Chapter 2. Technical Descriptions

Scanner units

Radome Based Scanners - 18" and 24"

Scanner configuration

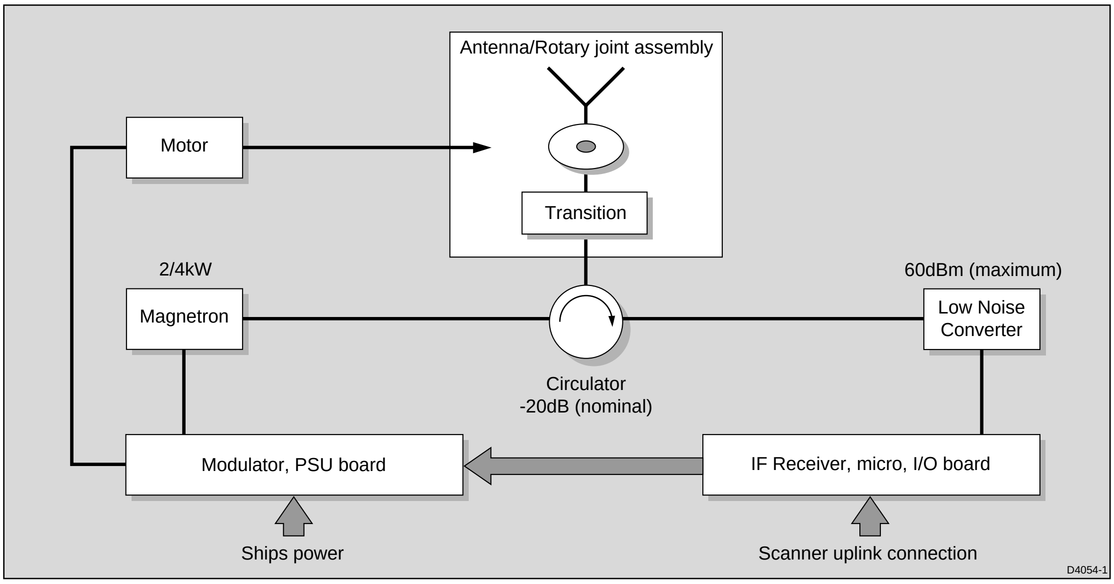

Figure 1. Scanner Block Diagram

The system comprises the functional blocks as shown in the above diagram. The basis of operation is as follows:

The ***Modulator, PSU board*** generates a high voltage pulse of 80nS, 250nS or 700nS duration dependant upon the range setting and the corresponding IF/Video filter control lines. This pulse begins on the rising edge of a negative going trigger at a pulse repetition frequency (PRF) also defined by the range setting. The resulting pulse is output to the ***magnetron*** which converts the energy into an RF pulse at a frequency of 9.41GHz (nominal).

All supply requirements are also provided by the ***Modulator, PSU board***.

The RF pulse is routed to an ***antenna*** via a 3-port ***circulator*** which propagates microwave energy in only one direction and thereby provides isolation between the transmit source and the ***low noise converter***. A rotary joint is used to maintain continuity between a waveguide output from the circulator and a microstrip input to the antenna. This is achieved via transitions into, and back out of, a section of co-axial line which is configured with a 'split' perpendicular to the axis of rotation. The energy is then radiated by the antenna with a narrow azimuth beam shape (5.2° for the 18" patch, 3.9° for the 24" patch), with low sidelobe levels (<-22dB). The elevation beamwidth is maintained at approximately 25° in order to illuminate targets during pitch and roll of the transmitting vessel.

Echoes are returned due to reflections from potential targets such as boats, buoys, land etc, and in the form of clutter from sea, rain, etc.

The returned energy is collected by the same ***antenna*** used to transmit the original pulse and is routed through the ***circulator*** to the ***low noise converter (LNC)***. These comparatively low level signals are amplified by a low noise transistor in order to maintain signal/noise performance and are mixed down to an IF frequency of 60MHz nominal for further amplification and subsequent detection.

The ***IF receiver board*** provides further low noise amplification and adjustable gain to maximise the dynamic range ("dynamic attenuation control") in the presence of clutter, target and range variations.

The IF board also includes a logarithmic detection stage with approximately 50dB dynamic range, which provides a compressed signal output in terms of dB input power versus output Voltage level.

Various filtering stages are also employed in the ***IF Receiver*** to provide optimum signal/noise characteristics for the detected pulse and to provide some immunity against the bulk effects of rain.

The ***IF Receiver*** also provides the interface for the up-link commands to the scanner, including clutter and gain selection, stepper motor control and display synchronisation pulse generation.

Receiver configuration (LNC/IF)

The basic configuration of the microwave and IF receiver circuitry is as follows :

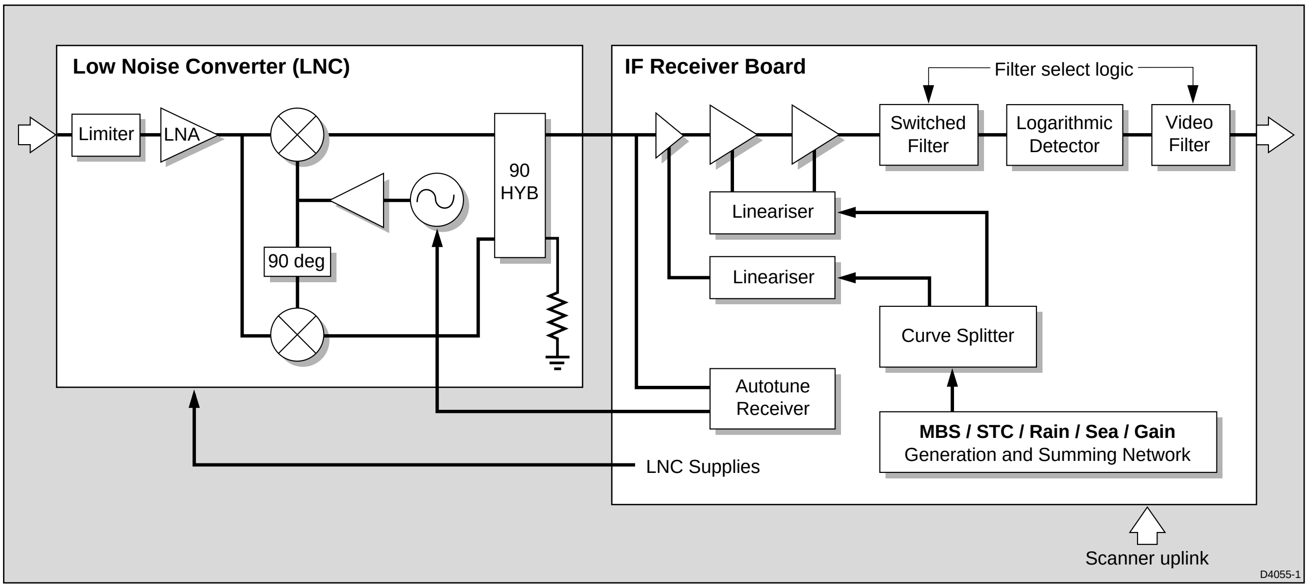

Figure 2. Receiver Configuration (LNC/IF)

Low Noise Converter/Limiter (LNC)

The primary function of the LNC is to provide low noise amplification of the low level signal returns and mixing to an IF frequency of 60MHz nominal.

The low noise amplification is provided by a single low noise FET, with bias conditions, and associated matching set to minimise noise figure and maximise gain and compression levels. Maximum gain is required so as to minimise the noise figure contribution from subsequent stages. The mixing function is carried out in an image reject mixer configuration which reduces image noise by 20dB nominal in order to minimise the degradation in overall noise figure.

Protection is provided in the form of three limiter diodes which are configured to become forward biased in the presence of increasing RF power.

NOTE. There are no user / dealer serviceable parts within the LNC due to its high frequency of operation.

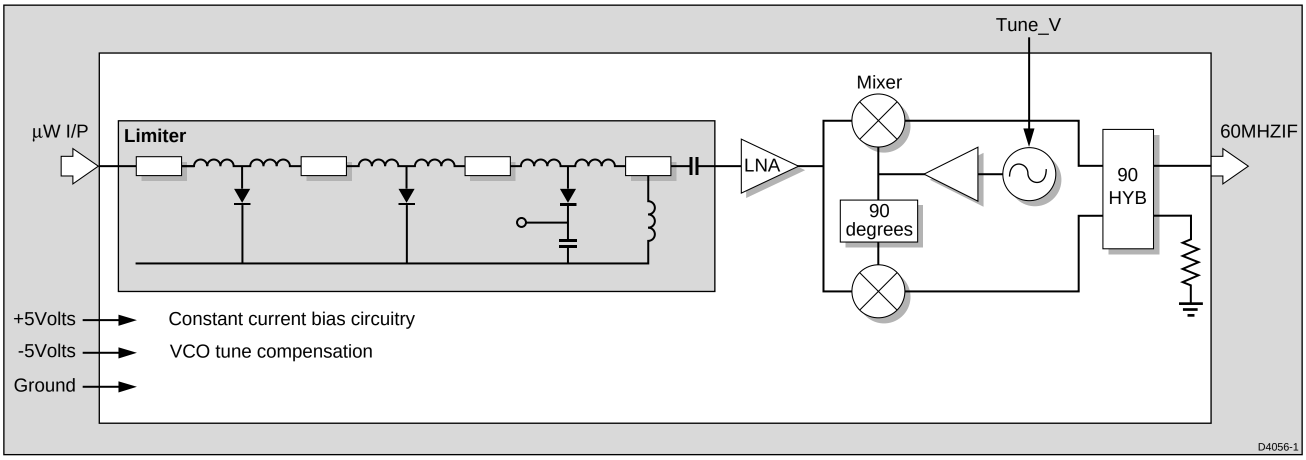

Figure 3. LNC Configuration

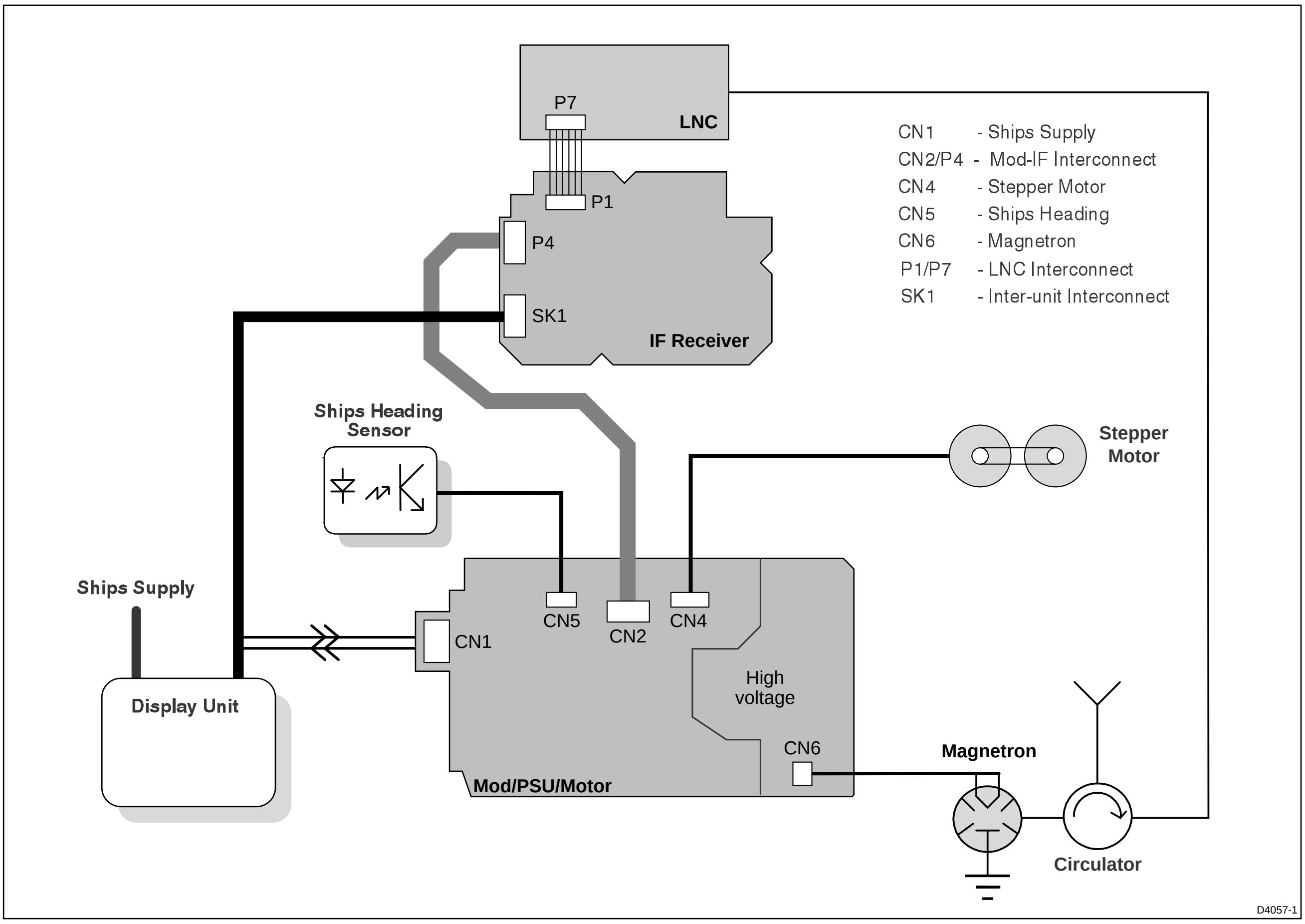

Figure 4. Scanner Interfaces

Modulator / PSU PCB

Interface Description

The interfaces to the Mod/PSU are shown in Figure 4.

The individual signal functions are described below :-

Connectors

Connector	Function	Type
CN1	Ships Supply connector	4 way WAGO clamp
CN2	Mod-IF interconnect	18 way Picoflex ribbon connector
CN4	Stepper motor connector	6 way Molex type
CN5	Ships heading sensor	3 way Molex type
CN6	Magnetron heater connector	2 way Molex type

Ship Supply Power Input (CN1)

Ref.	Signal Name	Type	State	Function
CN1-5 CN1-6	+BATT_IN	Power input	–	Ships power i/p
CN1-1 CN1-2	–BATT_IN	Power input	–	Ships power return

PSU Control/Status (CN2)

Ref.	Signal Name	Type	State	Function
CN2-12	Heater_EN_N	Logic input	0 1	Enable MOD + 6.3V, MOD + 300V, MOD +12V outputs i.e. enable magnetron heater, modulator PSU and stepper motor PSU. Disable the above

Modulator Control/Status (CN2)

Ref.	Signal Name	Type	State	Function
CN2-18	RADAR_TX_EN	Logic input	1 0	Enable modulator (magnetron) pulses Disable modulator, regardless of activity on PRI_PLS
CN2-9 CN2-11	PW0, PW1	Logic input Logic input	*PW0* *PW1* 0 0 1 0 0 1 1 1	Select modulator pulse width as follows :- 80ns pulse 250ns pulse 700ns pulse 700ns pulse (not used)
CN2-8	PRI_PLS	Logic input	clock	10us+/-0.5us low. Rising edge triggers modulator pulse. Frequency will be varied according to pulse width; 80ns PRF = 2250Hz ; 200ns PRF=1500Hz, 700ns PRF=750Hz. See Figure 5.
CN2-3	HEATER_OK	Logic output	1 0	Implies magnetron heater is connected and drawing > minimum current. Magnetron heater faulty or magnetron disconnected.
CN2-17	MOD_ISENSE	Analogue output	0-5.0V	Indicates peak magnitude of magnetron anode current and thus indicates approximately peak R.F. power output. See Figure 7.
CN2-16	MOD_SENSE1	Analogue output	0-5.0V	Analogue voltage indicates build standard.
CN2-13	MOD_SENSE2	Analogue output	0-5.0V	Analogue voltage indicates build standard.

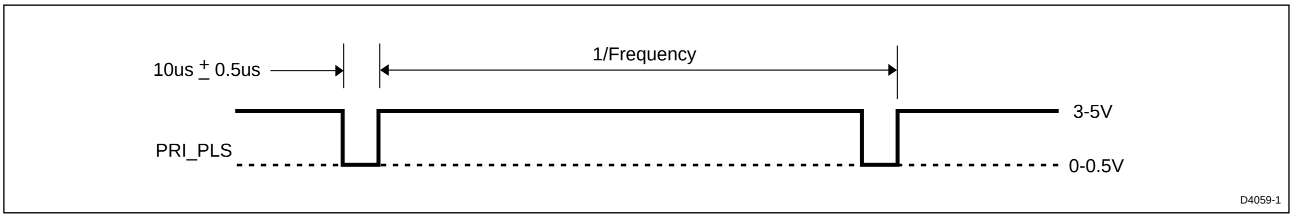

Figure 5. Modulator clock format, PRI_PLS

Motor Control

Ref.	Signal Name	Type	State	Function
CN2-12	MOTOR_EN_N	Logic input	0 1	Enable Motor (either Stepper or 3-phase) Disable Motor
CN2-10	STEP_IO	Logic input/output	clock	For stepper motor build standard: input at 181 Hz; 50% duty cycle. Determines stepper motor speed. For all build standards this line acts to identify the type of build standard in conjunction with the MOTOR_EN_N control as follows: When MOTOR_EN_N=1 (motor = off) : STEP_IO = 1 for stepper motor build standard.

Ships Heading Interface

Ref.	Signal Name	Type	State	Function
CN2-15	SHP_IN	Logic output	clock	Neg. going edge: Indicates antenna position is at nominal zero azimuth.

Receiver Power Supply

Ref.	Signal Name	Type	State	Function
CN2-1	IF-5V	Power	–	-5V power rail to receiver
CN2-2	IF+5V	Power	–	+5V power rail to receiver
CN2-4	IF+26V	Power	–	+26V power rail to receiver
CN2-6	IF+12V	Power	–	+12V power rail to receiver
CN2-5 CN2-7	GND GND	Power	–	Isolated GND return from receiver power rails

Stepper Motor Interface

Ref.	Signal Name	Type	State	Function
CN4-6	STMO1	Analogue	–	Phase A2 switch
CN4-5	STMO2	Power	–	+12Vmotor
CN4-4	STMO3	Analogue	–	Phase A1 switch
CN4-3	STMO4	Analogue	–	Phase B1 switch
CN4-2	STMO5	Power	–	+12Vmotor
CN4-1	STMO6	Analogue	–	Phase B2 switch

Ships Heading Sensor Opto-coupler Interface

Ref.	Signal Name	Type	State	Function
CN5-1	BZ	Analogue	–	Opto emitter connection
CN5-2	+5V	Power	–	+5V to Opto LED anode and collector connection
CN5-3	SHGND	Power	–	Current limited Opto LED cathode GND connection

Magnetron Interface

Ref.	Signal Name	Type	State	Function
CN6-1	HEATER	Analogue output	–	Magnetron heater/cathode power and signal connection.
CN6-2	HEAT/CATH	Analogue output	–	Magnetron heater/cathode power and signal connection.

Note: The polarity of these two signals is immaterial. The magnetron anode connection is made through the body of the device to the local GND.

Modulator / PSU

Design Overview

The Modulator / PSU PCB integrates the modulator, power supply and motor drive functions of the radar scanner assembly.

The power supply section provides regulated power to all functions within the scanner unit. The modulator drives the magnetron when triggered from a simple logic input with one of three pre-set pulse widths selected by the IF receiver. The Motor Controller drives the stepper motor which rotates the antenna.

One common PCB design is used for all current Pathfinder radar systems, however the build standard is changed to suit differing configurations (motor type, magnetron power, etc).

The figure below shows an overall block diagram of the Mod/PSU PCB showing the principal circuit blocks :-

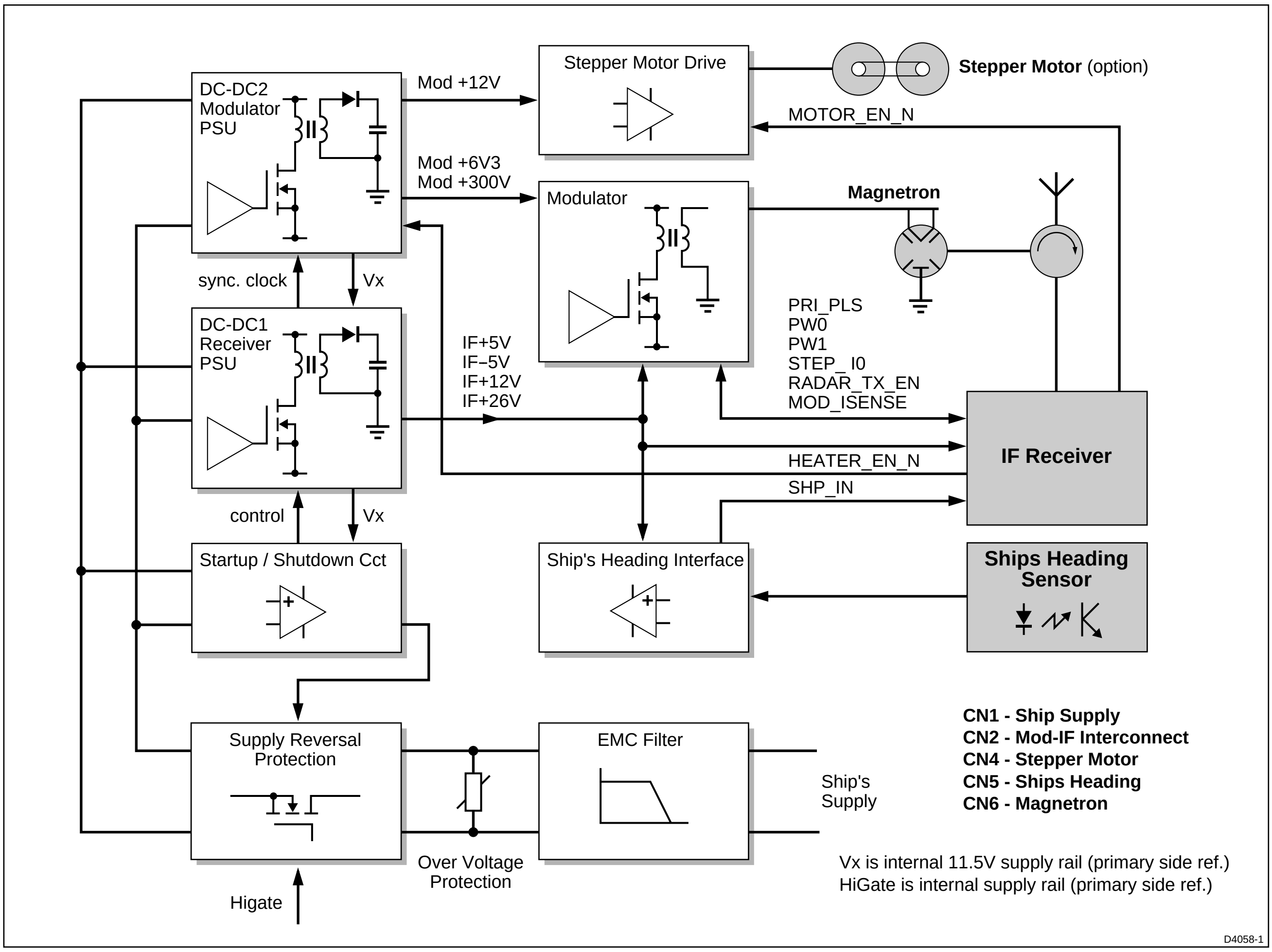

Figure 6. Modulator/PSU Overview

Circuit Description

EMC Filter

The EMC filter section comprises of a common mode inductor and associated filter capacitance's to minimise EMC problems with other electronic equipment.

Over Voltage Protection

A varistor, VD1, protects the unit from over voltage surges.

Supply Reversal Protection

The scanner is protected from inadvertent reversal of the ships supply by FET, Q56. This FET will not connect the ships supply to the board as long as its polarity is reversed. When the ships supply is connected correctly the FET will switch on as the internal charge pump formed by D59, D60, etc drives the HIGATE supply to approx. 12V greater then the ships supply voltage.

DC-DC1 and Start / Shutdown Circuit

This is a switch mode power supply unit which derives the low voltage supplies for the receiver assembly. It is configured as a flyback converter whereby the ships supply is switched at approx. 72kHz across the primary of transformer Tx2 by FET Q38. Pulse width modulation (PWM) control is by IC U12 which senses the voltage of an internal power rail, Vx, and drives the FET to maintain voltage regulation. With the exception of the internal supply Vx which has the ships supply as its ground reference, all other output voltage rails are isolated from the ships supply and therefore must be ground referenced to the secondary side when measured (note when fitted within the core assembly the secondary side ground reference is connected to the main metal casting).

This supply is itself powered from one of its own output rails, Vx ,the power back winding with initial start-up current from the ships supply. The supply is protected from operation at inadequate ships supply voltages by the start/shutdown circuit comprising of Q57, Q58, etc. This circuit will shut the supply down if the ships supply falls below the minimum scanner operating voltage of 8.7V.

This supply is configured as the 'master' supply and therefore it must be running before the high voltage supply DC-DC2 will function. Thus a fault in this unit is likely to shutdown the high voltage supply.

Scanner operating supply voltage range :

Parameter	Units	Min.	Max.	Conditions
Input Voltage Range	V	8.7	32.0	Measured at PCB input terminals.
Reverse polarity leakage current	uA	0	+/-100	Continuous ignoring any initial transient.
Max. Leakage current between isolated secondary GND and ships -BATT_IN (CN1-1/4)	uA	0	+/-1	Measured with 32.0V differential imposed between -BATT_IN and isolated GND.

Output Specification DC-DC1 :

Parameter	Units	Min.	Nom.	Max.	Conditions
IF-5V output voltage	V	-5.6	-6.0	-6.4	
IF-5V load	mA	0		125	Load will be reduced to minimum during standby state of IF receiver.
IF+5V output voltage	V	4.7	5.0	5.3	
IF+-5V load	mA	50		350	Load will be reduced to minimum during standby state of IF receiver.
IF+12V output voltage	V	11.2	12.0	12.4	
IF+12V load	mA	0		300	Load will be reduced to minimum during standby state of IF receiver.
IF+26V output voltage	V	25.0	27.0	29.0	
IF+26V load	mA	1		2	

DC-DC2

The operation of this switch mode power supply is very similar to DC-DC1. This supply generates the magnetron heater supply, the modulator high voltage supply (200-300V) and the 12V supply for the stepper motor. As for DC-DC1 a PWM control IC, U11, regulates the switching of a FET, Q37, which switches the ships supply across the primary of transformer Tx1. U26 and associated components, provide voltage feedback from the magnetron heater voltage rail. The high voltage modulator supply rail comprises of a number of series connected secondaries.

The PWM controller switches in synchronisation with DC-DC1 at approximately 72kHz. This supply is a slave to DC-DC1 and will shutdown with DC-DC1.

This supply is switched on by a low state on the the control signal, HEATER_EN_N (CN2-12). In normal operation this supply is disabled only when the radar is switched to '*standby mode*'.

Note: This supply requires that a magnetron heater load (or a 12 ohm/4W resistor) is connected at CN6 in order to function correctly, if the supply is operated with no connection at CN6 no damage will occur but the supply voltages may be found to be out of specification. (Also see Stepper Motor Controller)

Output Specification DC-DC2 :

Parameter	Units	Min.	Nom.	Max.	Conditions
MOD+6.3V output voltage	V	6.0	6.3	6.6	Measured as differential voltage at CN6
MOD+6.3V load	mA	430		650	
MOD+300V output voltage	V	196	210	224	2kW systems
MOD+300V load	mA	0		25	2kW systems
MOD+300V output voltage	V	250	270	288	4kW systems
MOD+300V load	mA	0		50	4kW systems
MOD+12V output voltage	V	11.2	12.0	12.8	
MOD+12V load	mA	350		500	2-phase, unipolar stepper motor

Modulator

IMPORTANT: The modulator circuit contains very high voltages and energy levels, care should be exercised in all maintenance activities in this area. Only those items which appear on the RME spares list may be replaced.

The modulator's function is to drive the magnetron in order to generate a transmit pulse at approx. 9.4GHz to the antenna. The modulator is required to generate three different pulse widths as selected by external logic control lines, PW0, PW1. The modulator is fired when triggered by the rising edge of the PRI_PLS logic level control signal from the micro controller. In addition a further control line RADAR_TX_EN is used to over-ride PRI_PLS and disable transmission when held low. Output sense lines indicate correct operation to the external micro controller.

The modulator comprises a high voltage pulse transformer, Tx3 and a switching FET Q42 together with associated control and pulse shaping circuitry. In operation the control circuitry selects one of three pulse widths which then drive the FET gate via IC U22. As the FET turns on it switches the high voltage supply, +MOD_300V, across the very low impedance of the pulse transformer primary. The current rapidly rises in the FET and its series source resistors (R132, R133, etc) until the FET begins to turn-off thus holding the current at a constant level. The resulting primary voltage pulse causes an associated secondary pulse stepped-up by the transformer turns ratio to several kV.

When the secondary voltage reaches the magnetron switch-on threshold it will 'fire' generating a burst of microwave power at several kW and at a frequency of approx. 9.4GHz.

The FET is protected from operation at excess temperature by a thermistor, PT1 screwed to the FET heatsink and its associated circuitry. It is further protected from operation with unstable supply voltage by Q54.

The control circuitry comprises of a number of monostables. Each of which generates one of the three different pulse widths used for different range settings. Three variable resistors, RV1, RV2 and RV3, set the exact pulse width required. These variable resistors are preset at the factory. They require specialist equipment for tuning and must not be adjusted by the service engineer.

Two circuit blocks monitor the performance of the modulator / magnetron to provide diagnostic information for service personnel which may be read in the diagnostics menu at the display unit.

- Comparitor Q62, Q63 senses the correct flow of magnetron heater current and provides anoutput,HEATER_OK which is normally a logic high when the magnetron is connected and the high voltage supply is enabled (in transmit mode or during the 70 second warm-up period).
- Peak detector D55, etc detects the peak pulsed magnetron current flow and derives the signal MOD_ISENSE which gives some indication of the transmit power. Note that the presence of the pulse shaping circuitry alone results in some current flow and so this indicator must be interpreted with care.

System Power	Parameter	Units	80ns Pulse Width		250ns Pulse Width		700ns Pulse Width		Conditions
			Min.	Max.	Min.	Max.	Min.	Max.	
2kW	MOD_ISENSE	V	1.9	3.0	2.2	3.0	2.2	3.0	
4kW	MOD_ISENSE	V	1.3	2.4	1.6	2.4	1.8	2.4	

Figure 7. MOD_ISENSE Voltage

Modulator Clock, PRI_PLS

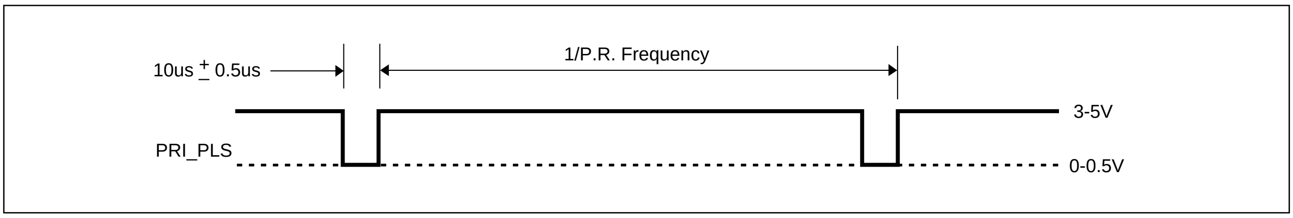

Figure 8. Modulator clock, PRI_PLS

Ships Heading Sensor

The ships heading sensor is used to indicate that the antenna is aligned with the vessels fore and aft line. It provides one output pulse per antenna revolution. This information is utilised by the IF receiver to synchronise the radar output to the ships heading.

A slotted optical transducer is interrupted by the principal gear of the antenna rotary joint assembly. This results in a negative going pulse at CN5-1. This pulse is variable in amplitude with ambient lighting level and device tolerance. This pulse is conditioned by the interface formed by U23 and reappears as SHP_IN at CN2-15 as a negative going pulse of approximately 5V amplitude. If the antenna is rotating normally this pulse will have a repetition rate of approximately 2.5 seconds.

Stepper Motor Controller

A stepper motor is used to rotate the antenna of all radome radar units. The stepper motor is a 2-phase unipolar type driving the antenna main gear by means of a flexible belt. The stepper motor is mounted to the main casting which provides heat sinking for the motor. The motor frequency is determined by the frequency of the external drive clock, STEP_IO which originates at the IF board micro controller and is nominally 181Hz. The motor drive interface comprises U24 and associated circuitry. An enable signal, MOTOR_EN_N switches the motor drive on when at logic 0. The motor is connected at CN4. Pins 2 and 5 are the raw 12V motor supply (only active when the high voltage PSU, DC-DC2, is enabled). Pins 1,3,4 and 6 carry the motor winding drive signals. If any winding drive signal becomes disconnected the motor will normally fail to rotate but will vibrate instead. If the magnetron heater at CN6 is disconnected the motor may rotate with reduced torque.

IF Receiver PCB

Interface Description

The Interfaces to the IF Receiver are shown in Figure 4.

The individual signal functions are described below:-

Connectors

Connector	Function	Type
SK1	Display connector for serial communications video and syncronisation timing signals	8 way Molex C-grid socket
P1	LNC connector	20 way SAMTEC CLH-110-F-D-DV-P (7 pins used only)
P4	Mod-IF interconnect	18 way Picoflex ribbon connector

Display Connector (SK1)

Ref.	Signal Name	Type	State	Function
SK1-1 SK1-2	AZ_SHP_OUTB AZ_SHP_OUT	clock, differential pair output	normally high, low going clock normally low, high going clock 0 - 5.0V	A differential output pair providing azimuth pulses to synchronise antenna position with the display (10us duration at approximately 820 Hz). The SHP (ships heading position) pulse is superimposed on the signal once per antenna revolution (30us pulse every 2.5 secs)
SK1-3 SK1-4	SER_IOB SER_IO	digital comms, differential pair bi-directional	2.2 V nom. DC bias 2.8 V nom. DC bias	An RS485 Bi-directional serial communications link operating at 19.2 kBaud. It provides control of the scanner operation and monitoring functions from the Radar display.
SK1-5 SK1-6	PRI_OUTB PRI_OUT	clock, differential pair output	normally low, high going clock normally high, low going clock 0 - 5.0V	A differential output pair providing PRI (Pulse Repetition Interval) pulses to synchronise the firing of the transmitter with the display video. Rate is according to range setting.
SK1-7 SK1-8	VIDEO GND VIDEO	Analogue Video output	AC coupled 1.75V max peak signal into 75 ohms	The raw Radar video signal from the scanner.

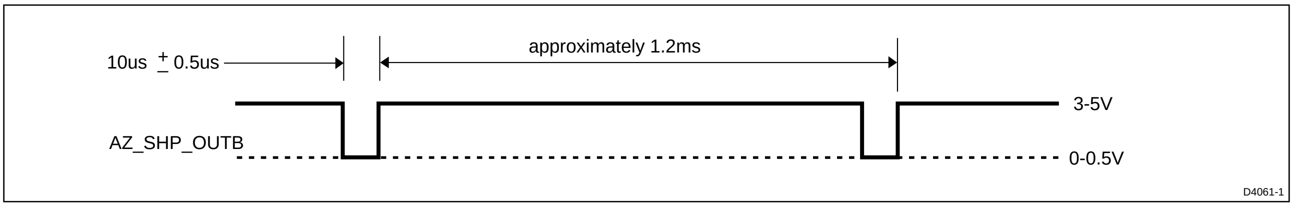

Figure 9. AZ_SHP_OUTB / AZIM_DNEG

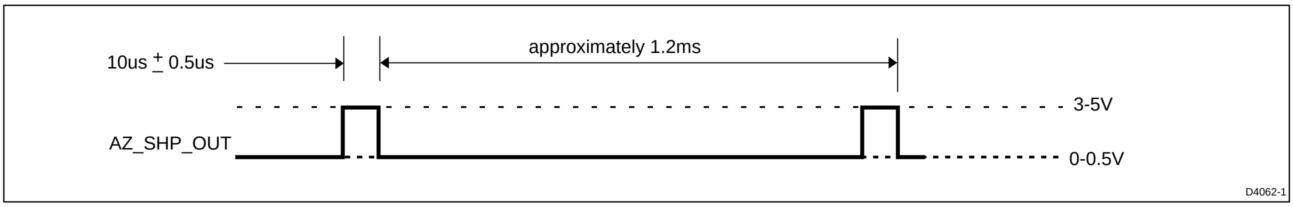

Figure 10. AZ_SHP_OUT / AZIM_DPOS

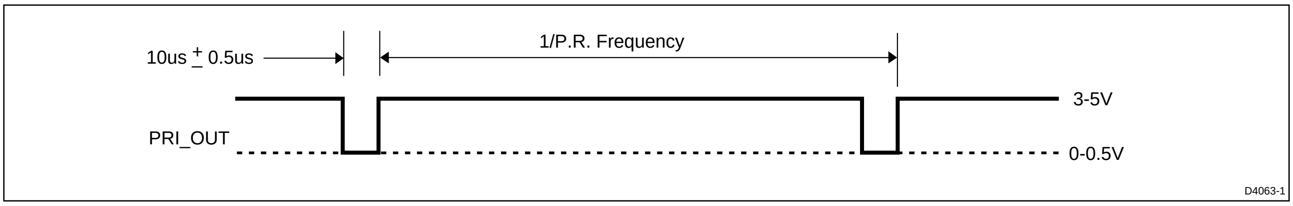

Figure 11. PRI_OUT / PRI_DPOS

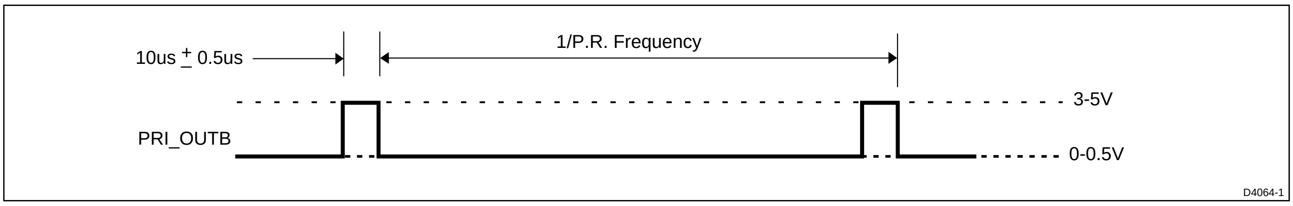

Figure 12. PRI_OUTB / PRI_DNEG

LNC Connector (P1)

Ref.	Signal Name	Type	State	Function
P1-1 P1-2	GND 60MHz IF	60MHz Intermediate Frequency (IF) Radar received signal input	N/A	The down-converted received radar signal from the LNC at 60MHz carrier frequency.
P1-3	Not Connected	N/A	N/A	N/A
P1-4	RF_ATTENV	Analogue control voltage output	0 - 10V	A control voltage to apply RF attenuation to the LNC limiter diodes.This function is not used by SL72 and SL74 systems.
P1-5	TUNE_V	Analogue control voltage output	4 - 24 V	A control voltage that is applied to the LNC VCO (Voltage Controlled Oscillator) to maintain the tuning of the IF input to 60MHz.
P1-6	GND	Analogue output	0V	Analogue ground reference for the LNC supplies.
P1-7	+5V	Analogue Output (switchable)	0V in standby mode +5V in transmit mode	The 5v supply for the LNC. It is switched off in standby mode to save power.
P1-8	-5V	Analogue Output	-5.9V nom.	The -5.9V supply for the LNC

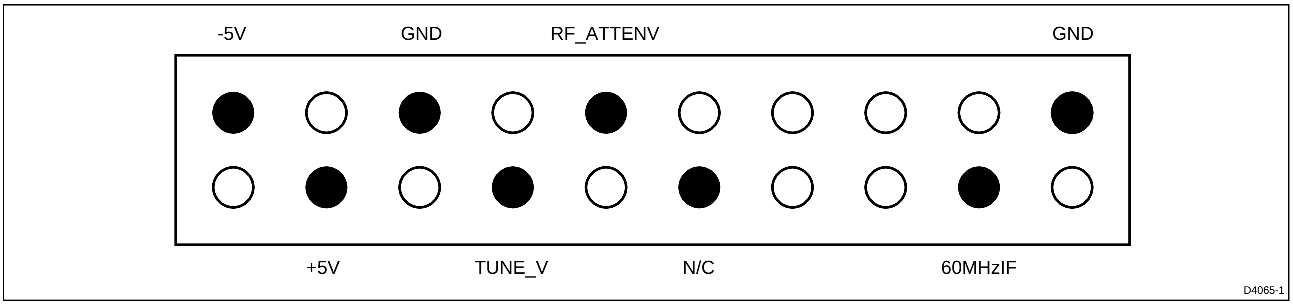

Figure 13. LNC Connector P1 connections as viewed from component side of board

Mod / IF Interconnect (P4)

This connector P4 is pin to pin identical to CN2 connector on the MOD / PSU PCB. See MOD / PSU interface section for details.

IF Receiver

Circuit Description

Main Receiver

The prime function of the IF receiver is to provide low noise amplification and logarithmic detection of the 60MHz IF (Intermediate Frequency) Radar received signal, to give a video signal output suitable for displaying on the Radar screen (after digital processing at the display).

The receiver provides low noise amplification, dynamic IF gain control (STC) and selectable IF bandwidths to optimise target detection for all ranges and for various sea and weather conditions. The following summarises the functions of the circuitry.

A low noise amplifier (AR1), is situated prior to an adjustable gain monolithic microwave integrated circuit (MMIC) amplifier stage (U9 and U10) in order to define the noise figure of the system. This incorporates the relevant circuitry to provide fast gain control via the STC generator.

General amplification and attenuation control is also provided by the cascaded MMIC amplifiers U9 and U10 in conjunction with factory-tuned inductors (L4, L10 and L11) and capacitors to tailor the bandwidth characteristics of the circuit.

IF Bandwidth switching between 12MHz and 3MHz is configured to provide matched filtering for the shorter 80ns and 250ns pulses respectively which is automatically set when the Radar range is adjusted. Gain is increased accordingly to maintain a relatively constant noise power at the receiver output.

A switched video filter is used in conjunction with the 3MHz IF filter to provide matched filtering for the longest 700nS pulse. This is typically 0.69MHz wide

Remaining variations in noise power as a consequence of the different signal bandwidths (i.e. noise power is directly proportional to bandwidth) are adjusted in the display.

A 'fast time constant' circuit is used to provide a continuously variable high pass filter to provide some immunity against the bulk effects of rain.

N.B. The variable inductor coils L4, L10 and L11 are preset at the factory. They require specialist equipment for tuning and must not be adjusted by the service engineer.

The PRI rates and video noise can be observed at the appropriate connectors (see interface section) for the different range settings as follows:

Summary of bandwidths, pulse widths and PRI rates:

Radar Range Setting	IF BW	Video BW	Pulse width used	PRI rate	Video Noise level
0.125 to 0.75 nm	12MHz	12MHz	80ns	2250 Hz	>500mV pk-pk
1.5 and 3nm	3MHz	12MHz	250ns	1500 Hz	>500mV pk-pk
6nm to max range	3MHz	0.69MHz	700ns	750 Hz	>250mV pk-pk

Autotune Receiver

The autotune receiver provides frequency selective peak detection of high level 'main-bang' transmitter pulses. This is achieved using a high impedance branch from the main receiver input with a transistor/diode based amplifier/detector circuit (Q31, Q32, D16, Q33, Q37). The detection frequency bandwidth of the autotune receiver is set at the factory using variable inductors L7, L8 and L9. The output of the receiver is buffered (U6A) and passed to the scanner microprocessor. A tuning algorithm is then performed at the display to set the difference frequency between the magnetron and VCO (Voltage Controlled Oscillator) to a fixed IF frequency of 60MHz using the TUNE_V control line P1 pin5. Both coarse and fine adjustment are provided by the microprocessor to allow for initial setting and subsequent fine tuning.

N.B. The variable inductor coils L7, L8 and L9 are preset at the factory. They require specialist equipment for tuning and must not be adjusted by the service engineer.

STC/Main Bang Suppression (MBS)

The STC circuitry consists of a logarithmic function generator split into four outputs and multiplied by 4, 3.2 and 2 to generate the respective R4, sea clutter and rain curves respectively.

These curves are offset as requested via processor/operator demands and then combined to provide an output equal to the greatest of the inputs. A curve splitter and linearisation circuits are used to match the output control levels to the characteristics of each attenuator.

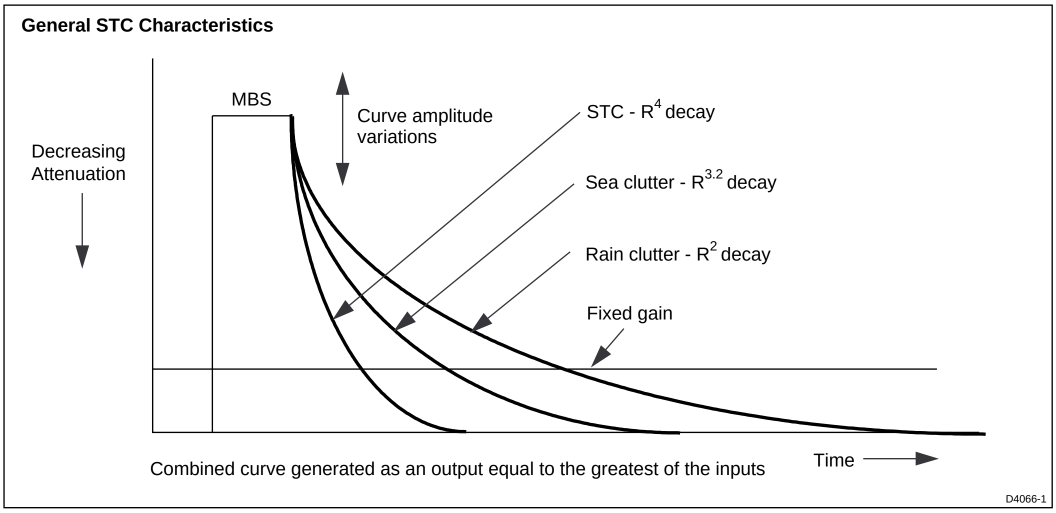

Figure 14. General STC Characteristics

Main bang suppression amplitude and duration controls are configured so as to override these STC controls.

For low values of attenuation the attenuation is applied to the Monolithic amplifiers in order to preserve system noise figure. At higher values of attenuation the attenuation is divided between the IF pin attenuator (D17) used to control the first IF amplifier stage, and the Monolithic amplifiers.

Microcontroller

The microcontroller subsystem, using an NEC 78054 device, is integrated onto the IF receiver board and provides the following functions :-

- Generates analogue control voltages via a multi channel Digital to Analogue Connector (DAC) for all user and automated scanner adjustments
- Reads the tune indicator input and adjusts tune control voltage as necessary.
- Controls modulator pulse width selection.
- Generates stepper motor pulses
- Generates Azimuth pulses for display synchronisation.
- Generates the PRI (Pulse Repetition Interval) pulses to fire the magnetron, start the STC cycle and synchronise the display.

- Buffers the Ships Heading Pulse from the MOD/PSU PCB for synchronising the display.
- Communicates with the display via a serial interface.

Initial Scanner set up (EEprom stored values)

The scanner has non volatile storage (EEprom U18) for the following items:-

- Optimum VCO coarse and fine tune settings for Short, Medium and Long pulses
- MBS Duration and Amplitude for Short, Medium and Long pulses
- Range Zero Offset (adjusted by Display Timing function in Advanced settings Menu) for Short, Medium and Long pulses
- Stepper motor ramp time and pulse period - pre-set at factory - non adjustable
- Azimuth zero offset (adjusted by Bearing Alignment function in Radar Set Up Menu)
- PRI Jitter Offset - used to help with interference rejection.
- STC Preset Max - a preset level of R^4 clutter curve is set to equalise close target returns
- Scanner Size - storage of the antenna size fitted to the Scanner - used to set Max Range for Display
- Modulator Power - The power of the modulator in kW - also used to set Max range for Display

The above stored parameters each have a factory set and used working location. These values are set at the factory and are optimised for each individual scanner unit to provide optimum performance and a good starting value when the Radar system is first operated. However, the VCO tuning, range zero offset and Azimuth zero offset used working values are adjustable from the display during Radar operation.

Due to temperature variations affecting the LNC, the VCO tuning values are adjusted by the display when Auto mode is selected to give optimum tuning. The present optimum value is stored when a range change (i.e. transmit pulse length change) is made, so that when the range is selected again, the auto-tune function is at a better starting point. Normally this adjustment is made just to the fine tune value for each pulse length. Occasionally, a change in coarse tune may be necessary. If tuning problems occur, the Tune Preset function in the Advanced Settings Menu provides a manual way of adjusting the coarse tune used working value.

The Range Zero Offset is adjusted manually from the display Advanced Settings Menu (Display Timing) as part of the normal Radar installation procedure. If the inter unit cable is kept to the supplied length the Display Timing should not normally need adjusting.

STC preset maximum is set at the factory, however the STC preset value can also be changed via the Advanced Settings Menu.

When a Factory Reset is performed (press MENU, select SYSTEM SET UP, the press and hold MENU for 5 second countdown) the scanner copies the Factory set values back into the used working locations of the EEprom so the scanner and display are as they were set up when they left the factory.

The EEprom also stores the scanner Build Standard information that is accessible through the Diagnostics Menu - see chapter 4 - fault finding.

Antenna / Rotary Joint Assembly

The scanners use either 18" or 24" microstrip patch arrays

The primary specifications for the antenna / rotary joint assembly are as follows :-

Parameter	**18" Radome**	**24" Radome**
Operating frequency	9.410GHz ± 63MHz*	9.410GHz ± 63MHz*
Azimuth beam angle	5.2° nom	3.9° nom
Elevation beam angle	<28° nom	<28° nom
Antennae gain across bandwidth	22.3dB nom	22.9dB nom
Return loss	>15.0dB	>15.0dB
Sidelobe levels	>22.0dBc	>22.0dBc

* Bandwidth requirements are defined by the magnetron uncertainty

Figure 15. Antennae Outline Performance

Scanner Display connection

The scanner / display interface is a universal link between any display and any scanner. It consists of a single, multi-core cable with a single moulded plug at the display and multiple connections at the scanner:-

- Video, Serial bus, PRI, Azimuth/Ships heading pulse
- Power.

A moulded plug at the display provides the necessary sealing against the environment, whereas at the scanner this is provided with a compression cable gland, push-fit connector for signal (8 way) and sprung loaded connectors for power (2/4way).

The cable consists of the following cores :-

1. 75 ohm coaxial cable carrying the 1.75V peak to peak video signal from the scanner (pins 7and8).
2. Twisted pair cable carrying the 5V differential azimuth and ships heading reset synchronising signal from the scanner (pins 1and2).
3. Twisted pair cable carrying 5V differential PRI pulse synchronising signal from the scanner (pins 5and6).
4. Twisted pair cable carrying 5V differential, bi-directional serial communications signal (RS485) between scanner and display (pins 3and4).
5. 8.7V-32V DC at scanner

Maximum cable length between scanner and display is 50 metres, this assumes the correct wire gauge is used which may entail the use of separate power feed to the scanner. Refer to Section 6.3, Inter-Unit Cable, in the operation manual.