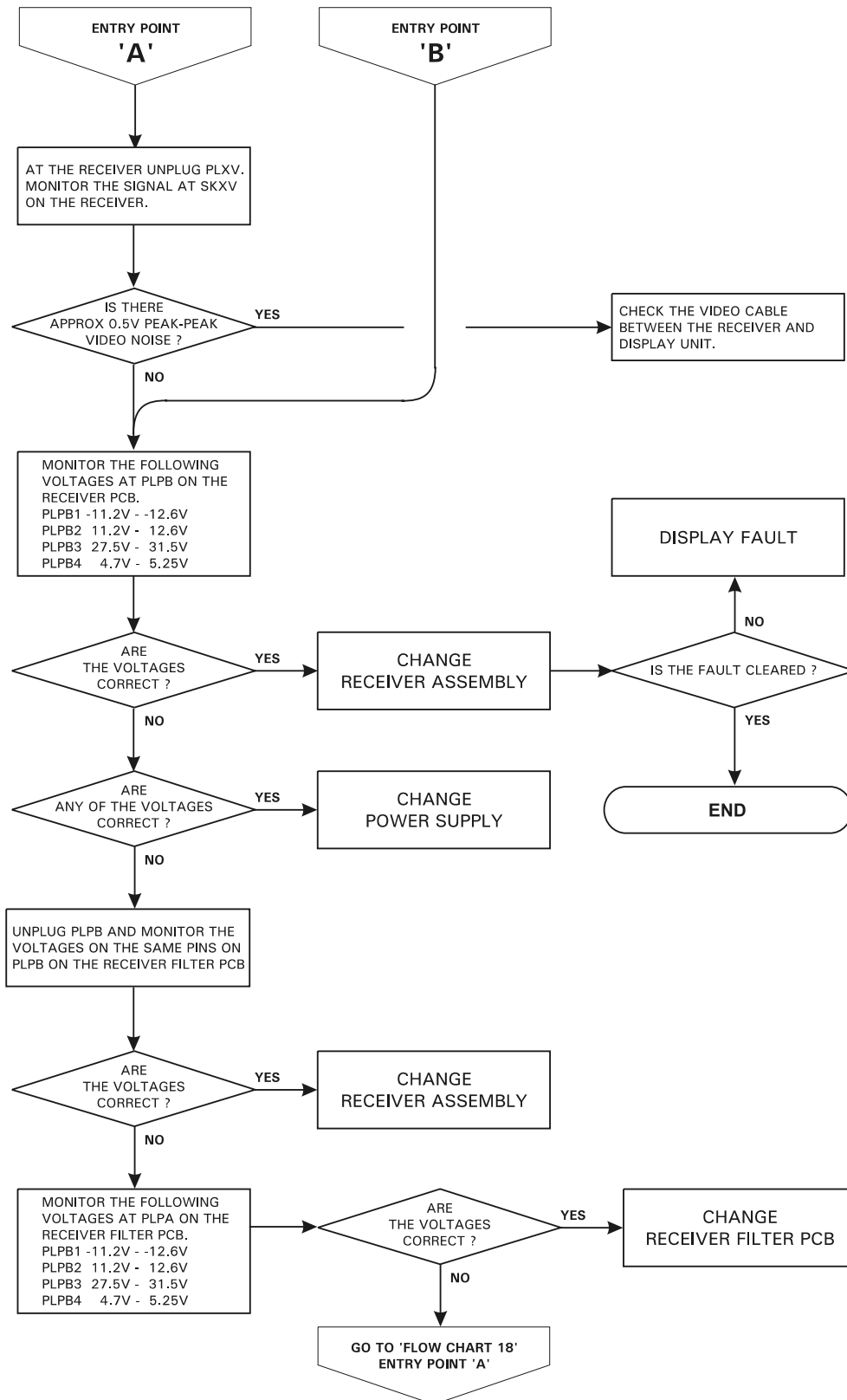


**FLOW CHART 16 - X-BAND SCANNER FAULTS ('TX ERROR'/'LOW VIDEO ERROR' Displayed)**



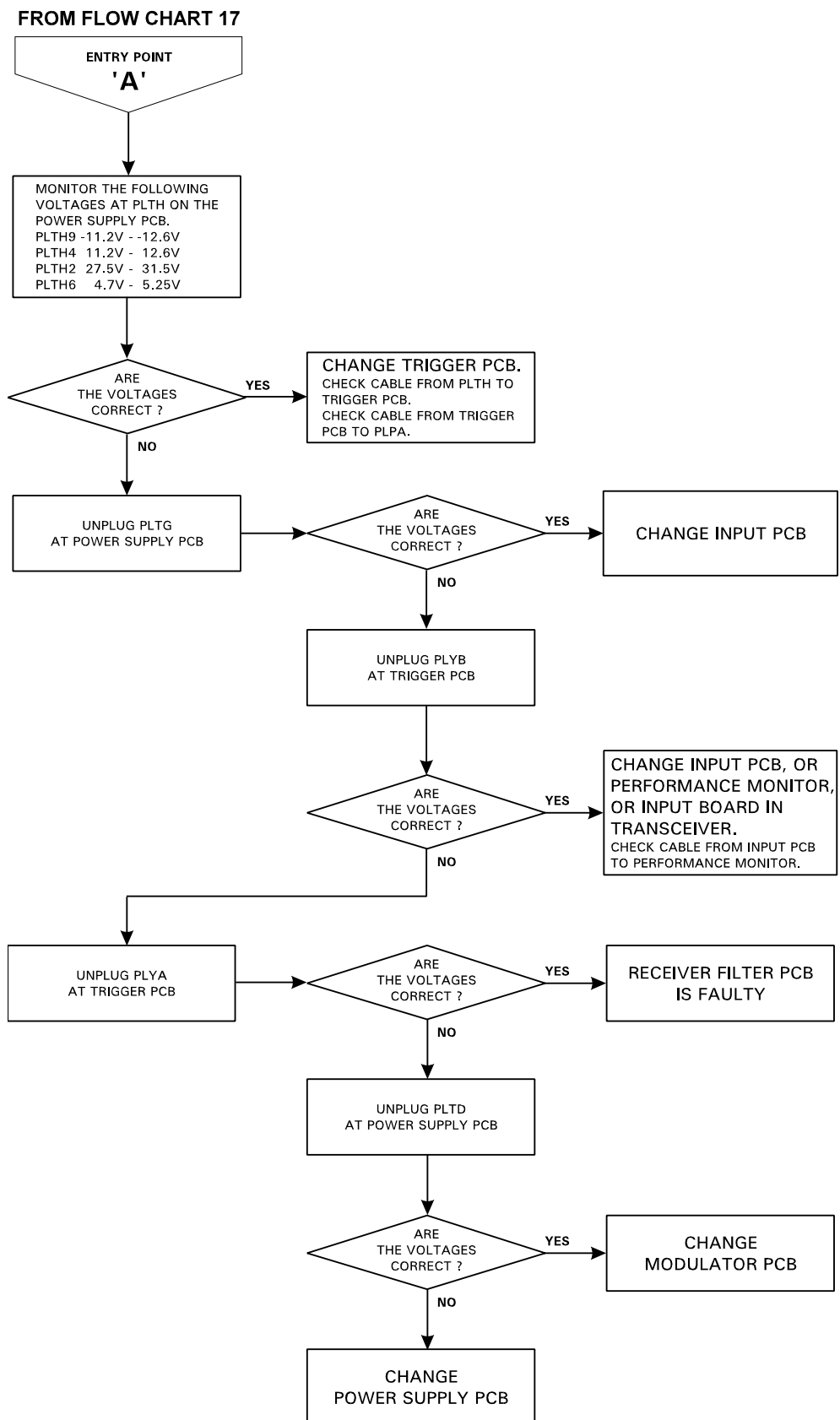
Fault Finding and First Line Servicing

**FLOW CHART 17 - X-BAND SCANNER FAULTS**

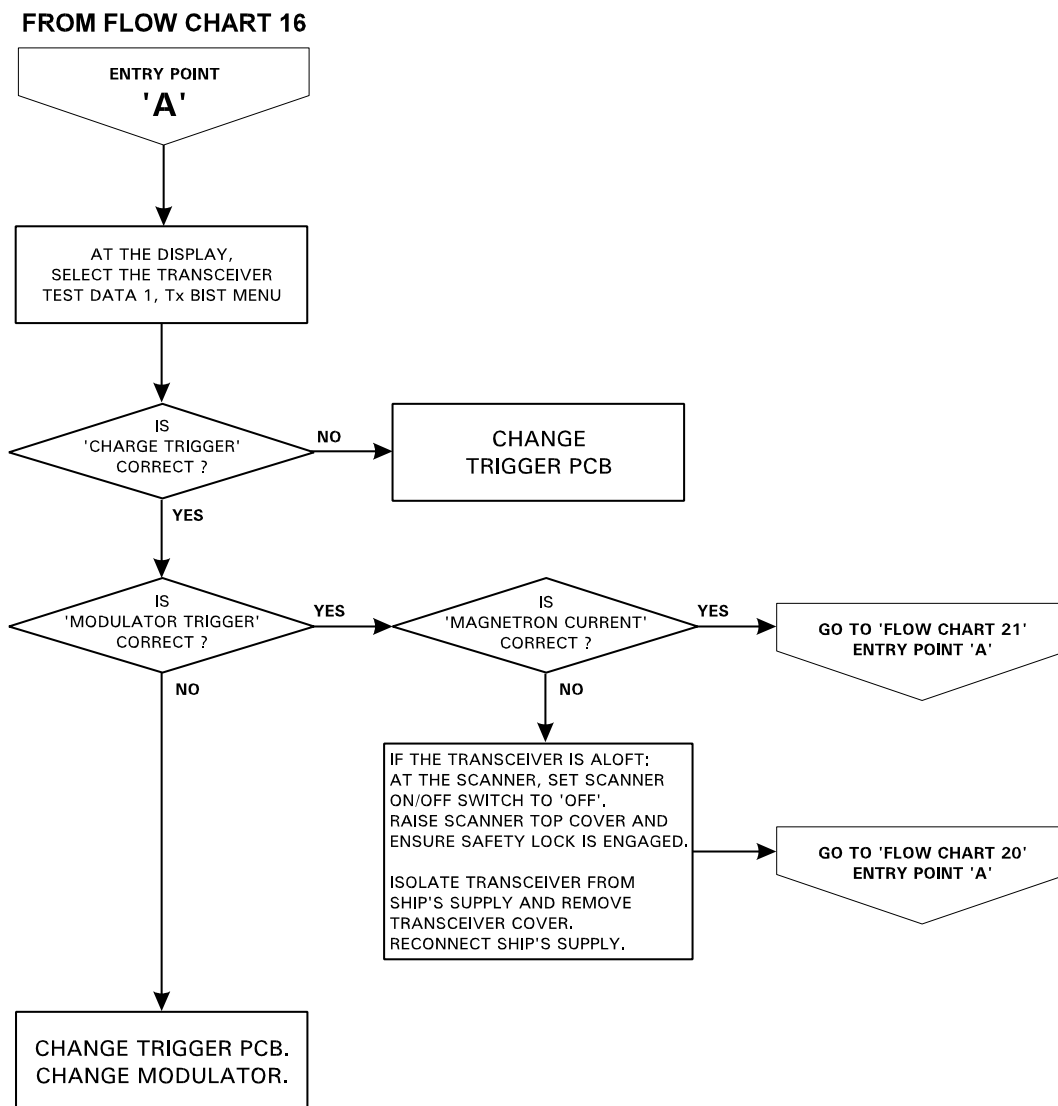




**FLOW CHART 18 - X-BAND SCANNER FAULTS**

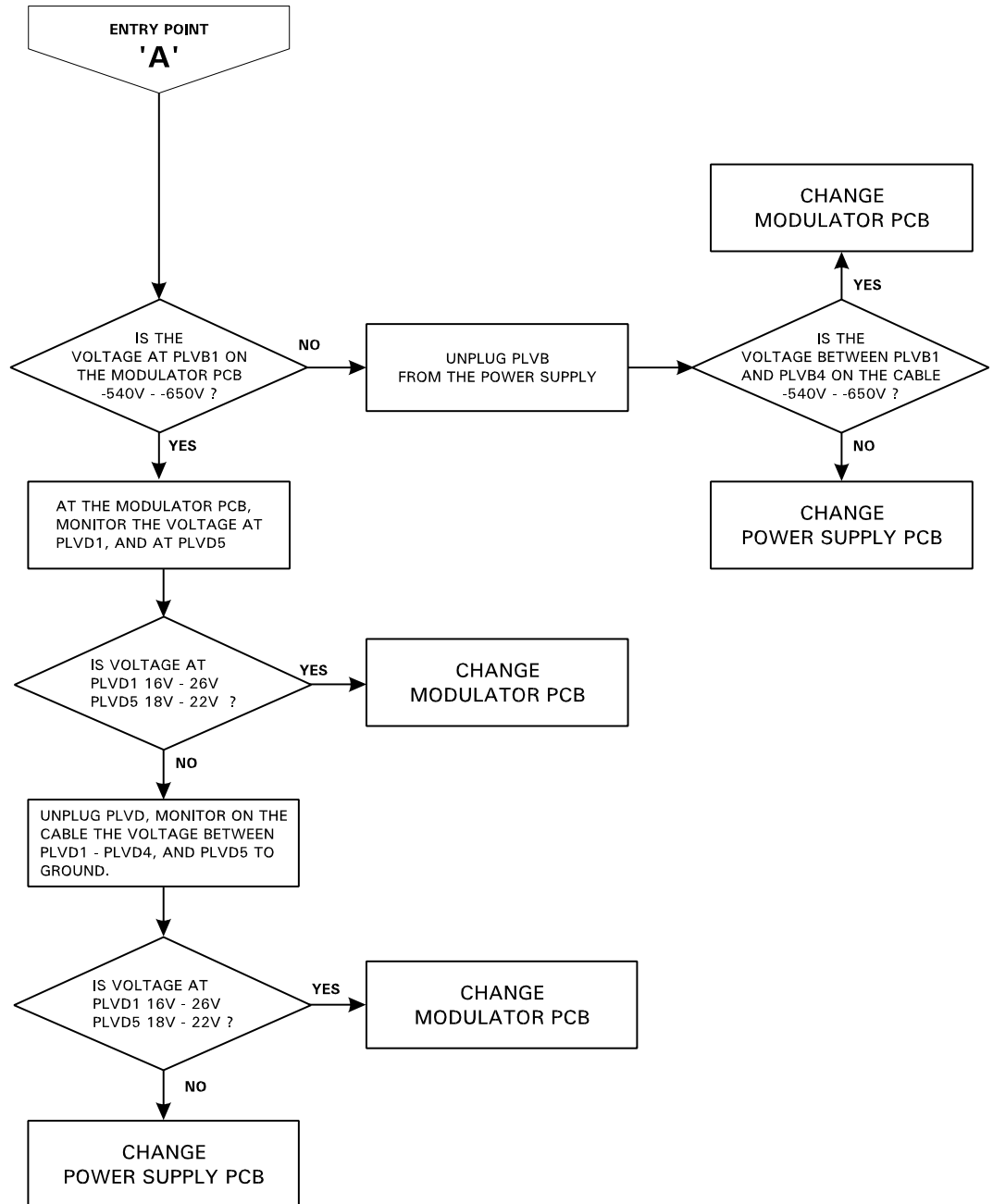


**FLOW CHART 19 - X-BAND SCANNER FAULTS**  
**('LOW VIDEO ERROR' Displayed)**



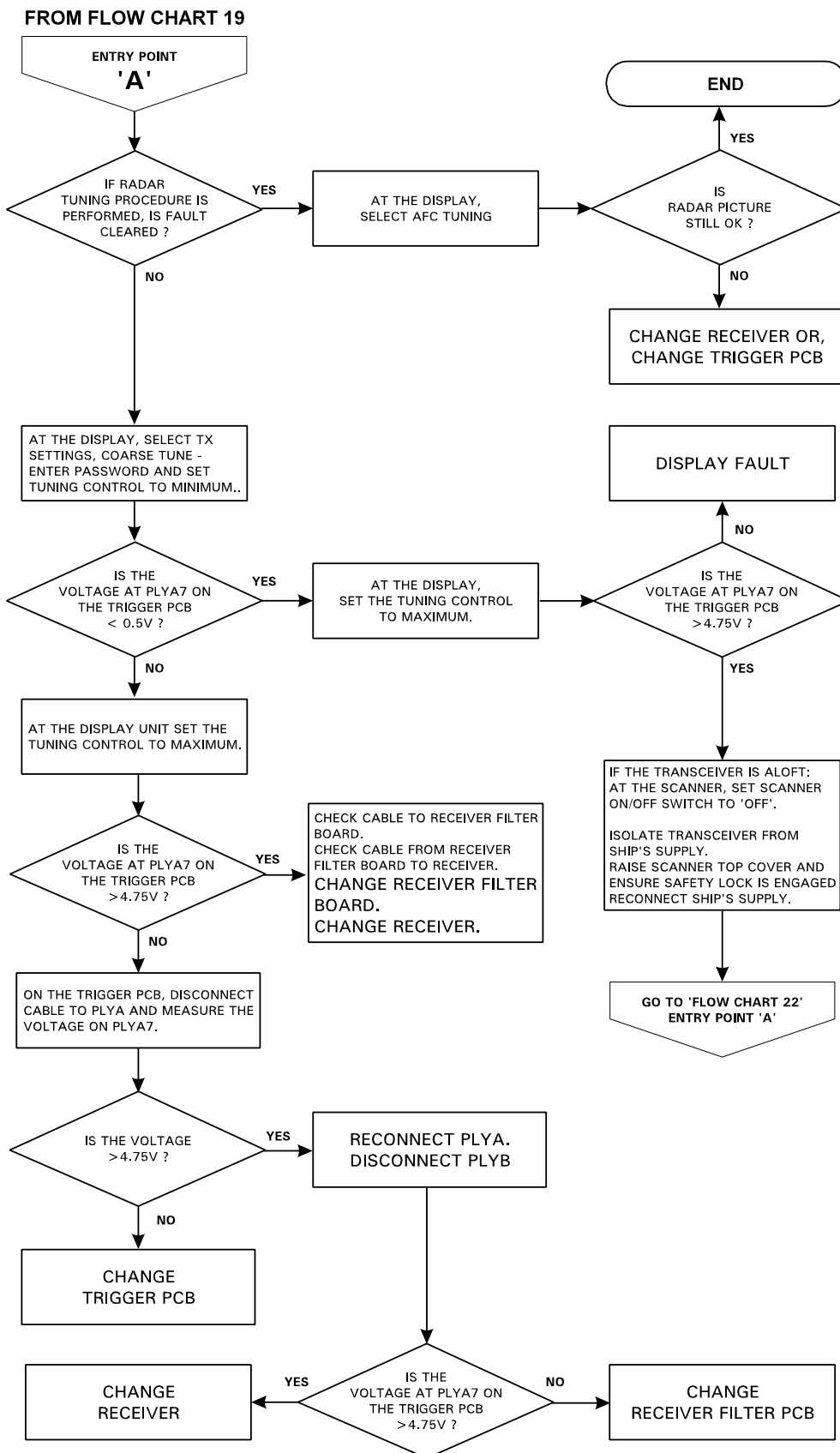
**FLOW CHART 20 - X-BAND SCANNER FAULTS**

FROM FLOW CHART 19 OR 24

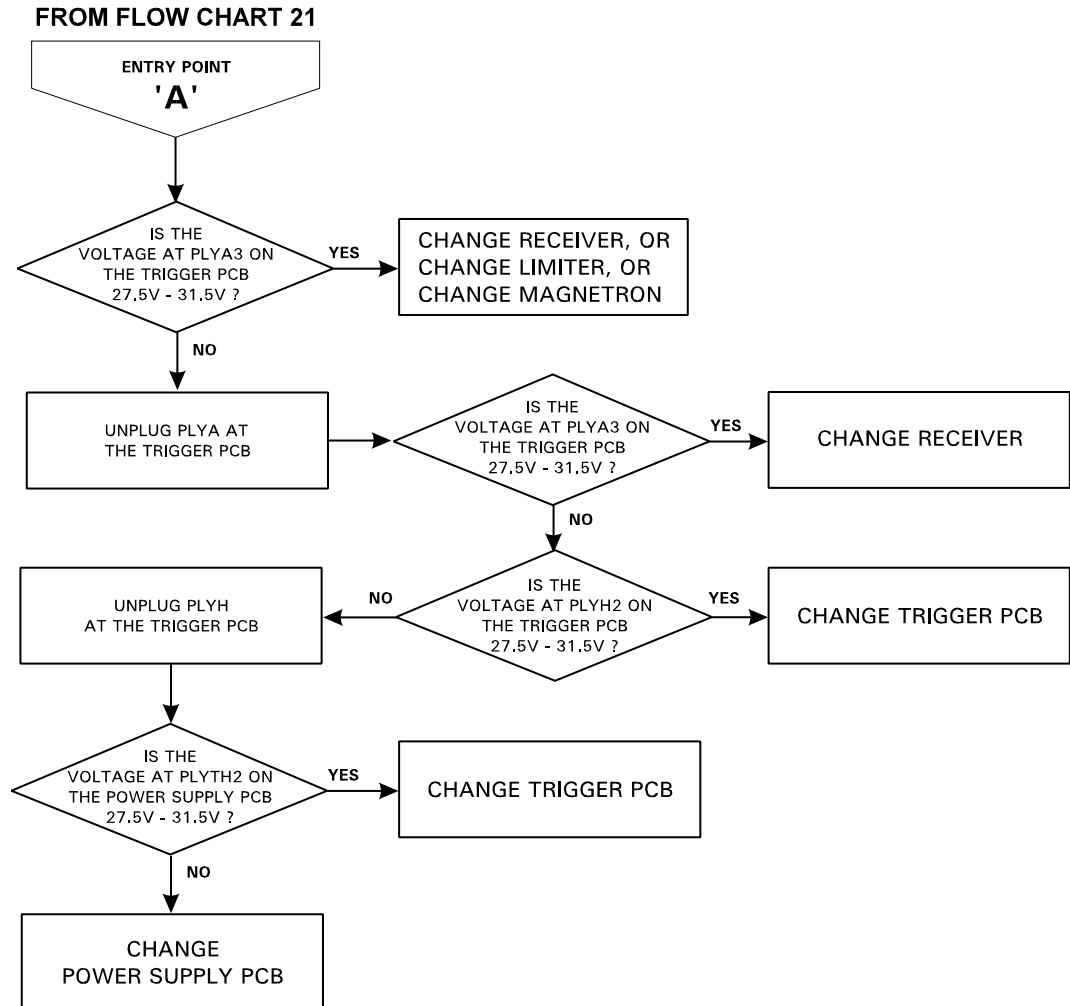


Fault Finding and First Line Servicing

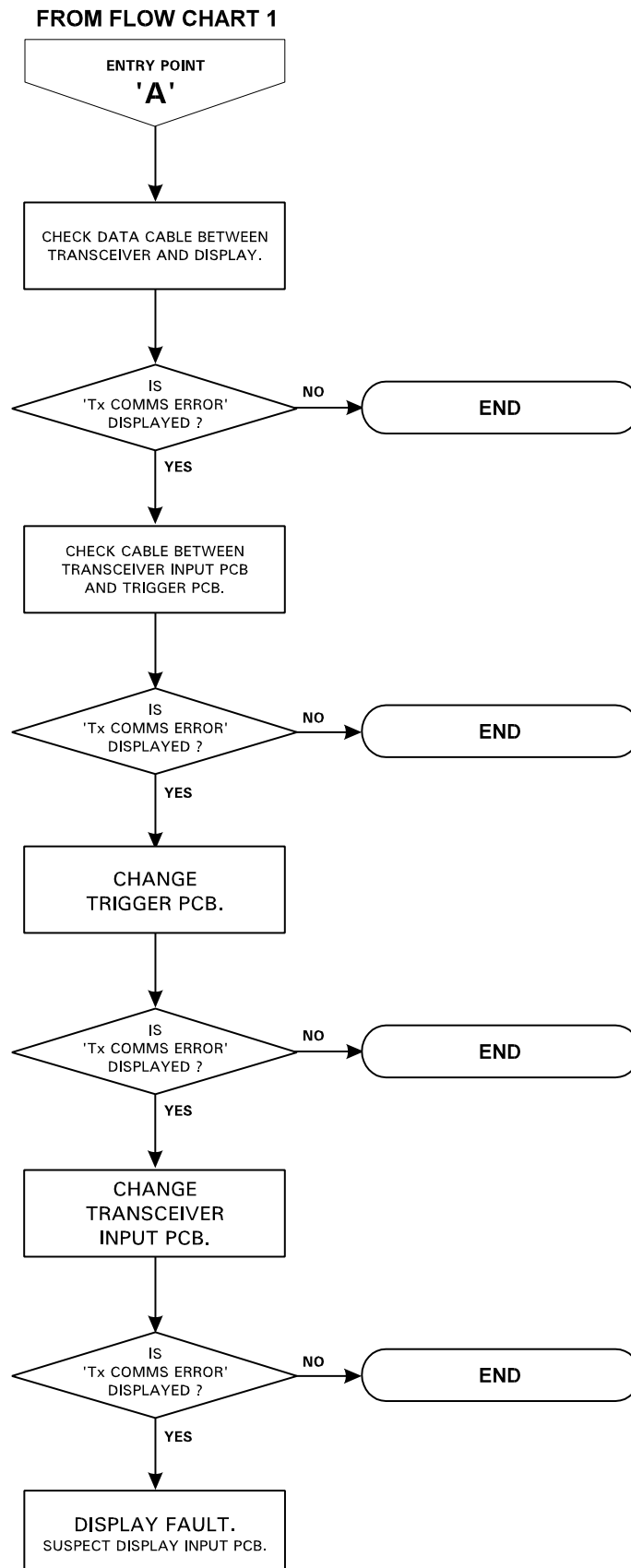
**FLOW CHART 21 - X-BAND SCANNER FAULTS**



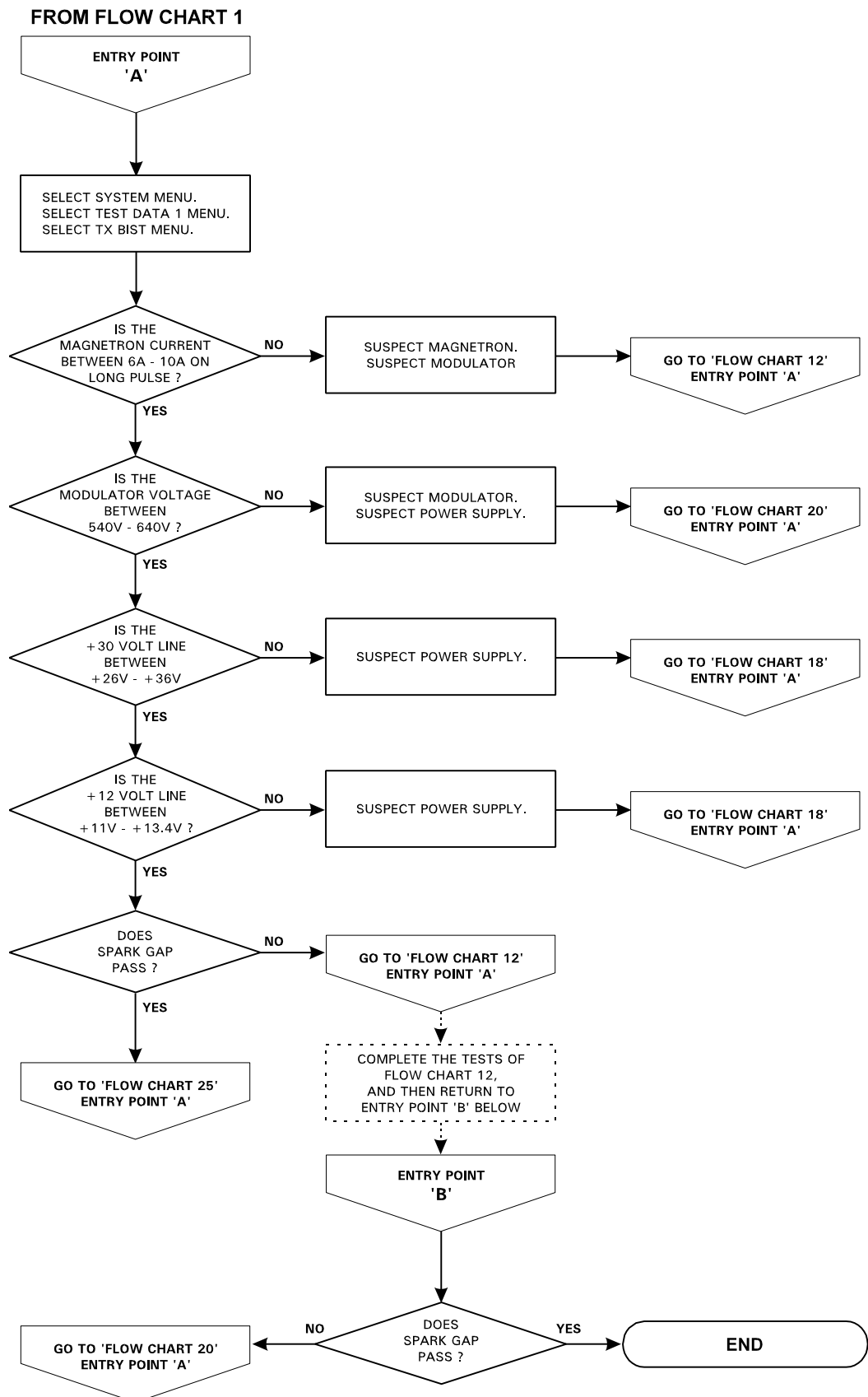
**FLOW CHART 22 - X-BAND SCANNER FAULTS**



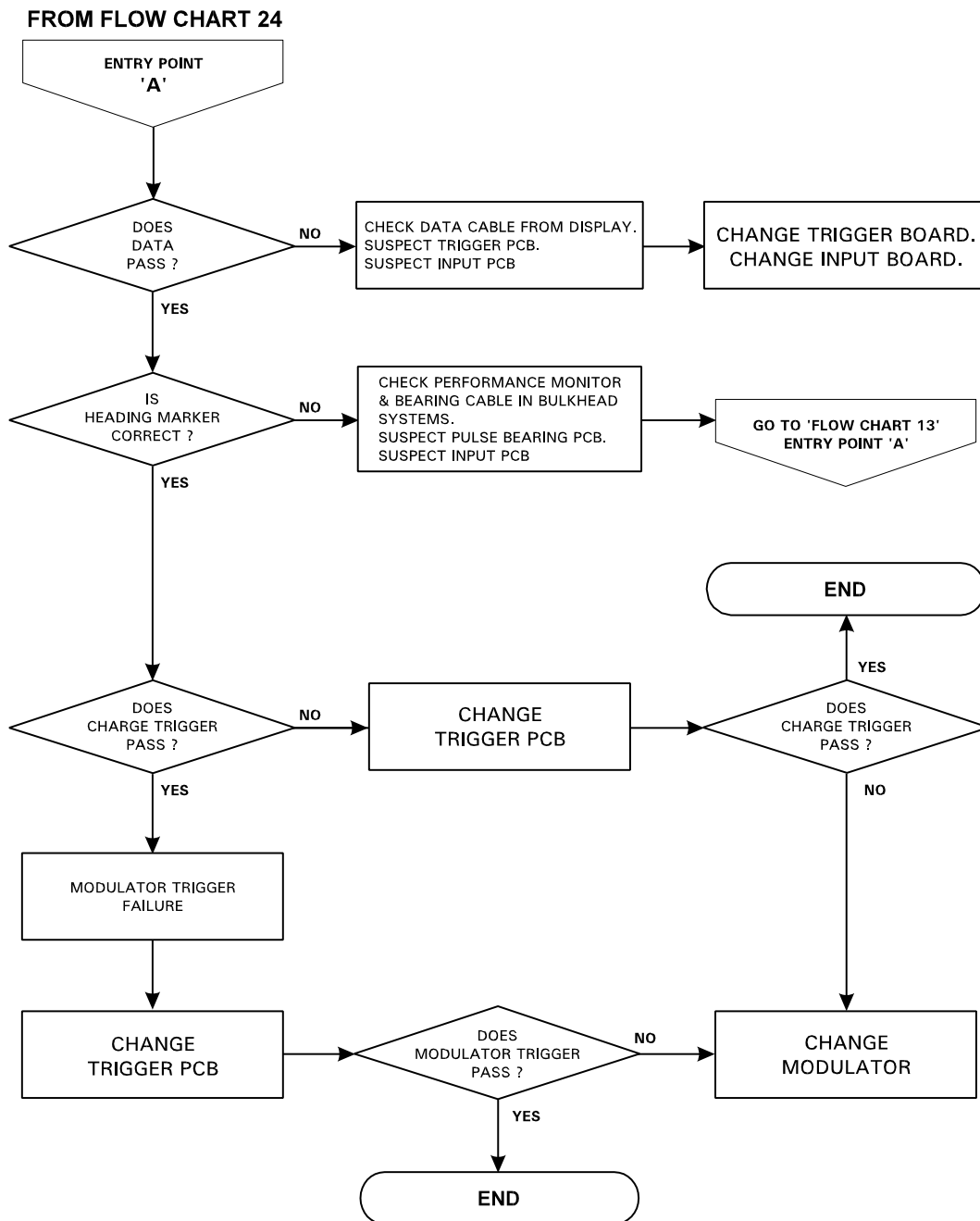
## Fault Finding and First Line Servicing

**FLOW CHART 23 - X-BAND SCANNER FAULTS**  
(**'TX COMMS ERROR'** Displayed)

**FLOW CHART 24 - X-BAND SCANNER FAULTS  
(‘TX BIST ERROR’ Displayed)**



**FLOW CHART 25 - X-BAND SCANNER FAULTS**





### 3 First Line Servicing

**WARNING:**

BEFORE REMOVING ANY COMPONENT PARTS, THE EQUIPMENT MUST BE ISOLATED FROM THE MAINS SUPPLY.

#### 3.1 Display Units

(Including Processor Electronics Units and Control Modules)

##### 3.1.1 Preliminary Notes

1. Isolate the mains supply to the display unit.
2. Before disassembling the Processor Electronics Unit or Display Monitor Unit components of the Display Unit, ensure that the integrity of the connections to the units has been checked.
3. All radar user controls, except for display monitor brilliance are routed through the Display Processor board. Consequently, a display processor fault may indicate faults on the Display Processor board, the Joystick/Trackerball, the Memory Card Unit or the Keyboard.

##### 3.1.2 Removal and Replacement of Processor Electronics Unit (PEU) Sub-assemblies

PEU sub-assemblies may include the following units:-

- Display Power Supply
- Display/Radar Processor board(s)
- Integral Keyboard (optional)
- Integral Joystick/Trackerball
- Integral Memory Card Unit
- On/Off Switch assembly

The Processor Electronics Unit is located in the pedestal of console mounted displays, or underneath the display monitors of integral (desk mounted) displays. Refer to Figure 6.1 and the steps below for access to these units.

Ensure that access is available to the front of the PEU. This is identified by the location of the sloping moulding on the unit. In console displays, pedestal covers will have to be removed and the PEU unbolted for access. Unplug any cables connected to the front of the PEU.

To release the outer PEU moulding, remove the two fixing screws at the front, and pull the moulding forward.

##### **Removing and Replacing the Fan Filter**

If an integral keyboard is fitted in the outer moulding, the fan filter can be accessed by the removal of the four screws securing the fan grill to the inner moulding.

## Fault Finding and First Line Servicing

If no keyboard is fitted in the outer moulding, the fan filter is located in the rectangular filter recess at the front of the inner moulding. It is removable once the outer moulding has been released.

### **Removing and Replacing the Integral Keyboard (optional)**

The integral Keyboard can be removed and replaced at this stage. Be sure to re-connect its cable.

If the outer moulding contains a keyboard, disconnect its cable where it plugs into the inner moulding. Remove the four fixing screws securing the inner moulding to the PEU main body, and pull the moulding away from the body. Disconnect all cables to units in the inner moulding at the processor boards and power supply in the main body of the PEU.

### **Removing and Replacing the Integral On/Off Switch assembly**

The switch fixing plate can be removed from the inner moulding using a small M3 spanner, and the switch assembly pushed out of the fixing plate. Reverse the procedure for replacement.

### **Removing and Replacing Integral Joystick/Trackerball and Memory Card assemblies**

If a memory card assembly is fitted, disconnect the cable linking it to the joystick/trackerball assembly. Loosen the locating screw for the appropriate assembly - see Figure 6.1. Pull the required assembly out from its moulding aperture by pivoting it on the lower edge of the aperture, and then lifting up. Reverse the procedure for replacement.

### **Removing and Replacing the Power Supply**

Disconnect the power cable at the front of the power supply. The power supply can then be removed by pulling on the strap at the front of the power supply cover, and sliding the unit out.

Slide the replacement unit back in, ensuring that it is firmly pressed home. Reconnect the power cable.

### **Removing and Replacing the Processor Board(s)**

In displays with a single Combined Processor board, replace this board if either radar processor or display processor faults are suspected.

In displays with separate Radar and Display Processor boards, identify the board to be replaced. The display processor has more connectors on its edge than the radar processor. Remove any cables still connected to the board. Use the plastic ejection levers at each end of the board to lever out, and then pull out the board.

Remove all daughter boards from the processor board, and transfer them to the replacement board, ensuring correct orientation and location. Ensure that links on the replacement board are set appropriately.

## Fault Reporting and First Line Servicing

Replace the board ensuring that the ejection levers are in their home position when the board is plugged in. Ensure that the board is firmly pressed home. Reconnect any cables, if appropriate, to other processor boards.

### Removing and Replacing the Compass Board

The Compass board is a daughter board on the Display Processor board or Combined Processor board. Use the above procedure for replacing the processor board(s) in this case, but only replace the compass board, with one of the same type. Ensure that the links on the replacement board are set appropriately.

### Re-assembling the Processor Electronics Unit

Reconnect cables from front PEU moulding, and re-secure the mouldings, remembering to re-connect the Keyboard, if appropriate. Refer to Figure 6.7 in case of difficulty.

## 3.1.3 Removal and Replacement of Kit Control Panel Modules

Kit Control Panel modules may include the following modules:-

- Keyboard module (optional)
- Joystick/Trackerball module
- Memory Card module
- On/Off Switch module
- Brilliance module

Each module is secured by nuts from underneath the console control panel top surface. Access can be obtained by removing the control panel lower cover, removing the two control panel fixing screws, and hinging the control panel down. See Figure 6.2. Unplug connecting cables to the modules before removing them.

Replacement is the reverse of the above procedure.

## 3.1.4 Removal of Display Monitor unit Sub-assemblies

### Integral Display Monitors

Remove monitor outer cover by unscrewing the two screws on the top of the cover, lifting the cover up and then forward, and unplugging the brilliance control cable at the Brilliance board (mounted on the bezel moulding). The Brilliance board can be removed, if necessary, by unscrewing it from the bezel moulding.

Unplug all cables connected to the monitor, taking note of the location of the Secondary Viewer cable, if fitted.

Unscrew the four screws at the edge of the finned drive board heatsink, that secure it to the chassis, and hinge it away from the chassis. Using the appropriate monitor block diagram for the particular monitor display (figures 6.3 to 6.6), identify the monitor components contained within the dotted outline in the diagram. These must be replaced as a group. Leaving the drive board until last, and first having ensured that at least 3 minutes has elapsed from switch-off for the CRT anode voltage to safely discharge, disconnect the identified

## Fault Finding and First Line Servicing

interconnected components from the rest of the unit. The drive board assembly (this includes the finned heatsink) can be removed by unscrewing the hinge arms and board stay from the unit.

### Console and Kit Display Monitors

To gain access to the display monitor in the 340 split cabinet console, refer to Figure 6.2. Ensure that the console is securely assembled and deck mounted. Remove the control panel lower cover. Whilst supporting the console control panel, release its two captive fixing screws, and then let it swing down. Release the two captive monitor fixing bolts under the monitor. They are accessible from between the control panel and display monitor. Remove the display top handle by undoing its three fixing screws. Undo the four CRT bezel fixings, and guide the top of the monitor forward into the unit's service position.

Unplug all cables connected to the monitor, taking note of the location of the Secondary Viewer cable, if fitted.

Release the two latch levers securing the finned drive board heatsink to the chassis, and hinge it away from the chassis. Using the appropriate monitor block diagram for the particular monitor display (Figures 6.3 to 6.6), identify the monitor components contained within the dotted outline in the diagram. These must be replaced as a group. Leaving the drive board until last, and first having ensured that at least 3 minutes has elapsed since switch-off for the CRT anode voltage to safely discharge, disconnect the identified interconnected components from the rest of the unit as a group. The drive board (this includes the finned heatsink) can be removed by detaching the earth braid connection to the chassis at the drive board, releasing the board stay, and sliding the drive board hinges apart.

### 3.1.5 Replacing and Setting-up of Display Monitor Unit Sub-assemblies

Replace the boards using the appropriate board set as shown in Section 4.1 of this chapter. To fit the board sets, use the reverse of the removal procedure. After reconnecting the external monitor cables, connect the internal brilliance control up (if applicable), and leave the drive board in its hinged down position to facilitate adjustments during the setting up procedure below.

**Note** -: *If an RGB output board is fitted to the drive board that is being replaced, this must be transferred to the drive board in the replacement board set. It is secured by two screws on the drive board heatsink, and its ribbon cable plugs into the drive board.*

After checking that the display boards are fully reconnected, power up the radar display, and check that the fan (if fitted) is operating. Refer to 'Monitor Test Mode' section in Chapter 5 of the Ship's Manual 65800010B for the following adjustments:

Adjust the brilliance control to a normal level. Access the monitor test mode, and select Test Pattern 1.

Identify the location of the focus and screen (Grid 2) controls. If they are not situated on the

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## Fault Reporting and First Line Servicing

LOPT, they will be found on the adjoining dual focus module.

Adjust the focus control(s) for the sharpest white grid lines.

### **Geometry**

Using the Monitor Test menu on the screen, adjust (if necessary) the geometrical parameters in the left hand column of the menu to produce the closest match to Test Pattern 1 as shown in the manual. If necessary, adjust the horizontal linearity inductor LI to match the width of the left hand squares to the other squares. Adjust the pattern size to fill the screen with its white border fully visible.

### **Colour Level Adjustment**

This must be carried out under the minimum operating ambient light level conditions. Select Test Pattern 2, and adjust the display brilliance control to maximum. Adjust the preset brightness parameter (Monitor Test menu) so that the pattern is just visible.

Select Test Pattern 3 with a solid white rectangle displayed. Adjust the display brilliance control, black level (red) and black level (blue) so that the white rectangle is just visible and a good white.

Adjust the display brilliance, and red and blue gain controls to give the brightest picture without any signs of video overload (streaking), and a white rectangle with a hint of blue. If necessary, the green gain can also be adjusted.

Repeat the colour level adjustment procedure until no further adjustments are required.

If any problems are encountered regarding insufficient control range on any of the controls, adjust the screen (G2) control on the drive board as follows:

Using a DVM, measure the voltages on TP26, 27 and 28 on the drive board (on external connectors edge of board) with respect to the chassis. Adjust the screen control so that the three voltages measured are in the range 65 to 95V. The colour level adjustment procedure must then be carried out once more.

As a final step, set the display brilliance to maximum, and adjust the preset contrast control to give the brightest picture without video overload.

Switch off and complete the re-assembly of the display monitor. If the picture size was adjusted without the CRT bezel fitted, re-adjust the picture size so that the white border of Test Pattern 1 is fully visible.

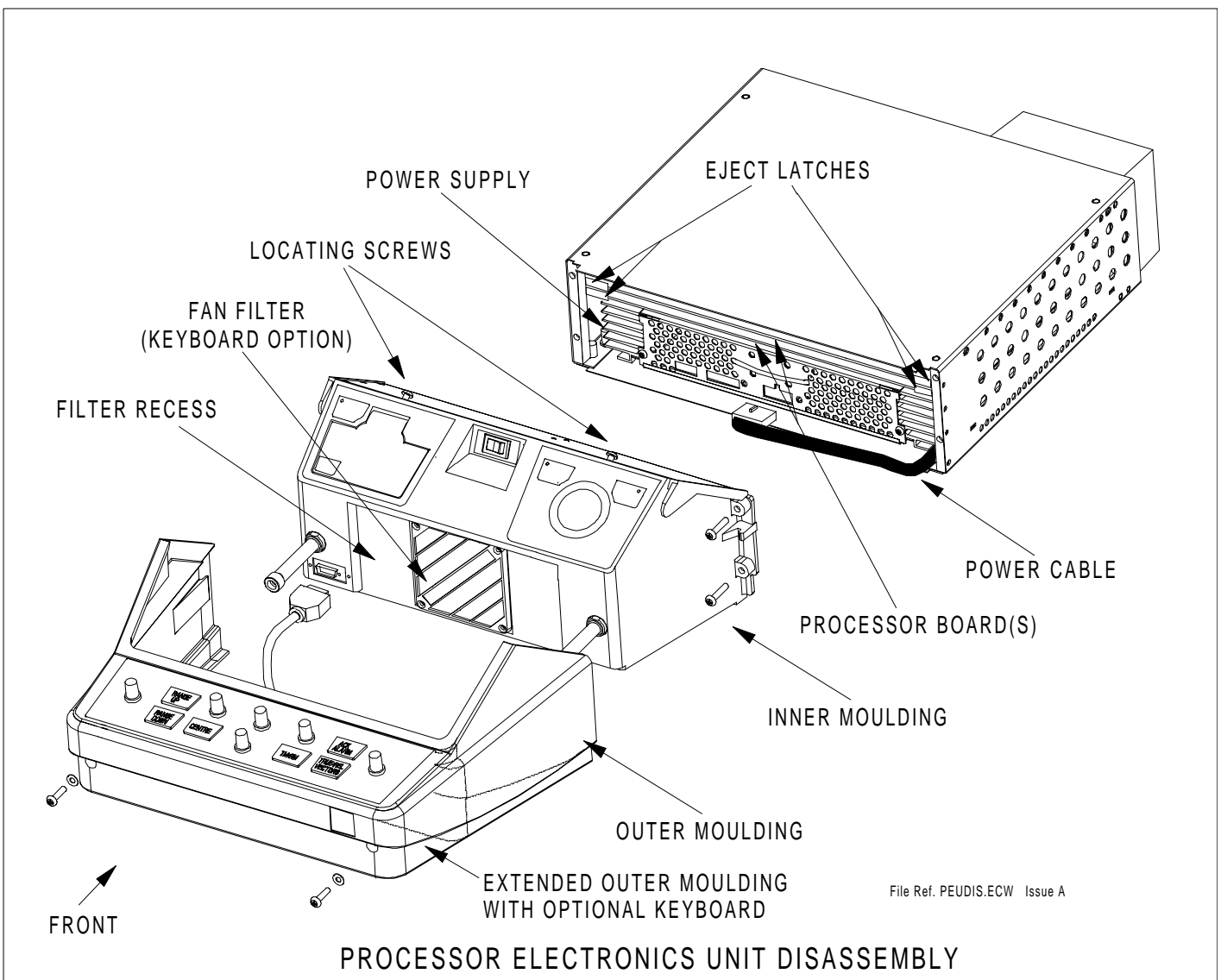


Figure 6.1 Processor Electronics Unit - Disassembly

### 3 First Line Servicing

**WARNING:**

BEFORE REMOVING ANY COMPONENT PARTS, THE EQUIPMENT MUST BE ISOLATED FROM THE MAINS SUPPLY.

#### 3.1 Display Units

(Including Processor Electronics Units and Control Modules)

##### 3.1.1 Preliminary Notes

1. Isolate the mains supply to the display unit.
2. Before disassembling the Processor Electronics Unit or Display Monitor Unit components of the Display Unit, ensure that the integrity of the connections to the units has been checked.
3. All radar user controls, except for display monitor brilliance are routed through the Display Processor board. Consequently, a display processor fault may indicate faults on the Display Processor board, the Joystick/Trackerball, the Memory Card Unit or the Keyboard.

##### 3.1.2 Removal and Replacement of Processor Electronics Unit (PEU) Sub-assemblies

PEU sub-assemblies may include the following units:-

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- Integral Keyboard (optional)
- Integral Joystick/Trackerball
- Integral Memory Card Unit
- On/Off Switch assembly

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Ensure that access is available to the front of the PEU. This is identified by the location of the sloping moulding on the unit. In console displays, pedestal covers will have to be removed and the PEU unbolted for access. Unplug any cables connected to the front of the PEU.

To release the outer PEU moulding, remove the two fixing screws at the front, and pull the moulding forward.

##### **Removing and Replacing the Fan Filter**

If an integral keyboard is fitted in the outer moulding, the fan filter can be accessed by the removal of the four screws securing the fan grill to the inner moulding.

## Fault Finding and First Line Servicing

If no keyboard is fitted in the outer moulding, the fan filter is located in the rectangular filter recess at the front of the inner moulding. It is removable once the outer moulding has been released.

### **Removing and Replacing the Integral Keyboard (optional)**

The integral Keyboard can be removed and replaced at this stage. Be sure to re-connect its cable.

If the outer moulding contains a keyboard, disconnect its cable where it plugs into the inner moulding. Remove the four fixing screws securing the inner moulding to the PEU main body, and pull the moulding away from the body. Disconnect all cables to units in the inner moulding at the processor boards and power supply in the main body of the PEU.

### **Removing and Replacing the Integral On/Off Switch assembly**

The switch fixing plate can be removed from the inner moulding using a small M3 spanner, and the switch assembly pushed out of the fixing plate. Reverse the procedure for replacement.

### **Removing and Replacing Integral Joystick/Trackerball and Memory Card assemblies**

If a memory card assembly is fitted, disconnect the cable linking it to the joystick/trackerball assembly. Loosen the locating screw for the appropriate assembly - see Figure 6.1. Pull the required assembly out from its moulding aperture by pivoting it on the lower edge of the aperture, and then lifting up. Reverse the procedure for replacement.

### **Removing and Replacing the Power Supply**

Disconnect the power cable at the front of the power supply. The power supply can then be removed by pulling on the strap at the front of the power supply cover, and sliding the unit out.

Slide the replacement unit back in, ensuring that it is firmly pressed home. Reconnect the power cable.

### **Removing and Replacing the Processor Board(s)**

In displays with a single Combined Processor board, replace this board if either radar processor or display processor faults are suspected.

In displays with separate Radar and Display Processor boards, identify the board to be replaced. The display processor has more connectors on its edge than the radar processor. Remove any cables still connected to the board. Use the plastic ejection levers at each end of the board to lever out, and then pull out the board.

Remove all daughter boards from the processor board, and transfer them to the replacement board, ensuring correct orientation and location. Ensure that links on the replacement board are set appropriately.



## Fault Reporting and First Line Servicing

Replace the board ensuring that the ejection levers are in their home position when the board is plugged in. Ensure that the board is firmly pressed home. Reconnect any cables, if appropriate, to other processor boards.

### Removing and Replacing the Compass Board

The Compass board is a daughter board on the Display Processor board or Combined Processor board. Use the above procedure for replacing the processor board(s) in this case, but only replace the compass board, with one of the same type. Ensure that the links on the replacement board are set appropriately.

### Re-assembling the Processor Electronics Unit

Reconnect cables from front PEU moulding, and re-secure the mouldings, remembering to re-connect the Keyboard, if appropriate. Refer to Figure 6.7 in case of difficulty.

## 3.1.3 Removal and Replacement of Kit Control Panel Modules

Kit Control Panel modules may include the following modules:-

- Keyboard module (optional)
- Joystick/Trackerball module
- Memory Card module
- On/Off Switch module
- Brilliance module

Each module is secured by nuts from underneath the console control panel top surface. Access can be obtained by removing the control panel lower cover, removing the two control panel fixing screws, and hinging the control panel down. See Figure 6.2. Unplug connecting cables to the modules before removing them.

Replacement is the reverse of the above procedure.

## 3.1.4 Removal of Display Monitor unit Sub-assemblies

### Integral Display Monitors

Remove monitor outer cover by unscrewing the two screws on the top of the cover, lifting the cover up and then forward, and unplugging the brilliance control cable at the Brilliance board (mounted on the bezel moulding). The Brilliance board can be removed, if necessary, by unscrewing it from the bezel moulding.

Unplug all cables connected to the monitor, taking note of the location of the Secondary Viewer cable, if fitted.

Unscrew the four screws at the edge of the finned drive board heatsink, that secure it to the chassis, and hinge it away from the chassis. Using the appropriate monitor block diagram for the particular monitor display (figures 6.3 to 6.6), identify the monitor components contained within the dotted outline in the diagram. These must be replaced as a group. Leaving the drive board until last, and first having ensured that at least 3 minutes has elapsed from switch-off for the CRT anode voltage to safely discharge, disconnect the identified

## Fault Finding and First Line Servicing

interconnected components from the rest of the unit. The drive board assembly (this includes the finned heatsink) can be removed by unscrewing the hinge arms and board stay from the unit.

### Console and Kit Display Monitors

To gain access to the display monitor in the 340 split cabinet console, refer to Figure 6.2. Ensure that the console is securely assembled and deck mounted. Remove the control panel lower cover. Whilst supporting the console control panel, release its two captive fixing screws, and then let it swing down. Release the two captive monitor fixing bolts under the monitor. They are accessible from between the control panel and display monitor. Remove the display top handle by undoing its three fixing screws. Undo the four CRT bezel fixings, and guide the top of the monitor forward into the unit's service position.

Unplug all cables connected to the monitor, taking note of the location of the Secondary Viewer cable, if fitted.

Release the two latch levers securing the finned drive board heatsink to the chassis, and hinge it away from the chassis. Using the appropriate monitor block diagram for the particular monitor display (Figures 6.3 to 6.6), identify the monitor components contained within the dotted outline in the diagram. These must be replaced as a group. Leaving the drive board until last, and first having ensured that at least 3 minutes has elapsed since switch-off for the CRT anode voltage to safely discharge, disconnect the identified interconnected components from the rest of the unit as a group. The drive board (this includes the finned heatsink) can be removed by detaching the earth braid connection to the chassis at the drive board, releasing the board stay, and sliding the drive board hinges apart.

### 3.1.5 Replacing and Setting-up of Display Monitor Unit Sub-assemblies

Replace the boards using the appropriate board set as shown in Section 4.1 of this chapter. To fit the board sets, use the reverse of the removal procedure. After reconnecting the external monitor cables, connect the internal brilliance control up (if applicable), and leave the drive board in its hinged down position to facilitate adjustments during the setting up procedure below.

**Note -:** *If an RGB output board is fitted to the drive board that is being replaced, this must be transferred to the drive board in the replacement board set. It is secured by two screws on the drive board heatsink, and its ribbon cable plugs into the drive board.*

After checking that the display boards are fully reconnected, power up the radar display, and check that the fan (if fitted) is operating. Refer to 'Monitor Test Mode' section in Chapter 5 of the Ship's Manual 65800010B for the following adjustments:

Adjust the brilliance control to a normal level. Access the monitor test mode, and select Test Pattern 1.

## Fault Reporting and First Line Servicing

Identify the location of the focus and screen (Grid 2) controls. If they are not situated on the LOPT, they will be found on the adjoining dual focus module.

Adjust the focus control(s) for the sharpest white grid lines.

### Geometry

Using the Monitor Test menu on the screen, adjust (if necessary) the geometrical parameters in the left hand column of the menu to produce the closest match to Test Pattern 1 as shown in the manual. If necessary, adjust the horizontal linearity inductor L1 to match the width of the left hand squares to the other squares. Adjust the pattern size to fill the screen with its white border fully visible.

### Colour Level Adjustment

This must be carried out under the minimum operating ambient light level conditions. Select Test Pattern 2, and adjust the display brilliance control to maximum. Adjust the preset brightness parameter (Monitor Test menu) so that the pattern is just visible.

Select Test Pattern 3 with a solid white rectangle displayed. Adjust the display brilliance control, black level (red) and black level (blue) so that the white rectangle is just visible and a good white.

Adjust the display brilliance, and red and blue gain controls to give the brightest picture without any signs of video overload (streaking), and a white rectangle with a hint of blue. If necessary, the green gain can also be adjusted.

Repeat the colour level adjustment procedure until no further adjustments are required.

If any problems are encountered regarding insufficient control range on any of the controls, adjust the screen (G2) control on the drive board as follows:

Using a DVM, measure the voltages on TP26, 27 and 28 on the drive board (on external connectors edge of board) with respect to the chassis. Adjust the screen control so that the three voltages measured are in the range 65 to 95V. The colour level adjustment procedure must then be carried out once more.

As a final step, set the display brilliance to maximum, and adjust the preset contrast control to give the brightest picture without video overload.

Switch off and complete the re-assembly of the display monitor. If the picture size was adjusted without the CRT bezel fitted, re-adjust the picture size so that the white border of Test Pattern 1 is fully visible.

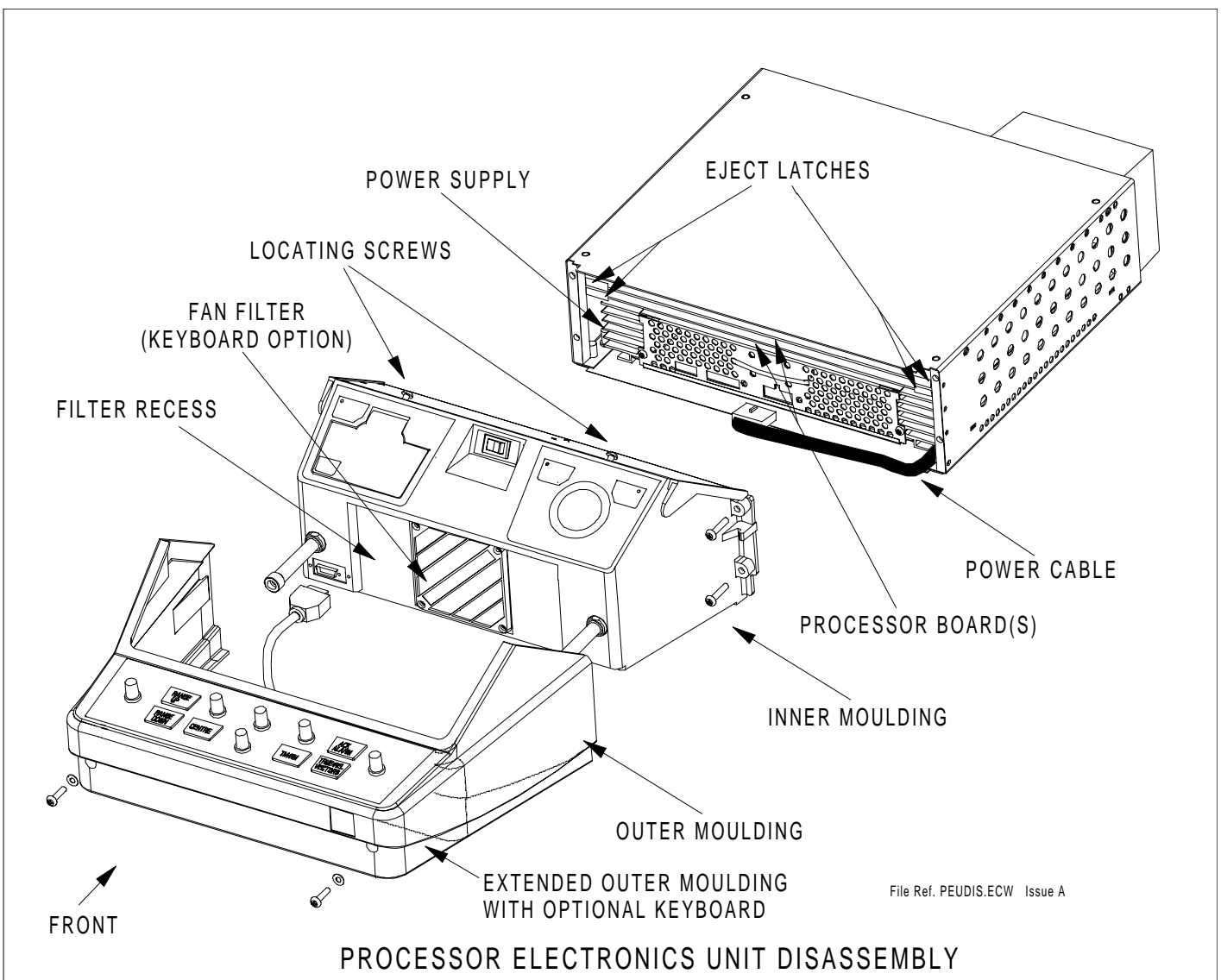


Figure 6.1 Processor Electronics Unit - Disassembly

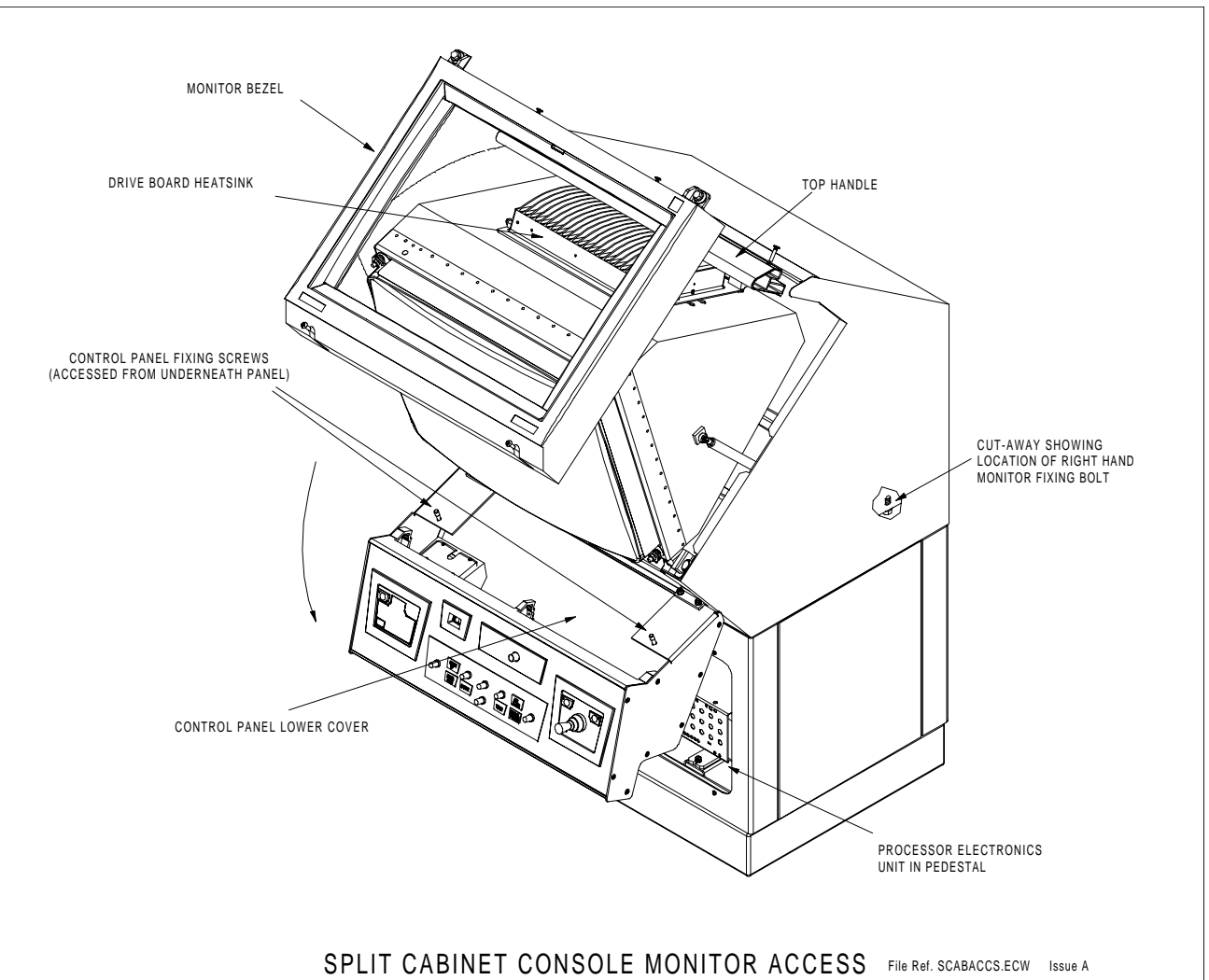
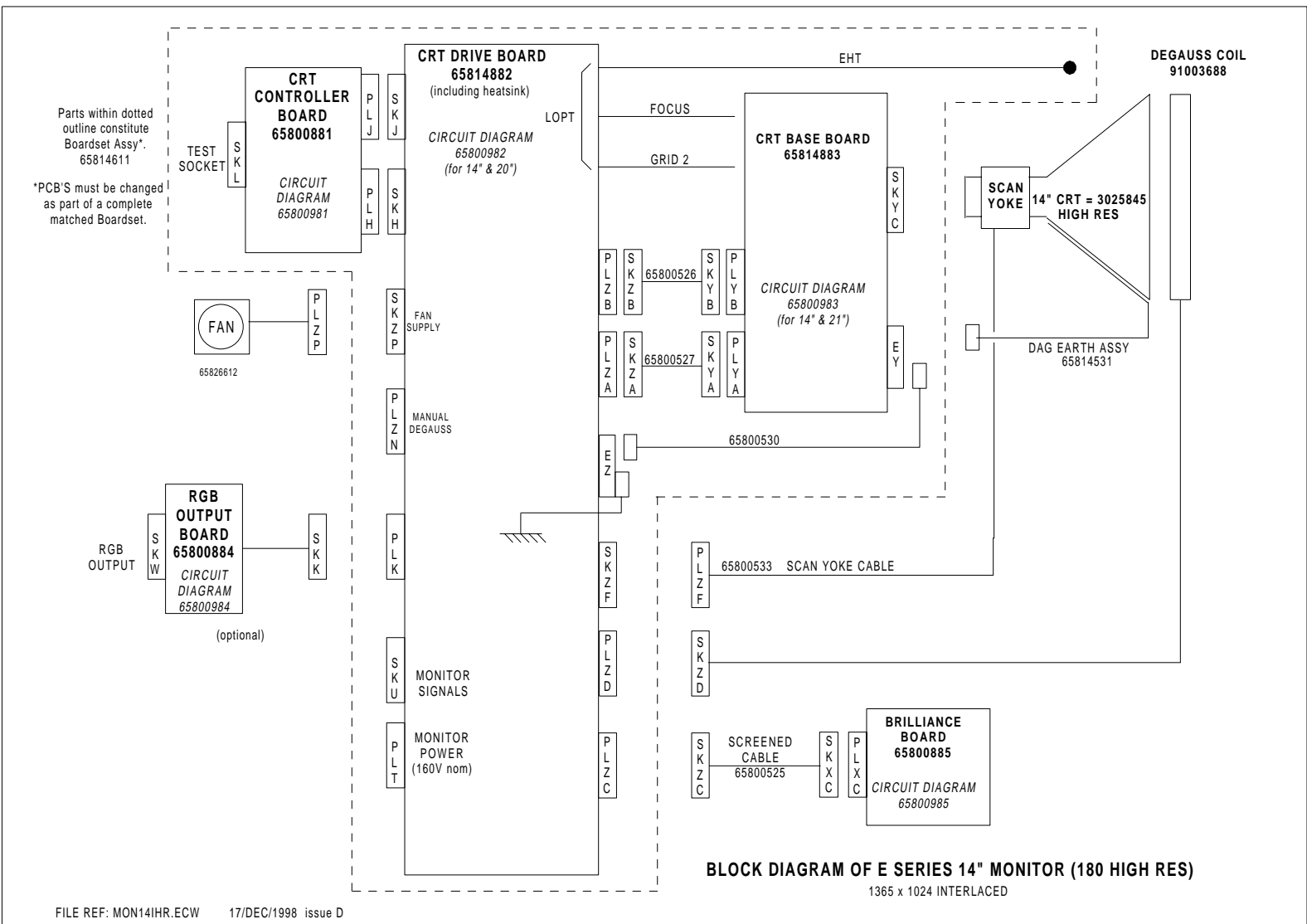


Figure 6.2 Split Cabinet Console - Monitor Access



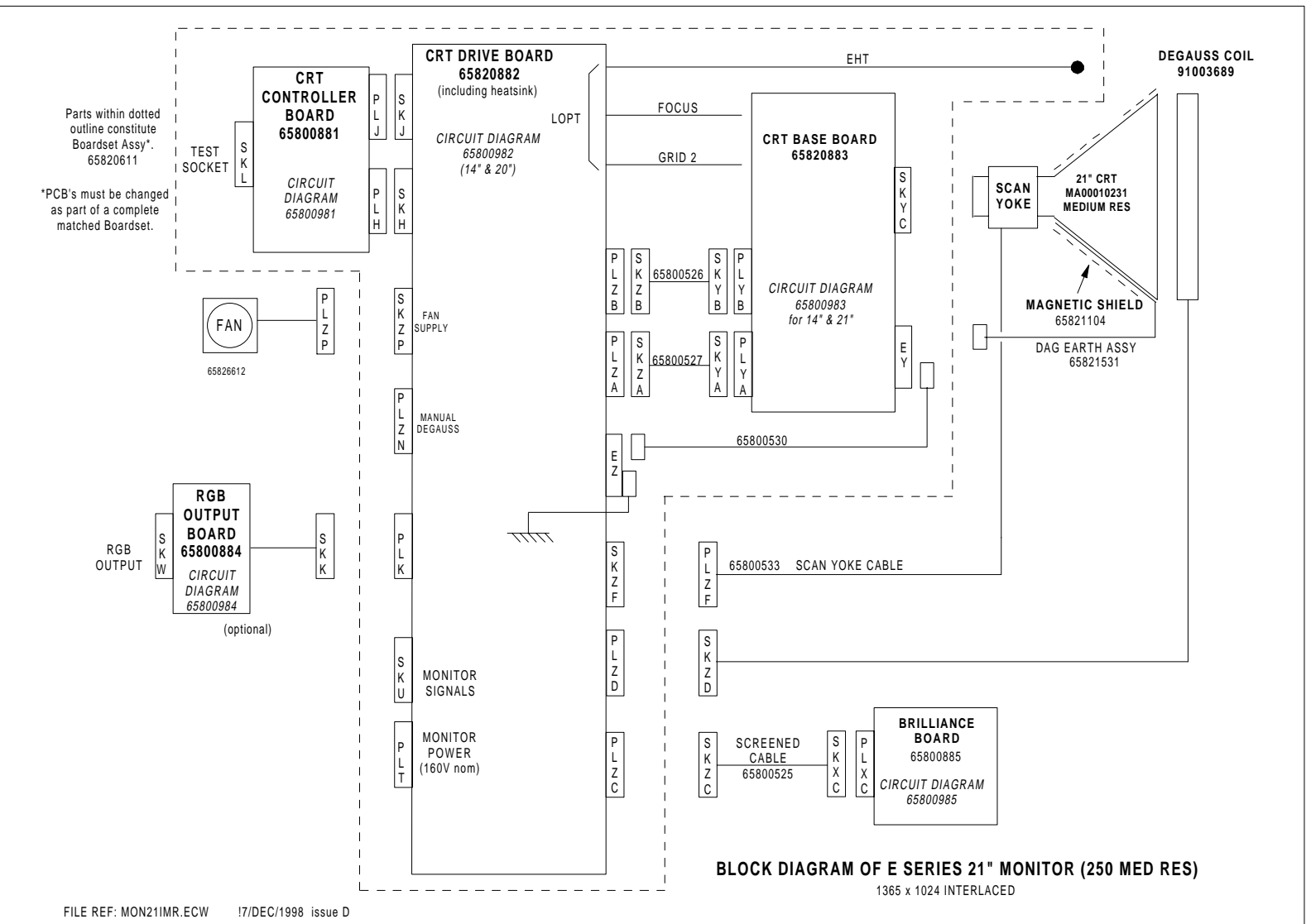


Figure 6.4 Block Diagram - 250 Monitor (21" Medium Resolution)

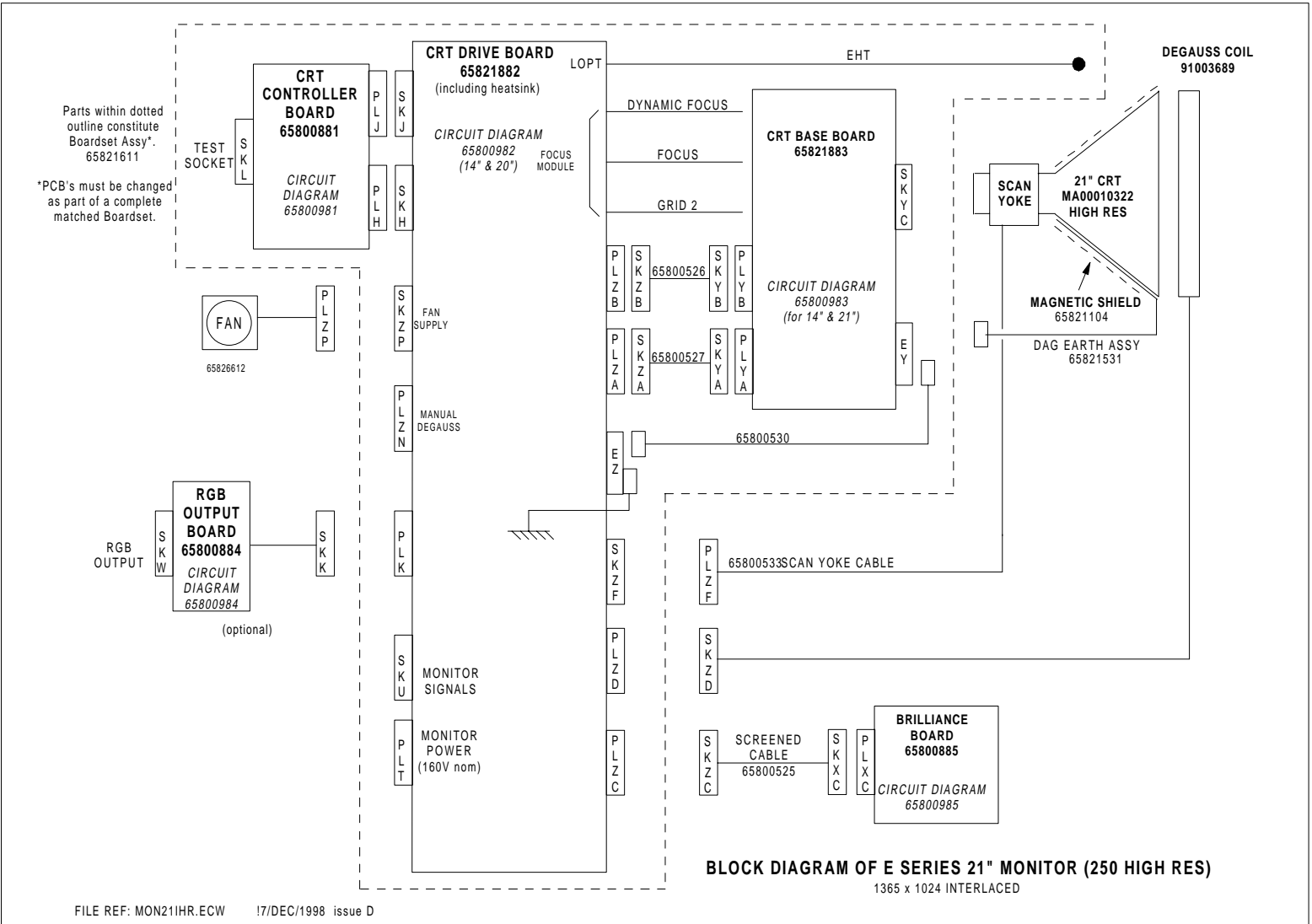


Figure 6.5 Block Diagram - 250 Monitor (21" High Resolution)



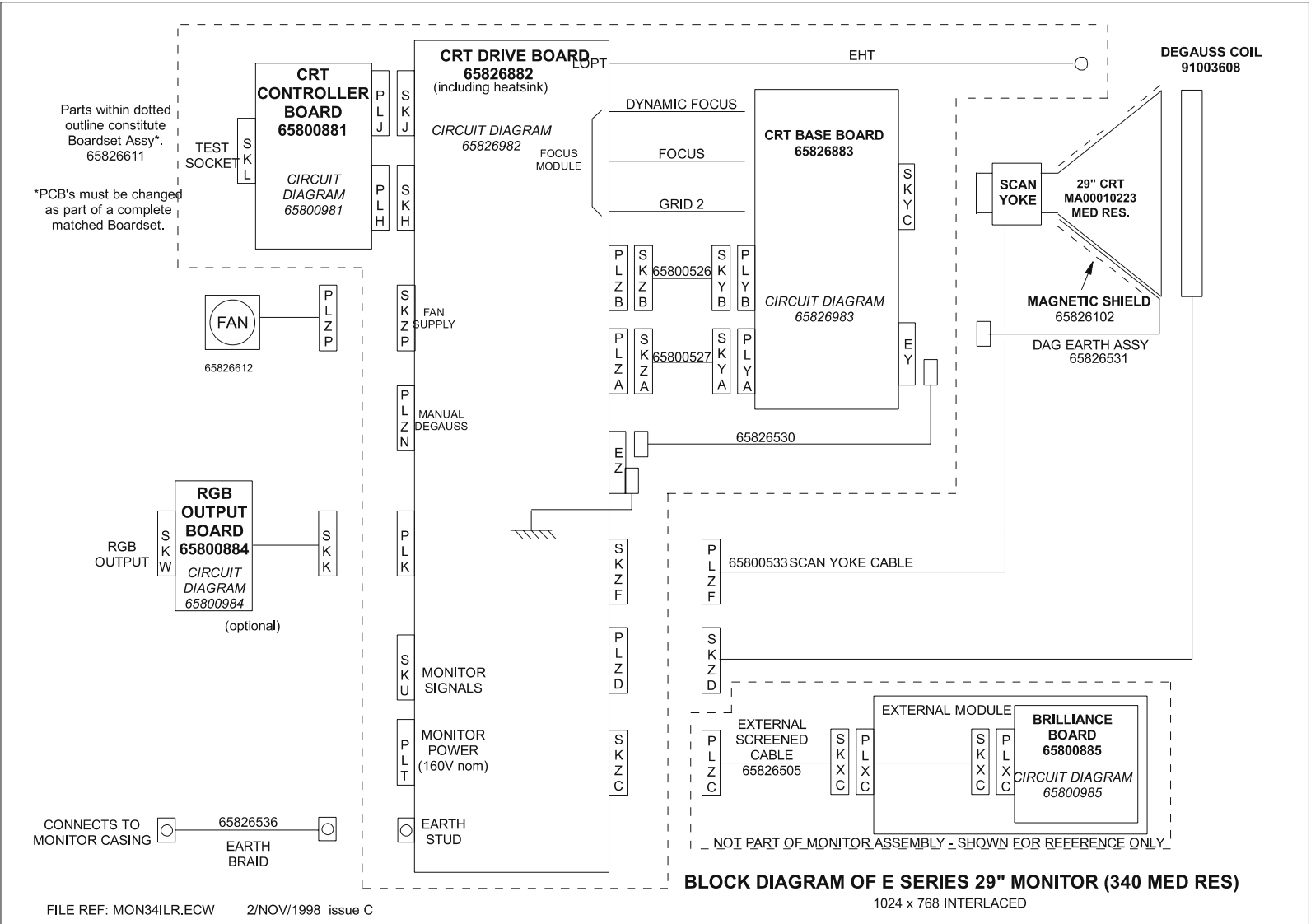


Figure 6.6 Block Diagram - 340 Monitor (29" Medium Resolution)

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Fault Finding and First Line Servicing

A3 page 6-73/74 Figure 6.7, discard this A4 sheet.

## 3.2 S-Band Scanner Unit

### 3.2.6 Magnetron Replacement

(Scanner Unit - Masthead Transceiver)

At the Scanner Control Unit set the isolating switch to the 'OFF' position and lock it. Rotate the antenna until the front face is pointing away from the transceiver.

Isolate the radar from the ship's mains supply using the isolating switch provided.

Refer to Figure 6.8, and remove the transceiver cover from the scanner unit. Refer to Figure 6.13, and follow the procedure for removing and replacing the magnetron.

Magnetron Current (Scanner Unit with Integral Transceiver)

When a Magnetron is replaced, the magnetron current must be set as follows:

On the Trigger pcb set links LK5 and LK6 to position 2-3.

Reconnect the ship's mains supply, and switch the radar ON.

Wait 3 minutes for the magnetron time delay to expire, and select long pulse.

Set the magnetron current as detailed in Figure 6.14.

Isolate the radar from the ship's mains supply using the isolating switch provided.

Reset LK5 and LK6 to position 1-2.

Replace the transceiver cover.

**Note** - Servicing kit (Part No. 65830700) is available to enable S-Band Masthead Transceivers to be run below decks on a dummy load (included in kit).

### 3.2.7 Magnetron Replacement (Bulkhead Transceiver)

Isolate the radar from the ship's mains supply using the isolating switch provided.

Refer to Figure 6.9, and remove transceiver cover. Refer to Figure 6.13, and follow the procedure for removing and replacing the magnetron.

Magnetron Current (Bulkhead Transceiver)

When a magnetron is replaced, the magnetron current must be set as follows:

Reconnect the ship's mains supply, and switch the radar ON.

Wait 3 minutes for the magnetron time delay to expire, and select long pulse.

Set the magnetron current as detailed in Figure 6.14.

Isolate the radar from the ship's mains supply using the isolating switch provided.

Replace the transceiver cover.

---

## Fault Finding and First Line Servicing

### 3.2.8 Heading Marker Replacement

At the Scanner Control Unit set the isolating switch to the 'OFF' position and lock it.

Isolate the radar from the ship's mains supply using the isolating switch provided.

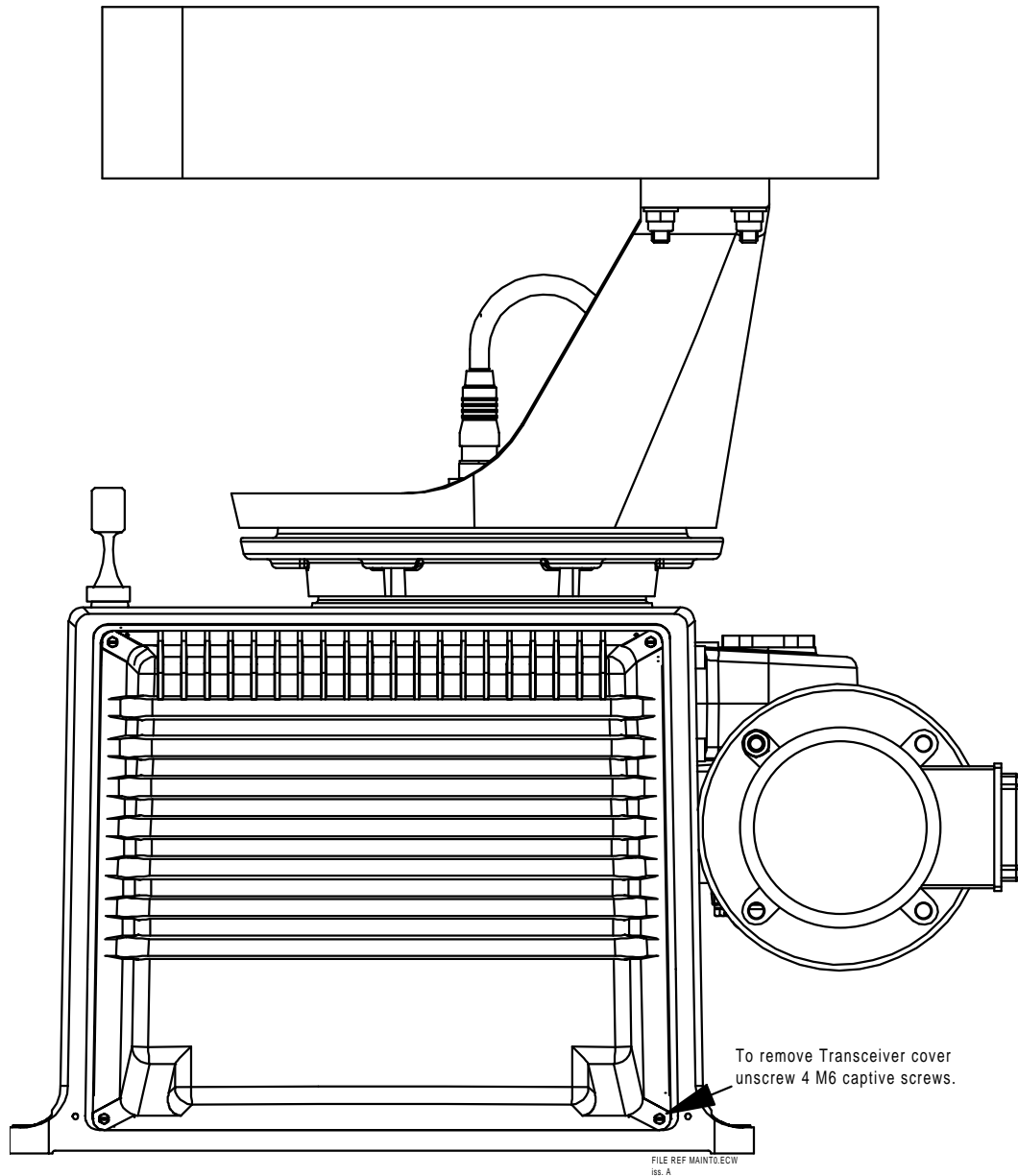
Rotate the antenna until the front face is pointing away from the transceiver.

Refer to Figure 6.22, and remove the Performance Monitor cover. The location of the Pulse Bearing pcb is shown in Figure 6.23. Remove the two securing screws and remove the pcb. Replace the pcb and secure with two screws. Two dowels of different diameters locate the pcb in the correct orientation.

### 3.2.9 Heading Marker Alignment

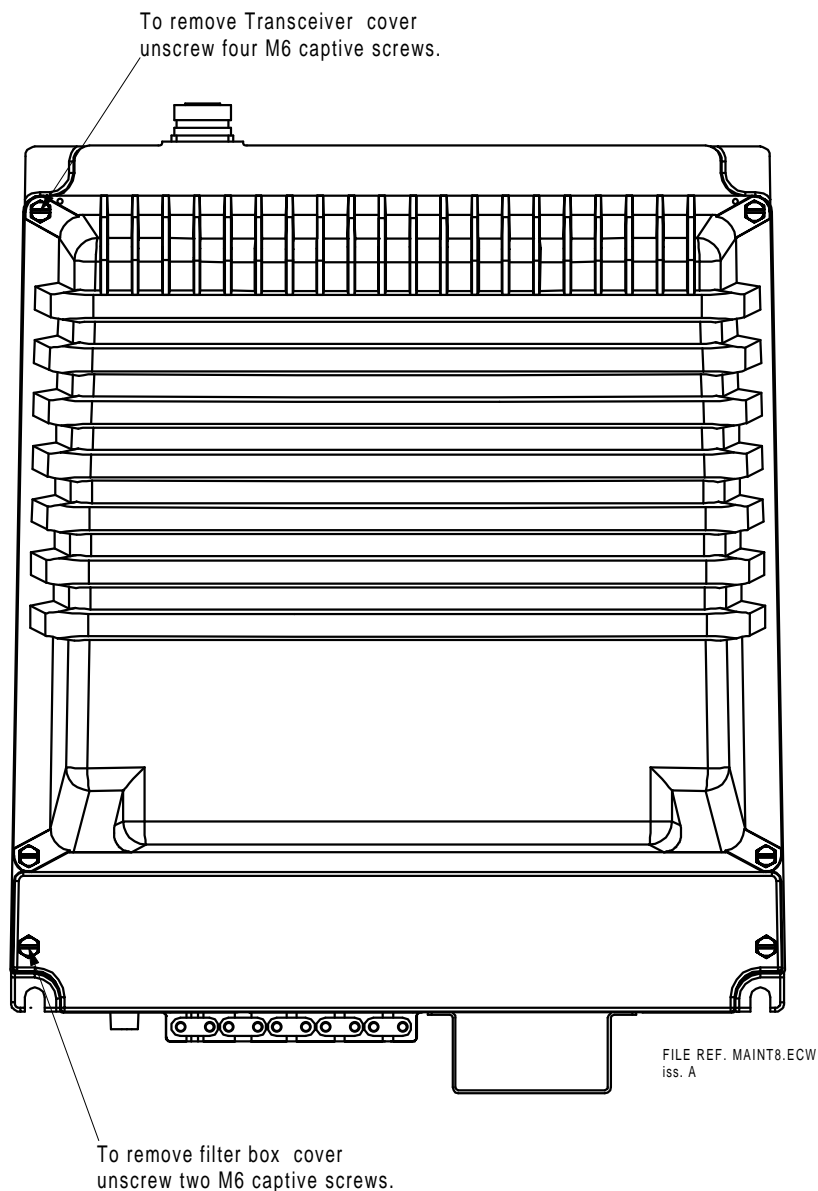
Alignment of the Heading Marker is achieved via the Initialisation menu at the Display Unit.

**DANGER!**  
LETHAL VOLTAGES ARE EXPOSED  
WHEN COVERS ARE REMOVED.  
ENSURE TRANSCIVER IS ISOLATED  
FROM SHIP'S SUPPLY, AND THAT  
THE SHIP'S SUPPLY TO THE SCANNER  
MOTOR IS ISOLATED AT THE SCANNER  
CONTROL UNIT.



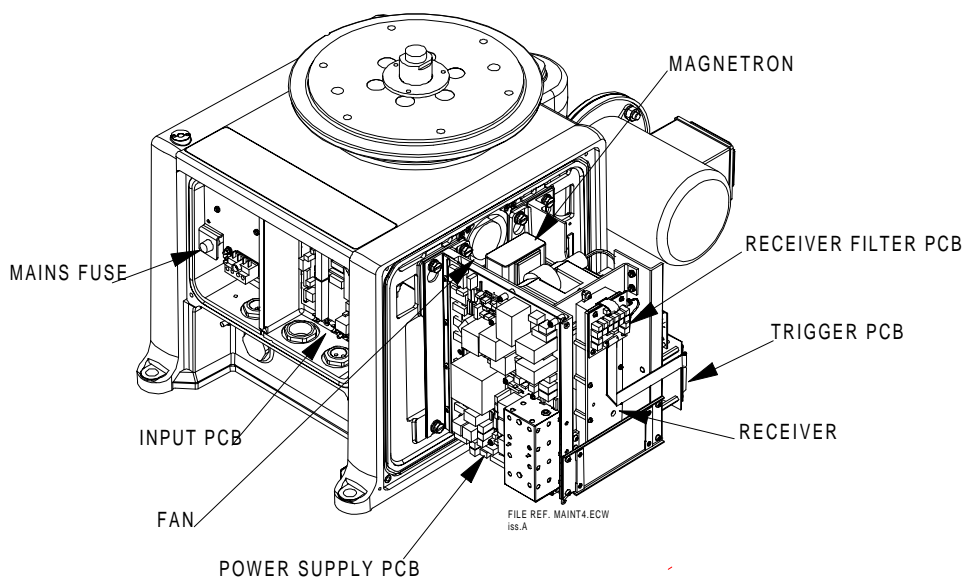
**Figure 6.8** Access to Transceiver (Turning Unit with Integral Transceiver)

**DANGER!**  
LETHAL VOLTAGES ARE EXPOSED  
WHEN COVERS ARE REMOVED.  
ENSURE THAT TRANSCEIVER IS  
ISOLATED FROM SHIP'S SUPPLY  
BEFORE REMOVING COVERS.



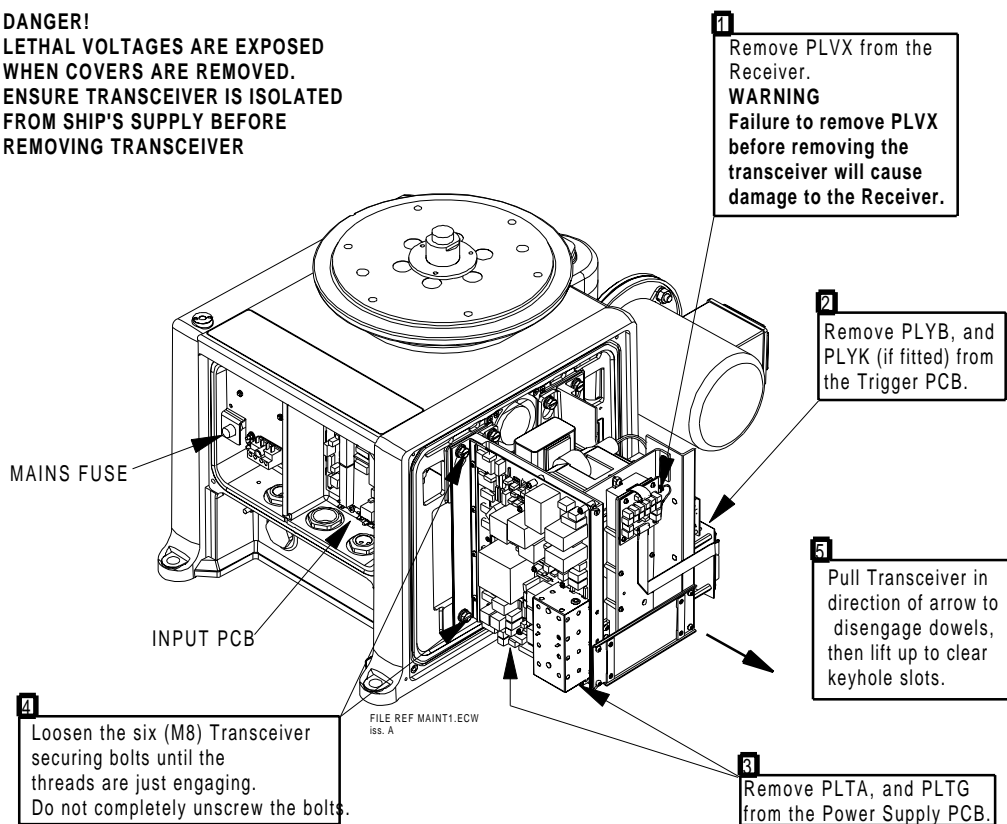
**Figure 6.9** Access to Transceiver (Bulkhead Transceiver)



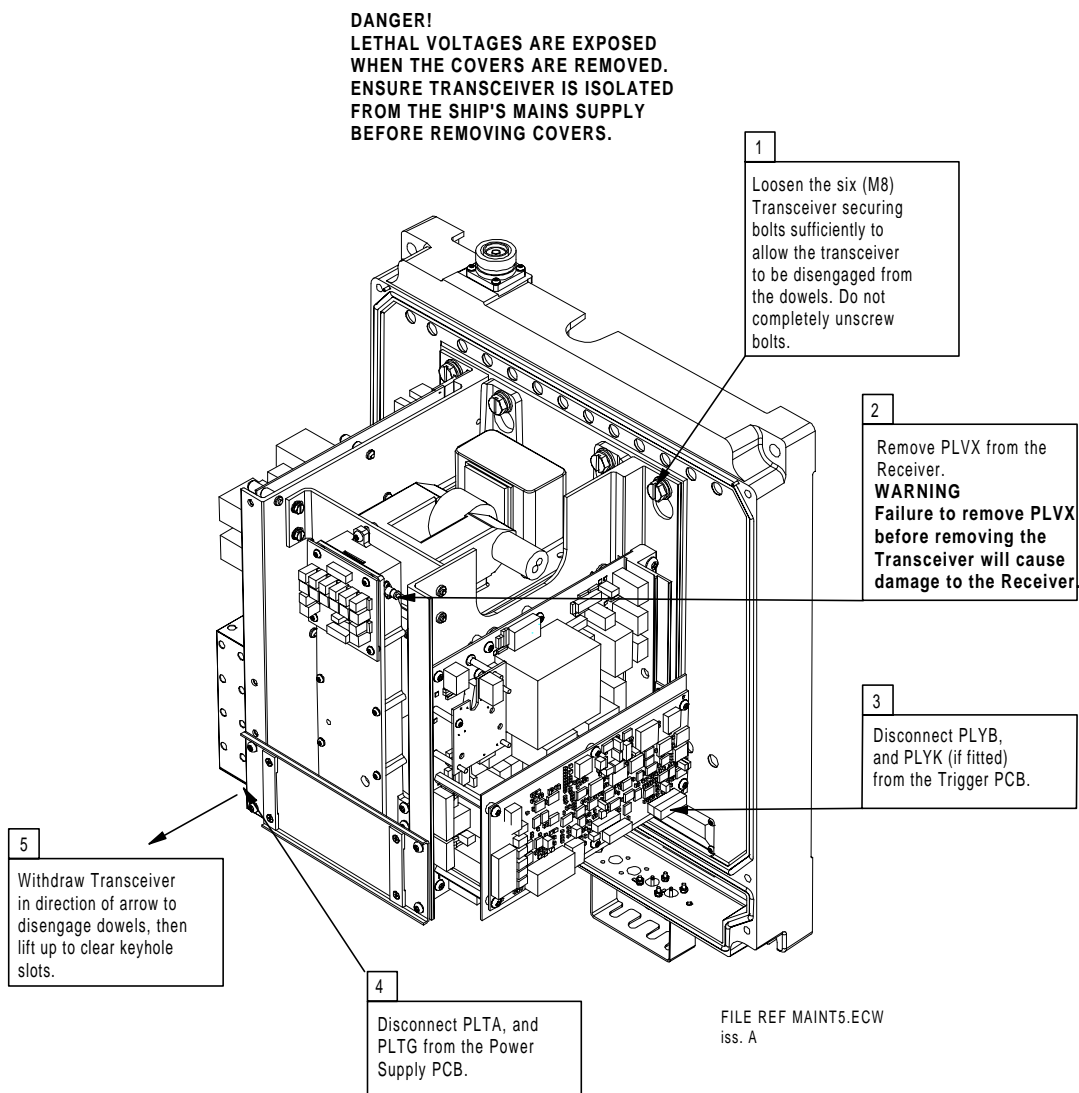


**Figure 6.10** Location of Major Parts

**DANGER!**  
LETHAL VOLTAGES ARE EXPOSED  
WHEN COVERS ARE REMOVED.  
ENSURE TRANSCEIVER IS ISOLATED  
FROM SHIP'S SUPPLY BEFORE  
REMOVING TRANSCEIVER

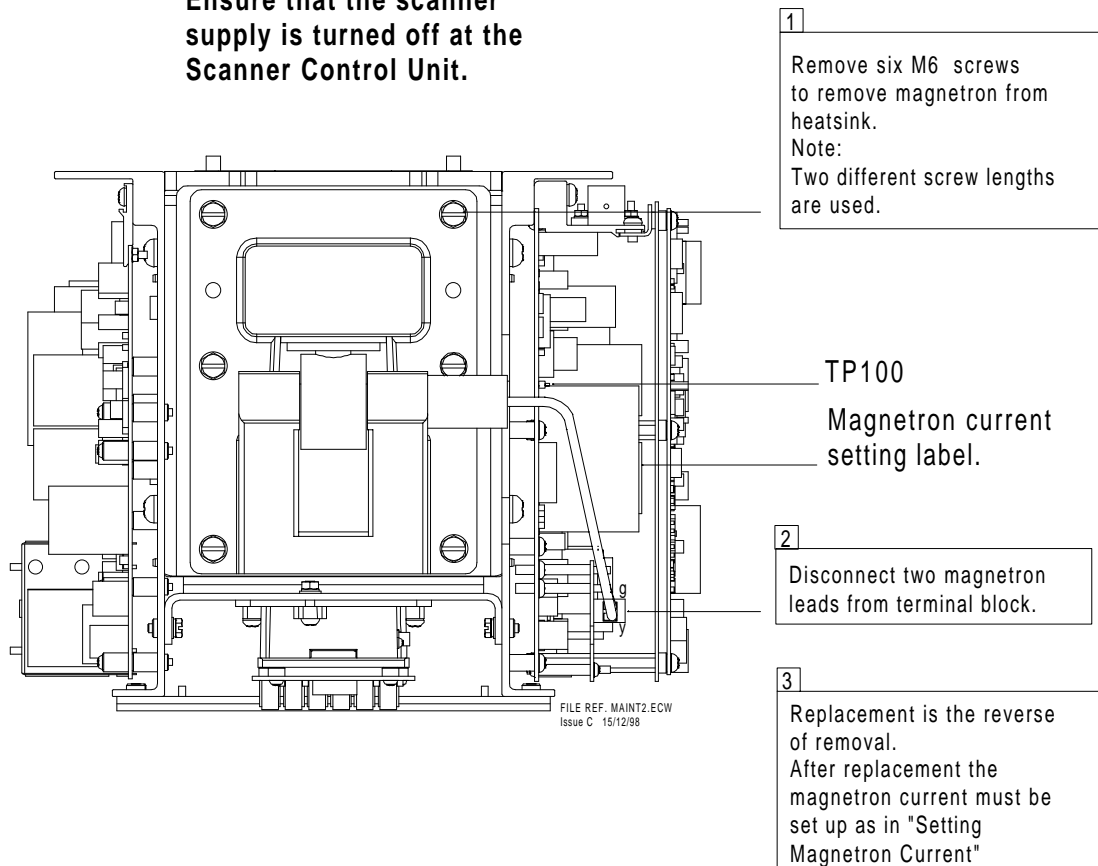


**Figure 6.11** Removing Transceiver from Turning Unit



**Figure 6.12** Removing Transceiver Assembly 65830630 (Bulkhead Transceiver)

**WARNING:**  
 Ensure that the scanner supply is turned off at the Scanner Control Unit.



**Figure 6.13** Magnetron Replacement

## Fault Finding and First Line Servicing

1

On the Trigger PCB set:  
LK5, and LK6 to 2 - 3.  
This is the service position,  
and will allow the transmitter  
to transmit when the antenna  
is stationary.

2

Restore the ship's supply  
to the Transceiver.  
Switch on at the Display  
and wait 3 minutes for timer.  
Select Long Pulse, Transmit  
at the Display.

3

On the Modulator PCB measure  
the voltage between TP100 and  
ground.

Note:

A DVM with an input impedance  
greater than 10 Mohms must be  
used for this measurement. Use  
of a meter with lower impedance  
could result in damage to the  
magnetron.

4

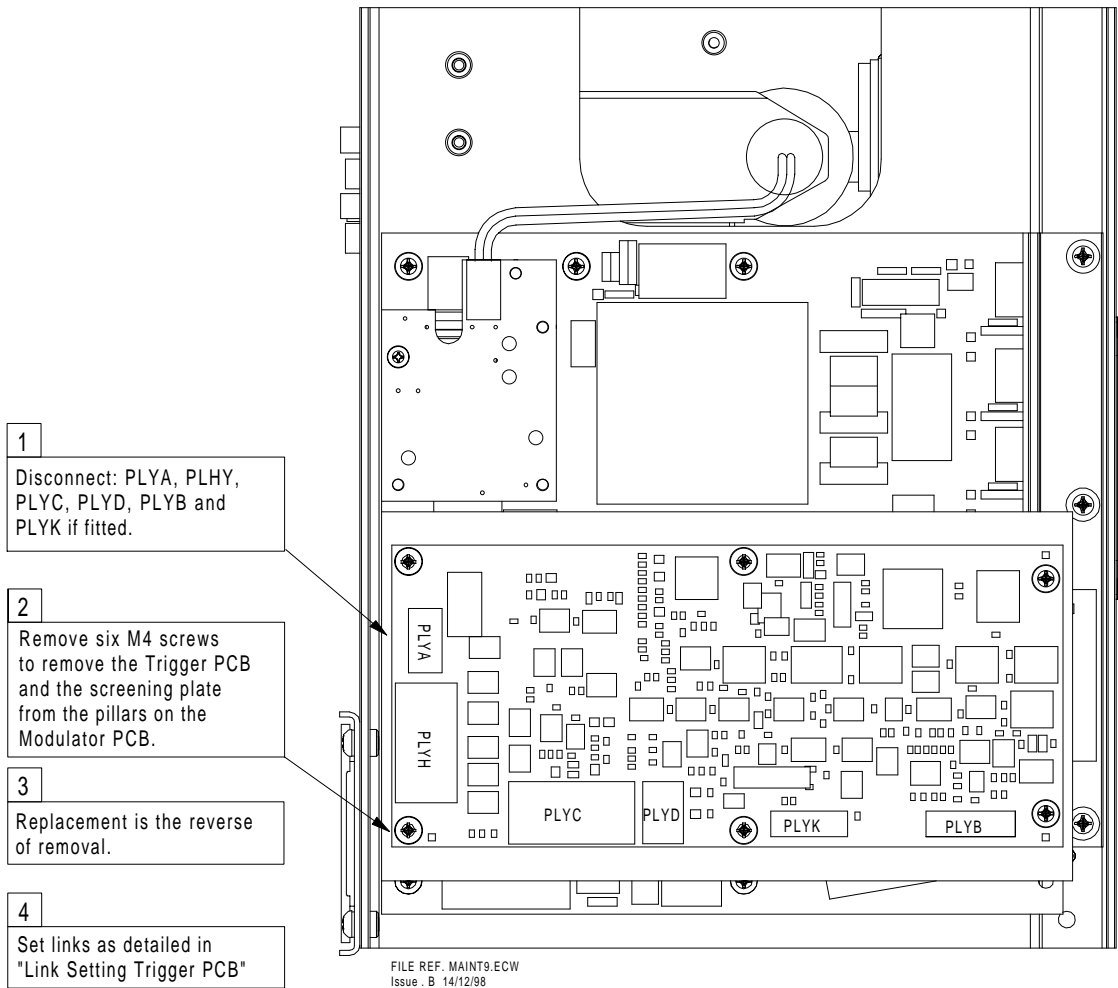
Adjust RV1 on the Power Supply  
PCB to give the same voltage on  
TP100 as is recorded on the label  
on the pulse transformer on the  
Modulator PCB.

6

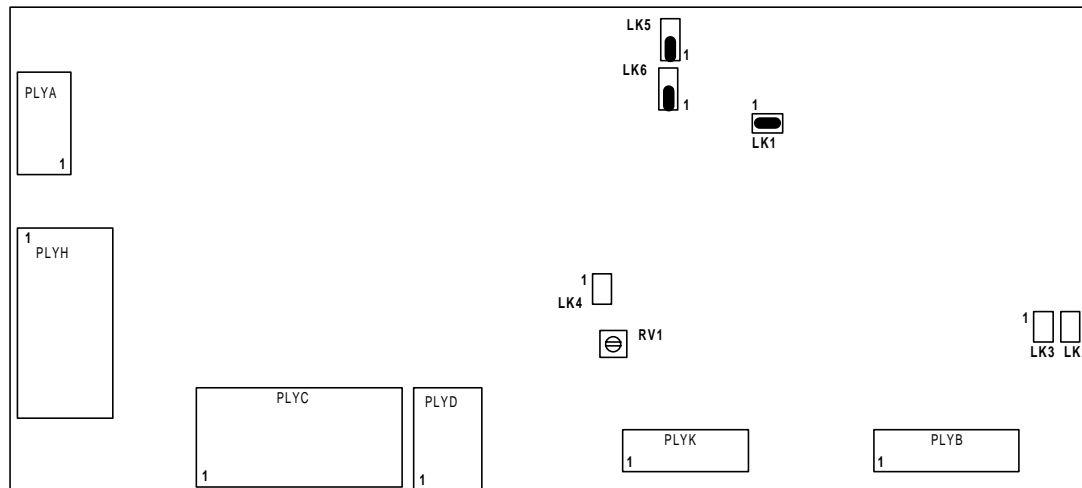
On completion of the procedure.  
Switch off.  
Reset LK5 and LK6 on the  
Trigger PCB to 1 - 2.

FILE REF. MAINT3.ECW  
Iss. D 21/01/99

**Figure 6.14** Setting Magnetron Current



**Figure 6.15** Replacing Trigger PCB



FILE REF. TRIGGER.ECW  
 iss. C

**ATE TEST LINKS**

LK1 FITTED  
 LK4 NOT FITTED

**BAUD RATE LINKS**

LK2 NOT FITTED  
 LK3 NOT FITTED

**SERVICE LINKS**

LK5 NORMAL OPERATION FITTED 1 - 2  
 LK6 NORMAL OPERATION FITTED 1 - 2

LK5 SERVICE FITTED 2 - 3  
 LK6 SERVICE FITTED 2 - 3  
 WHEN FITTED 2 - 3 THE TRANSMITTER  
 WILL OPERATE WHEN THE ANTENNA IS  
 STOPPED.

**RV1 SWEPT GAIN DELAY**

FACTORY SET DO NOT ADJUST

**Figure 6.16** Link Settings Trigger PCB

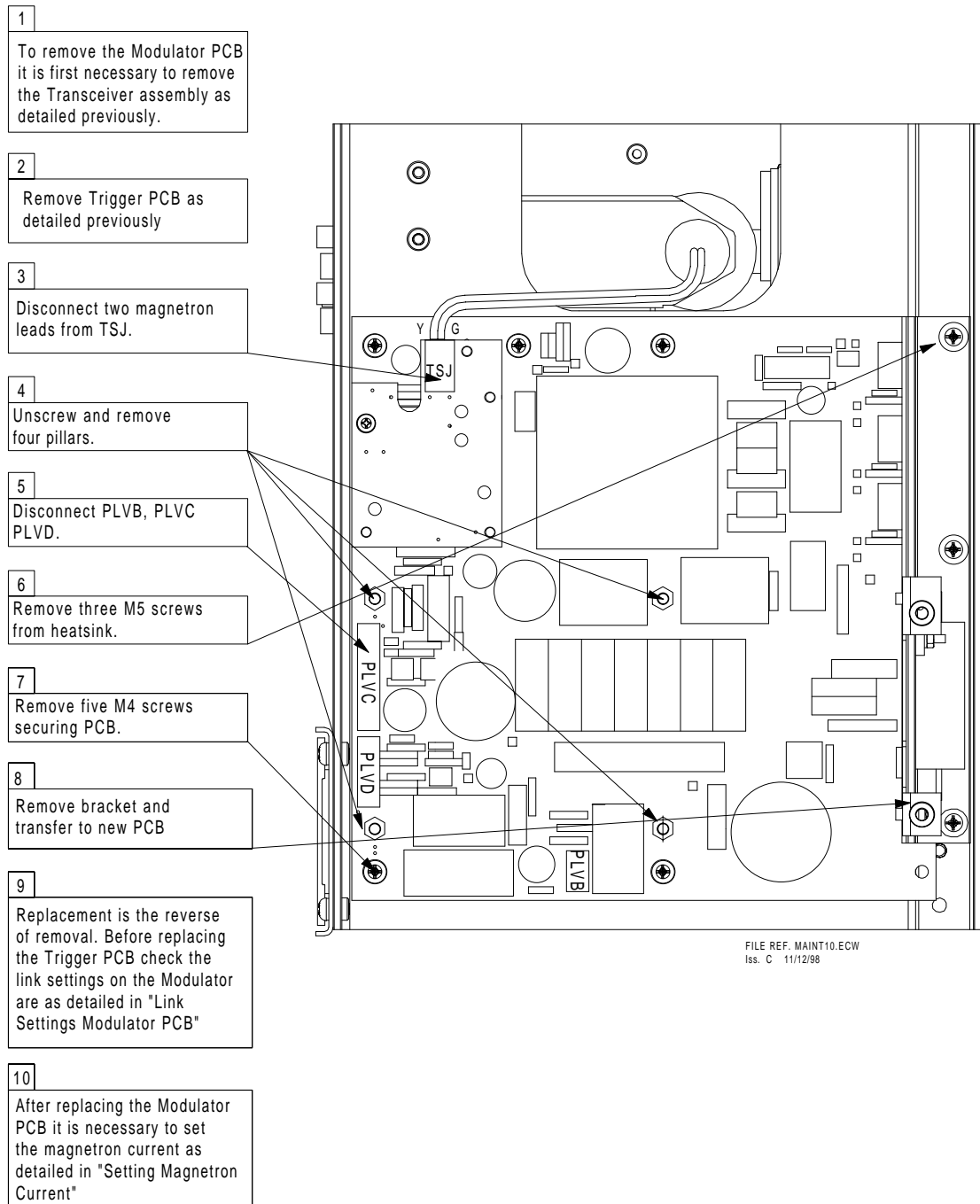
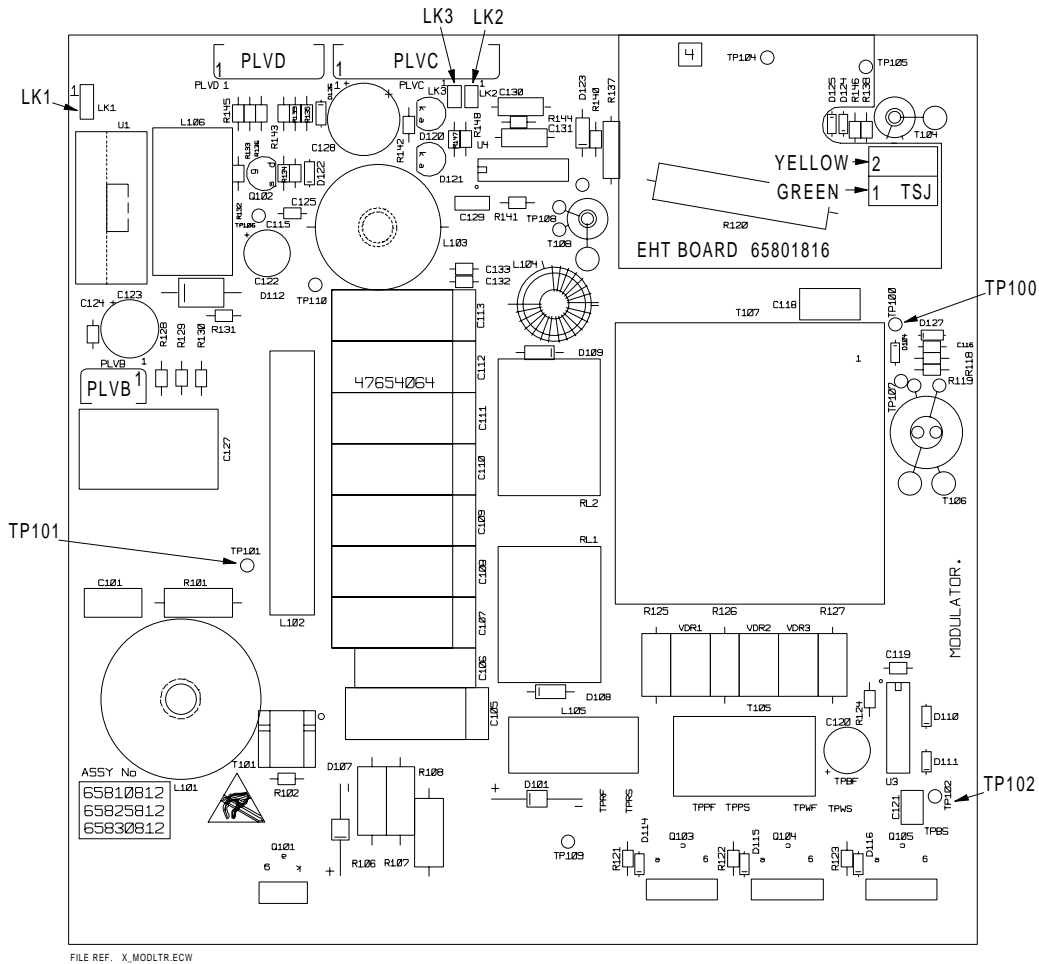


Figure 6.17 Replacing Modulator PCB

Fault Finding and First Line Servicing



FILE REF. X\_MODLTR.ECW

MODULATOR LINK SETTINGS FOR 65810812 / 65825812 / 65830812

	S-BAND	10 kW X-BAND	25 kW X-BAND
LK1	FITTED 2 - 3	FITTED 1 - 2	FITTED 1 - 2 FOR MAGNETRON MG5424
LK1			FITTED 2 - 3 FOR MAGNETRON M1458
LK2	FITTED	NOT FITTED	NOT FITTED
LK3	NOT FITTED	FITTED	NOT FITTED

NOTE THAT LINK 1 IS CONFIGURABLE FOR HEATER TURNDOWN ON 25KW X-BAND  
 NOTE THAT LINKS 2 & 3 ARE HARDWIRED FOR SPECIFIC USAGE.

TEST POINTS:

- TP100 MAGNETRON CURRENT MONITOR
- TP101 CHARGE TRIGGER
- TP102 MODULATOR TRIGGER

Figure 6.18 Link Settings - Modulator PCB



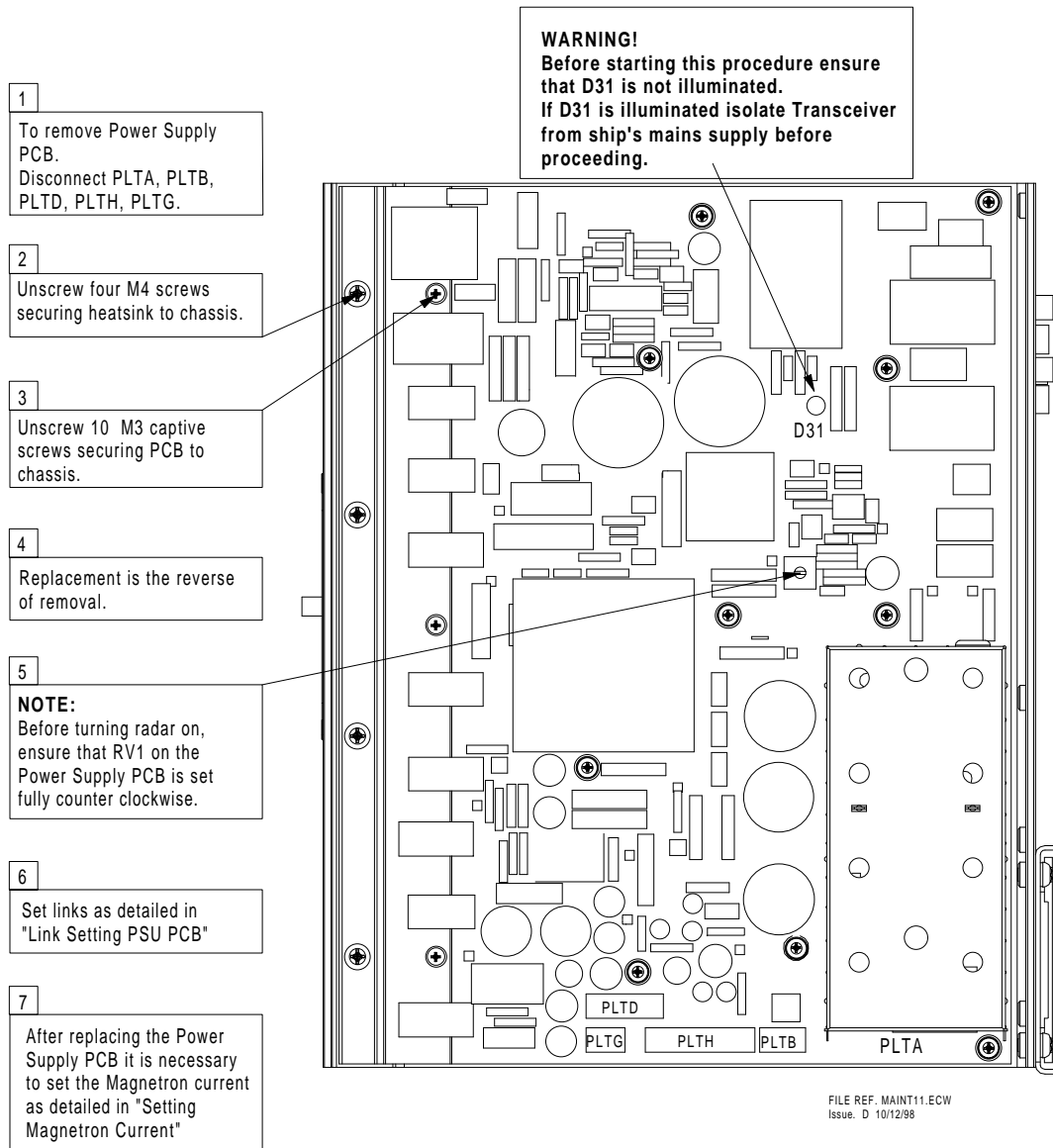


Figure 6.19 Replacing Power Supply PCB

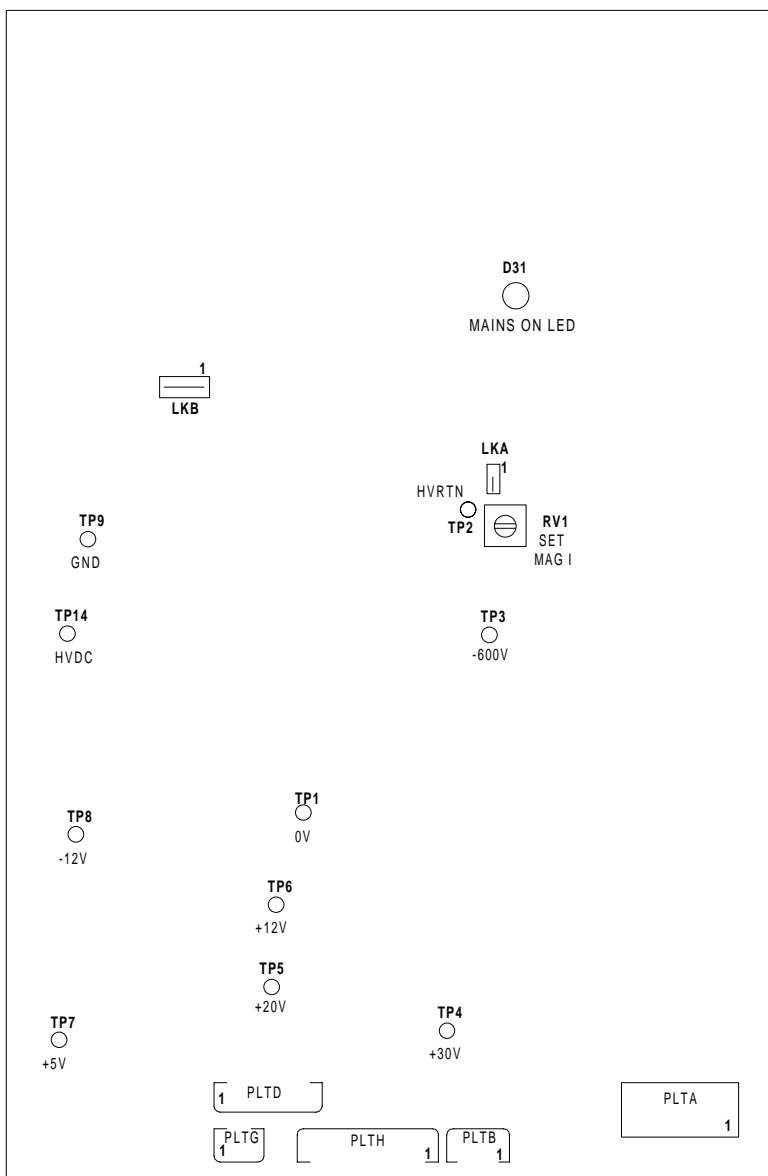
**TEST POINTS**

- TP1 0V
- TP3 -600V
- TP4 +30V
- TP5 +20V
- TP6 +12V
- TP7 +5V
- TP8 -12V

The above voltages are measured with respect to TP1.

- TP2 HVRTN
- TP14 HVDC (380V)

The voltage on TP14 is measured with respect to TP2.



FILE REF PSU.ECW  
 Issue. D 15/12/98

**"LKA" START TEST LINK**

LKA NORMAL OPERATION FITTED 2 - 3  
 LKA TEST FITTED 1 - 2  
 WHEN IN THE TEST POSITION THIS LINK ALLOWS THE POWER SUPPLY TO OPERATE WITHOUT BEING CONNECTED TO THE CONTROL SIGNALS FROM THE DISPLAY COMPATIBILITY UNIT.

**"LKB" HIGH VOLTAGE ISOLATION LINK**

LKB NORMAL OPERATION FITTED  
 LKB ISOLATE HV SUPPLY NOT FITTED  
 THIS LINK CAN BE USED TO ISOLATE THE POWER FACTOR CORRECTION CIRCUIT FROM THE REST OF THE POWER SUPPLY AS AN AID TO FAULT FINDING.

Link Setting Power Supply PCB

**Figure 6.20** Link Settings - Power Supply PCB

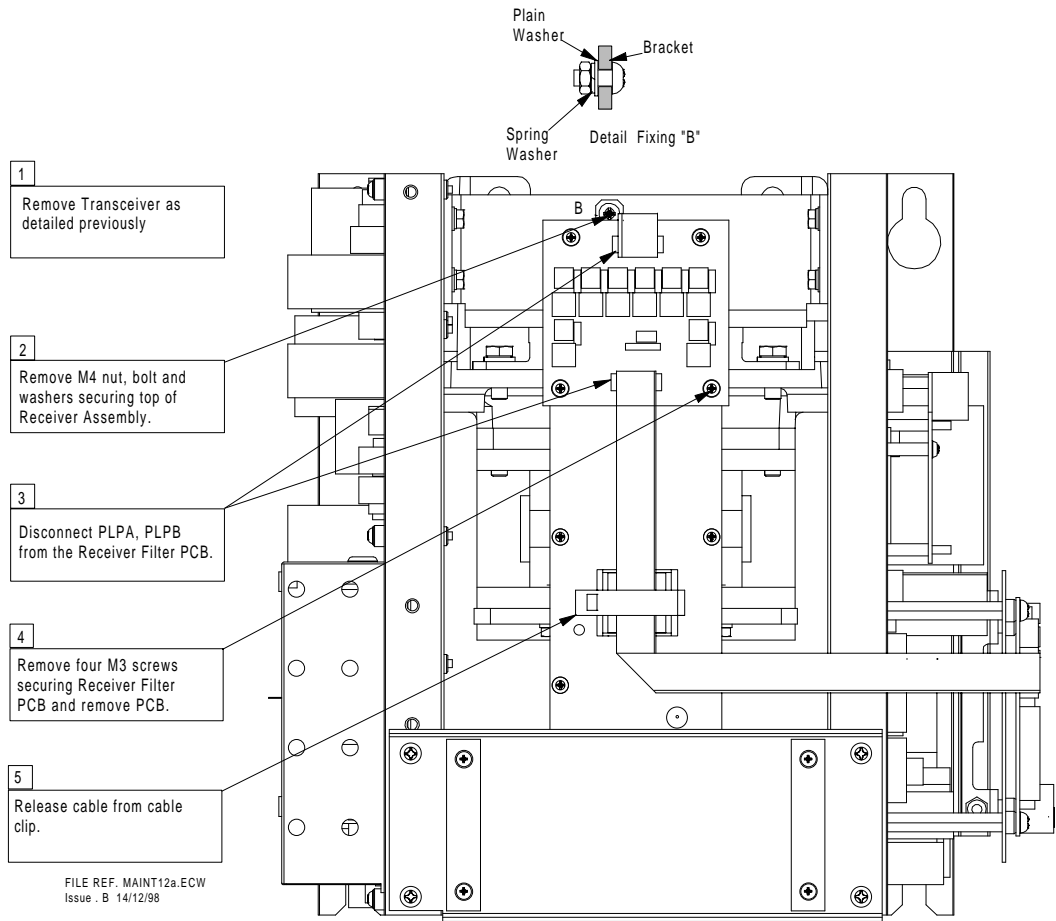


Figure 6.21 (Sheet 1 of 2) Replacement of Receiver Assembly 65830616

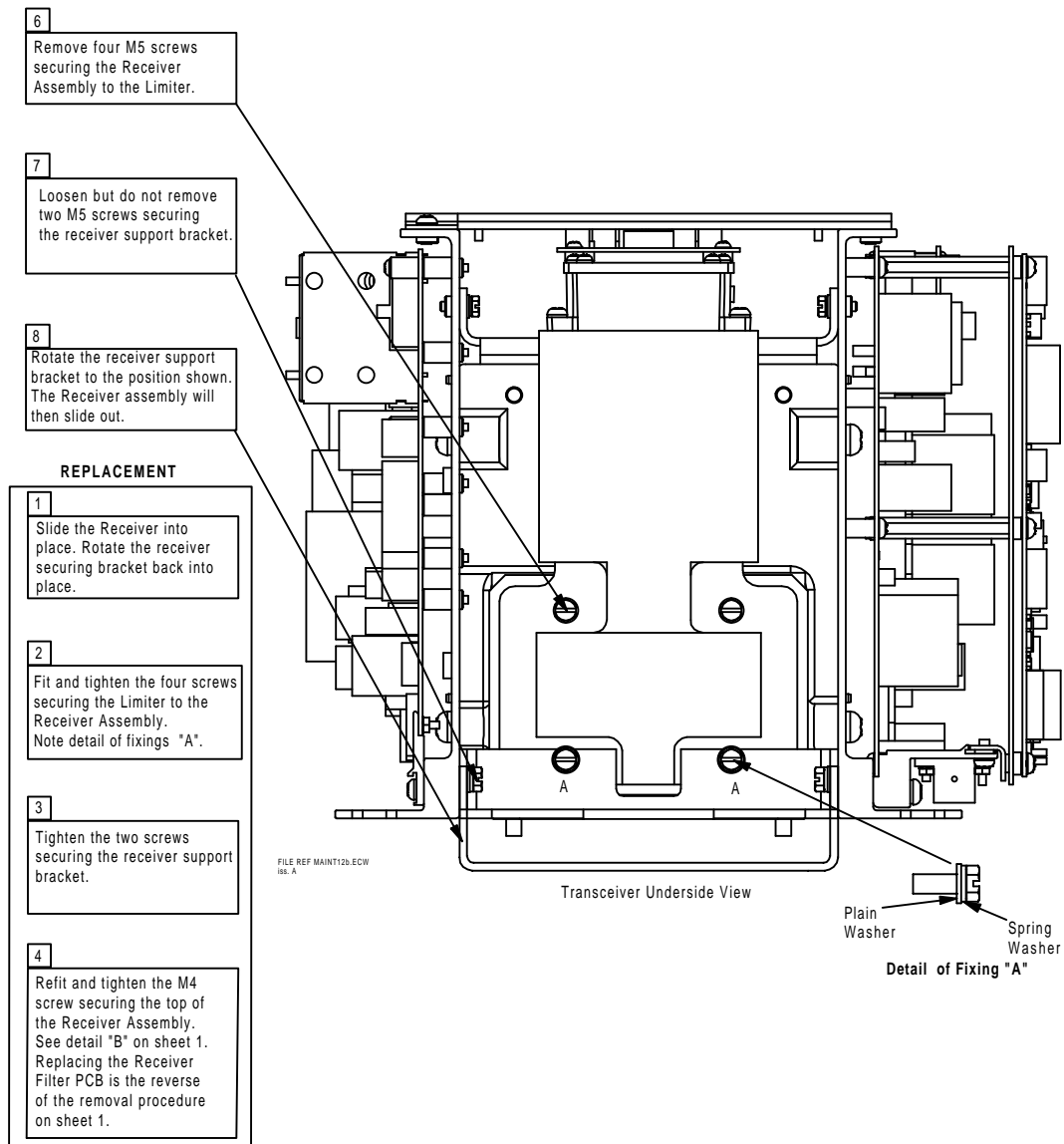
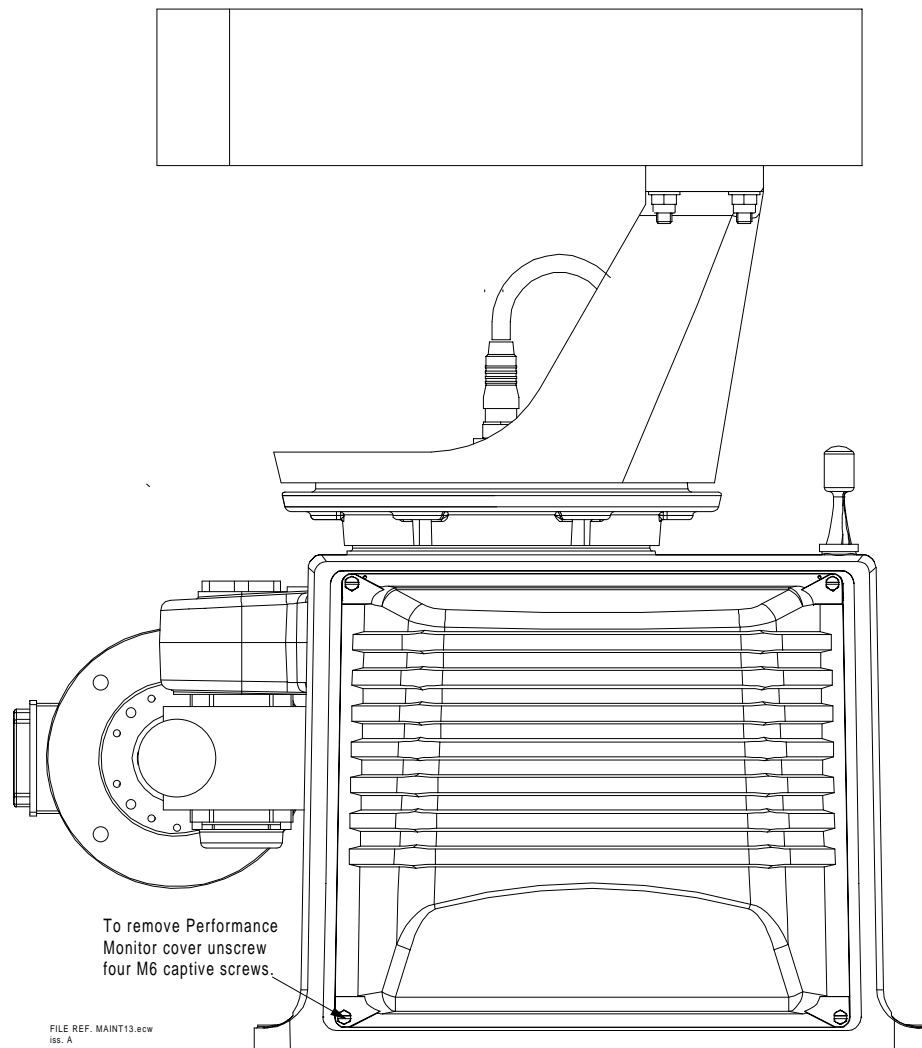


Figure 6.21 (Sheet 2 of 2) Replacement of Receiver Assembly 65830616

**DANGER!**  
 LETHAL VOLTAGES ARE EXPOSED  
 WHEN COVERS ARE REMOVED.  
 ENSURE TRANSCIVER IS ISOLATED  
 FROM SHIP'S SUPPLY, AND THAT  
 THE SHIP'S SUPPLY TO THE SCANNER  
 MOTOR IS ISOLATED AT THE SCANNER  
 CONTROL UNIT.



**Figure 6.22** Access to Performance Monitor and Bearing and Heading Marker PCB

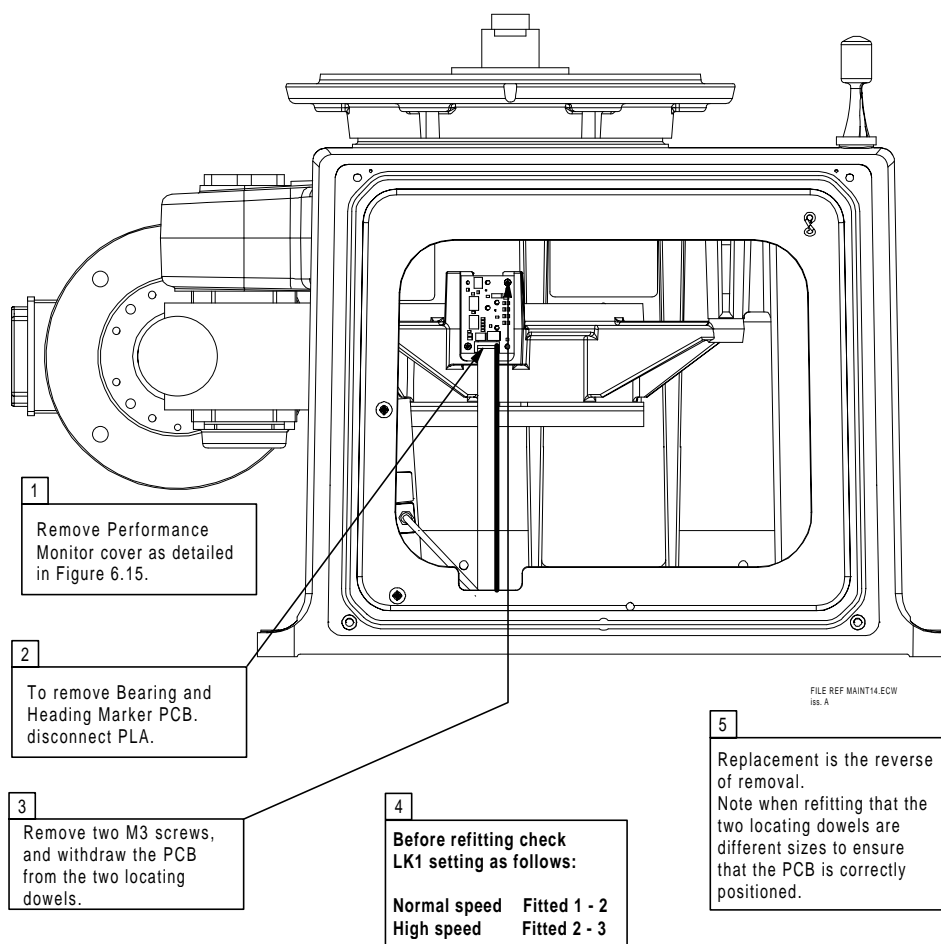


Figure 6.23 Replacing Bearing and Heading PCB

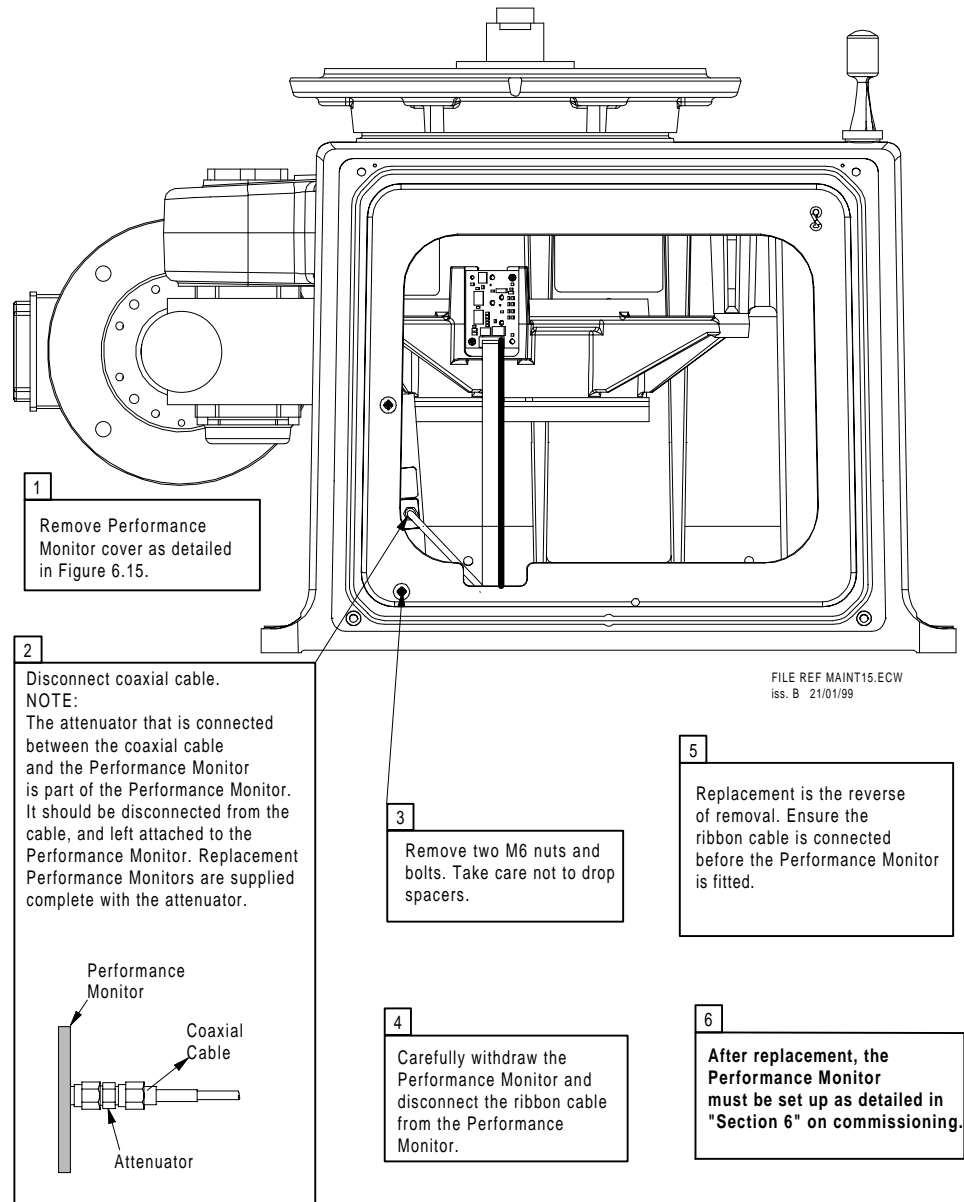
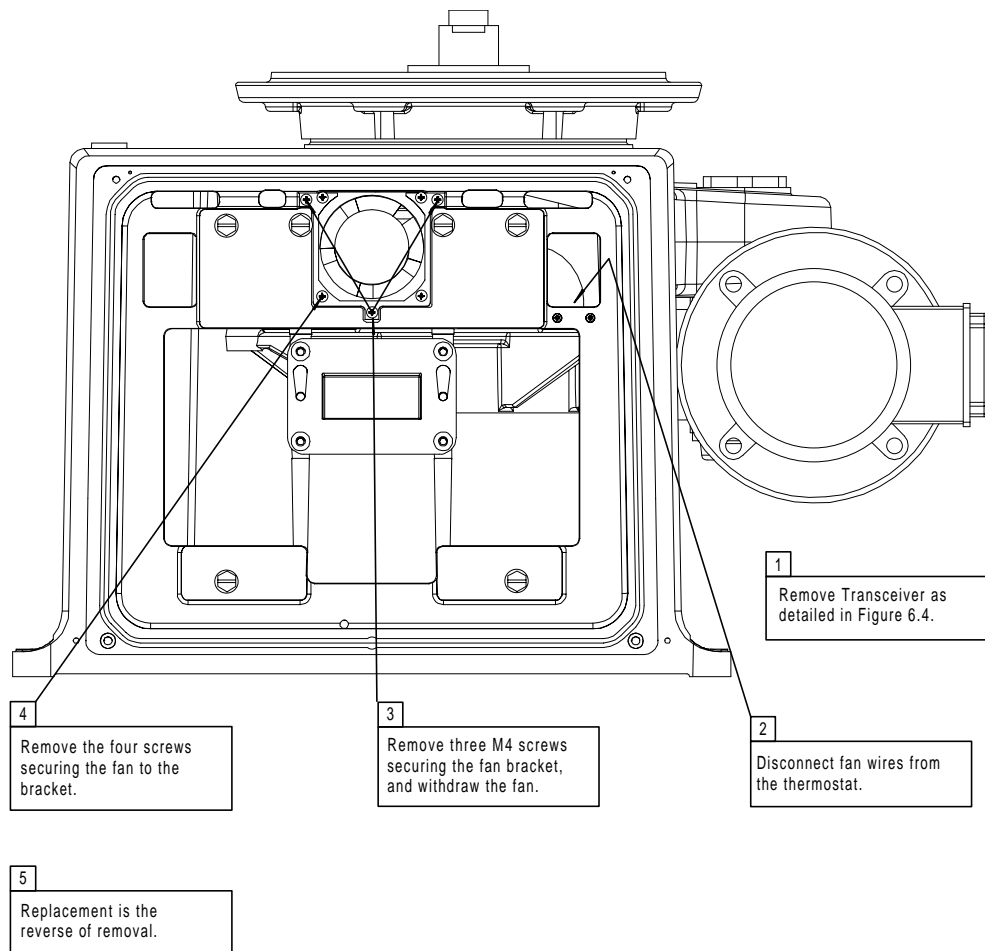


Figure 6.24 Replacing Performance Monitor



FILE REF MAINT16.ECW  
ISS. A

**Figure 6.25** Replacement of Fan Assembly



## 3.3 X-Band Scanner Unit

### 3.3.1 Access to Masthead Transceiver

Set Transceiver Unit to Standby and switch off the Display Unit from the front panel.

Isolate and remove both Ship's Switch Fuses in DC systems.

Isolate the radar from the ship's mains supply using the Isolating Switch provided for AC systems.

Turn the antenna into the service position, i.e. across the Transceiver axis, clear of any obstructions.

Undo the **four** captive bolts on the underside of each the upper casting. These secure the upper casting to the base casting.

Raise the upper casting into the upright position and **ensure that the support stay engages in the locked position. The sliding locking bolt should be pushed to the bottom of the slot in the stay to prevent inadvertent release of the upper casting.** Refer to Figure 6.26.

***Note** - Servicing kits (65810700 (10kW) and 65825700 (25kW)) are available to enable X-Band Masthead Transceivers to be run below decks on a dummy load (included in kit).*

### 3.3.2 Access to Bulkhead Transceiver

Set Transceiver Unit to Standby and switch off the Display unit from the front panel.

Isolate and remove both Ship's Switch Fuses in DC systems.

Isolate the radar from the ship's mains supply using the Isolating Switch provided for AC systems.

Undo the **four** screws that retain the upper cover to the lower chassis and lift clear.

### 3.3.3 Removing and Replacing the Transceiver from Masthead Turning Unit

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

***Note** - The Masthead and Bulkhead Transceiver Units are identical and only minor differences exist in terms of fixtures.*

Disconnect the cables from the following sockets:-

SKV Video co-axial cable to receiver assembly.

PLYB Ribbon cable to Trigger PCB.

PLTK Cable from PSU to Motor Drive PCB.

PLTA Cable from PSU to Input Filter PCB (mains supply).

PLTG Cable from PSU to Input PCB.

Refer to Figure 6.28.

Situated around the base of the Circulator plate, release the four M6 captive screws that hold the microwave assembly to the waveguide transition.

## Fault Finding and First Line Servicing

Remove the three screws that hold the Modulator heatsink to the chassis.  
Slacken the two large bolts that hold the PSU heatsink to the chassis.

The PSU heatsink has slotted holes that enable the transceiver to be slid upwards (towards the microwave output transition) and removed without fully removing the two bolts. Before sliding up and removing the Transceiver, ensure that no cables are caught on any of the metalwork to avoid damage.

### Replacement

The replacement sequence is as follows:-

Locate the Transceiver approximately onto the upper casting using the two large slotted holes in the PSU heatsink.

Slacken the two screws that hold the PSU chassis plate to the Modulator chassis plate, see Figure 6.28.

Slacken the screw that holds the Circulator mounting plate to the PSU chassis plate.

The three screws in the Modulator heatsink should be fitted but only **partially** tightened. The four M6 microwave assembly retaining screws can now be fully engaged and tightened. The three screws in the Modulator heatsink can now be fully tightened. The two large bolts in the slotted holes in the PSU heatsink can now be fully tightened. The two screws that hold the PSU chassis plate to the Modulator chassis plate can now be fully tightened. The screw that holds the circulator mounting plate to the PSU chassis can now be fully tightened.

**Note** - *This sequence is important to ensure that the microwave alignment takes priority in terms of mechanical tolerances.*

Replace all cables removed earlier.

### 3.3.4 Removing and Replacing the Transceiver from Bulkhead Transceiver Chassis

Refer to sub-section 3.3.2 (Access to Bulkhead Transceiver), paying attention to all safety aspects. Check that the Transceiver is fully isolated from the ship's supply.

**Note** - *The Masthead and Bulkhead Transceiver Units are identical and only minor differences exist in terms of fixtures.*

Disconnect the cables from the following sockets:-

SKV	Video co-axial cable to receiver assembly.
PLYB	Ribbon cable to Trigger PCB.
PLTK	Cable from PSU to Input PCB (motor supply)
PLTA	Cable from PSU to Input Filter PCB (mains supply).
PLTG	Cable from PSU to Input PCB.

---

## Fault Reporting and First Line Servicing

Refer to Figures 6.28 and 6.33.

Situated around the base of the Circulator plate, release the four M6 captive screws that hold the microwave assembly to the waveguide transition.

Remove the three screws that hold the Modulator heatsink to the chassis.

Slacken the two large bolts that hold the PSU heatsink to the chassis. The PSU heatsink has slotted holes that enable the transceiver to be slid upwards (towards the microwave output transition) and removed without fully removing the two bolts. Before sliding up and removing the Transceiver, ensure that no cables are caught on any of the metalwork to avoid damage.

**Note** - *On Bulkhead Transceivers, a small clip is fitted to the chassis to retain the lower edge of the Modulator PCB and support plate. This is purely a slide-in fixture and does not require undoing.*

### Replacement

Locate the Transceiver approximately onto the chassis using the two large slotted holes in the PSU heatsink.

Ensure that the small clip fitted to the chassis engages the lower edge of the Modulator PCB and support plate during the replacement process.

Slacken the two screws that hold the PSU chassis plate to the Modulator chassis plate, refer to Figure 6.33.

The three screws in the Modulator heatsink should be fitted but only **partially** tightened.

The four M6 microwave assembly retaining screws can now be fully engaged and tightened.

The three screws in the Modulator heatsink can now be fully tightened.

The two large bolts in the slotted holes in the PSU heatsink can now be fully tightened.

**Note** - *This sequence is important to ensure that the microwave alignment takes priority in terms of mechanical tolerances.*

Replace all cables removed earlier.

### 3.3.5 Magnetron Replacement - Masthead and Bulkhead Transceivers

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Refer to Figure 6.28.

Disconnect the two EHT leads from the Modulator PCB terminal block.

Remove the four screws holding the Magnetron to the magnetron mounting plate.

### Replacement

Replacement is the reverse of the removal process

Ensure that the polarity of the EHT leads is correct. The PCB is marked 'Y' for yellow and 'G' for green.

## Fault Finding and First Line Servicing

Ensure that any earth bonding leads to the Magnetron are refitted.

**After replacement the magnetron current must be set up as in Figure 6.34.**

### 3.3.6 Setting the Magnetron Current

Refer to Figure 6.34 for the necessary procedure for setting Magnetron current.

### 3.3.7 Trigger PCB - Replacement

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Refer to Figure 6.35 for the necessary procedure for replacing the Trigger PCB.

### 3.3.8 Trigger PCB - Link Settings

Refer to Figure 6.36 for the necessary procedure for setting the link settings on the Trigger PCB.

### 3.3.9 Modulator PCB - Replacement

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Refer to Figure 6.37 for the necessary procedure for replacing the Modulator PCB.

### 3.3.10 Modulator PCB - Link Settings

Refer to Figure 6.38 for the necessary procedure for setting the link settings on the Modulator PCB.

### 3.3.11 PSU PCB - Replacement

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Refer to Figure 6.39 for the necessary procedure for replacing the PSU PCB.

### 3.3.12 PSU PCB - Link Settings

Refer to Figure 6.40 for the necessary procedure for setting the link settings on the PSU PCB.

### 3.3.13 Bearing and Heading Marker PCB - Replacement

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Refer to Figure 6.29.

The PCB is attached to a support casting and should be removed as a combined assembly by slackening the two screws retaining the support casting, and then sliding it towards the outside of the upper casting to clear the screws.

The PCB and support casting can then be removed after the cable has been unplugged from PLRE.

**Note** - When refitting the PCB to the support casting there are dowel pegs of different diameters used to locate the PCB in the correct orientation.

Before refitting the assembly, check that the link LK1 is set for either Normal Speed (pins 1-2) 28 RPM or High Speed (pins 2-3) 45 RPM.

### 3.3.14 Heading Marker Alignment

Alignment of the Heading Marker is achieved via the Initialisation menu at the Display Unit.

### 3.3.15 Receiver Assembly - Replacement (Masthead)

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply. Remove the Transceiver Assembly as described at sub-section 3.3.3.

Unplug the ribbon cable from the Receiver to the Receiver Filter PCB

Unplug the ribbon cable from the Receiver Filter PCB to the Trigger PCB.

Refer to Figure 6.28 for location of the screws securing the Low Noise Front End (LNFE) to the Limiter.

**Note** - The replacement Receiver is supplied with the LNFE already fitted.

Remove the four screws that hold the LNFE to the Limiter.

Remove the bracket that secures the Receiver to the microwave assembly at the Receiver end, and remove the whole Receiver assembly.

Before fitting the replacement assembly, remove the Receiver Filter PCB from the old unit, and fit it to replacement unit.

Replacement is the reverse of the removal process.

### 3.3.16 Receiver Assembly - Replacement (Bulkhead)

Refer to sub-section 3.3.2 (Access to Bulkhead Transceiver), paying attention to all safety aspects. Check that the Transceiver is fully isolated from the ship's supply.

Refer to Figures 6.28 and 6.33.

Unplug the ribbon cable from the Receiver to the Receiver Filter PCB.

Unplug the ribbon cable from the Receiver Filter PCB to the Trigger PCB.

Unplug the video co-axial cable from the Receiver.

Refer to Figure 6.28 for the location of screws securing the Low Noise Front End (LNFE) to the Limiter.

**Note** - The replacement Receiver is supplied with the LNFE already fitted.

Remove the four screws that hold the LNFE to the Limiter and remove the whole assembly.

Before fitting the replacement assembly, remove the Receiver Filter PCB from the old unit, and fit it to replacement unit.

Replacement is the reverse of the removal process.

## Fault Finding and First Line Servicing

### 3.3.17 Performance Monitor - Replacement

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Remove the two retaining screws that hold the Performance Monitor to the upper casting (see Figure 6.29) and withdraw the unit.

Un-screw the bar that retains the RF absorber to the body of the Performance Monitor. Disconnect the ribbon cable to the Performance Monitor.

Replacement is the reverse of the removal process.

Ensure that after the ribbon cable is reconnected to the Performance Monitor, the RF absorber is refitted.

**After replacement, the Performance Monitor must be set up as detailed in Chapter 4 under 'Selecting the Performance Monitor' Facility**

### 3.3.18 Motor Drive Board - Replacement

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Unplug the three cable assemblies from the Motor Drive PCB, and remove the three screws (refer to Figure 6.30).

Slide the PCB out of the retaining clip at the opposite end of the PCB.

**Before fitting the replacement PCB, ensure that the speed setting link LK1 is correctly set for the intended operational speed. Positions 1 & 2 marked 'LO' is for 28 RPM operation. Position 2 & 3 marked 'HI' is for 45 RPM operation. If in doubt, compare the setting with the old PCB.**

Replacement is the reverse of the removal process.

Ensure that all three cable assemblies are reconnected to the PCB.

### 3.3.19 Motor and Gearbox Assembly - Replacement.

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Refer to Figure 6.29 for the location of the three screws that retain the motor support casting to the upper casting, and remove the screws.

The motor support casting complete with Motor Drive PCB can now be withdrawn from the belt drive.

Remove the four screws that retain the motor and gearbox assembly to the support casting.

**Note** - *These four countersunk screws are fitted with screw retaining fluid. When fitting the new motor, these screws should be refitted using 'Loctite Screwlock 222' low breaking strength fluid.*

Remove the impeller from the old motor and fit to the replacement.

Replacement is the reverse of the removal process, taking care to engage the motor pulley into the drive belt.

### 3.3.20 Drive Belt - Replacement

Refer to sub-section 3.3.1 (Access to Masthead Transceiver), paying attention to all safety aspects. Check that the transceiver is fully isolated from the ship's supply.

Remove the Transceiver as detailed at sub-section 3.3.3.

Remove the motor support casting and motor assembly as detailed at sub-section 3.3.19.

Refer to Figure 6.29.

Remove the three bolts as indicated that retain the waveguide transition support casting to the rotating joint.

**Note** - *Since the waveguide transition support casting has two sleeve inserts to aid accuracy in alignment, some resistance may be felt when removing it.*

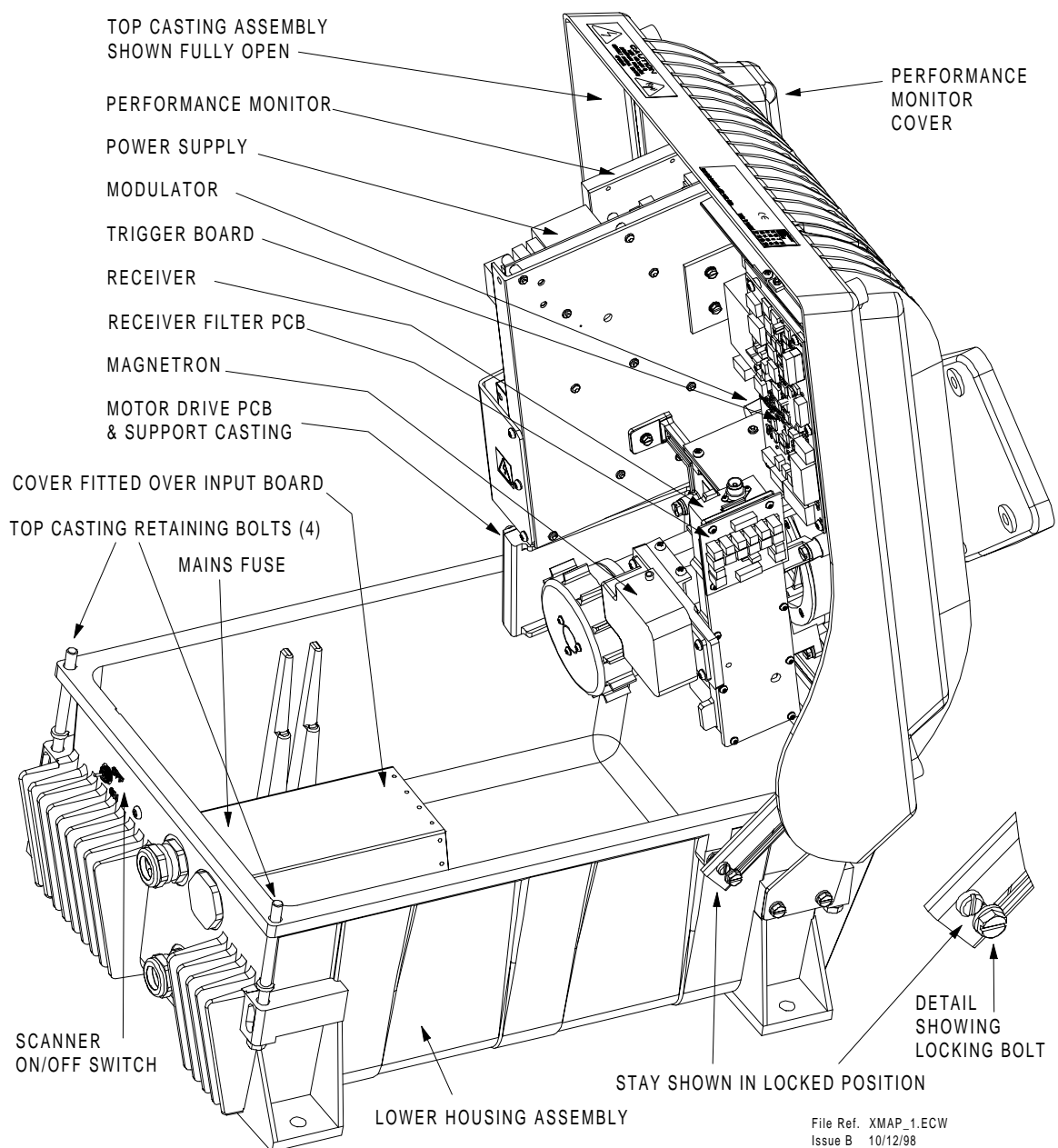
Care should be exercised when removing the casting to avoid damage to the assembly or to the brass microwave probe at the centre of the hub.

The replacement drive belt can now be fitted.

Re-assembly is the reverse of the removal process.

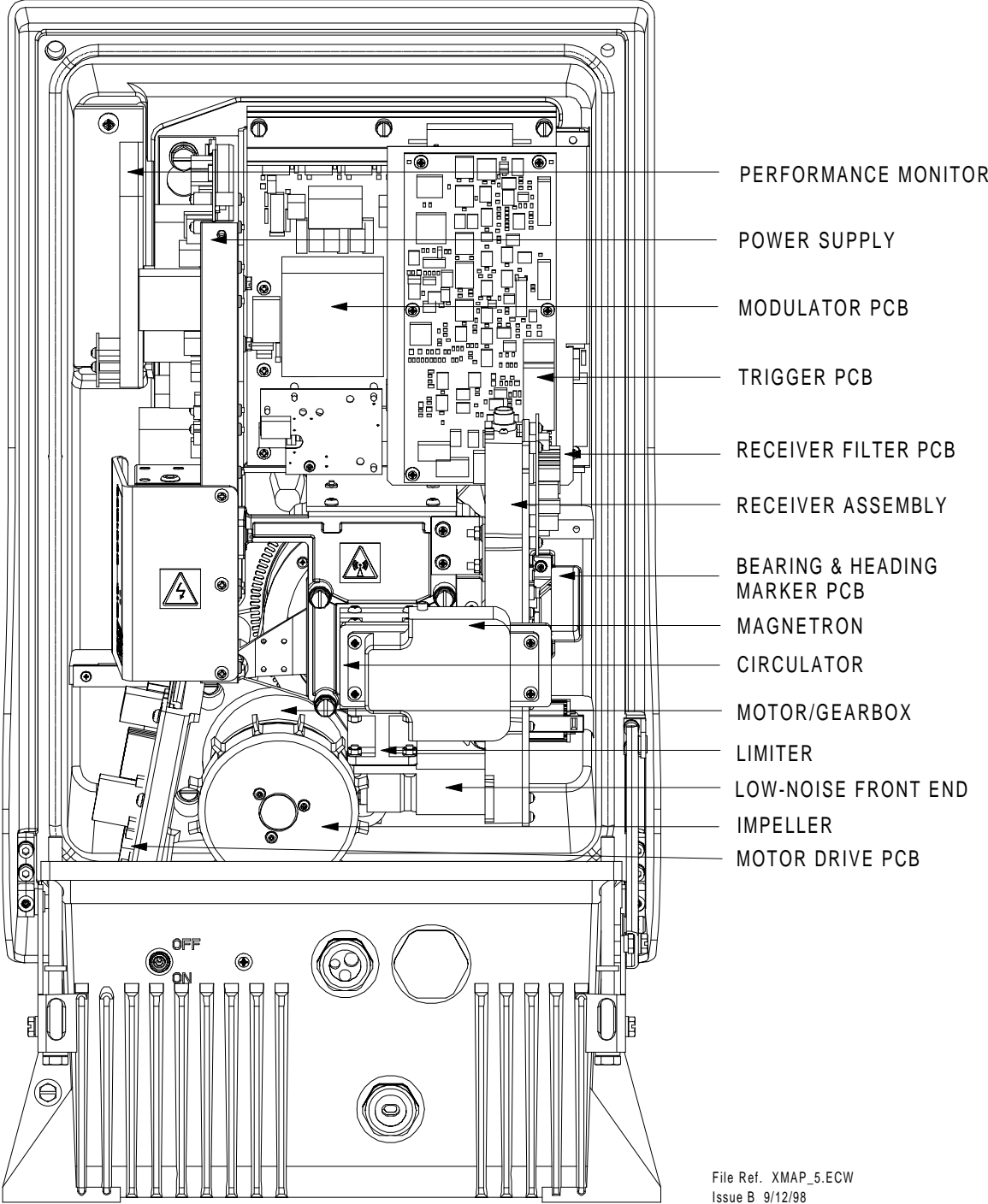
Care should be exercised to avoid damage to the brass microwave probe at the centre of the hub during re-insertion into the transition.

Ensure that the motor pulley is correctly engaged into the belt.



**Figure 6.26** X-Band Masthead Turning Unit - Internal view showing Transceiver





File Ref. XMAP\_5.ECW  
Issue B 9/12/98

Figure 6.27 X-Band Masthead Turning Unit - View showing Main Assemblies

Fault Finding and First Line Servicing

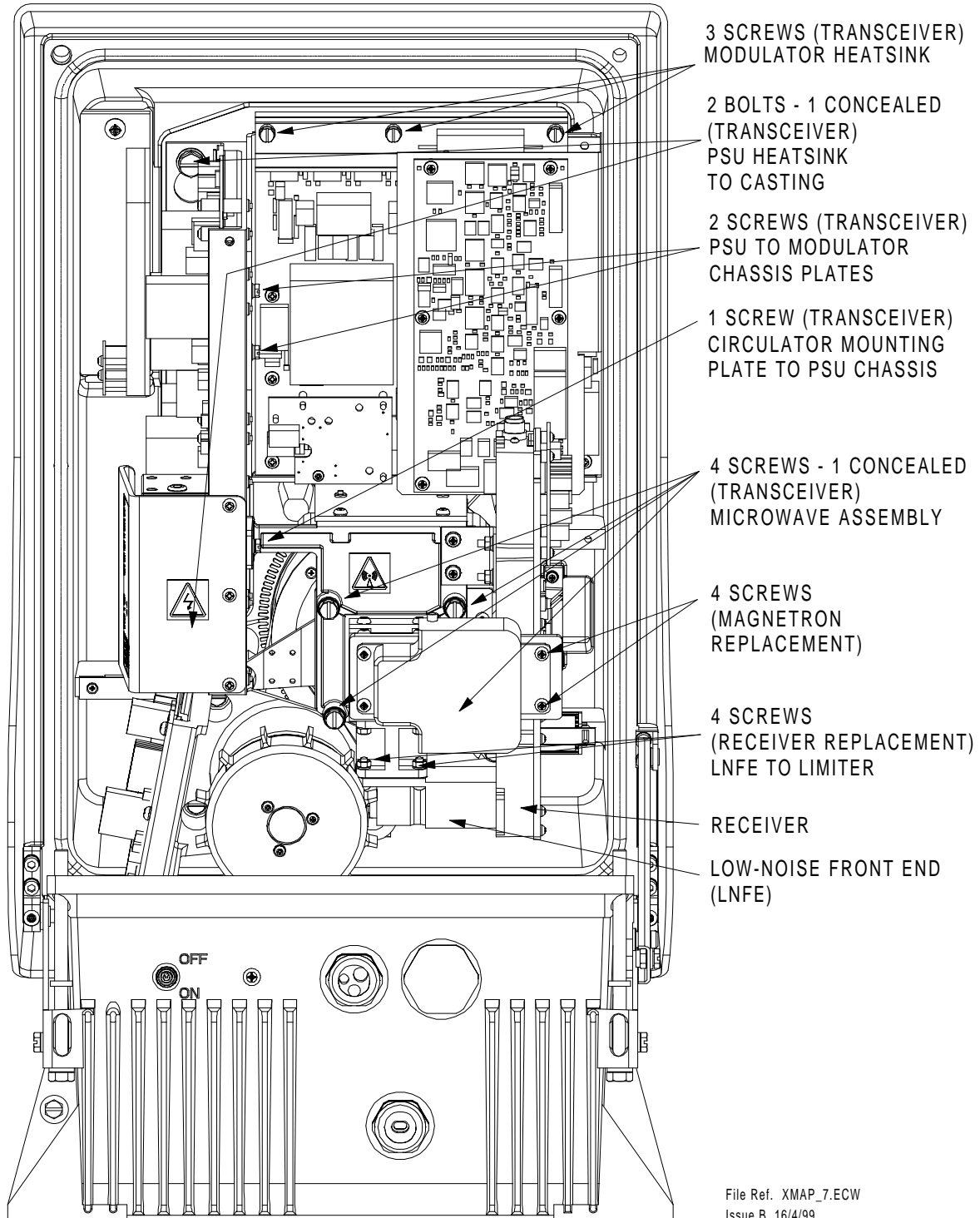
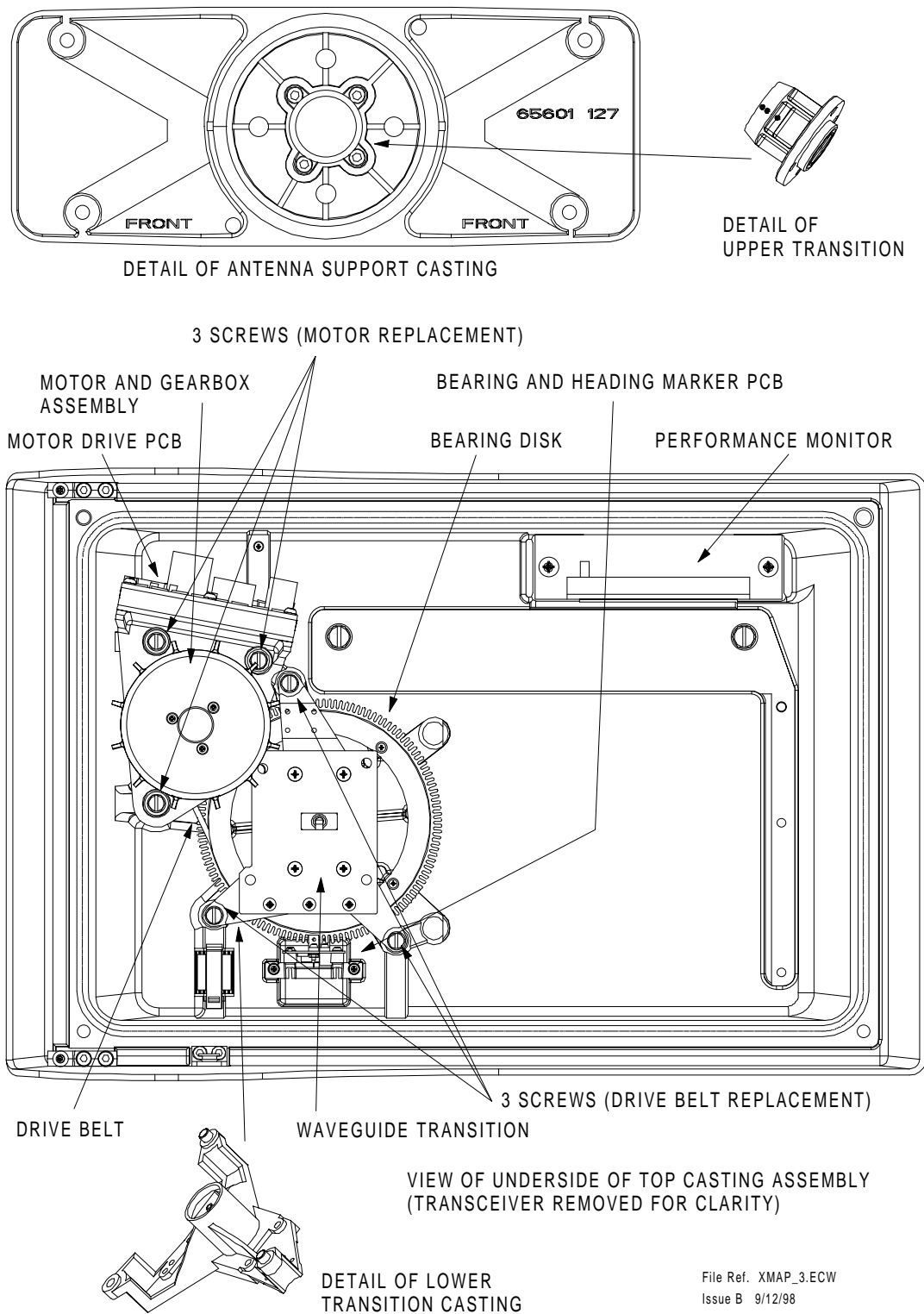
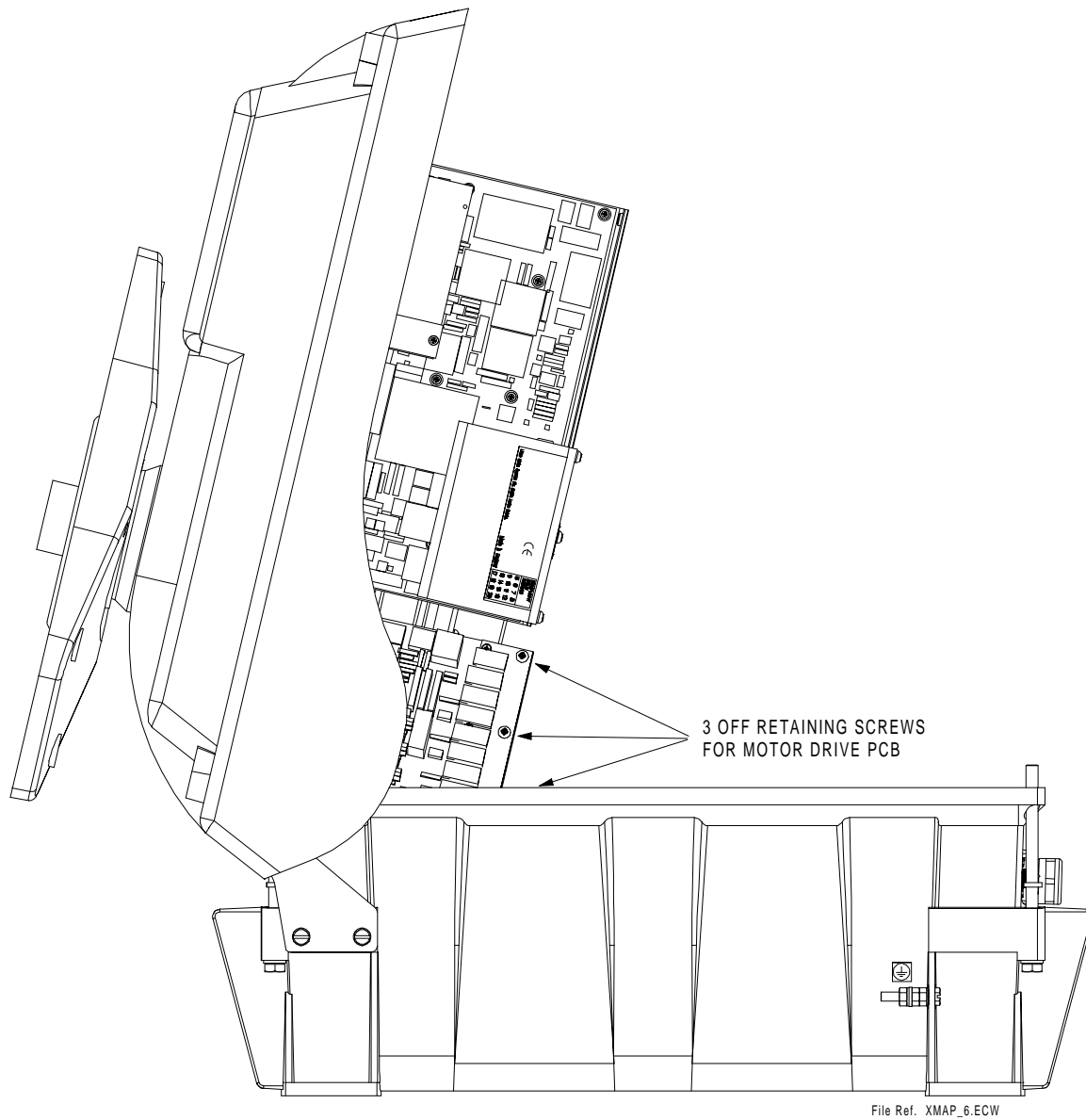


Figure 6.28 X-Band Masthead Turning Unit - Fitment of Main Assemblies



**Figure 6.29** X-Band Masthead Turning Unit - View inside upper casting with Transceiver removed



**Figure 6.30** X-Band Masthead Turning Unit - Side view showing Motor Drive Board retaining screws

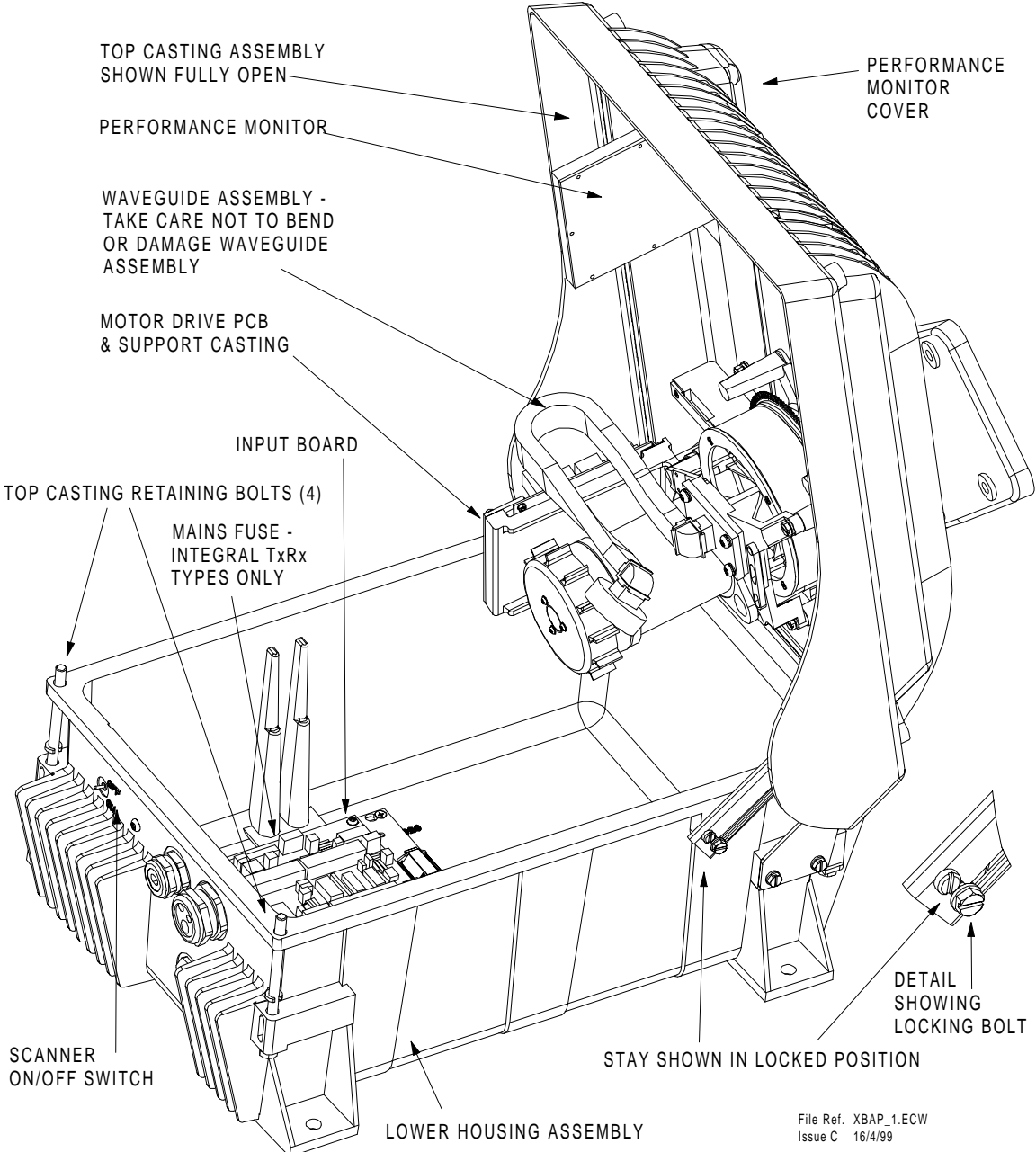


Figure 6.31 X-Band Bulkhead Turning Unit - View showing Main Assemblies

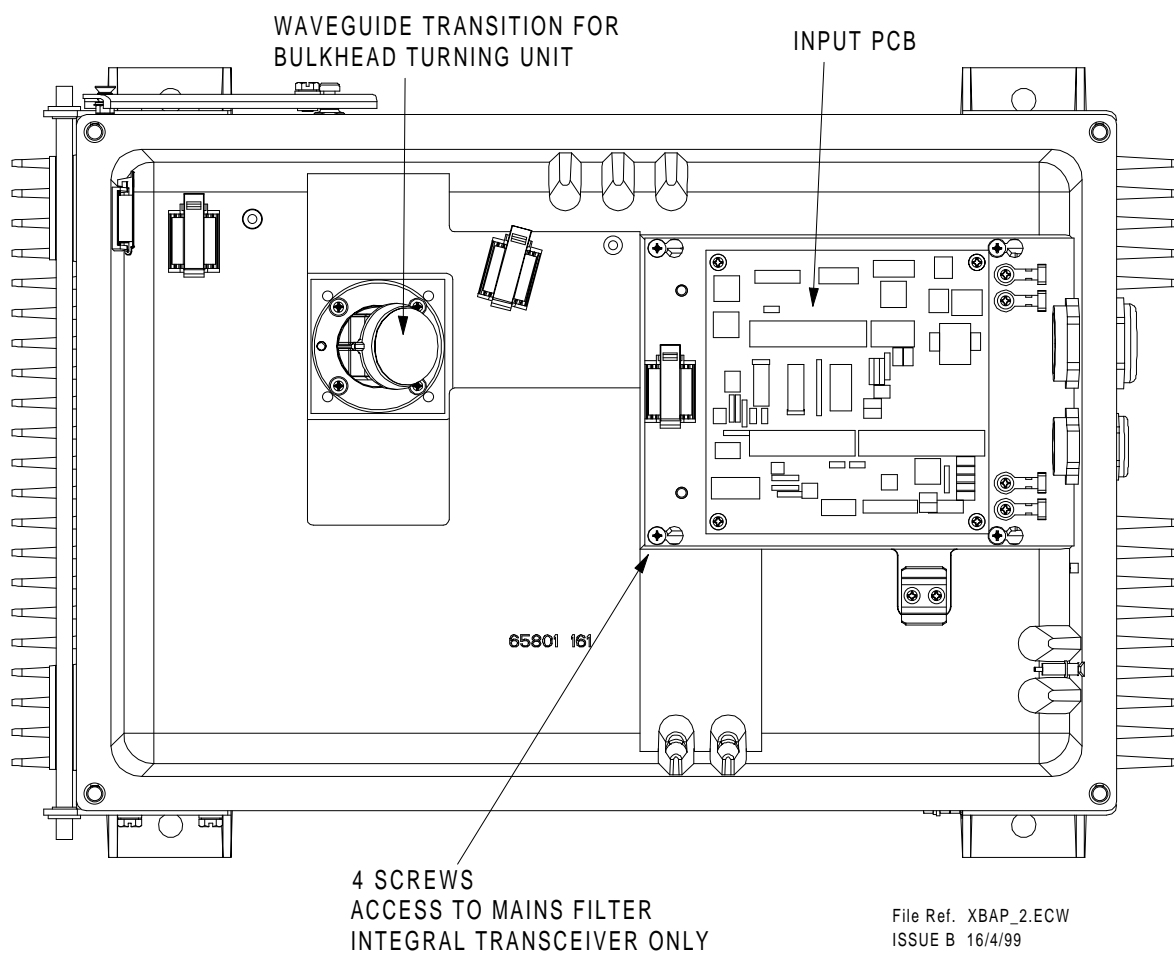
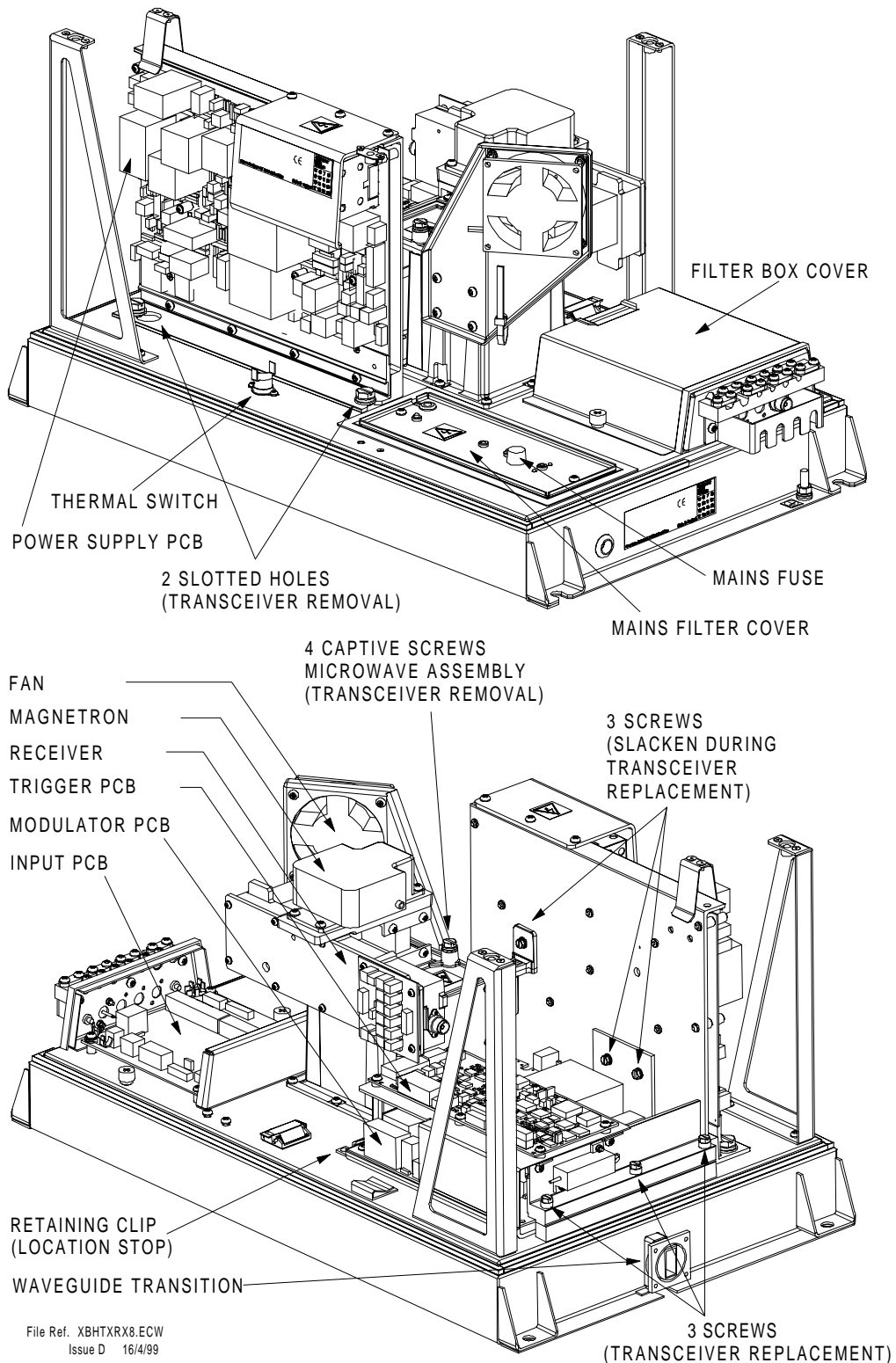


Figure 6.32 X-Band Bulkhead Turning Unit - View showing assemblies fitted to lower casting.



VIEW OF BULKHEAD TRANSCIEVER WITH COVER REMOVED

**Figure 6.33** Bulkhead Transceiver - View with Cover Removed

## Fault Finding and First Line Servicing

1

On the Trigger PCB set:  
LK5, and LK6 to 2 - 3.  
This is the service position,  
and will allow the transmitter  
to transmit when the antenna  
is stationary.

2

Restore the ship's supply  
to the Transceiver.  
Switch on at the Display  
and wait 3 minutes for timer.  
Select Long Pulse, Transmit  
at the Display.

3

On the Modulator PCB measure  
the voltage between TP100 and  
ground.  
Note:  
A DVM with an input impedance  
greater than 10 Mohms must be  
used for this measurement. Use  
of a meter with lower impedance  
could result in damage to the  
magnetron.

4

Adjust RV1 on the Power Supply  
PCB to give the same voltage on  
TP100 as is recorded on the label  
on the pulse transformer on the  
Modulator PCB.

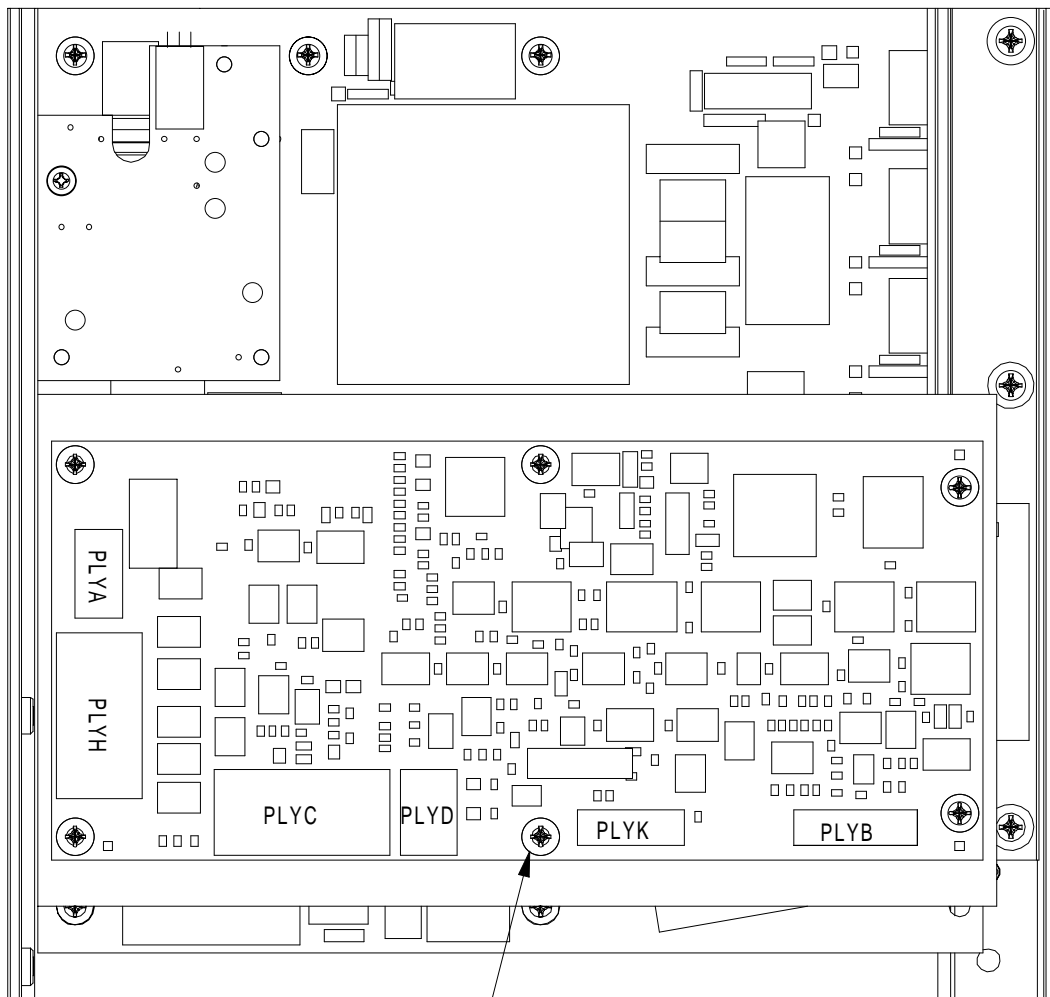
6

On completion of the procedure.  
Switch off.  
Reset LK5 and LK6 on the  
Trigger PCB to 1 - 2.

FILE REF. MAINT3.ECW  
Iss. D 21/01/99

**Figure 6.34** Setting Magnetron Current





**1**  
Disconnect: PLYA, PLHY, PLYC, PLYD, PLYB and PLYK if fitted.

**2**  
Remove six M4 screws to remove the Trigger PCB and the screening plate from the pillars on the Modulator PCB.

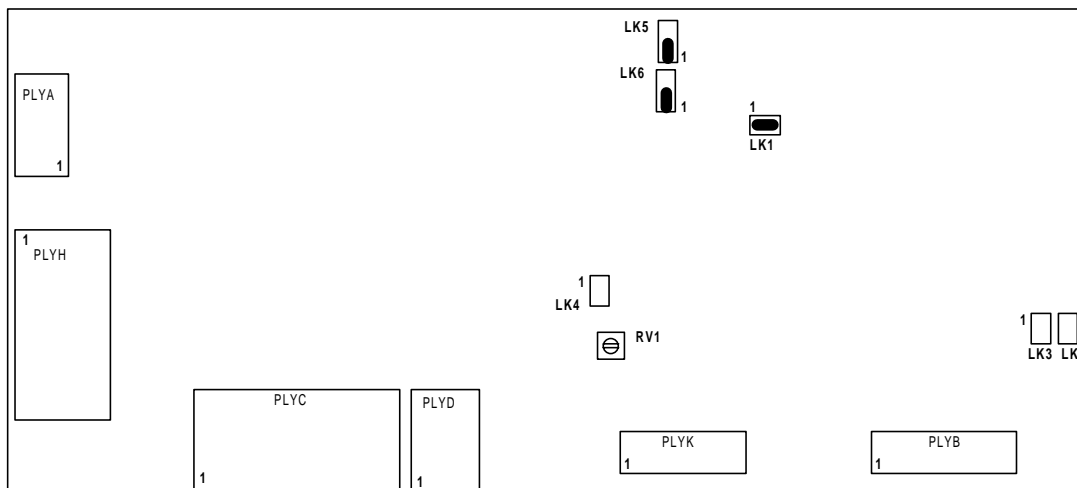
**3**  
Replacement is the reverse of removal.

**4**  
Set links as detailed overleaf.

FILE REF. XMAINT9.ECW  
iss. A

REPLACING TRIGGER PCB

**Figure 6.35** Replacing Trigger PCB



FILE REF. TRIGGER.ECW  
 iss. C

**ATE TEST LINKS**

LK1 FITTED  
 LK4 NOT FITTED

**BAUD RATE LINKS**

LK2 NOT FITTED  
 LK3 NOT FITTED

**SERVICE LINKS**

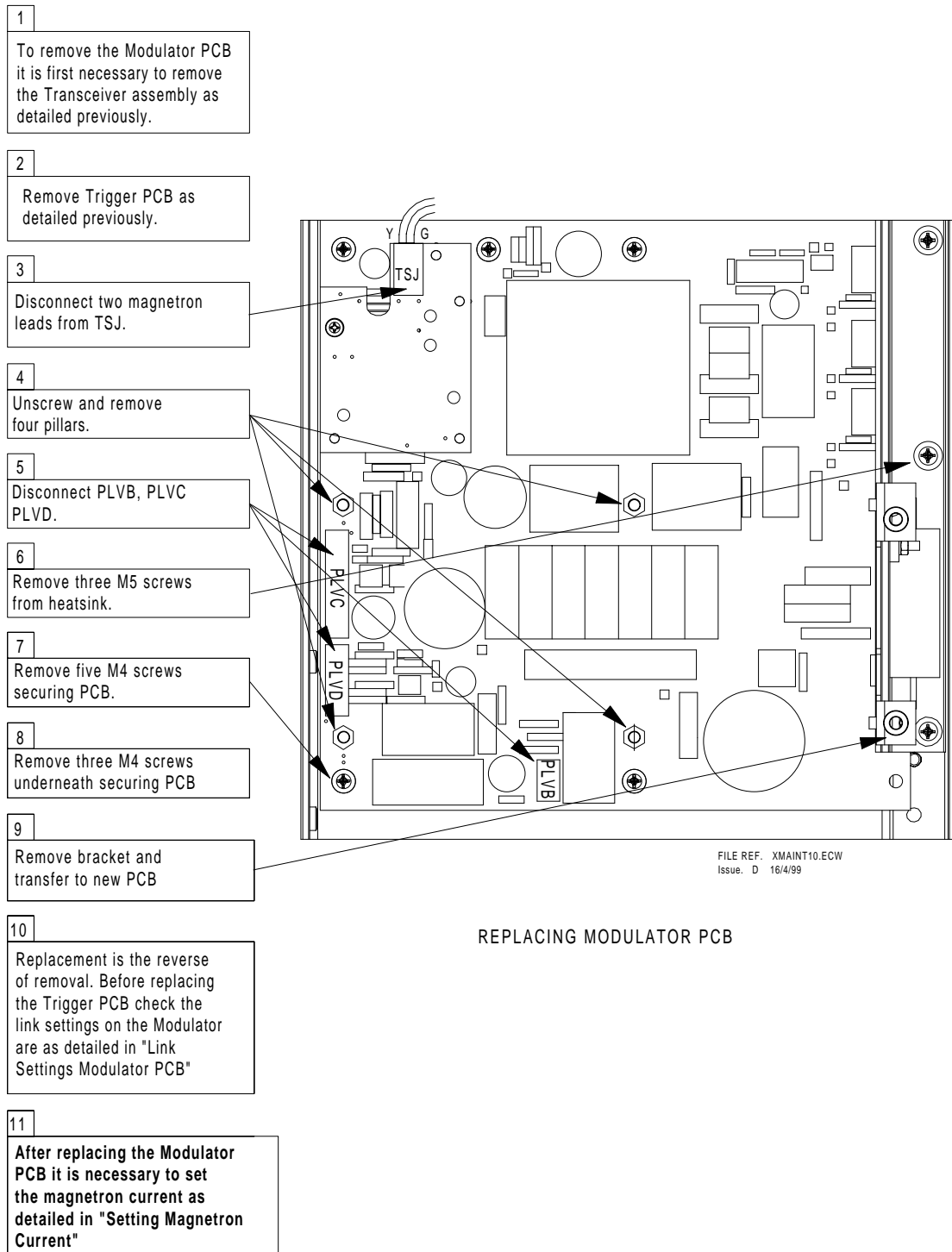
LK5 NORMAL OPERATION FITTED 1 - 2  
 LK6 NORMAL OPERATION FITTED 1 - 2

LK5 SERVICE FITTED 2 - 3  
 LK6 SERVICE FITTED 2 - 3  
 WHEN FITTED 2 - 3 THE TRANSMITTER  
 WILL OPERATE WHEN THE ANTENNA IS  
 STOPPED.

**RV1 SWEPT GAIN DELAY**

FACTORY SET DO NOT ADJUST

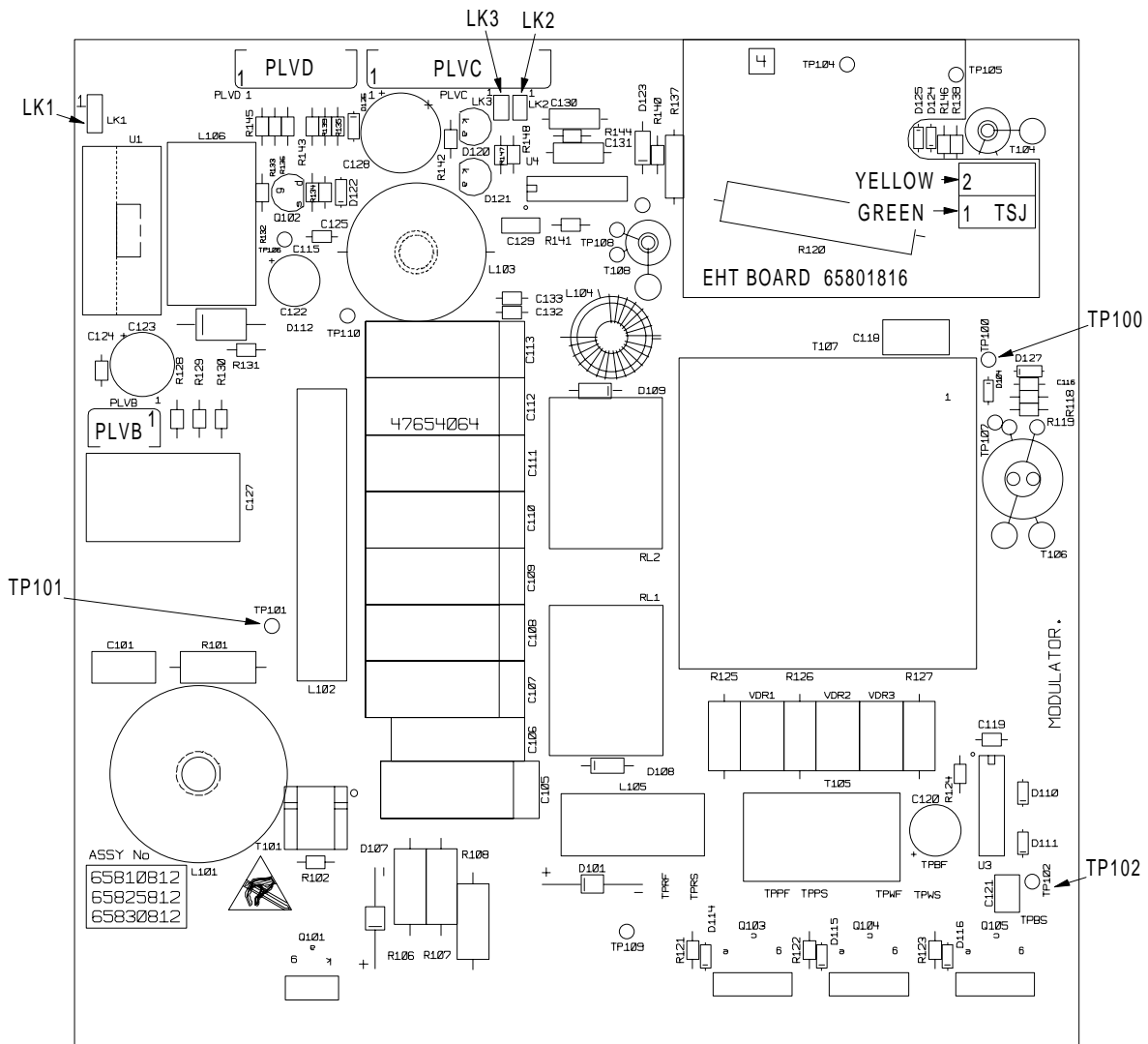
**Figure 6.36** Link Settings - Trigger PCB



REPLACING MODULATOR PCB

**Figure 6.37** Replacing Modulator PCB

Fault Finding and First Line Servicing



FILE REF. X\_MODLTR.ECW  
ISSUE B 16/4/99

MODULATOR LINK SETTINGS FOR 65810812 / 65825812 / 65830812

	S-BAND	10 kW X-BAND	25 kW X-BAND
LK1	FITTED 2 - 3	FITTED 1 - 2	FITTED 1 - 2 FOR MAGNETRON MG5424
LK1			FITTED 2 - 3 FOR MAGNETRON M1458
LK2	FITTED	NOT FITTED	NOT FITTED
LK3	NOT FITTED	FITTED	NOT FITTED

NOTE THAT LINK 1 IS CONFIGURABLE FOR HEATER TURNDOWN ON 25kW X-BAND  
NOTE THAT LINKS 2 & 3 ARE HARDWIRED FOR SPECIFIC USAGE ON LATER MODULATORS.

TEST POINTS:

- TP100 MAGNETRON CURRENT MONITOR
- TP101 CHARGE TRIGGER
- TP102 MODULATOR TRIGGER

Figure 6.38 Link Settings - Modulator PCB

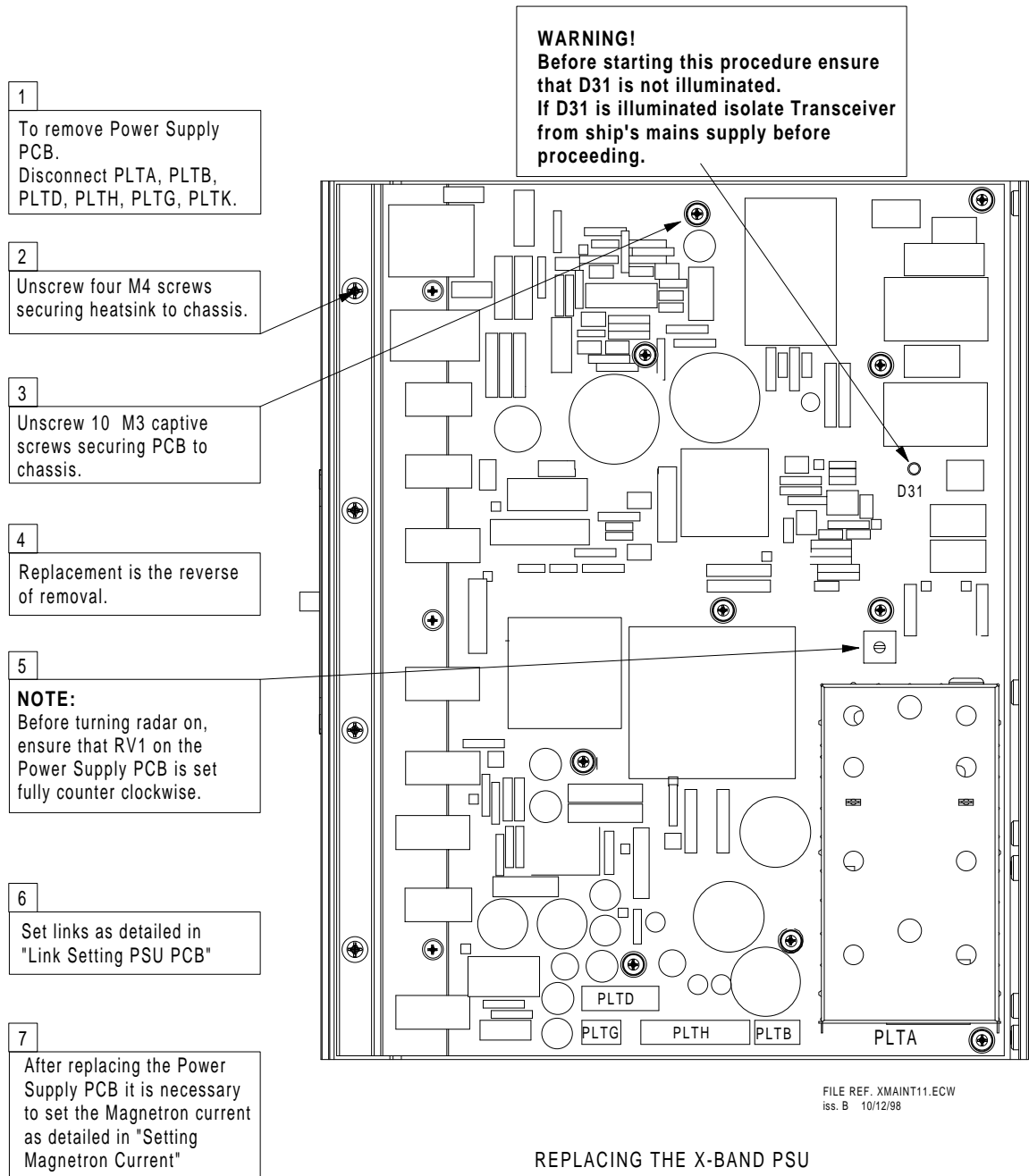
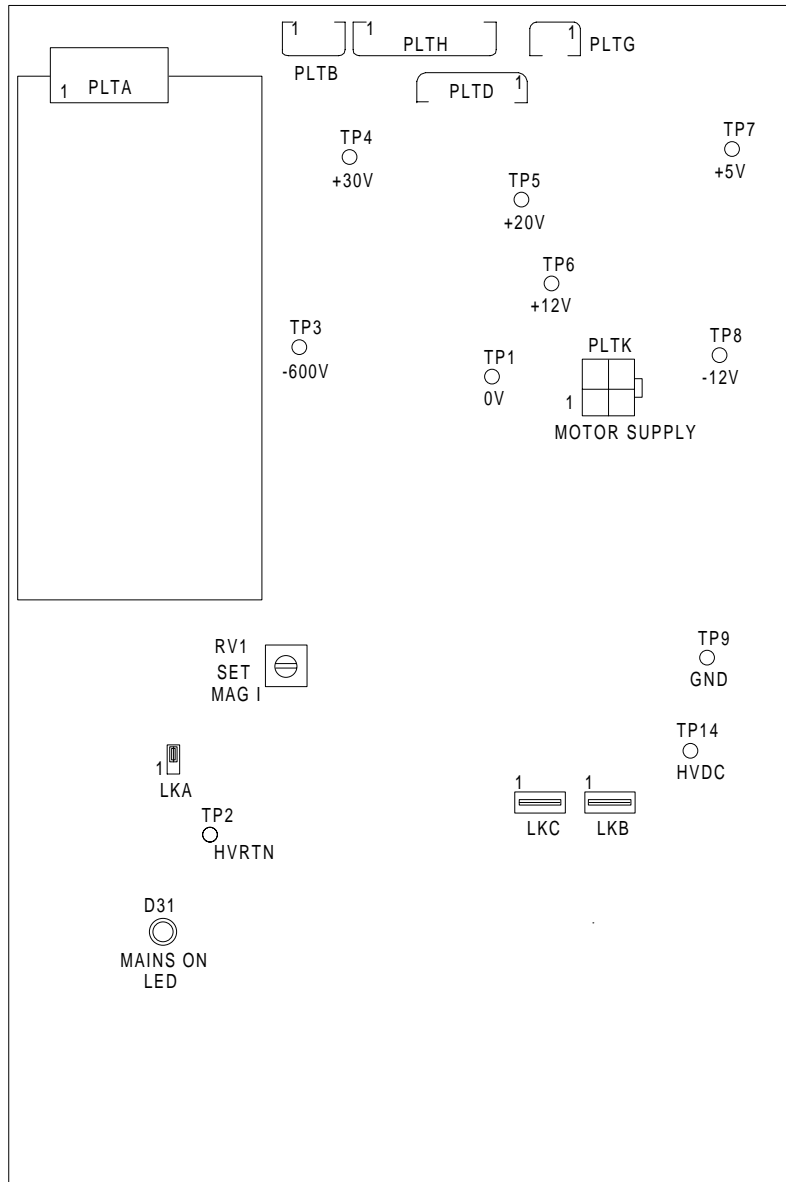


Figure 6.39 Replacing PSU PCB

Fault Finding and First Line Servicing



"LKA" START TEST LINK  
 LKA NORMAL OPERATION FITTED 2 - 3  
 LKA TEST FITTED 1 - 2  
 WHEN IN THE TEST POSITION THIS LINK  
 ALLOWS THE POWER SUPPLY TO  
 OPERATE WITHOUT BEING CONNECTED  
 TO THE CONTROL SIGNALS FROM THE  
 DISPLAY UNIT.

HIGH VOLTAGE ISOLATION LINK  
 LKB NORMAL OPERATION FITTED  
 LKB ISOLATE HV OPERATION NOT FITTED  
 THIS LINK CAN BE USED TO ISOLATE  
 THE POWER FACTOR CORRECTION  
 CIRCUIT FROM THE REST OF THE  
 POWER SUPPLY AS AN AID TO  
 FAULT FINDING

LKC - MOTOR SUPPLY ISOLATION LINK  
 NORMALLY FITTED

TEST POINTS

- TP1 0V
- TP3 -600V
- TP4 +30V
- TP5 +20V
- TP6 +12V
- TP7 +5V
- TP8 -12V

THE ABOVE VOLTAGES  
 ARE MEASURED  
 WITH RESPECT TO TP1

TP2 HVRTN  
 TP14 HVDC (380V)  
 THE VOLTAGE ON TP14  
 IS MEASURED  
 WITH RESPECT TO TP2.

FILE REF XPSU.ECW  
 ISS. B 4/12/98

LINK SETTING AC X-BAND POWER SUPPLY PCB 65825816

Figure 6.40 Link Settings - PSU PCB

## 4 Limited Spares List for Field Replacement

### 4.1 Display Monitors

Assembly Type	Part Numbers			
	180 High Res.	250 Med Res.	250 High Res.	340 Med Res.
CRT	3025845	MA00010231	MA00010322	MA0001223
Degauss Coil	91003688	91003689	91003689	91003608
CRT Board Set*	65814611	65820611	65821611	65826611
consisting of:-	consisting of:-	consisting of:-	consisting of:-	consisting of:-
Drive PCB	65814882	65820882	65821882	65826882
Base PCB	65814883	65820883	65821883	65826883
Controller PCB	65800881	65800881	65800881	65800881
Brilliance PCB	65800885 (desk mounting displays ONLY)			
Fan	65826612			
Video O/P (Optional)	65800884			

\*Note that all three CRT PCBs must be changed as a complete matched set.

## 4.2 S-Band Turning Units (Masthead and Bulkhead)

Assembly	Part Number
TRIGGER PCB ASSEMBLY	65801801
INPUT PCB ASSEMBLY (MASTHEAD TRANSCEIVER)	65801804/65801813
INPUT PCB ASSEMBLY (BULKHEAD TRANSCEIVER)	65801814
POWER SUPPLY PCB ASSEMBLY	65801809
BEARING AND HEADING MARKER PCB ASSEMBLY	65801805
RECEIVER FILTER PCB ASSEMBLY	65801818
RECEIVER ASSEMBLY	65830616
MODULATOR PCB ASSEMBLY	65830812
LIMITER ASSEMBLY	91005224
MAGNETRON	91005225
CIRCULATOR	91005223
PERFORMANCE MONITOR	91003746
MOTOR 220/240V AND 380/440V 3PH Normal Speed	91003751
MOTOR 110/220V 3PH Normal Speed	91003752
MOTOR 220/240V AND 380/440V 3PH High Speed	91003753
MOTOR 110/220V 3PH High Speed	91003754
MAINS FILTER PCB ASSEMBLY	91005228
FUSE 3.15A (240VAC SYSTEM)	MA00007245
FUSE 5.0A (115VAC SYSTEM)	2180413
FAN - AXIAL 80x80x25 12VDC (MASTHEAD Tx/Rx)	65830656
THERMAL SWITCH (FOR FAN - MASTHEAD Tx/Rx)	MA00007765



### 4.3 X-Band Turning Units (Masthead and Bulkhead) (10kW & 25kW Units)

Assembly	Part Number
TRIGGER PCB ASSEMBLY	65801801
INPUT PCB ASSEMBLY (TURNING UNIT)	65801813
INPUT PCB ASSEMBLY (BULKHEAD TRANSCEIVER)	65801820
POWER SUPPLY ASSEMBLY (AC)	65825816
POWER SUPPLY ASSEMBLY (DC)	65810816
INPUT FILTER PCB ASSEMBLY (DC)	91003686
BEARING AND HEADING MARKER PCB ASSEMBLY	65801805
RECEIVER FILTER PCB ASSEMBLY	65801818
RECEIVER ASSEMBLY	65801616
MODULATOR PCB ASSEMBLY (10kW)	65810812
LIMITER ASSEMBLY (10kW)	91005221
MAGNETRON (10kW)	91003015
MODULATOR PCB ASSEMBLY (25kW)	65825812
LIMITER ASSEMBLY (25kW)	91005226
MAGNETRON (25kW)	91003496
CIRCULATOR	91005227
PERFORMANCE MONITOR	91005220
MOTOR DRIVE & DYNAMIC BRAKE PCB ASSEMBLY	65801811
MOTOR & GEARBOX ASSEMBLY	91003765
IMPELLER	65801136
MAINS FILTER PCB ASSEMBLY (AC)	65825601
FUSE 3.15A (240VAC SYSTEM)	MA00007245
FUSE 5.0A (115VAC SYSTEM)	2180413
FUSE 16A (24VDC SYSTEM)	2162342
BELT DRIVE (40W)	MA00008979
FAN - AXIAL 80x80x25 12VDC (BULKHEAD Tx/Rx)	65830656
THERMAL SWITCH (FOR FAN - BULKHEAD Tx/Rx)	MA00007765
CABLE ASSY. - SCANNER ON/OFF (INC. SWITCH)	65801506

## 4.4 Processor Electronics Unit

Assembly	Part Number
DISPLAY PROCESSOR PCB ASSEMBLY	65800811
RADAR PROCESSOR PCB ASSEMBLY	65800812/813/814/815
COMPASS PCB ASSEMBLY	65800831/832
INPUT/OUTPUT PANEL ASSEMBLY (AC/DC)	65800818/821
BACKPLANE	65800819
POWER SUPPLY (AC/DC) PCB ASSEMBLY	65800822/823
MEMORY CARD ASSEMBLY	65800602
MEMORY BUFFER ASSEMBLY	65826607
ON/OFF SWITCH ASSEMBLY	65800607
JOYSTICK ASSEMBLY	65800606
TRACKERBALL ASSEMBLY	65800603
KEYBOARD MODULE	65845600
FAN ASSEMBLY	65800613
AIR FILTER (Standard)	65800111
AIR FILTER (Integral Keyboard Option)	65800214

## 4.5 Kit Display Control Panel

Assembly	Part Number
ON/OFF SWITCH MODULE	65826656
JOYSTICK MODULE	65826658
TRACKERBALL MODULE	65826654
MEMORY CARD MODULE	65826655
KEYBOARD MODULE	65845600
BRILLIANCE MODULE	65826657

## 1 Introduction

The BridgeMaster E Radar System is designed to function reliably for many years. To ensure optimum performance, specific maintenance tasks must be performed at regular intervals. This chapter details the recommended maintenance plan that should be adhered to.

## 2 Maintenance Plan

### WARNING: LETHAL VOLTAGE HAZARD

Before the following maintenance tasks are started (except the fan operation check), the equipment must be isolated from the mains supply. In addition to this, no components or assemblies should be touched for at least five minutes. This is to ensure that any high voltage capacitors have discharged.

Interval	Action	Notes
3 Monthly	Check the screen of the Display for dirt.	Use a soft cloth to clean the screen. If available, use an anti-static spray. <b>Solvents should never be used as a cleaning agent.</b>
3 Monthly	Check that the Processor Electronic power supply fan is working (with unit switched ON).  For 340 Displays, <b>also</b> check that the logic fan is working (with unit switched ON).	To ensure good reliability, it is essential that the circulating air within the unit is maintained. Remove any dust build up within the unit and around the bezel air intakes at the front of the unit.. If necessary remove the front bezel to wash or replace the bezel filter.
3 Monthly	Plug rechargeable memory cards into a powered-up display for at least one hour.	Rechargeable memory cards have no removable batteries.

Interval	Action	Notes
6 Monthly	Check the window of the Antenna for excessive dirt.	Excessive dirt or carbon deposits from the ship's funnels may cause reduced radar performance. Use hot soapy water to clean the antenna window. <b>Never use solvents. DO NOT paint.</b>
6 Monthly	Check all external nuts, bolts and washers on the Scanner Unit, for corrosion and for correct tightness.	The nuts, bolts and washers must be replaced if they are heavily corroded, and suitable anti-corrosion compound applied.
6 Monthly	In the S-Band Scanner unit check for oil leaks in the gearbox.  In the X-Band Scanner unit check for condition of the drive belt.	If leaks are detected, refer to Service Engineer

## Chapter 7

### Routine Maintenance

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Interval	Action	Notes
2 Yearly	Replace the primary battery on non-rechargeable memory cards. (Memory card battery replacement kit Part No. 65600712)	Change battery while card is plugged into a powered-up display.

**Note:** - *If damage to any of the items being checked during routine maintenance is observed, call for a service repair.*

## **1 Introduction**

This chapter will be used for recording system and equipment modifications (including the issue of Modification Leaflets), and for conveying information released after publication.

# Chapter 8

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## Modifications

Intentionally Blank