No. : OM-E3294-0F

FURUNO

OPERATOR'S MANUAL

MARINE RADAR

MODEL 1800

FURUNO ELECTRIC CO., LTD.
NISHINOMIYA, JAPAN

8807300T(8807,yoha)
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A WORD TO FURUNO MODEL 1800 OWNERS:

Congratulations on your choice of the FURUNO Model 1800 Radar. We are confident that you will enjoy many years of operation with this fine piece of equipment.

For over 30 years Furuno Electric Company has enjoyed an enviable reputation for quality and reliability throughout the world. This dedication to excellence is furthered by our extensive global network of agents and dealers.

The Model 1800 Radar is just one of the many Furuno developments in the field of radar. The compact, lightweight but rugged unit is easy to install and operate and is suitable for use on a wide variety of vessels.

This unit is designed and constructed to give the user many years of trouble-free operation. However, to obtain optimum performance from this unit, you should carefully read and follow the recommended procedures for installation, operation and maintenance. No machine can perform to the utmost of its ability unless it is installed and maintained properly.

We would appreciate feedback from you, the end-user, about whether we are achieving our purposes.

Thank you for considering and purchasing Furuno equipment.

CAUTION

No one navigational aid should be relied upon exclusively for the safety of vessel and crew. The navigator has the responsibility to check all aids available to confirm his position. Electronic aids are not a substitute for basic navigational principles and common sense.

CONTENTS

FEATURES

The Model 1800 has a large variety of functions, all contained in a rugged plastic case.

All controls respond immediately to the operator's command and each time a touchpad is depressed, the corresponding change can be seen on the screen.

* Daylight viewing radar specially designed for small craft and sailing yachts.
* Traditional FURUNO reliability and quality in a compact, lightweight and low-cost radar.
* High definition 9" raster-scan display.
* 4 levels of target quantization for high target definition without problems associated with single-level quantization systems.
* On-screen alpha-numeric readout of all operational information.
* 7 ranges from 0.25 to 24 nm; 3kW transmitter power
* Dual pulselengths and pulse repetition rates automatically selected, optimizing both short-range and long-range performance.
* EBL (Electronic Bearing Line), VRM (Variable Range Marker), Interference Rejector, anti-sea clutter and rain clutter control provided.
* Operates on 10.2 to 40.0VDC power supply and consumes only 43W. Protection against reverse polarity and excessive voltage provided.
* Optional radar alarm available for use as anti-collision aid.

SPECIFICATIONS OF MODEL 1800

SCANNER UNIT

1. Radiator: Slotted Waveguide Array (housed in radome)
2. Radiator Length: 54cm
3. Horizontal Beamwidth: 4°
4. Vertical Beamwidth: 25°
5. Sidelobe Attenuation:
   Within ± 20° of mainlobe: -18dB
   Outside ± 20° of mainlobe: -23dB
6. Polarization: Horizontal
7. Antenna Rotation: 24 r.p.m. nominal

TRANSCEIVER MODULE (Contained in radome)

1. Transmitting Tube: Magnetron 9M302/E3513, 9M332 or MG5251
2. Frequency & Modulation: 9410MHz ± 30MHz, P0N
3. Peak Output Power: 3kW nominal
4. Pulselength & Pulse Repetition Rate:

Item \ Range	0.25	0.5	1.5	3	6	12	24
Pulse Repetition Rate	Approx. 3360Hz			Approx. 840Hz			
Pulselength	0.08us (Short)			0.5us (Long)			

5. Modulator: SCR Line Type Pulse Modulator
6. I.F.: 60MHz
7. Tuning: Manual
8. Receiver Front End: MIC (Microwave IC)
9. Bandwidth: 7MHz/3MHz
10. Duplexer: Circulator with diode limiter

DISPLAY UNIT

1. Indication System: Raster scan, Daylight display
2. Picture Tube: 9-inch rectangular CRT

3. Range (nm)	0.25	0.5	1.5	3	6	12	24
4. Range Ring Interval (nm)	0.125	0.125	0.25	0.5	1	2	4
5. Number of Rings:	2	4	6	6	6	6	6

6. Bearing Resolution: 5°

7. Bearing Accuracy: Better than 1°

8. Range Discrimination: Better than 25m

9. Minimum Range: Better than 25m

10. Range Ring Accuracy: 1.5% or 70m, whichever is the greater.

11. VRM Accuracy: 1.5% or 70m, whichever is the greater.

12. Mark Indication: Heading Mark, Bearing Scale, Range Ring, VRM, EBL, Alarm Zone (Option)

13. Numeral/Character Indication: Range, Range Ring Interval (RINGS), EBL, VRM, Interference Rejection (IR), ST-BY, Rain Clutter Rejection (FTC), Radar Alarm (ALARM) --- Option (RA-48 needed)

14. Interference Rejector: Built-in

ENVIRONMENT CONDITION

1. Vibration:

Vibration Freq.	Total Amplitude
1 to 12.5Hz	± 1.6mm
12.5 to 25Hz	± 0.38mm
25 to 50Hz	± 0.10mm

2. Ambient Temperature: Scanner Unit -------- -25°C to +70°C
Display Unit -------- -15°C to +55°C

3. Humidity: Relative humidity, 93% ± 2% at +40°C ± 3°C

POWER SUPPLY & POWER CONSUMPTION

10.2VDC - 40.0VDC, 43W

COMPASS SAFE DISTANCE

	STANDARD COMPASS	STEERING COMPASS
DISPLAY UNIT	0.6m	0.4m
SCANNER UNIT	3.1m	1.75m

COMPLETE SET:

No.	Name	Type	Code No.	Q'ty	Remarks
1	Scanner Unit	RSB-0016	000-083-711	1	11kg
2	Display Unit	RDP-043	000-088-221	1	6.2kg
3	Installation Materials	CP03-02600	000-082-907	1 set	
4	Accessories	FP03-01600	000-081-026	1 set	
5	Spare Parts	SP03-02600	000-081-037	1 set	

INSTALLATION MATERIALS:

No.	Name	Type	Code No.	Q'ty	Remarks
1	Plug	FM-142P	000-511-406	1	For Power cable
2	Sig. Cable Assy. 10m	S03-10-10	008-204-650	1	Connectors Fitted
3	Round Head Screw	M10x50 SUS304	000-800-976	4	For Scanner Unit Mounting
4	Hex. Nut	M10 SUS304	000-863-111	4	
5	Flat Washer	M10 SUS304	000-864-131	4	
6	Spring Washer	M10 SUS304	000-864-261	4	

ACCESSORIES:

No.	Name	Type	Code No.	Q'ty	Remarks
1	Hood Assy.	FP03-01620	003-160-660	1	
2	Bracket Assy.	FP03-01611	003-160-640	1	For Display Unit Mounting
3	Tapping Screw	6x20 SUS304	000-800-414	5	
4	Flat Washer	M6 SUS304	000-864-129	5	
5	Washer	8.2x30.0x1.0 SUS304	000-800-486	2	
6	Knob Bolt	KG-B3 M8x25	000-800-554	2	

SPARE PARTS:

No.	Name	Type	Code No.	Q'ty	Remarks
1	Fuse	FGMB 10A AC125V	000-104-815	2	w/Parts Box

OPTION:

No.	Name	Type	Code No.	Q'ty	Remarks
1	Radar Alarm	RA-48	000-030-045	1	
2	External Buzzer	OP03-21	000-030-097	1	
3	Power Cable 5m	VV-S 2.0x2C	003-192-000	1	
4	Sig. Cable Assy. 15m	S03-10-15	008-204-660	1	Connectors Fitted.
	Sig. Cable Assy. 20m	S03-10-20	008-204-670		
	Sig. Cable Assy. 30m	S03-10-30	008-204-680		

PRINCIPLE OF OPERATION

The term "RADAR" is an acronym meaning RAdio Detection And Ranging. Although the basic principles of radar were developed during World War II, primarily by scientists in Great Britain and the United States, the use of echoes as an aid to navigation is not a new development.

Before the invention of radar, when running in fog near a rugged shoreline, ships would sound a short blast on their whistles, fire a shot, or strike a bell. The time between the origination of the sound and the returning of the echo indicated how far the ship was from the cliffs or the shore. The direction from which the echo was heard indicated the relative bearing of the shore.

Today, the method of determining the distance to a target is much more accurate because of pulse-modulated radar. Pulse-modulated radar determines the distance to the target by calculating the time difference between the transmission of a radar signal and the reception of the reflected echo. It is a known fact that radar waves travel at a nearly constant speed of 162,000 nautical miles per second. Therefore the time required for a transmitted signal to travel to the target and return as an echo to the source is a measure of the distance to the target. Note that the echo makes a complete round trip, but only half the time of travel is needed to determine the one-way distance to the target. This radar automatically takes this into account in making the Range calculation.

The bearing to a target found by the radar is determined by the direction in which the radar scanner antenna is pointing when it emits an electronic pulse and then receives a returning echo. Each time the scanner rotates pulses are transmitted in the full 360° circle, each pulse at a slightly different bearing from the previous one. Therefore, if we know the direction in which the signal is sent out we know the direction from which the echo must return.

Note that the speed of the radar waves out to the target and back again as echoes is extremely fast compared to the speed of rotation of the antenna. By the time radar echoes have returned to the scanner, the amount of scanner rotation after initial transmission of the radar pulse is extremely small.

The range and bearing of a target is displayed on what is called a Plan Position Indicator or PPI. This display is essentially a polar diagram, with the transmitting ship's position at the center. Images of target echoes (sometimes called a "pip") are received and displayed at their relative bearings, and at their distance from the PPI center. With a continuous display of the images of targets, the motion of the transmitting ship is also displayed.

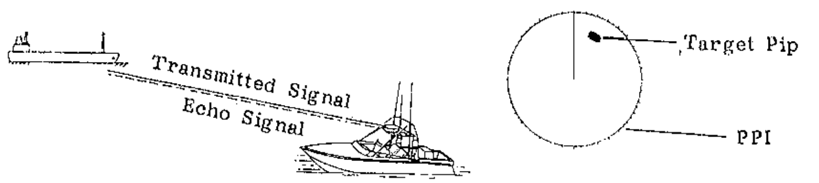


Fig.1 How Radar Works

INSTALLATION

As was pointed out in the Introduction to this manual, this machine can do its intended functions only if it is installed properly.

GENERAL MOUNTING CONSIDERATIONS

This radar consists of two units: the Display Unit and the Scanner Unit. The Scanner Unit has been designed to withstand all the rigors of the marine environment, and if installed properly, is thoroughly waterproof. A "domed" type of Scanner Unit, where the scanner mechanism is enclosed in a fiberglass dome, ensures that halyards and other rigging won't get tangled up in the rotating scanner.

The Display Unit is carefully constructed to be able to withstand the humidity and corrosive atmosphere common in a pilothouse, but it is not designed to be used outside, directly exposed to the environment! Salt water spray (or even coffee spills) will most assuredly cause damage to the sensitive components inside. Keep these factors in mind when planning the installation of the Display Unit.

Many owners will undoubtedly use this radar on small boats. The Display Unit must be mounted inside an enclosed cabinet, completely shielded from salt water spray, and from fresh water spray if the boat is usually hosed down after a day's outing. Corrosion can occur, especially on the rear connectors exposed to salt spray, unless these are taped and thoroughly sealed with putty compounds made especially for this purpose. Most small boats are equipped with such an enclosed cabinet, and most have clear doors so that equipment may be seen behind them.

FURUNO WILL ASSUME NO RESPONSIBILITY FOR CORROSION DAMAGE CAUSED BY EXPOSURE TO EITHER FRESH OR SALT WATER SPRAY!

The Display Unit consumes only a moderate amount of power, so there is no need for forced air ventilation. However it is necessary to provide adequate space behind and around the Display Unit to allow some circulation of cooling air and to provide convenient access to the rear connectors.

Even though the picture is quite legible even in bright sunlight, it is a good idea to keep the Display Unit out of direct sunlight or at least shaded because of heat that can build up inside the cabinet.

It is a regrettable fact of modern life that small attractive electronic gear seems to attract undue attention from thieves. In your installation planning it is a good idea to provide means either to hide the gear when you are not aboard or take the gear off the boat completely when you are finished for the day. Consideration should be made to provide space for access to the mounting hardware on the side and to the connectors behind the Display Unit.

DETAILED INSTRUCTIONS

SCANNER UNIT INSTALLATION

The Scanner Unit is completely watertight when installed correctly. It

should be placed where there is a good all-round view with, as far as possible, no part of the ship's superstructure or rigging intercepting the scanning beam. Any obstructions will cause shadow and blind sectors. A mast, for instance, with a diameter considerably less than the width of the scanner, will cause only a small blind sector, but a horizontal spreader or crosstrees in the same horizontal plane as the Scanner Unit would be a much more serious obstruction and the Scanner Unit would need to be placed well below or above it.

It is rarely possible to place the Scanner Unit where a completely clear view in all directions can be obtained. Thus, the angular width and relative bearing of any shadow sectors should be determined for their influence on the radar at the first opportunity after fitting. (The method of determining shadow and blind sectors is shown later in this section.)

The Scanner Unit should be generally mounted as high as possible on the boat to ensure best performance at the maximum range. But this is perhaps not as important as might be supposed for a small boat. For example, increasing the height from 10 feet to 13 feet off the water won't net very much if you are looking for another boat which also only rises 10 feet off the water. Doing so would increase the range capability from 7.7 nautical miles to 8.3 nautical miles, an increase that may not be worth the serviceability problems involved in mounting the scanner higher on the boat.

In addition, if your boat is equipped with a radio direction finder, its antenna should not be positioned in close proximity to the Scanner Unit, since the DF would be adversely affected. A separation of more than 2 meters is recommended.

The compass safe distance (3.1m (10.17 feet) standard compass and 1.7m (5.58 feet) steering compass) should be also observed. If the distance is not enough, deviation of the magnetic compass will result.

On a sailboat, the Scanner Unit is normally mounted up on the mast. On power boats, it is usually installed on a framework above the flying bridge. However, in many cases, the unit can be installed directly on the top of the wheelhouse near the ship's centerline.

When this radar is to be installed on larger vessels, take care to consider the following points.

1) The interconnection cable is run between the Scanner Unit and the Display Unit and is 10 meters long. If additional interconnection cable is required for a particular installation, an unbroken length of cable must be used (i.e., no splices allowed!), and maximum length of the interconnection cable is 30 meters. On a sailboat where it will be necessary to step the mast for maintenance, a junction box may be installed at the base of the mast, under the floorboards. The junction box must be watertight and the wire breakout must be kept as short as possible.

2) Deposits and fumes from a funnel or other exhaust vents can adversely affect the performance of the antenna, since hot gases may warp the radome. The scanner unit must not be mounted in a position where it may be subjected to temperatures in excess of 70°C (158°F).

The figure on the next page shows typical Scanner Unit placement.

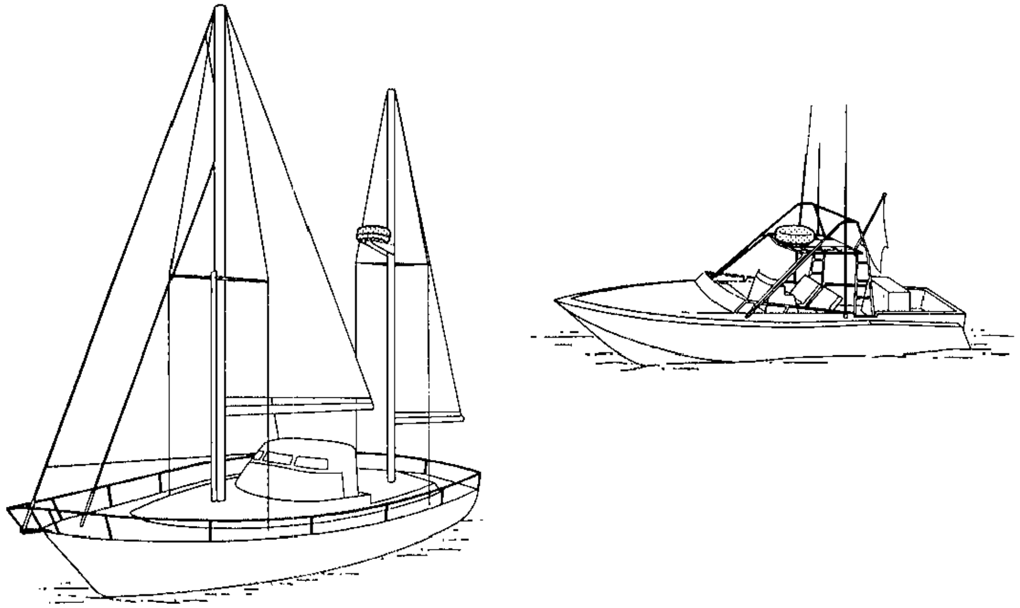


Fig.2 Typical Scanner Unit Placement

Scanner Unit Preparation and Unpacking:

After deciding the location of the Scanner Unit, preparation and unpacking of the Scanner Unit is necessary. Use the following procedure.

1. Open the radome package carefully. Unbolt the four screws used to hold the white radome cover to the blue radome base and carefully lift the radome up over the insides of the dome.

2. Remove the antenna stoppers. This will release the scanner from its shipping preparation position, and allow it to rotate freely, as well as to allow access to the transceiver assembly.

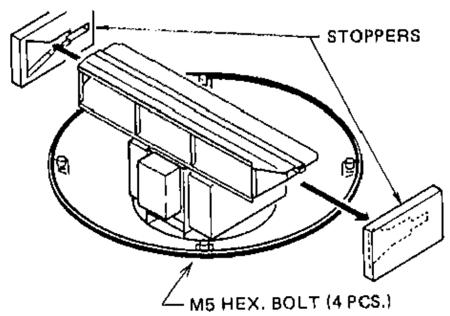


Fig.3 Unpacking the Scanner Unit

3. Remove the four M10 bolts together with spring and flat washers on the bottom of the radome base assembly. These bolts, spring and flat washers may be discarded.

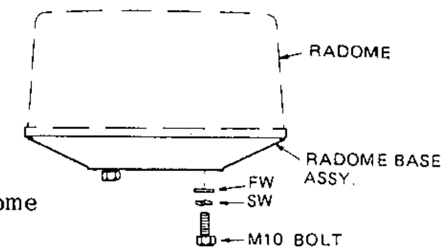


Fig.4 Preparing the Radome Base for Mounting

4. Undo the four M6 hex. bolts securing the transceiver module to the radome base, and take out the transceiver module together with the radiator.

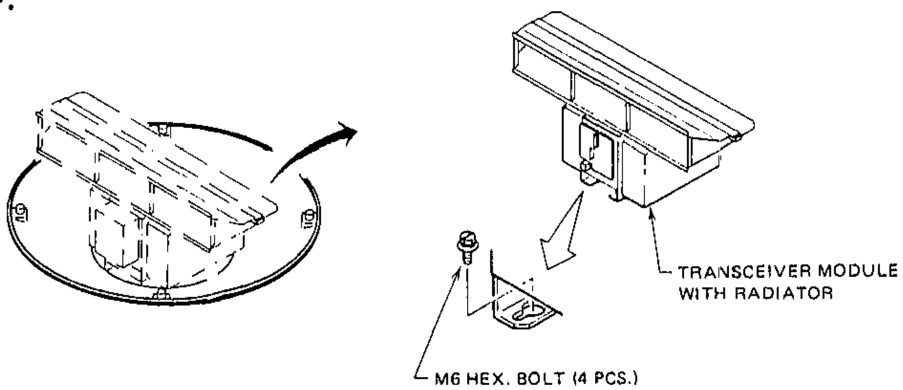


Fig.5 Removing the Transceiver Module

Scanner Unit Mounting

The mounting surface must be parallel with the ship's waterline and provided with six holes whose dimensions are shown in Fig.6: Four 12mm (1/2") holes for fixing, one 25mm (1") hole for cable entry and one 20mm (3/4") hole for the vent tube.

There is a "HEAD" label on the Scanner Unit which should face the bow direction. The unit is adjusted so that a target echo returned from the "HEAD" label direction will be shown on the 0° (Heading Marker) position on the screen. When drilling holes, take care that the holes are parallel with the fore and aft line.

In very hot and humid climates, moisture may condense inside the radome, causing corrosion. To prevent this, a vent tube is fitted on the base of the radome. This tube is designed to allow the radome to "breathe" while not allowing entry of water from outside into the dome. Therefore, make sure the tube is kept free of foreign materials and is not pinched or kinked. The vent tube extends downward by 27mm (1.1") from the radome base. Ensure the vent tube extends downward before installing the radome. See Fig.7.

5. Now install the radome base on the mounting surface. Find the "HEAD" label outside the radome base. Next, position the radome base so that the "HEAD" label faces the bow direction. This alignment should be carried out as accurately as possible.

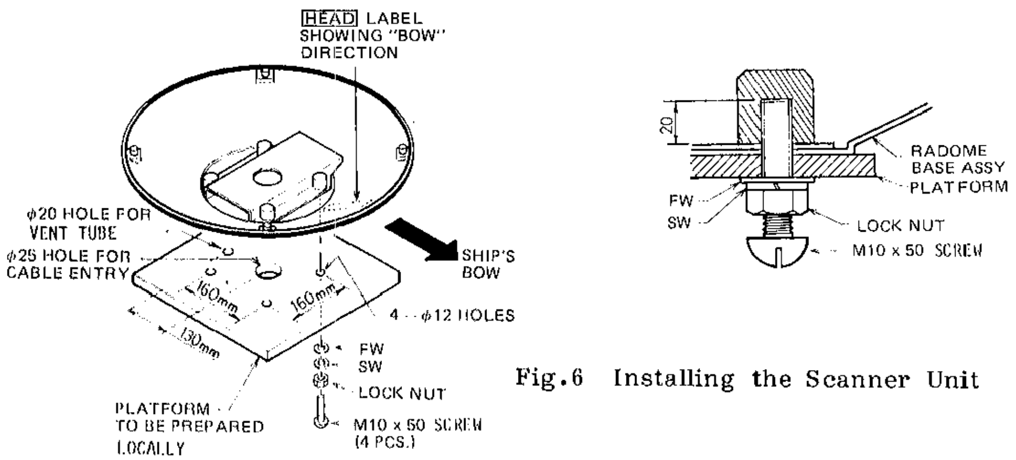


Fig.6 Installing the Scanner Unit

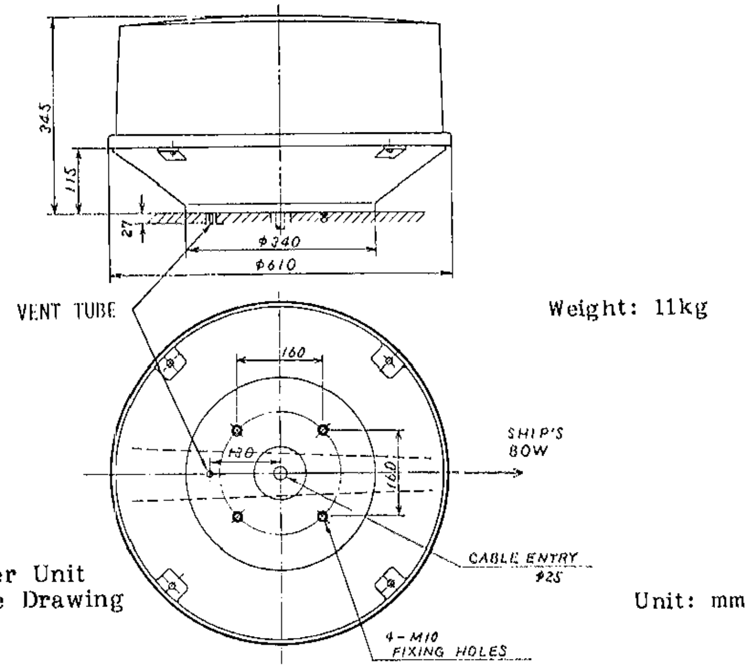


Fig.7 Scanner Unit Outline Drawing

6. After making sure that the vent tube is in the correct position, fix the radome base to the mounting surface with the four M10 x 50 screws, flat and spring washers supplied as the installation materials (hand-tighten only).

CAUTION

Do not overly tighten the radome base fixing bolts, otherwise the radome base may crack.

7. Then, tighten the lock nuts securely with a wrench.

Wiring and Final Preparation of Scanner Unit:

8. Run the interconnection cable from the Display Unit to the Scanner Unit. A hole of at least 19mm (0.75") dia. must be drilled through the deck or

bulkhead for cable entry. After the cable is passed through the hole, a sealing compound should be applied to this hole for waterproofing.

In order to minimize the chance of picking up electrical interference, avoid where possible routing the interconnection cable near other on-board electrical equipment. Also avoid running the cable in parallel with power cables.

9. Remove the cable clamping plate by loosening four M4 bolts and gaskets at the center of the radome base. See Figs.8 & 9.

10. Pass the cable through the hole at the bottom of the radome base. Three plugs are provided on the end of the interconnection cable for connection inside the Scanner Unit.

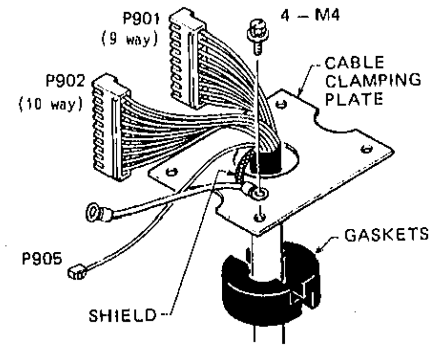


Fig.8 Cable Grounding Method

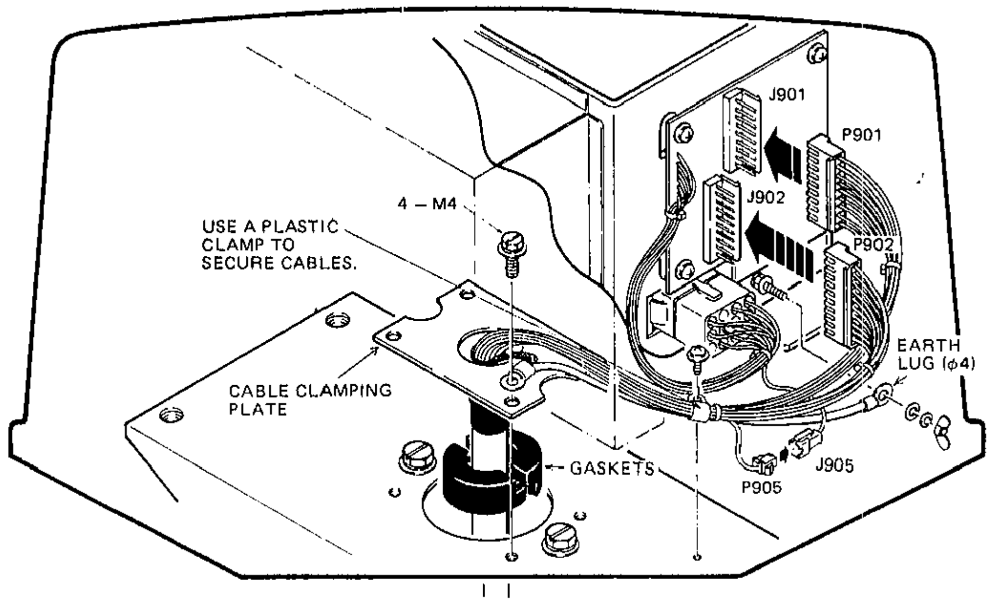


Fig.9 Cable Assembly and Connection

11. Put the gaskets in position as shown in Fig.8. If the gaskets are incorrectly installed, water may come into the radome.

12. Secure the cable with the cable clamping plate. At this time, ground the shield of the cable by using one of the fixing bolts for the cable clamping plate. See Figs.8 and 9.

13. Fix all lead wires to the base with the plastic clamp provided.

14. Put the transceiver module back into position and secure it with the four M6 bolts. Then, mate the three plugs, referring to Fig.9.

15. Put the radome on the radome base assembly, taking note of that the narrower recessed part should face in the direction of the bow. See the figure below.

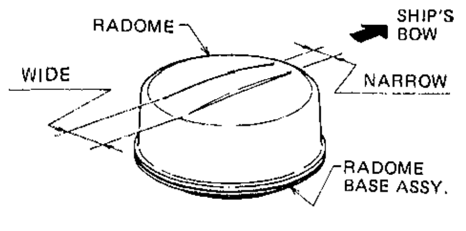
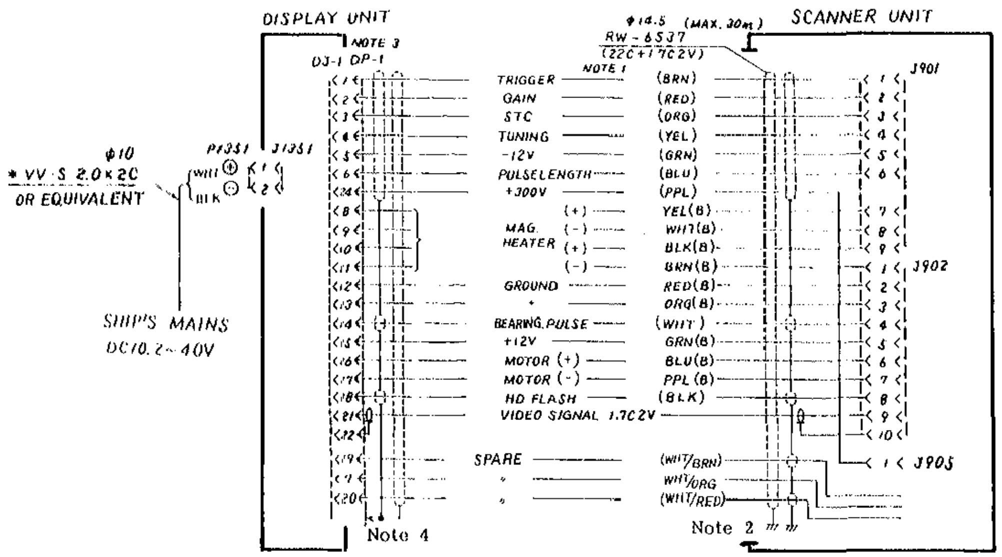


Fig.10 Radome Cover Placement

16. Tighten the radome fixing bolts temporarily, because it may have to be opened again for "Relative Bearing Alignment."

17. The cable run must be properly supported, and must not be used to provide impromptu foot-holds or hand-holds!! Clips or hangers should be employed every 9 inches.



Note: 1. Wire color code ( ): Inner wires; (B): Large wires.
2. Shield should be effectively grounded at scanner unit.
3. Connector plug factory-wired
4. Shield ground through connector case
5. *: shipyard supply

Fig.11 Interconnection Diagram

DISPLAY UNIT INSTALLATION

Locate the Display Unit in a position where it can be viewed and operated conveniently but where there is no danger of salt or fresh water spray or immersion.

Compass Safe Distance; The magnetic compass may be affected if the Display Unit is placed too close, because of fields generated in the radar. The compass safe distance (approximately 0.6m(1.97feet) standard compass and approximately 0.4m(1.31feet) steering compass) must not be disregarded.

The orientation of the Display Unit should be so that the radar screen is viewed while the operator is facing in the direction of the bow. This makes determination of your position much easier.

The Display Unit is mounted in a trunnion mount. The mount itself can be installed either overhead, on a bulkhead, or on a tabletop. The drawing below gives the recommended clearances and the mounting dimensions for this unit. You can use the mount itself as a template for locating the mounting bolt holes. Since the unit weighs 6.2kg (13.6 pounds), reinforce the mounting place, if necessary.

The mounting procedure is:

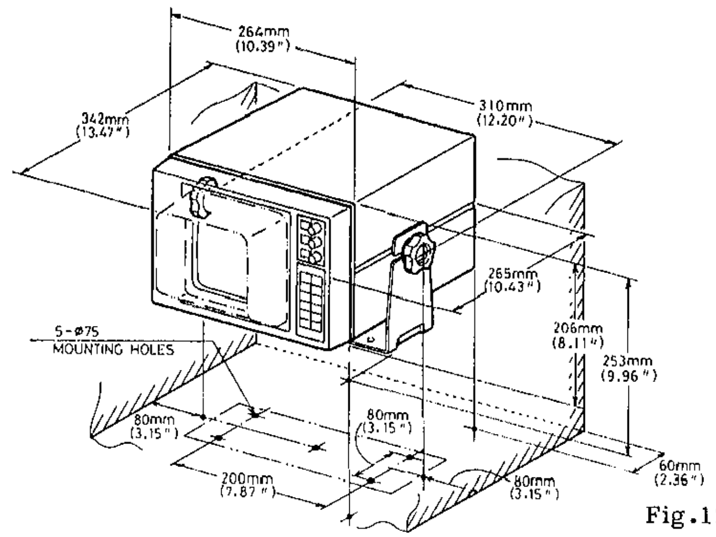
1. Mark the screw locations by using the trunnion as a template.

2. Drill five pilot holes for the trunnion.

3. Install the trunnion using the screws supplied.

4. Fit knobs and knob washers to the display unit.

5. Install the display unit in the trunnion. Tighten the knobs securely.



Weight: 6.2kg

Fig.12 Display Unit Outline Drawing

As was stated before, make sure you allow enough clearance both to get to the connectors behind the unit and to allow you to get your hands in on both sides to loosen or tighten the mounting knobs. Make sure you leave at least a foot or so of "service loop" of cables behind the unit so that it can be pulled forward for servicing or easy removal of the connectors.

Now comes the wiring part. The only wiring necessary is for power connection and the interconnection cable.

Antenna Connection

The interconnection cable from the Scanner Unit is connected to the back of the display unit.

Power Connection

The Model 1800 is designed for 12 volt, 24 volt or 32 volt battery systems. No internal wiring changes are needed for input voltages from 10.2 to 40.0VDC. A piece of gear of this quality deserves to have a circuit breaker dedicated to it alone. The size of the wire feeding power to the unit should be no less than AWG #14 (2.0mm square).

Refer to the figure below for assembly of the power connector.

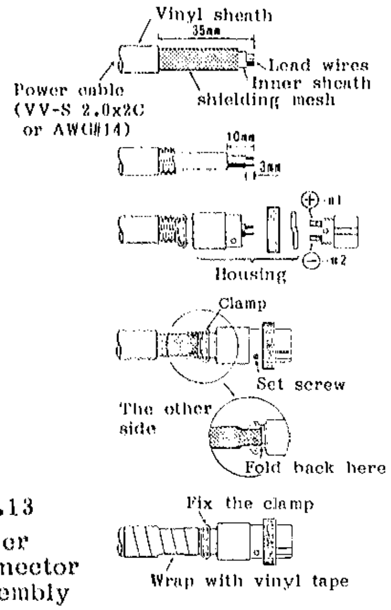


Fig.13
Power Connector Assembly

1) Strip off 35mm of the vinyl sheath, taking care not to nick the shielding mesh, and then slide the shielding mesh back.

2) Strip off 10mm of the inner sheath, and then remove about 3mm of the insulation from both ends of the lead wires.

3) Slide connector's housing over the cable.

4) Solder the lead wires to the connector, taking note of the polarity.
⊕ --- #1 & ⊖ --- #2

5) Assemble the connector, and then tighten the set screw.

6) Fold back the shielding mesh and clamp the connector over top of it.

7) Wrap the shielding mesh with vinyl tape.

Ground Connection

Run heavy duty ground wire from the grounding terminal on the rear bottom of the Display Unit to the nearest grounding point on the boat.

Follow the drawing below for detailed wiring information.

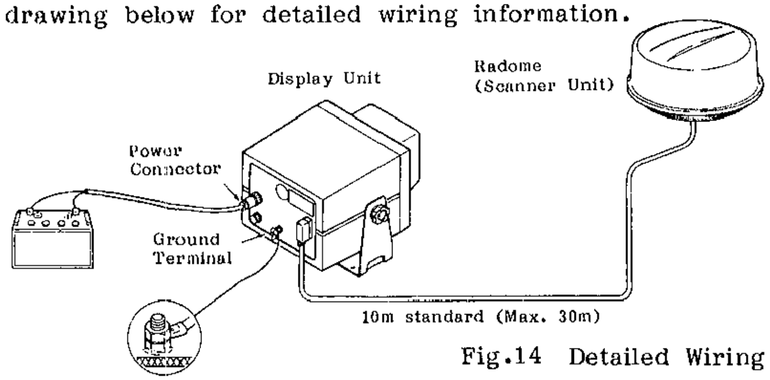


Fig.14 Detailed Wiring Diagram

CHECKING THE INSTALLATION

After completing the installation, it is a good idea to recheck to ensure that all the steps of the installation were accomplished in accordance with the instructions. Use the following check list.

Table 1 Installation Check List

Check Items	Tick here.
1) The "HEAD" label on the radome base faces the bow direction correctly.	☐
2) The radome base fixing bolts and lock nuts are fully tightened.	☐
3) The cable gland is waterproof at the radome base.	☐
4) The cable is securely retained against the mast or mounting and is free of interference from running rigging.	☐
5) Check that the cable gland or entry on the deck is waterproof, if provided.	☐
6) The power connections to the battery are of correct polarity.	☐
7) Check that the plugs at the rear of the display are inserted correctly and are secure.	☐
8) Carry out the "Relative Bearing Alignment," "Measurement of Blind Shadow Sectors" and "Sweep Timing Adjustment" after the above checks.	☐

Now is the time to turn on the unit and carry out the necessary tuning and presetting adjustments.

INITIAL PROCEDURES

1. Depress the POWER button on the lower left of the Display unit, and the "ON" LED above the POWER button will light up. In approximately 2 minutes and 30 seconds, the message "ST-BY" will appear near the center of the screen. While this two and one-half minute warmup is in process, remove the blind cover plate on the rear panel of the Model 1800 Display Unit. This will expose the four preset adjustments. Turn the front panel TUNE control to 12 o'clock, the GAIN control at 2 o'clock, and the STC control at maximum Counter Clockwise.

2. When the screen indicates "ST-BY" press the TX touchpad. The radar will start transmitting on the 0.25 mile range, and you will probably see a number of targets around you, even though the gain, tuning and other tuning adjustments have yet to be optimized.

3. Press the touchpad labeled RANGE and then push the Up arrow until the

radar is on the 6 mile range. Bring up the GAIN control until a small amount of noise appears on the screen. At this point, unless the tuning just happens to be at the optimum point, reach around and slowly adjust the coarse TUNING control accessible through the hole in the back panel, watching the screen for radar targets. You must patiently adjust this coarse-tuning control in very small increments, allowing the sweep to go around completely in order to observe the effect of a single small change in its setting. When you are finished optimizing the coarse tuning control on the back panel, verify that the fine TUNING control on the front panel peaks up for maximum radar echoes at 12 o'clock, or at least close to that point.

4. Now, while still on the 6 mile range, adjust the GAIN control on the front panel, for a little background noise showing on the screen, and then hit the RANGE touchpad, followed by four pushes on the Down tochpad to bring you down to the 0.25 mile range. Without disturbing the front panel GAIN control, adjust the STC control until nearby radar targets are clearly shown on the screen. Too much STC action will eliminate small targets, and too little STC action will cause the screen to be so full of targets and noise that it is hard to determine which target is which as compared to visual sightings. Note that adjusting the GAIN and STC controls in this manner (GAIN at long range, STC at short range) will equalize the picture at all ranges, and you will not have to jockey back and forth with the GAIN control especially when you change range scales.

RELATIVE BEARING ALIGNMENT

You have mounted the Scanner Unit with the "HEAD" label facing straight ahead in the direction of the bow. Therefore, a small but conspicuous target dead ahead visually should appear on the heading line (zero degree).

In practice, you will probably observe some small error on the display for most installations because of the difficulty in achieving accurate initial positioning of the Scanner Unit. The following adjustment will compensate for this error. If you don't know how to do it well, it's best you leave this part to a competent service technician. (Remember that the top radome fixing bolts remain untightened. They should now be secured if the following alignment is not necessary.)

1. Identify a suitable target (e.g., ship or buoy) at a range between 1/8 to 1/4 miles, preferably located on or around the heading flash. To minimize errors of bearing you should generally keep echoes in the outer half of the picture by changing the range scale.

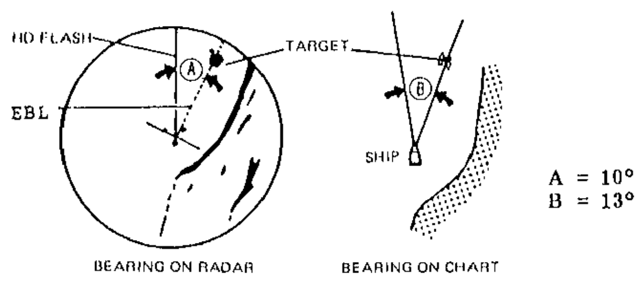


Fig.15 Relative Bearing Alignment

(When the relative bearing of a target measured on the radar screen Ⓐ does not agree with that measured on the navigation chart Ⓑ.)

2. Press the EBL key to bring up the EBL on the screen.

3. Press either of the arrow keys until the EBL lies directly over the target.

4. Read the EBL bearing at the bottom left on the screen.

5. Find the relative bearing to the target from the ships bow visually, using a pelorus.

6. Compare the bearing measured in step 4 and 5 above, and calculate the direction and magnitude of the bearing error.

7. Remove the radome to have access to the transceiver module and slightly loosen the two screws which secure the heading flash key at the port inside the dome. If the screws are loosened excessively, fine adjustment will be more difficult.

8. There are vertical lines located below the heading flash key. The lines closer to the center mark (darker line) are equivalent to a bearing error correction of approximately 1.5°. The lines further away from the center are slightly less than 1.5°.

   Adjust the heading flash key, moving to the right-hand side (aft direction) or to the left-hand side (fore direction). For the example in Fig.15, move the heading flash key to the right-hand side by about 2 marks for a correction of 3° error to the starboard side.

9. After adjustment, tighten the heading flash key fixing screws securely.

10. Install the radome on the radome base assembly, being careful of its direction. The narrower recessed part should face the bow direction. See Fig.10.

11. Tighten the radome fixing bolts securely.

12. As a final test, move the boat towards a small buoy and ensure that the buoy shows up dead ahead on the radar when it is visually dead ahead.

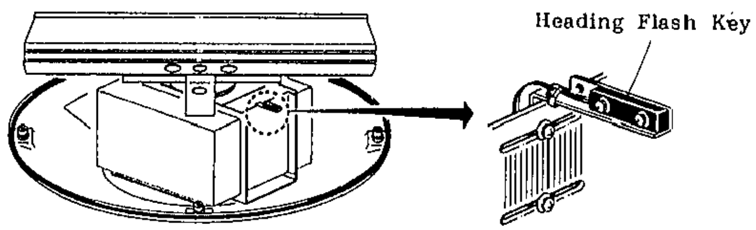


Fig.16 Location of Heading Flash Key

SWEEP TIMING ADJUSTMENT

This adjustment is carried out to ensure proper radar performance, especially on short ranges. The radar measures the time required for a transmitted echo travel to the target and return to the source, and the received echo is displayed on the CRT based on this time. Thus, at the instant the transmitter is fired, the "Sweep" should start from the center of the CRT (sometimes called sweep origin).

A "trigger" pulse generated in the Display Unit is sent to the Scanner Unit through the interconnection cable to trigger the transmitter (magnetron). The time taken by the signal to travel up to the Scanner Unit varies, depending largely on the length of interconnection cable. During this period the Display Unit should wait before starting the sweep. When the Display Unit is not adjusted correctly, the echoes from a straight local object, e.g. a harbor wall, straight pier, etc. will not appear with straight edges -- i.e., they will be seen as "pushed out" or "pulled in" near the picture center. The range of objects will also be incorrectly shown.

Therefore, the following adjustment should be carried out after installation, even if the standard cable of 10 meters has been used.

Procedure

1. Set the unit at 0.25 nm range and adjust the GAIN and STC controls properly.

2. If this hasn't already been done, remove the blind plate on the rear panel by loosening four screws.

3. Visually, select a straight object, e.g. a harbor wall, straight pier, etc.

4. Adjust the "TRIG" potentiometer (VR3, second one from left) so that a straight object will appear straight with no "pushing" or "pulling" near the picture center.

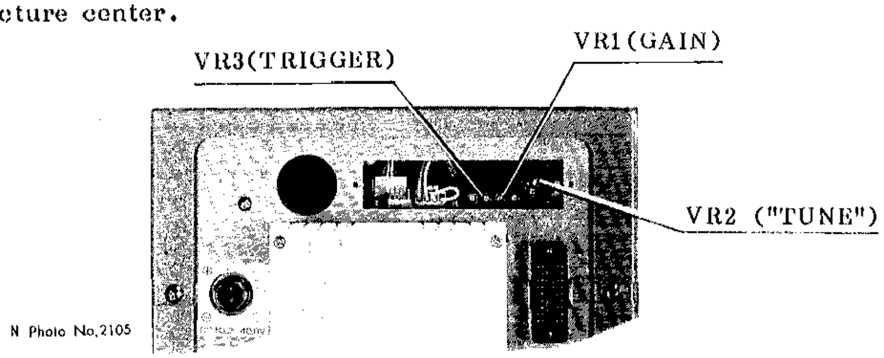


Fig.17 Location of Pot. VR1 (GAIN) and VR3 (TRIGGER)

R Photo No. 422

(A) improper, pulling inward

(B) proper

(C) improper, pushing outward

Fig.18 Sweep Timing Adjustment

ADJUSTMENT OF PRESET GAIN

At the installation, preset the Receiver Gain as below.

1. Set the controls: RANGE: max. range; GAIN: fully CW (max.); STC: fully CCW (min.); FTC: off, and IR: on.

2. Set VR1 at the position where a little backbround noise appears on the screen. See Fig.17 for the location of VR1.

3. Confirm that the noise increases when the IR circuit is not activated. (IR touchpad: OFF)

TUNING ADJUSTMENT

Tuning is preadjusted at the factory. However if the best tuning condition is not obtained with the TUNE control set at its mid-travel, execute the following procedure.

Procedure:

1. Transmit the radar on maximum range (long range) with the TUNE control set at its mid-travel and wait about 10 minutes for magnetron oscillation to stabilize.

2. Adjust potentiometer VR2 ("TUNE"), located on the PRESET CONTROL board at the rear side of the display unit (Fig.17), so that a comparatively weak long range echo is discerned with maximum definition.

MEASUREMENT OF BLIND SHADOW SECTORS

In some shadow sectors, it should be remembered that there may not be sufficient intensity to obtain an echo from very small targets even at close range, despite the fact that a large vessel may be detected at a much greater range in non-shadowed sectors. For these reasons the angular width and relative bearing of any shadow sectors should be determined. This section describes how to do this. In the case of a new vessel this should be done during sea trials. In other ships it should be done at the first opportunity after fitting a new radar set.

It should be realized that even a small shadow sector may hide another vessel if she is on a collision course. The bearing will remain constant in the shadow area and the approach of the other vessel may remain undetected until it is too late to avoid a dangerous situation.

Two methods of determining the angular width of a shadow sector are;

1) Turn the boat very slowly through 360° while a small but clearly defined target is observed at a distance of a mile or so. (Do not use a buoy with a reflector as this target is too powerful to achieve the required result.)

If the echo disappears while the boat is turning, the target has entered a shadow sector and it will again become visible when the target emerges from the shadow. Very quiet conditions of wind and sea are essential to ensure reliable results when this operation is carried out on a small craft since a rough sea can cause a buoy to be lost in the clutter or to be temporarily submerged or hidden by waves. An unsteady movement may cause the boat to swing through a shadow sector before the scanner has completed one revolution. In any case an average of several observations of each shadow sector should be taken. It is a waste of time to attempt the operation in anything other than very smooth water with little wind.

2) Another method is to observe the shadow sector against a background of sea clutter. Any shadows will show as dark sectors in the clutter. See Fig.19.

Note that a shadow cannot be fairly estimated in heavy clutter, as echoes from either side of the sector may be spread into it and give an illusion that objects in the sector are being observed. Nor can it be satisfactorily determined in confined waters, because of the probability of indirect, false or multiple echoes being produced from nearby buildings or other vessels.

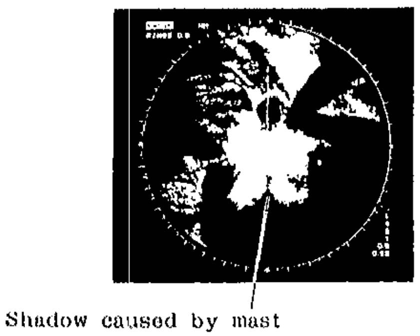


Fig.19 Appearance of a Shadow Sector on the Display Screen

The result of the above measurement should be recorded on a blind shadow sector diagram. Fig.21 is an example of a shadow sector diagram for the scanner unit sited as in Fig.20. The blind shadow sector diagram should be fixed near the Display Unit.

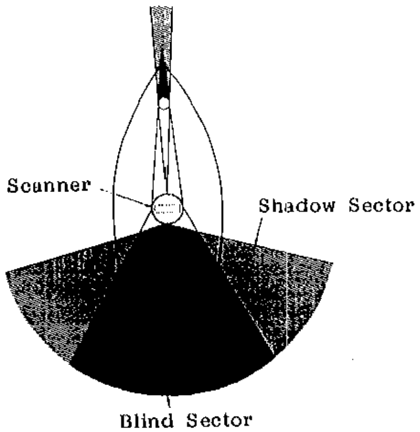


Fig.20 Shadows caused by obstructions

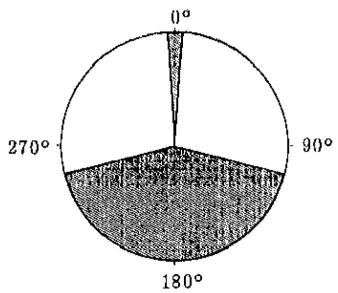


Fig.21 Shadow Sector Diagram for scanner sited as in left figure

OPERATIONAL OVERVIEW

THE FRONT PANEL

This radar is basically very easy to operate. If you change a control setting you will see the associated reaction almost immediately on the screen. Most touchpads carry abbreviated names to show their functions. The same nomenclature appears on the screen for confirmation.

Examine the Display Unit. You will notice that except for the power button, which is located at the lower left-hand side of the unit, all controls are on the right-hand side, and the CRT (display screen) is on the left-hand side. All controls are color-coded for easy identification of their function.

The TUNE, STC and GAIN controls (dark blue) are grouped together because they control the radar receiver. To prevent accidental alteration of the settings, all controls in this group may be locked by pushing in the control. When readjustment is necessary, push in and release the control to bring it out again.

The light blue TX, FTC, IR, HM OFF, BRIL and RING touchpads are mostly on/off controls. Adjusting the brightness of the CRT, reducing radar interference, and temporarily erasing the heading mark are some of the functions of this group of touchpads.

The two arrow touchpads are tri-colored to signify that they are used in conjunction with the VRM, EBL or RANGE touchpads. When activated by pressing one of the above three touchpads, the arrow touchpads are used to maneuver the markers which are used to measure the bearing and range of a target appearing on the display screen (EBL and VRM respectively), or change the range scale in use, depending on which touchpad is pressed. The touchpad is used to rotate the EBL clockwise, or move the VRM out away from the center of the CRT, or select a higher range scale. The touchpad performs the same function as the touchpad except that it works in the opposite direction, e.g., it rotates the EBL counterclockwise, moves the VRM closer to the center, or selects a lower Range scale. For operator convenience, a white light frames the on-screen indicator of the touchpad last pressed, among VRM, EBL and RANGE. This permits quick recognition of which setting can be changed without having to press the touchpad.

The MARK OFF touchpad is colored green and orange to indicate that it is used in conjunction with the EBL and VRM touchpads. Its function is to erase either/both marker(s) from the screen.

The illumination of the touchpad panel can be adjusted to suit your needs, by adjusting the Panel Dim pot. located behind the blind panel on the rear of the Display Unit.

To familiarize yourself with the controls of your unit, turn it on (presuming that it has already been installed) and try operating some of the controls as you review this section. The controls described in "Turning On and Off the Unit" and "Setting Up" appear in the order they should be operated when turning on the radar.

TUNE:	This control keeps the receiver tuned to the transmitter.
STC:	Used to suppress sea clutter caused by waves.
GAIN:	Adjusts the sensitivity of the receiver.
TX:	Sets the radar to either transmit or stand-by.
FTC:	Used to suppress precipitation clutter.
IR:	Eliminates or reduces interference caused by other nearby operating radars.
HM OFF:	Temporarily erases the heading mark from the screen.
BRIL:	Adjusts the brightness of the CRT.
RING:	Displays/erases the fixed range rings.
VRM:	Activates the Variable Range Marker.
MARK OFF:	Erases the VRM and/or EBL from the screen.
EBL:	Activates the Electronic Bearing Line.
RANGE:	Activates the controls used to select the range.
ARROW PADS:	Maneuvers the EBL and VRM, and selects the range.

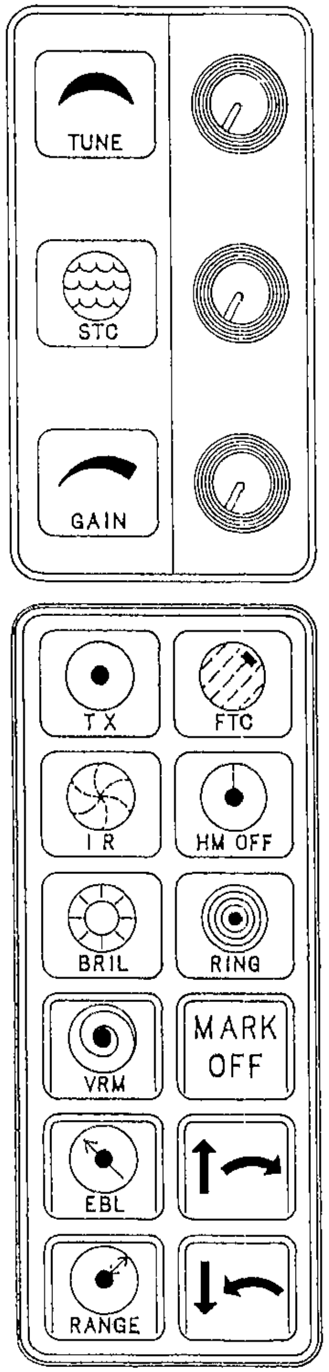


Fig.22 Front Panel Controls

TURNING THE UNIT ON AND OFF

Press the power button at the lower left-hand side of the display unit and power is applied to all circuits of the radar system. Both the "ON" LED above the power button and the touchpad panel will light up, the antenna will begin to rotate, but no targets appear on the CRT. This is because the magnetron needs approximately 2 min. and 30 sec. to warm up before the radar can be operated. The time remaining for warm up of the magnetron is displayed at the center of the CRT, from 2 min. 29 sec. to 1 sec.

SETTING UP

After power is applied and the magnetron has warmed up, the message "ST-BY" (Stand-by) will appear near the center of the display screen, indicating the radar is ready to transmit. However, no targets will appear on the screen until the radar is put into transmit by pressing the TX touchpad (TX is short for "transmit"). In ST-BY the radar is available for use at anytime--the scanner is rotating, but no radar waves are being transmitted. This mode is provided to extend the life of certain components.

Press the TX touchpad to begin transmission; the display screen will light up, and the status of the indicators on the display screen will default to the following: RANGE, 0.25nm; RINGS, ON; Range Scale, ON, and all other indicators, OFF. Fig.23 shows the location of the indicators. Additionally, the screen brilliance will be medium-bright and the heading mark and program version number are displayed. When the radar is transmitting, any echoes from targets will be displayed on the CRT.

At this time you may want to take a closer look at the display screen. The outermost ring on the screen defines the effective diameter of the display. Every five degrees on the ring is marked by a short dashed line, and every ten degrees by a longer dashed line. In addition, arrows mark bearings of 0°, 90°, 180° and 270°.

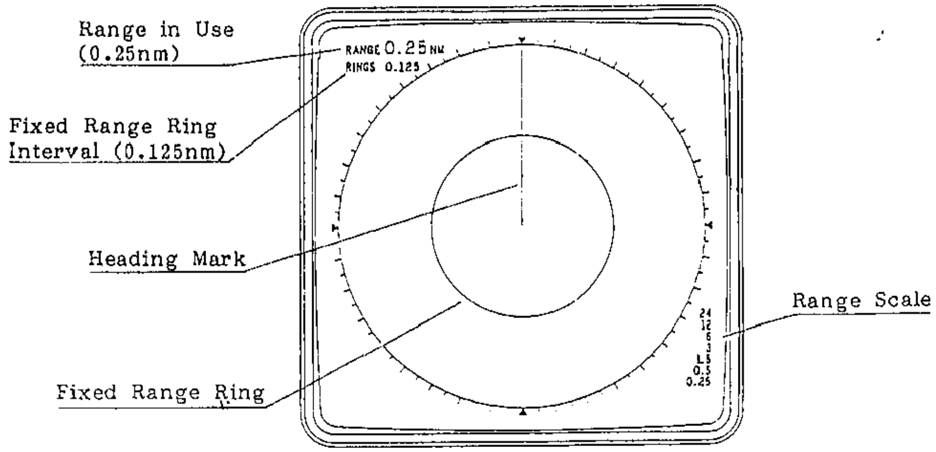


Fig.23 Location of Display Screen Indicators

The other group of rings are the fixed range rings. They enable the operator to make a quick estimate of the range to a target pip appearing on the screen.

The solid radial line at 0° is the heading mark. The heading mark is always on the screen and indicates the ship's heading. You may temporarily erase the mark by holding down the HM OFF touchpad.

The nearly invisible line rotating radially around the screen is called the "sweep." The sweep rotates synchronously with the scanner, so at any given time the direction in which the scanner is pointing is known. With every rotation echoes appear on the sweep as brighter spots of light, thus presenting a complete picture of the surrounding area.

As mentioned above, placing the radar in ST-BY helps extend component life. Therefore, when the radar will not be used for an extended period of time, but you want to keep it in a state of readiness, set it to ST-BY by pressing the TX touchpad again.

Range Selection

The range selected automatically determines the fixed range ring interval, the number of fixed range rings, pulselength, and pulse repetition, for optimal detection in both short and long ranges (see the table below). Most ranges are either half or twice its neighbor for easy identification of targets when changing the range.

The range chosen varies depending on circumstances. When navigating in or around crowded harbors, it is best to select a range between 0.5 and 3nm to watch for possible collision situations. If you select a lower range while on open water, increase the range occasionally to watch for vessels that may be heading your way. Remember that the maximum range a radar can see is dependent on many factors, not just the range scale marked on the display. Factors affecting maximum range are discussed in the Application section.

There are seven ranges available: 0.25, 0.5, 1.5, 3, 6, 12 and 24nm. The range settings available are displayed (when the radar is set to transmit) at the lower right-hand side of the CRT. To select a range, press the RANGE touchpad, followed by pressing either the / touchpad, depending on whether you want to select a higher range or a lower range respectively. Note that it is impossible to automatically increment the range setting by holding down the arrow touchpad. You must press, release and then press the arrow touchpad again when you want to select a range that is greater than one step lower or higher than the present range in use.

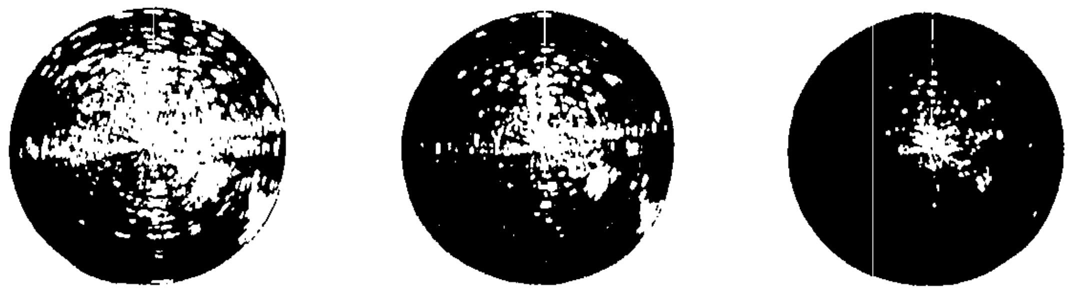
Table 2 Range Setting and corresponding Fixed Range Ring Interval and Number of Fixed Range Rings

Range (nm)	0.25	0.5	1.5	3	6	12	24
Range Ring Interval (nm)	0.125	0.125	0.25	0.5	1	2	4
No. of Fixed Range Rings	2	4	6	6	6	6	6

Setting the Gain Control

The GAIN control is used to adjust the sensitivity of the receiver, and thus the strength of echoes as they appear on the screen. It is adjusted so that a speckled noise background is just visible on the CRT.

To become acquainted with the way the GAIN control works, try rotating it between its fully counterclockwise and clockwise position as you observe the display. To properly set the gain, one of the higher ranges (12nm or 24nm) should be used--the speckled noise background is more apparent on these ranges. As you slowly turn the GAIN control clockwise you should be able to see the speckled background appear when the position of the control is between 2 and 3 o'clock. If you set up for too little gain, weak echoes may be missed. If you turn the GAIN control too far clockwise, yielding too much speckled noise background, strong targets may be missed because of the poor contrast between desired echoes and the background noise on the display. Fig.24 illustrates examples of gain settings which are too high, proper, and too low.



(A) too high (B) proper (C) too low

Fig.24 Setting the Gain Control

In certain circumstances it may be useful to slightly reduce the gain to improve range resolution; clear up the picture; or reduce clutter caused by rain or snow.

Range resolution is a measure of the capability of a radar to display as separate pips the echoes received from two targets which are on the same bearing, and are close together radially. With reduction in the gain setting, the echoes may be made to appear as separate pips on the display screen.

When sailing or cruising in crowded regions a slight reduction in gain often helps to clear up the picture. This should be done carefully, otherwise weak targets may be missed.

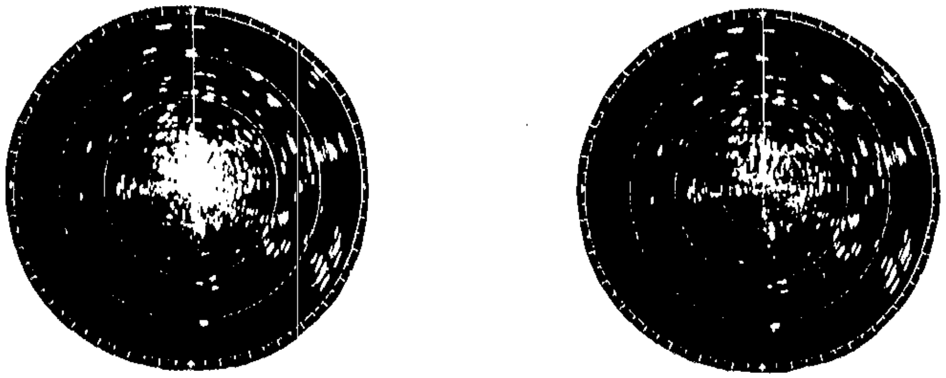
Echoes from ships inside a squall or storm may be obscured if the gain is at its normal setting, since the clutter may have masked, but not completely, echoes from the targets.

In all cases, the gain should be returned to its original position after any temporary reduction is no longer required.

Adjusting the STC Control

Echoes from waves can be troublesome, covering the central part of the display with random signals known as "sea clutter." The higher the waves, and the higher the scanner above the water, the further the clutter will extend. Sea clutter appears on the screen as a large number of small echoes which might affect radar performance (see Fig.25A). The action of the STC is to reduce the amplification of echoes at short ranges (where clutter is the greatest) and progressively increase amplification as the range increases, so that amplification will be normal at those ranges where sea clutter is not experienced. The control is only effective up to a maximum of about 6 miles.

The proper setting of the STC is such that the clutter is broken up into small dots, and small targets become distinguishable. If the control is not sufficiently advanced, other targets will be hidden in the clutter, while if it is set too high, sea clutter and targets will both disappear from the screen. As a general rule of thumb, turn the control clockwise until clutter has disappeared to leeward, but a little is still visible windward. Fig.25 illustrates how to adjust the STC control.



(A) Sea Clutter, STC control "OFF" (B) STC properly adjusted

Fig.25 Adjusting the STC

A common mistake is too over adjust the control so that all the clutter is removed. By rotating the control fully clockwise you will see how dangerous this may be; a dark zone is created near the center of the screen. This dark zone can be dangerous (targets may be missed), especially if the gain has not been properly adjusted. Always leave a little clutter visible on the screen, this ensures weak echoes will not be suppressed. If no clutter is visible on the screen, leave the control in the fully counterclockwise position.

As mentioned before (in the procedure to set up the GAIN and STC when the radar is first initialized after installation), the GAIN is normally set to the point where there is a trace of noise speckles showing on the screen on the 12 or 24 mile range, and then the STC is adjusted on the 0.25 mile range scale so that close-in targets in a harbor situation are clearly seen. This equalizes the GAIN/STC characteristics for all ranges, short and long.

In moderate conditions on the open sea, where there are no definite targets to be seen on the shorter ranges, you should still adjust the GAIN on the 12 or 24 mile range for some noise speckles on the CRT, and then go down to the 0.5 or 1.5 mile range to adjust the STC until a bit of sea clutter is observed close to the boat.

Adjusting the Brightness of the CRT

The BRIL touchpad is used to adjust the brightness of the CRT. As a general rule of thumb, choose a brighter setting for daytime use, and a lower setting for nighttime operation. However, note that with too little brilliance the display becomes difficult to see, and excessive brilliance decreases the life of the CRT.

There are four levels of illumination: dim, medium, medium-bright, and bright. Each time the BRIL touchpad is pressed the level will change in the above sequence.

Tune Control Adjustment

This control tunes the receiver to the exact frequency of the transmitter. For the first 30 minutes of operation the tuning should be checked periodically to ensure that the radar is operating properly. Readjustment after the first 30 minutes is normally not required.

The tuning is made by moving the control slowly through the limits of its travel to find the position where a comparatively weak long range echo is discerned on the screen with maximum definition. (The STC control is set at minimum.) The best tuning position is usually found at a point close to where the control is advanced 50% of its travel.

MEASURING RANGE AND BEARING

In the basic radar system your ship is in the center of the screen, and any target received is displayed in a map-like projection throughout 360°. This allows the bearing and range from your boat to a target appearing on the screen to be measured.

Range is measured with either the fixed range rings (rough estimate) or Variable Range Marker (VRM), and bearing is measured with the EBL (Electronic Bearing Line). The EBL and/or VRM markers are activated by pressing the corresponding touchpad, and the two arrow touchpads are used to maneuver the EBL or VRM. Press the touchpad to rotate the EBL clockwise or move the VRM out away from the center of the CRT. To rotate the EBL counterclockwise or move the VRM back toward the center of the CRT, press the touchpad. By holding down either arrow touchpad the setting of the marker is changed much more rapidly, and in the case of the VRM until the minimum or maximum is reached, depending on the range scale in use. Now try operating the EBL. While you press either arrow touchpad, notice the EBL indicator at the lower left of the screen--the numeral varies as the EBL rotates.

The EBL and/or VRM are erased from the screen by pressing the touchpad of the marker you want to erase, followed by pressing the MARK OFF touchpad.

Range Measurement

To obtain a rough measurement of the range to a target pip, the fixed range rings are used. The fixed range rings are the solid rings appearing on the CRT. These rings are activated/deactivated by pressing the RING touchpad. The range to a target using the fixed range rings is determined by counting the number of rings between the center of the CRT and the target. Check the fixed range ring interval (this value appears at the top left-hand side of the display screen) and judge the distance of the echo from the inner edge of the nearest ring. For example, the 6nm range scale has six fixed range rings, each at a 1nm interval. Therefore if a target is positioned close to the 2nd ring from the center of the display, the range to the target would be 2nm.

To obtain a more accurate reading of the distance to a target the VRM should be used. Now try measuring the range of the same target pip with the VRM. Activate the marker by pressing the VRM touchpad, and the message VRM1 will appear at the top of right-hand side of the screen. The VRM is presented on the screen as a dashed ring so as to distinguish it from the fixed range rings. Next, press either or touchpad so that the circle described by the VRM just touches the inside edge of the pip. You will see how much more accurate the VRM is by checking the range measured, which is shown below the VRM indicator at the lower right-hand side of the screen. The VRM is capable of measuring the range to targets from 0.001nm to 24nm, depending on the range in use. Fig.26 illustrates the proper method of range measurement with the VRM.

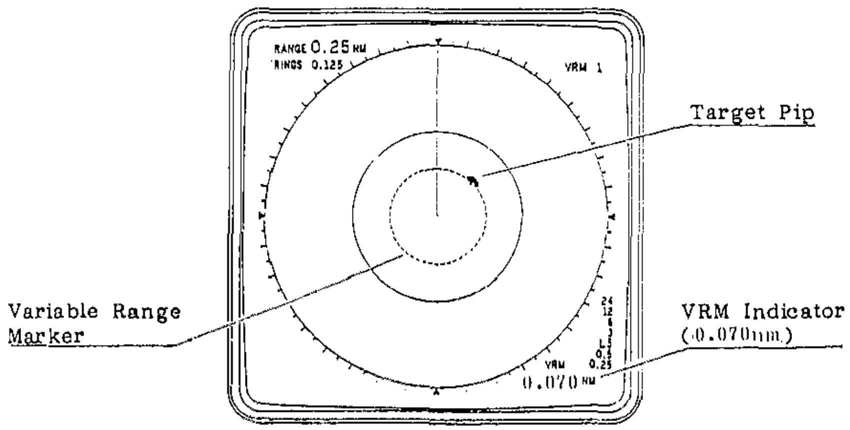


Fig.26 Range Measurement with the VRM Control

Bearing Measurement

To measure the bearing of a target pip, you should activate the EBL by pressing the EBL touchpad. The message EBL1 is displayed at the top right-hand side of the screen. The EBL is presented on the screen as a dashed radial line so as to distinguish it from the heading mark. Next press either or touchpad so that the EBL is positioned over the center of the target to be measured. Fig.27 illustrates the proper method of bearing measurement using the EBL. The measured bearing will appear below the EBL indicator at the lower left-hand side of the display screen. Bearing is measured to the nearest 0.5°.

The bearing measured by the built-in EBL in this radar gives "relative bearings"; that is, the bearings are relative to the bow of the vessel. If you spot a radar target at 45 degrees relative to your bow at a range of 1/2 mile from your boat, you should be able to look out the window and look at the target visually, provided of course that you aren't in a pea-soup fogbank.

If you want to relate the stationary targets seen on the radar to the markings on a navigational chart, you will have to determine where these radar targets are with respect to True North, given that you want to be able to read your navigational charts right-side up.

The procedure is simple: the ship's magnetic heading at the time the radar target is observed is added to the bearing of the target relative to the bow of the boat, and to this sum is added the magnetic deviation for the geographic area and the magnetic deviation of the boat. If the sum total exceeds 360 degrees, the 360 degrees is subtracted from the total to yield finally the radar target heading relative to True North.

For example, assume that the ship's heading is 45 degrees magnetic, the variation for the area is 16 Easterly, and at 45 degrees the deviation for the boat is 2 degrees Westerly. The True Heading of the vessel is thus: 45 + 16 - 2 = 59 degrees relative to True North. If a buoy is spotted on the radar at a relative bearing of 256 degrees, the resulting True target bearing is 256 + 59 = 315 degrees. If the buoy had been at 345 degrees relative heading on the radar, the resulting True target bearing would be 345 + 59 = 404. Since this is greater than 360, the result is 404 - 360 = 44 degrees True.

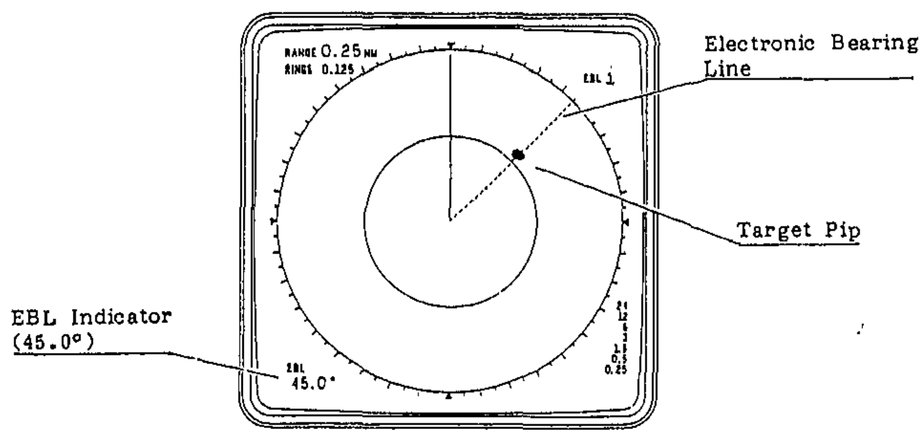


Fig.27 Measuring the Bearing of a Target Pip with the EBL

To ensure accurate bearing measurement, keep in mind the following points.

1) Bearing measurements of smaller targets pips are more accurate; the center of larger target pips is not as easily identified.

2) Bearings of stationary or slower moving targets are more accurate than bearings of faster moving targets.

3) To minimize errors of bearing you should generally keep echoes in the outer half of the picture by changing the range scale; angular difference

becomes difficult to resolve as a target approaches the center of the CRT.

REDUCING OR ELIMINATING INTERFERENCE

Basically there are three types of interference which may hinder radar reception: sea clutter, due to echoes off waves (mentioned earlier); precipitation clutter and interference from other shipborne radars operating nearby and on the same frequency band. This radar can eliminate or reduce these types of interference.

Precipitation Interference

The vertical beamwidth of the scanner is designed to see surface targets even when the ship is rolling. However, this design also has its disadvantages: rain storms, snow, or hail are detected in the same manner as normal targets. Precipitation clutter is easily recognizable by its wool-like appearance on-screen (see Fig.28). When this type of interference obscures a large area of the screen, you may use the FTC touchpad to eliminate or reduce the interference.

The FTC (Fast Time Constant) circuit works by splitting up these unwanted echoes into a speckled pattern, making recognition of solid targets easier. Because its effect upon the picture is to weaken it, but because it breaks up solid echoes, it also makes for better definition. For this reason, it may be switched on to clarify the picture when navigating in confined waters. However, with the circuit activated the receiver is less sensitive, weaker echoes may be missed. Therefore, deactivate the circuit when no interference exists. Press the FTC touchpad and you will see the FTC indicator appear at the upper-right hand side of the display screen. The circuit is switched off by pressing the touchpad again.

(A) rain squall, FTC "OFF"

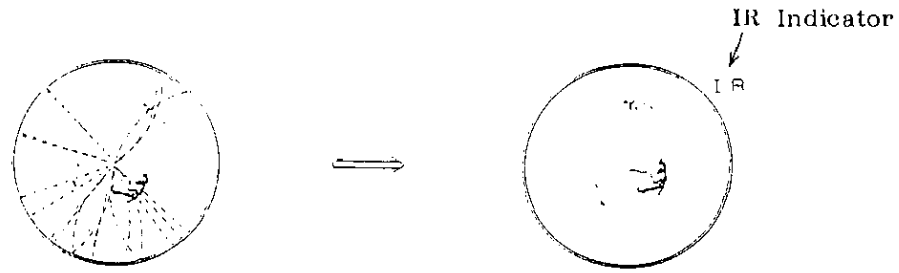
(B) FTC Circuit "ON," interference reduced

Fig.28 Precipitation Interference

Radar Interference

Radar interference may occur when in the vicinity of another shipborne radar operating in the same frequency band. It usually is seen on the display screen as a large number of bright dots either scattered at random or in the form of dotted lines extending from the center to the edge of the display screen. Fig.29 illustrates interference in the form of curved spokes. Interference effects are easily distinguished from normal echoes because they do not appear in the same place on successive rotations of the scanner.

This type of interference is reduced by activating the Interference Rejector circuit. Press the IR touchpad to activate the circuit, and you will see the IR indicator appear at the upper right-hand side of the screen. Press the touchpad again to switch off the circuit when no interference exists, otherwise weaker targets may be missed.



(A) radar interference, IR circuit "OFF"

(B) IR Circuit "ON," interference reduced

Fig.29 Radar Interference

APPLICATION

As an aid to navigation, radar can be a very valuable tool. No other navigation aid can give you the ability to spot vessels coming at you in the fog, or tell you the location of the inlet to the harbor in the pitch black of night. To help you understand better what your radar can and cannot do for you this section covers the characteristics and limitations of radar, picture interpretation, position fixing with radar and aids to navigation.

FACTORS AFFECTING MINIMUM RANGE

Targets disappearing from the screen when at close ranges can be dangerous. For this reason, detection of targets at short ranges is very important. Minimum range is determined primarily by transmitter pulselength. The shorter the transmission time, the sooner the return echoes can be received and their distance measured. This radar automatically determines the pulselength for both short and long ranges, for optimal detection of targets at short as well as long range.

Sea Return

Sea clutter echoes received from waves may hamper detection of targets beyond the minimum range set by the pulselength and recovery time. (Recovery time is the time required for the receiver to recover to half sensitivity after the end of a transmitted pulse, so it can receive a return echo.) Proper adjustment of the STC control may alleviate some of the problem.

Vertical Beamwidth

The ability to see targets very close to the boat is decreased if the antenna is mounted too high off the water, since the bottom of the vertical beam of the scanner cuts off nearby targets. Fig.30 illustrates the effects of a scanner mounted too high off the water.

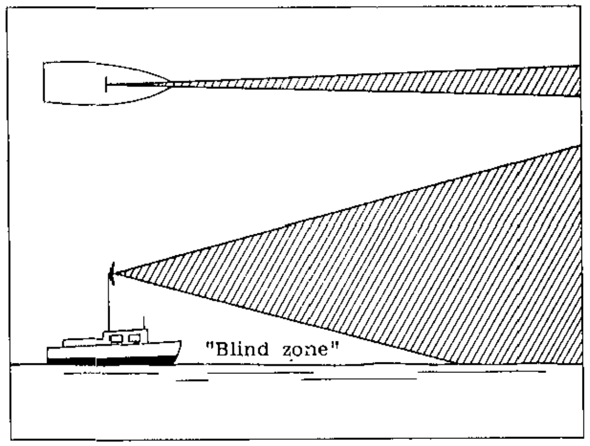


Fig.30 Effects of a Scanner Mounted too High off the Water

FACTORS AFFECTING MAXIMUM RANGE

It is nearly impossible to state that a radar has a maximum range. The maximum range a radar will "see" is dependent on many factors, not just the range marked on the screen. Not only does the sensitivity of the receiver and power of the transmitter but also the height above the water of both the scanner and target, the size, shape and composition of the target, and atmospheric conditions contribute to increase or decrease the maximum detectable range.

Radar Horizon

Radar is by its very nature essentially a "line-of-sight" phenomenon. That means that you have just about the same range to the horizon with a radar as you do with your own eyes. However under normal atmospheric conditions, the radar horizon is 6% greater than the optical horizon. Therefore, if the target does not rise above the horizon the radar beam cannot be reflected from the target.

Just as you can see a low-to-the-water speedboat only up relatively close to your boat, the radar can see a target high off the water farther than it can see an object which is close to the water. Further, the higher the antenna is mounted over the water the farther it is capable of seeing other targets. However a possible negative effect with mounting the antenna too high off the water is that due to the finite vertical beamwidth of the scanner, the amount of sea clutter due to reflections from nearby waves is increased to a greater distance from the boat.

Thus it is not at all uncommon to see a 3000 foot high mountain 50 miles away (provided the radar has a 50nm detection capability), while at the same time being only able to see a small power boat 3 or 4 miles away. (See Fig.31.)

The distance to the horizon from the scanner, under normal conditions, is calculated by the following formula.

$$R_{max} = 2.2 \times (\sqrt{h1} + \sqrt{h2})$$

Where Rmax: Radar Horizon (mile)
h1: Antenna height (meters)
h2: Target height (meters)

For example, to find the distance to the horizon in Fig.31, if the antenna height is 8 meters (26 feet) and the target height is 15.2 meters (50 feet) the maximum range is (when the cliff begins to appear on the radar),

$$R_{max} = 2.2 \times (\sqrt{8} + \sqrt{15.2}) = 14.8 \text{ miles.}$$

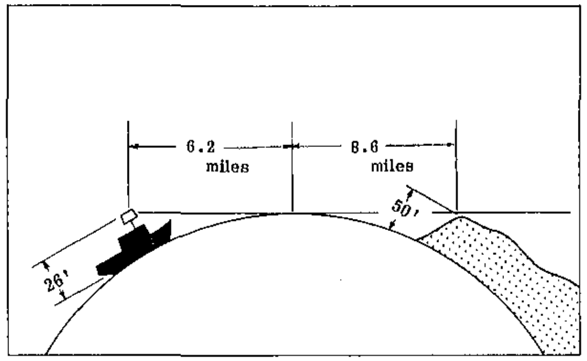


Fig.31 Radar Horizon

Target Properties

As a general rule of thumb, larger targets can be seen on the radar display at greater ranges, provided line-of-sight exists between the scanner and target. However, a large target with poor reflecting properties may not be detected as easily as a smaller target with better reflecting properties.

Since one of the main functions of radar is to detect other ships, the composition of a target ships' hull affects the detection range. A ship whose hull is made of conducting materials, such as a steel, return relatively strong echoes.

On the other hand, hulls made from wood or fiberglass return much weaker echoes. For example, under normal conditions (line-of-sight) a scanner mounted 15 feet above the water can typically see a 10,000 ton vessel 10 to 16 miles away. Under the same conditions, a small wooden boat can be seen only when it is between 1 and 4 miles away.

Vertical surfaces, such as a cliff, are good targets provided they face the radar. Inversely, horizontal and smooth surfaces such as mudbanks, sandy beaches, and gently sloping hills make poor targets because they disperse rather than reflect most of the energy that strikes them. Again, using a scanner 15 feet above the water as an example, a 500 foot hill can be seen when it is approximately 32 miles away.

The strongest radar echoes known come from built-up areas, docks, etc., because these targets are less subject to changes in aspect. These types of targets have three flat, smooth surfaces mutually at right angles. This type of arrangement is used on some radar buoys to increase their detection range.

INTERPRETING THE DISPLAY

In the previous section some of the characteristics and limitations of radar were discussed. Now its time to take a look at what you can expect to see on the radar screen. What shows up on the screen isn't likely to match exactly what is seen on a navigation chart. A radar cannot see through a mountain in the path between your boat and the harbor, nor can it see a small boat directly behind a large ship, since both the mountain and the larger vessel effectively shield the radar from the desired target.

To aid you in target identification, the echoes appearing on the display are quantized in four levels according to their intensity. The brightest intensity echoes are probably from steel ships, or piers, or other "good" targets. Poor targets, for example wooden boats, appear in the weakest intensities.

The ability to interpret a radar picture comes through practice and experience. Practice should be done during clear weather in daytime, since you can compare the picture with what you actually see around you. Go to an area you are familiar with and compare the way coastlines, buoys and other targets are displayed on the screen and the way they are drawn on a navigation chart. To observe the movement of an echo in relation to your position, try running your boat at various speeds and headings.

LAND TARGETS

Landmasses are readily recognizable because of the generally steady

brilliance of the relatively large areas painted on the display. Knowledge of the ship's navigational position will also tell you where land should be. On relative motion displays (this radar), landmasses move in directions and at rates opposite and equal to the actual motion of your own ship. Various factors such as distortion from beamwidth and pulselength make identification of specific features difficult. However, the following may serve as an aid to identification.

1) High, steep, rocky and barren landmasses provide good reflecting surfaces.

2) Low, vegetation covered lands make poor radar targets.

3) Submerged objects do not produce echoes.

4) Mud flats, marshes, sandspits, and smooth, clear beaches make poor targets because they have almost no area that can reflect energy back to the radar.

5) Smooth water surfaces such as lagoons and inland lakes appear as blank areas on the display--smooth water surfaces return no energy.

6) Although you might expect an object as large as a lighthouse to be a good radar target, in actuality the return echo is weak since the conical shape diffuses most of the radiated energy.

SHIP TARGETS

A bright, steady, clearly defined image appearing on the display is in all likelihood the target pip of a steel ship. There are several clues which can aid you in identification of a ship. Check your navigational position to overrule the possibility of land. Land and precipitation echoes are much more massive in appearance, whereas the target pips of ships are relatively small. The rate of movement can eliminate the possibility that the pip is an aircraft.

A target pip may brighten and become dim due to changes in aspect, etc. In most cases however a pip will fade from the display only when the range becomes too great.

ECHO SIZE

As the radar beam rotates, the painting of the pip on the display begins as soon as the leading edge of the radar beam strikes the target, and continues until the trailing edge of the beam is rotated beyond the target. Thus, a target cannot appear less wide than the beamwidth. As the beam widens with distance from the scanner, so also will the widths of targets vary on the display. Fig.32 illustrates the relationship between beamwidth and the appearance of a target pip.

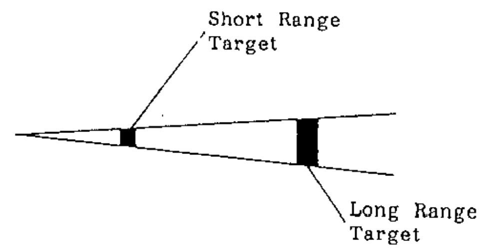


Fig.32 Beamwidth vs. Target Appearance

FALSE ECHOES

Occasionally false echoes appear on the screen at positions where there is no target. In some cases the effects can be reduced or eliminated. The operator should familiarize himself with the appearance and effects of these false echoes, so as not to confuse them with echoes from legitimate contacts.

Multiple Echoes

Multiple echoes occur when a short range, strong echo is received from a ship, bridge, or breakwater. A second, a third or more echoes may be observed on the display at double, triple or other multiples of the actual range of the target as shown in Fig.33. Multiple reflection echoes can be reduced and often removed by decreasing the gain or properly adjusting the STC.

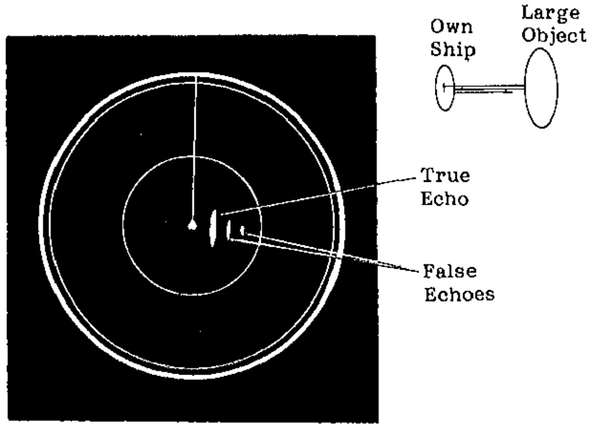


Fig.33 Multiple Echoes

Side-Lobe Echoes

Every time the scanner rotates, some radiation escapes on each side of the beam--called "side-lobes." If a target exists where it can be detected by the side lobes as well as the main lobe, the side echoes may be represented on both sides of the true echo at the same range, as shown in Fig.34. Side lobes show usually only on short ranges and from strong targets. They can be reduced through careful reduction of the gain or proper adjustment of the STC control.

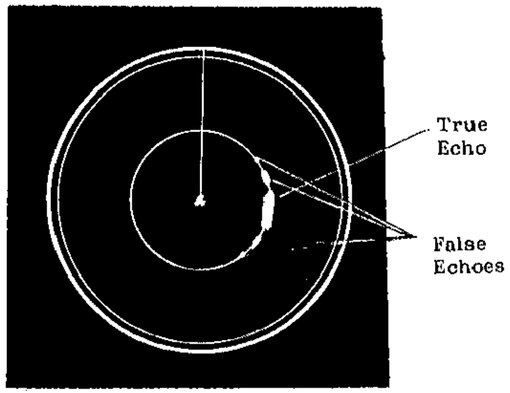


Fig.34 Side-Lobe Echoes

Blind and Shadow Sectors

Funnels, stacks, masts, or derricks in the path of antenna may reduce the intensity of the radar beam. If the angle subtended at the scanner is more than a few degrees a blind sector may be produced. Within the blind sector small targets at close range may not be detected while larger targets at much greater ranges may be detected. See Fig.35.

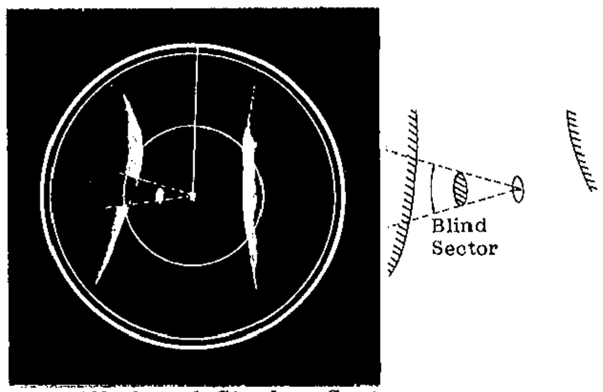


Fig.35 Blind and Shadow Sector

Indirect Echoes

Indirect echoes may be returned from either a passing ship or returned from a reflecting surface on your own ship, for example, a stack. In both cases, the echo will return from a legitimate contact to the antenna by the same indirect path. The echo will appear on the same bearing of the reflected surface, but at the same range as the direct echo. Fig.36 illustrates the effect of an indirect echo. Indirect echoes may be recognized as follows. (1) they usually occur in a shadow sector; (2) they appear on the bearing of the obstruction but at the range of the legitimate contact; (3) when plotted, their movements are usually abnormal, and (4) their shapes may indicate that they are not direct echoes.

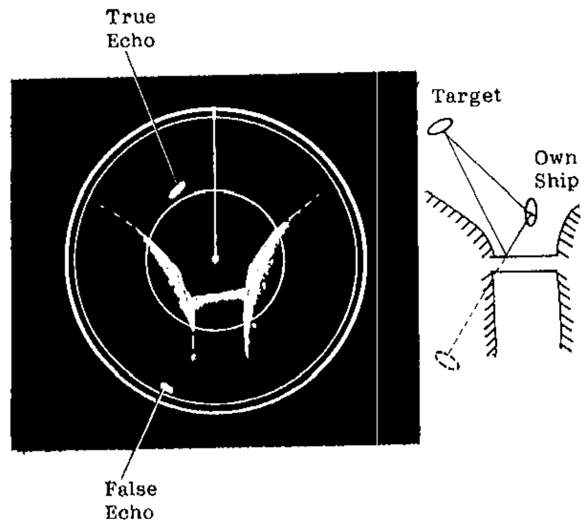


Fig.36 Indirect Echoes

RADAR PICTURE AND CORRESPONDING CHART

Under normal conditions, a picture which is very similar to a chart can be obtained on the radar display. The radar picture and corresponding chart shown in Fig.37 are from the Kada Inland Sea, south of Osaka Bay, in Southwestern Japan.

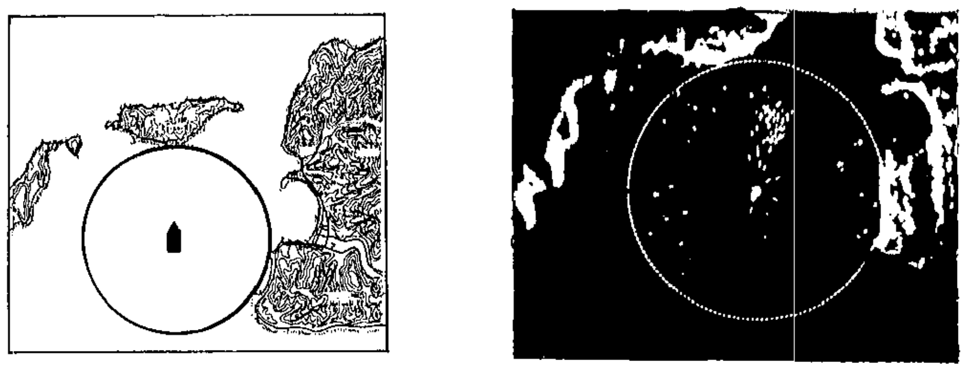


Fig.37 Navigational Chart and Corresponding Radar Picture

POSITION FIXING WITH RADAR

Position fixing with radar can be accurate and easy once you become familiar with the different methods. The three most common methods will be discussed in this section. Take a compass, and a navigation chart to try to fix your position while reviewing this section.

By Radar Range

The simultaneous measurement of the ranges to two or more fixed objects is normally the most accurate method of obtaining a fix with radar alone. Preferably at least three ranges should be used. However the use of more than three range arcs may introduce excessive error because of the time lag between measurements, i.e., you will be moving as you take successive measurements.

When obtaining a fix, it is best to measure the most rapidly changing range last because of a smaller time lag in the radar plot from the ship's actual position. For greater accuracy, the objects selected should provide arcs with angles of cut as close to 90° as possible. Small, isolated, radar-conspicuous fixed objects whose associated range arcs intersect at angles approaching 90° provide the most reliable and accurate position fixes. Objects at longer ranges are less accurate for position fixing because they may be below the radar horizon and because the width of the radar beam increases with range.

To fix your position, first, measure the range to two or more prominent navigational marks which you can identify on the chart. (The method for measuring range is found on page 28.) Next, with the compass sweep out the ranges from the charted positions. The point of intersection of the arcs is your estimated position. The correct method of position fixing when using radar range is illustrated in Fig.38.

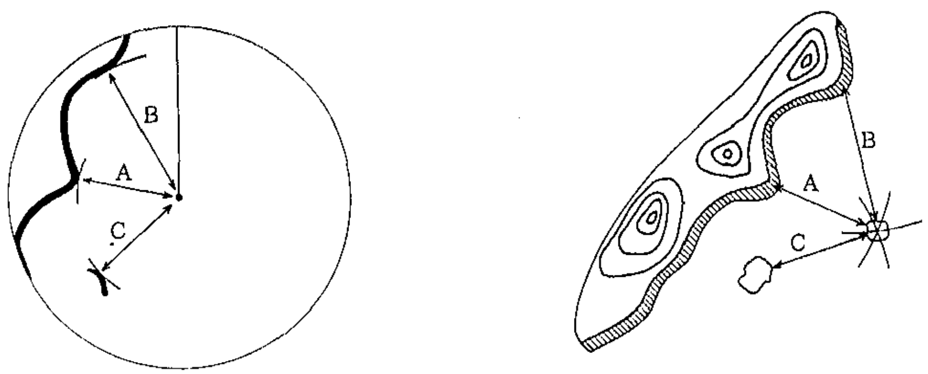


Fig.38 Position Fixing Using Radar Ranges

By Range and Bearing to a Point of Land

The advantage of position fixing by range and bearing to a point of land is the speed with which a fix can be obtained. A distinct disadvantage however is that this method is based upon only two intersecting position lines, a bearing line and range, obtained from two points of land. If possible, the object used should be small, isolated and identified with reasonable certainty. To fix your position using range and radar bearing,

first, measure the relative bearing of the target with the EBL, noting the exact direction of the ship's heading when doing so. Next, make allowance for compass deviation (true or magnetic) and find the true bearing of the target (see page 29). Sweep out the range to the target with the compass on the chart and plot the true bearing of the target. The point of intersection is your approximate position. Fig.39 illustrates the correct method of position fixing using a range and bearing to a point of land.

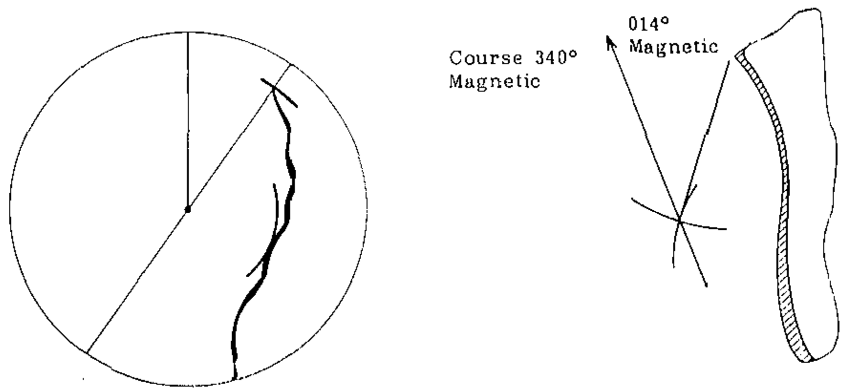


Fig.39 Position Fixing Using Range and Bearing to a Point of Land

By Two Bearings

Generally, fixes obtained from radar bearing are less accurate than those obtained from intersecting range arcs. The accuracy of fixing by this method is greater when the center bearings of small, isolated radar-conspicuous objects can be observed. Similar to position fixing using range and bearing, this method affords a quick means for initially determining approximate position. The position should then be checked against other means to confirm reliability.

Position fixing using two bearings is determined by measuring the relative bearings for the two targets and then determining their true bearings. Plot the two bearings on the chart; the point of intersection of the two bearings is your approximate position. Fig.40 illustrates the correct method of position fixing using two bearings.

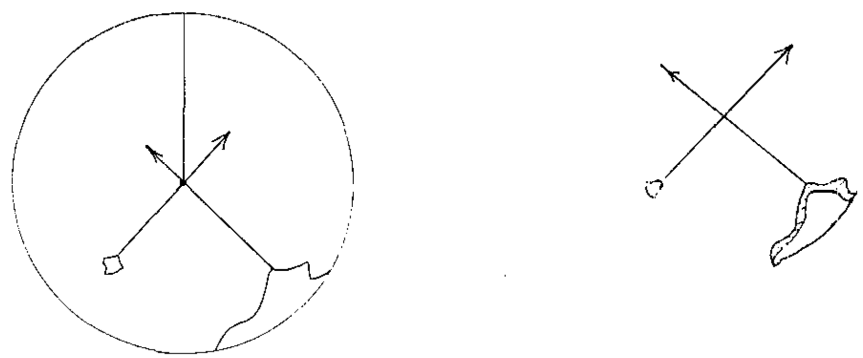


Fig.40 Position Fixing Using Two Bearings

COLLISION AVOIDANCE

Collisions at sea sometimes occur because the radar picture doesn't match the information provided by the eye in clear weather and because of the misunderstanding of relative motion.

In a relative motion display your ship is represented by the spot of light fixed at the center of the screen, whatever the speed of your own ship. With both your own ship and the target in motion, the successive pips of the target do not indicate the actual or true movement of the target. If own ship is in motion, the pips of fixed objects, such as landmasses, move on the display at a rate equal to and in a direction opposite to the motion of own ship. Only when your ship is stopped or motionless do target pips move on the display in accordance with their true motion. Fig.41 illustrates the relative and true motion of a target contacted by radar.

In Fig.41, ship A, at geographic position A1, on true course of 001° at 14 knots initially observes ship B on the PPI at bearing 179° at 4.1 nm. The bearing and distance to the ship changes as ship A proceeds from position A1 to A3. The changes in the positions of ship B relative to ship A are illustrated in the successive PPI presentations corresponding to the geographic positions of ships A and B. Likewise, ship B, at geographic position B1, on true course 25° at 21 knots initially observes ship A on bearing 001° at 4.1 nm.

The radar operator aboard ship A will determine that the relative movement of ship B is approximately 66.5°, whereas the operator aboard ship B will determine that the relative movement of ship A is approximately 238°. These figures were obtained using a maneuvering board.

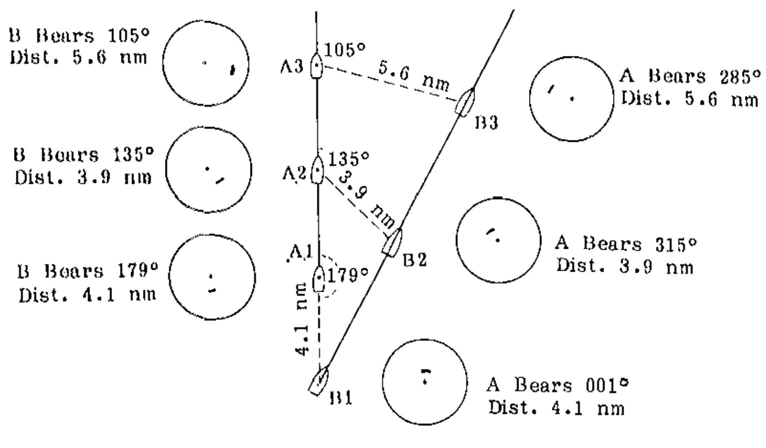


Fig.41 Relative Motion vs. True Motion

Assessing the Risk

The moment an echo appears on the screen its range and relative bearing should be measured and its true or magnetic bearing noted. This is best done on a chart or plot. Collision risk can be assessed by carefully watching the true or magnetic bearing of an approaching vessel. If the bearing of the target does not appreciably change a possibility of collision may exist. You should take proper action in accordance with the Regulations for Preventing Collisions at Sea.

AIDS TO NAVIGATION

Various aids have been developed to aid the navigator in identifying radar targets.

RADAR BEACONS

Radar beacons are transmitters operating in the marine frequency band which produce distinctive indications on the radar displays of ships within range of these beacons. There are two classes of beacons: racon and ramark.

Racon

A racon is an omnidirectional transmitter which emits a distinctive signal when triggered by the pulse from a ship's radar. Both range and bearing to the target can be extracted from the signal. Because the beacon's signal travels at the same time as the echo arriving the ship's range to the target can be determined. Since the signal will be received only when the scanner is pointing directly at the beacon, bearing is shown as well as the range and the vessel's position is thus determined. The range and bearing of the racon signal is measured in exactly the same manner as a normal target pip. The racon signal appears on the display as either a radial line originating at a point just beyond the radar beacon or as a Morse code signal displayed radially from just beyond the beacon. See Fig.42. Note that with the FTC or IR circuit switched on, the racon marker line may partially disappear.

(A) Coded Racon Signal (B) Racon Signal

Fig.42 Racon Signal Appearance

Ramark

A similar type of beacon is known as a ramark. It transmits continously on a frequency constantly varying so as to sweep through the entire radar band. The ramark signal appears as a radial line from the center of the CRT. The radial line may be a continuous narrow line, a series of dashes, a series of dots, or a series of dots and dashes. Fig.43 illustrates the appearance of a ramark signal, as a dotted line, and as a dashed line. Although the ramark flash shows only the bearing to the beacon, if the ramark is mounted on the coast and this can be also seen on the screen, a fix can be obtained from the ramark.

(A) as a dotted line (B) as a dashed line

Fig.43 Ramark Signal Appearance

MAINTENANCE

GENERAL

Satisfactory operation of the radar depends in large measure on periodic maintenance as outlined below.

CAUTION

DISCONNECT POWER BEFORE PERFORMING
ANY MAINTENANCE PROCEDURES.

1) Keep the equipment as free as possible from dirt, dust and water splashes. The display unit cover must be cleaned with a dry, clean, soft cloth.

2) Inspect whether the screws securing the components are properly tightened.

3) Inspect the connection at the rear panel.

SCANNER UNIT

Radome

Wipe the surface of the radome with a clean soft cloth. Check that there is no dirt or caked salt on the surface. A heavy deposit of dirt or caked salt on the painted surface of the upper radome will cause a considerable drop in radar performance. Do not use chemical cleaners except for alcohol. Check for cracks or deterioration of the rubber packing and replace it if necessary. Do not paint the surface of the radome.

Mounting

Check that the radome base and the radome cover fixing bolts are secured tightly.

DISPLAY UNIT

Cleaning the screen

The face of the cathode-ray tube will, in time, accumulate a coating of dust which tends to dim the picture.

Clean lightly with a soft cloth (flannel or cotton), moistened with alcohol or cleaning fluid if desired. Do not use excess pressure, you may scratch the surface.

Fuse replacement

To protect the equipment from serious damage, a 10A fuse is provided on the rear panel. The fuse protects against overvoltage/reverse polarity of the ship's mains or internal fault of the equipment. If the fuse has blown, first find the problem before replacing it with a new one. A fuse rated for more than 10A must not be used, since it may cause serious damage to the equipment. OVER FUSING WILL VOID WARRANTY.

TROUBLESHOOTING

In this section, troubleshooting is arranged in two parts: one for the user and the other for the service shop. "Basic troubleshooting" for user includes simple tests of the equipment which the user can handle, such as operation, installation and visual checks. The "More extensive troubleshooting" is considerably more complicated and must be done by a qualified technician. If something appears wrong with your unit, check the equipment referring to the "Basic troubleshooting." In case the trouble is not found after performing these checks, and the unit still appears faulty, call your electronics technician for service.

BASIC TROUBLESHOOTING

In most cases when the unit fails to operate properly the cause is very simple. Before calling for service or sending out the unit for repairs, check the following.

1) Nothing appears on screen
(Check that the "ON" LED lights up. If yes, the trouble may be the unit itself. If not, check the following.)

* Is the battery dead?
* Is the fuse blown?
* Supply voltage is normal?
* Corrosion on battery terminal?
* Poor contact of power cable?

2) No echo but numerical and character indicators

* Is the antenna plug loose?

3) Low sensitivity

* Is the GAIN setting too low?
* Is the STC setting too high?
* Is the FTC set to ON?
* Is the BRIL set too low?
* Is the receiver detuned?
  (Coarse TUNE setting wrong.)
* Is the radome dirty?

4) Heavy noise

* Is the unit grounded?

5) Sweep not rotating

* Is the antenna plug loose?
* Is the 10-way connector inside the radome loose?

MORE EXTENSIVE TROUBLESHOOTING

Any replacement of defective parts (except for fuse) should be carried out by a qualified serviceman. The most common troubles you may experience and their possible causes are listed below.

WARNING AGAINST HIGH TENSION

At several places in the unit there are high voltages, enough to kill anyone coming into direct contact with them. Do not change components or inspect the equipment with the voltage applied. A residual charge may exist in some capacitors with the equipment turned off. Always short all supply lines to the chassis with an insulated screwdriver or a similar tool prior to touching the circuit.

Typical Symptoms/Its Causes (Refer to pages 47 and 48 for the location of parts.)

1) Nothing appears on CRT.

* CRT assembly faulty
* SPU-6394 board defective

2) Scanner does not rotate.

* Scanner rotating mechanism jammed
* Scanner motor B801 faulty
* MOTOR CONTROL board SI-5588 defective

3) Scanner rotates too fast/slow.

* Scanner motor B801 defective
* MOTOR CONTROL board SI-5588 defective

4) Picture synchronization is abnormal.

* SPU-6394 board defective

5) Sweep rotation is not synchronized with antenna rotation.

* Scanner motor B801 defective
* SI-5588 board defective
* SPU-6394 board defective

6) Heading marker does not appear.

* HM OFF touchpad key defective
* SPU-6394 board defective

7) Range rings do not appear.

* RING touchpad key defective
* SPU-6394 board defective

8) Marks and legends appear but no echo nor noise appear.

* Discontinuity or shortcircuit of coaxial cable
* SPU-6394 board defective
* IF-5657 board defective

9) Poor sensitivity

* Magnetron deteriorated.
* MIC detuned.

10) Noise appears but no echo.

* MD-4171 modulator board defective
* IF-5657 board defective
* Magnetron heater voltage not applied
* Magnetron defective (Refer to "CHECKING THE MAGNETRON.")

11) Best tuning is not obtained at mid-travel of TUNING control.

* Frequency deviation of the magnetron
  (Refer to "PRESETTING THE RECEIVER TUNING.")

CHECKING THE MAGNETRON (Measuring the Magnetron Current)

The life of the magnetron depends largely on how many hours it is used. Fewer target echoes appear on the screen when the magnetron gets "old." To decide whether the magnetron is good or not, use the following procedure to measure the magnetron current.

1. Connect the multimeter, set to 10VDC range, to pin #3(+) and #5(-) of P/J 801 on the chassis of the transceiver module.
2. Operate the radar for transmission on 0.25nm range.
3. Confirm that the magnetron current (voltage) is within the rating (1.3 to 2.4VDC). The magnetron current is measured as a voltage.
4. Change the range setting to 16 nm with RANGE touchpad key and confirm that the voltage is within the rating (1.8 to 2.4VDC).

If the voltage is far out of the range specified above, the magnetron may be faulty.

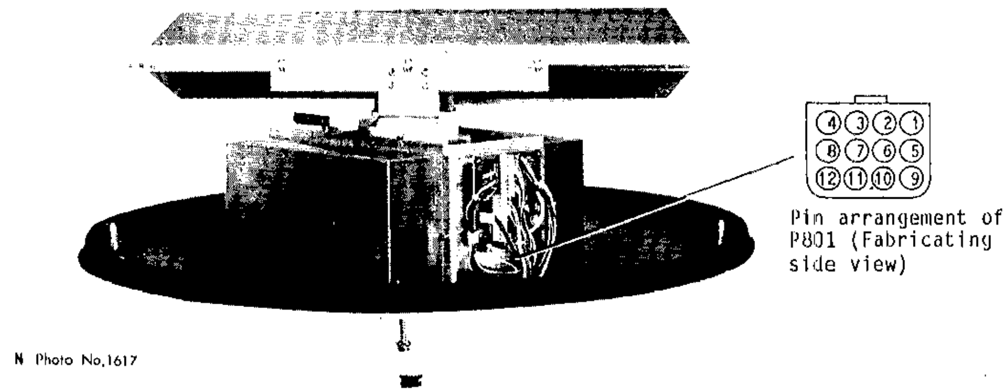


Fig.44 Measuring the Magnetron Current

PRESETTING THE RECEIVER TUNING

The best sensitivity is obtained with the front panel TUNE control at around its mid-travel. If not, adjust the coarse tuning potentiometer "TUNE"(VR2) behind the blind plate on the rear panel.

1. Operate the radar for normal picture and leave it for about 10 minutes to stabilize the oscillation of the magnetron.

2. Set the front panel TUNE control at mid-travel. Adjust VR2 slowly so that a weak long range echo is discerned with maximum sensitivity.

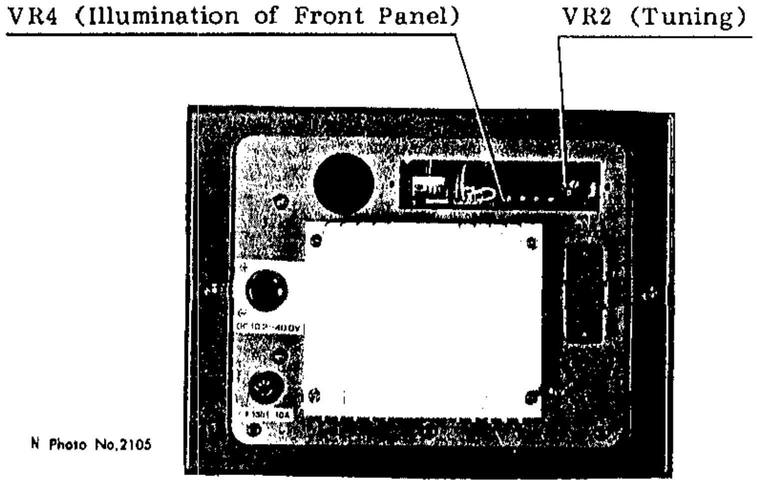


Fig.45 Location of Pot.VR2 and VR4

ADJUSTING THE PANEL DIMMER

If panel illumination is too bright or dark, adjust the potentiometer "DIM," VR4 on the inside of the rear panel.

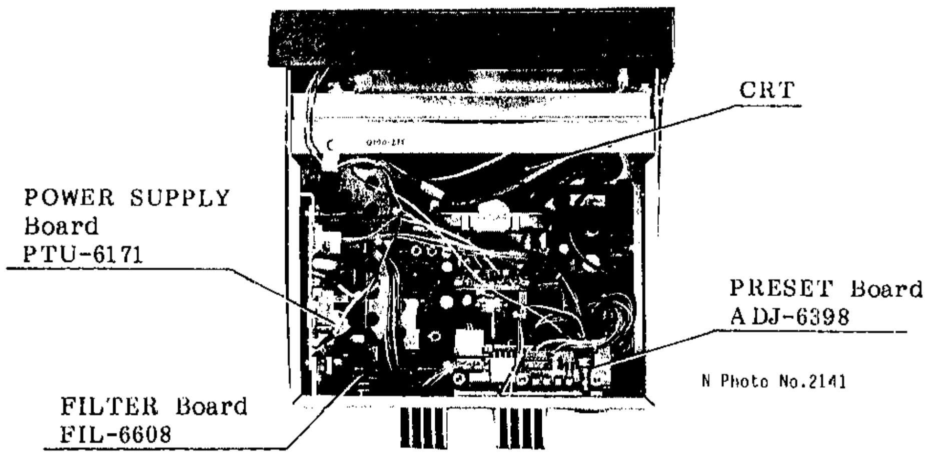


Fig.46 Display Unit, Top View

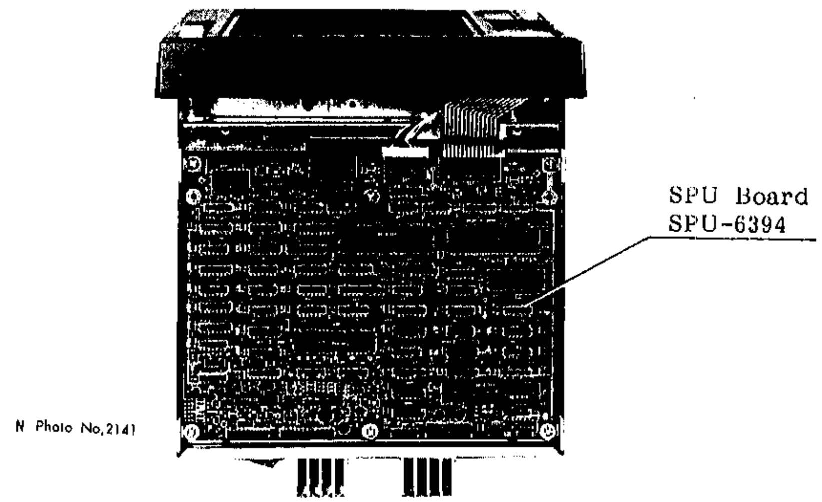
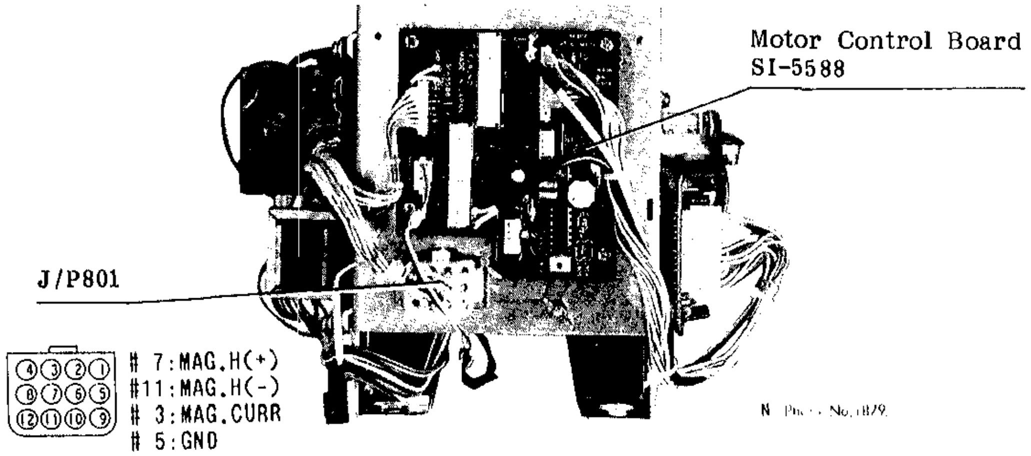


Fig.47 Display Unit, Bottom View



Rating of Magnetron
Current: 1.8 to 2.4VDC

Fig.48 Modulator, Side View

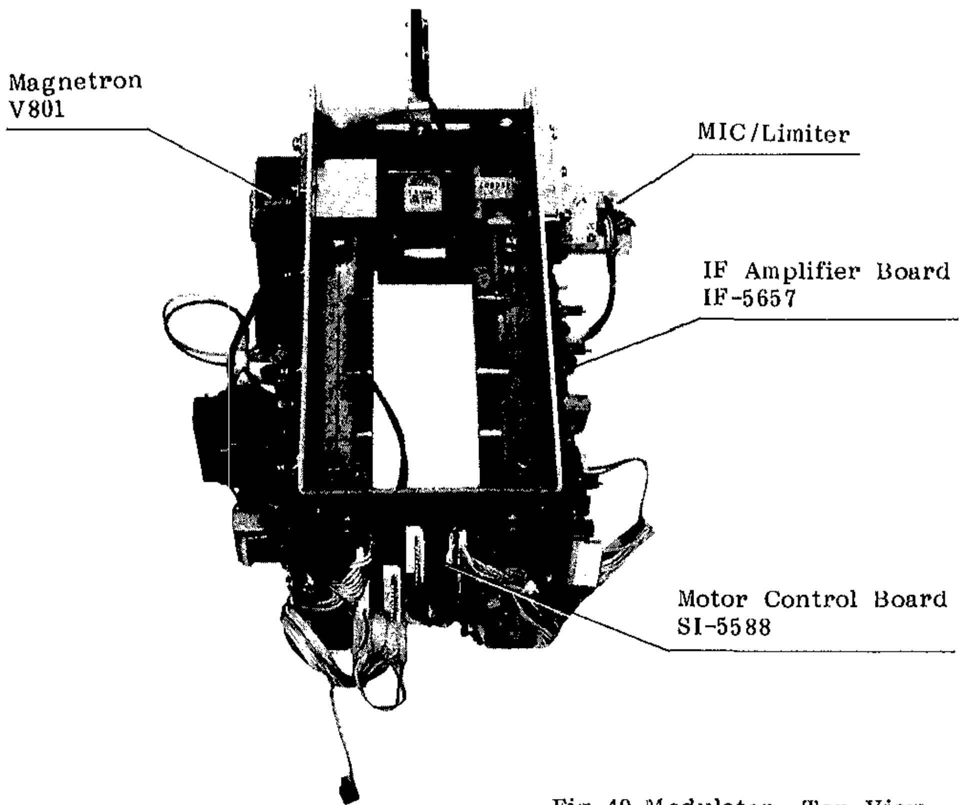


Fig.49 Modulator, Top View

APPENDIX A ALARM FUNCTION

ALARM ---- Option (RA-48 is required.)

If the RA-48 Radar Alarm is optionally mounted on the bottom of the display, a radar alarm function is available as below. Note that the SET RESET touchpad is located on the front panel of the RA-48.

SETTING/DELETING THE ALARM

The alarm function allows the operator to set the desired range (0 to maximum range) and bearing (0 to 360°) for a guard zone. Should ships, islands, landmasses, etc. come into the guard zone an alarm will be generated. The alarm is very effective as an anti-collision aid when using an autopilot or navigating in narrow channels.

Although the alarm is useful as anti-collision aid, it does not relieve the operator of the responsibility to watch out for possible collision situations. The alarm should not be used as a primary means to detect possible collision situations.

Now the procedure to set the alarms.

Procedure

Before setting the alarm ensure the gain is set properly. Too high a gain will trip the alarm needlessly, and if the gain is set too low weaker targets may be missed; the alarm will not sound should weaker targets come into the guard zone. To set, for example, a guard zone between 2.20 and 3.30nm use the following procedure.

1. Set the range at 6nm; press the VRM touchpad to display the VRM marker on the screen. VRM1 is displayed at the top right-hand side of the screen.

2. While observing the VRM indicator at the lower right-hand side of the screen, press / until the VRM stops at 3.30nm. (The order which you set the inner and outer range limits is interchangeable.) See Fig.A.

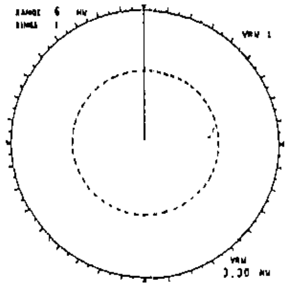


Fig.A

3. Press the SET/RESET touchpad once, and the outer/inner range of the alarm is set. At this time a weak intensity ring is overlaid on the VRM to mark the inner or outer limit of the guard zone. Furthermore, the message "VRM1" will change to "VRM2," and the message "ALARM" is displayed at the top right-hand side of the screen, indicating the alarm is now activated. See Fig.B.

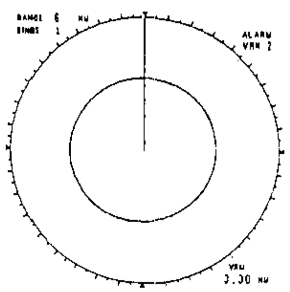


Fig.B

4. Press / until the VRM stops at 2.20nm and press the SET/RESET touchpad. A "doughnut ring" marks the inner and outer limits of the alarm. See Fig.C and Fig.D.

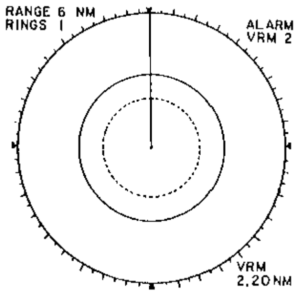


Fig.C

5. To change the inner or outer range of the alarm, repeat steps 2 thru 4. Now if a target comes into the zone marked by the doughnut ring an alarm is sounded. You may cancel the alarm at any time by pressing and holding the SET/RESET touchpad for at least two seconds. If the guard zone goes out of the screen when changing to a lower range, the message "UP RANGE" is displayed at the top right-hand side of the screen, informing you to up the range to redisplay the guard zone on the screen.

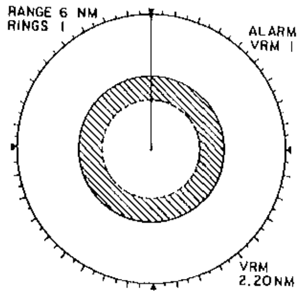


Fig.D

If you desire to set a bearing sector alarm as well, proceed to the next step.

To set, for example, a 90° bearing sector between 315° and 45°, use the following procedure.

6. Press the EBL touchpad to display the EBL on the screen. EBL1 is displayed at the top right-hand side of the screen.

7. By observing the EBL indicator at the lower left-hand side of the screen, press the / touchpad until the EBL is positioned at 315°. See Fig.E.

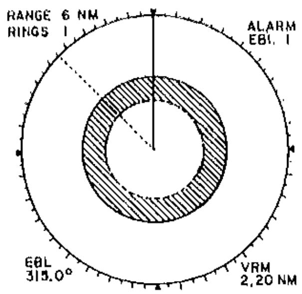


Fig.E

8. Press the SET/RESET touchpad, and the bearing in step 7 is set. A small 2-3 degree blank space is created in the doughnut ring at the area around 315°, however it is "repainted" once the other side of the bearing sector is set. At this time the EBL1 indication will change to EBL2, indicating you should set the other side of the bearing sector. See Fig.F.

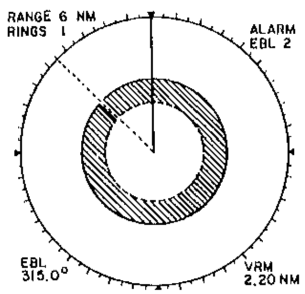


Fig.F

9. Then, press / to position the EBL at 45°, and hit the SET/RESET touchpad. The setting of the guard zone is now completed. To change the bearing sector, repeat steps 7 and 8. See Fig.G and Fig.H.

10. Any ships, islands, landmasses, etc. coming into the guard zone will trigger the alarm, telling the operator to proceed with caution. The guard zone and alarm sound may be cancelled at any time by pressing and holding the SET/RESET touchpad for at least two seconds.

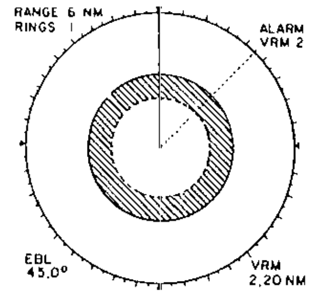


Fig.G

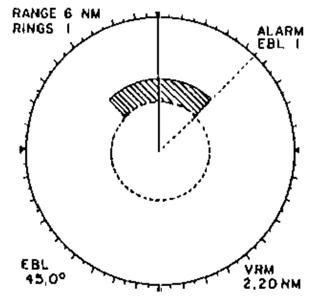
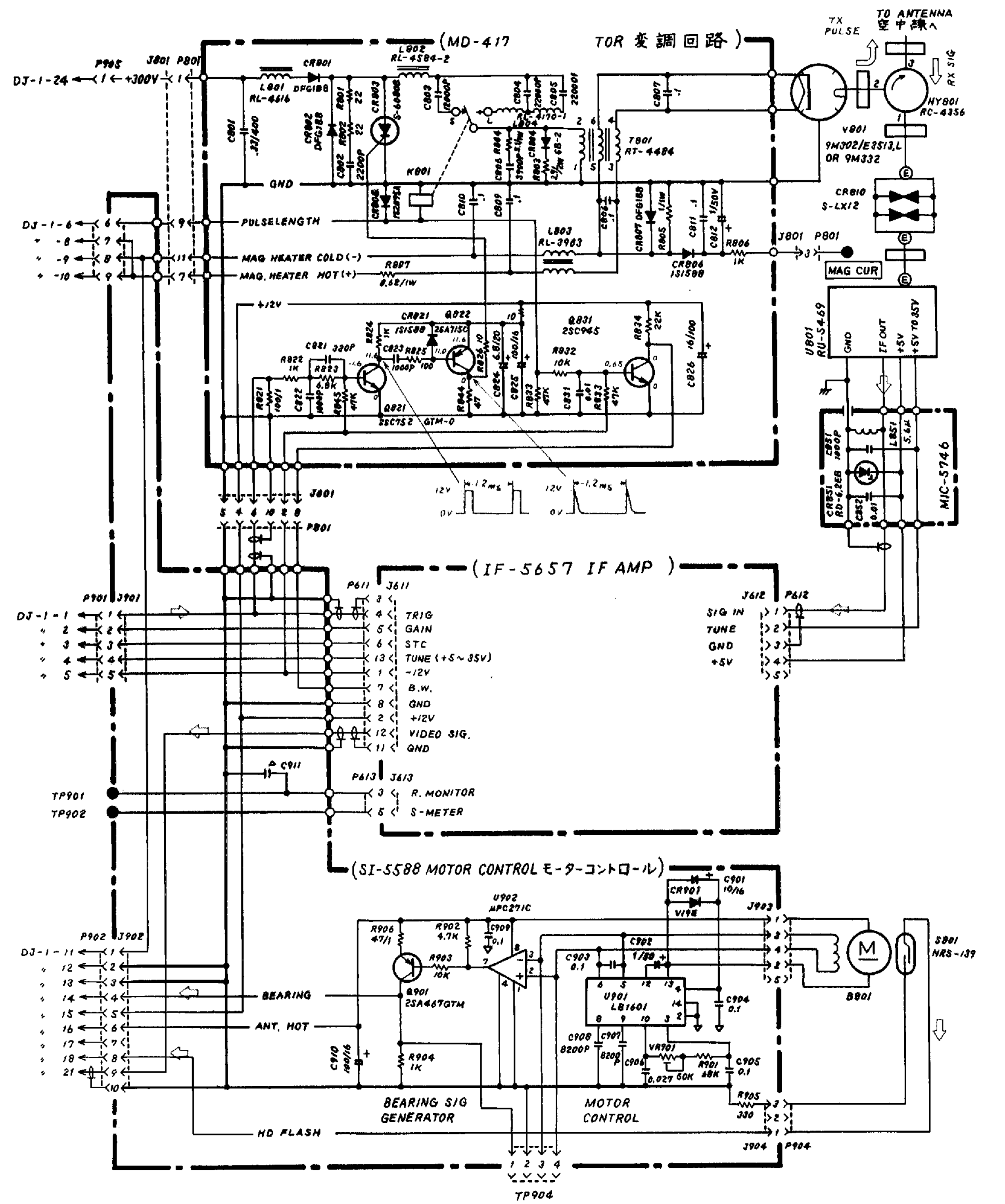


Fig.H

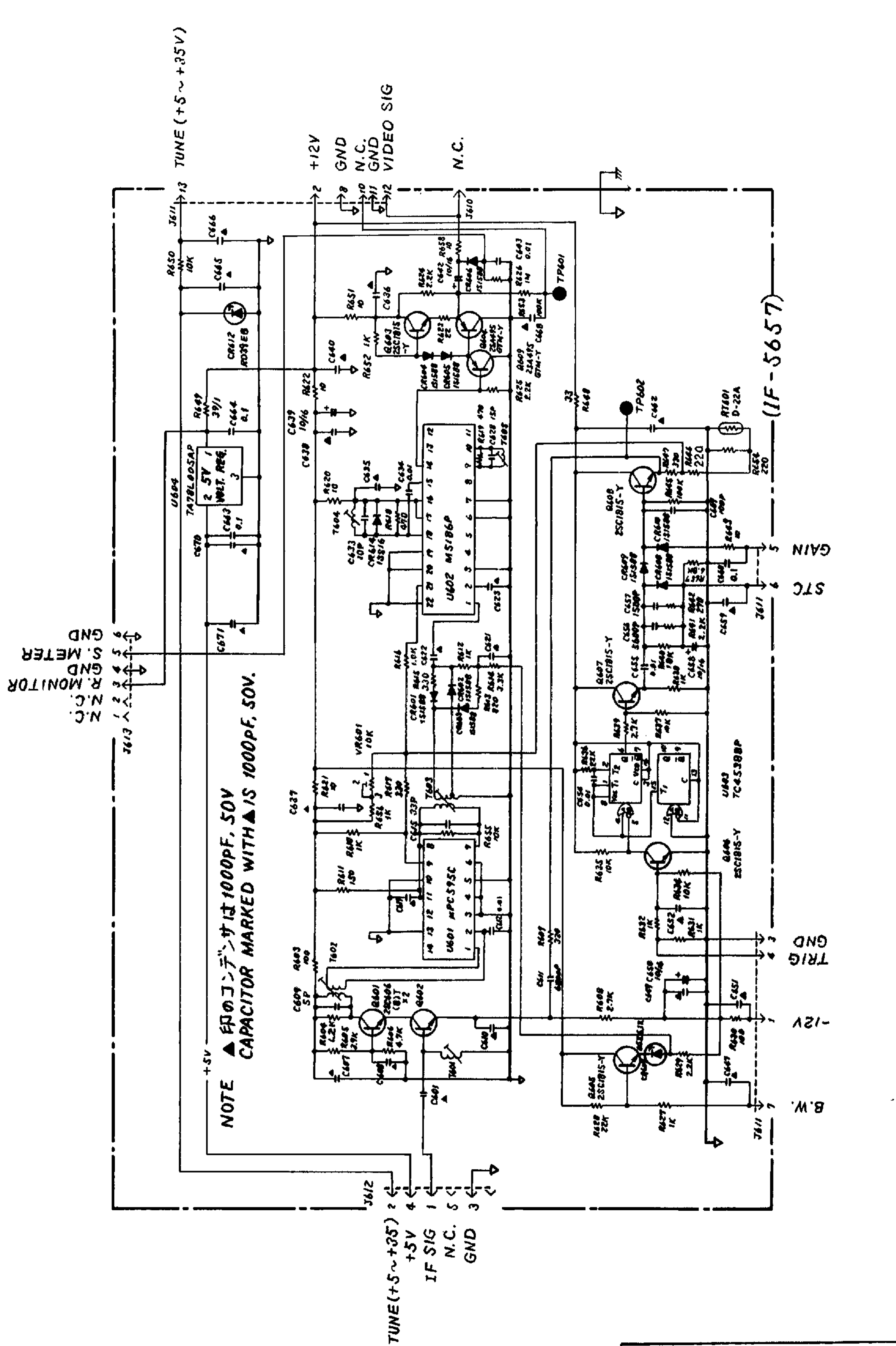


NOTE 1. ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.

2. DC VOLTAGES ARE MEASURED WITH GAIN MAX & STC MAX ON ST-BY/SHORT RANGE.

3. WAVEFORMS ARE MEASURED WITH GAIN MAX & STC MAX ON TX/3 MILE RANGE.

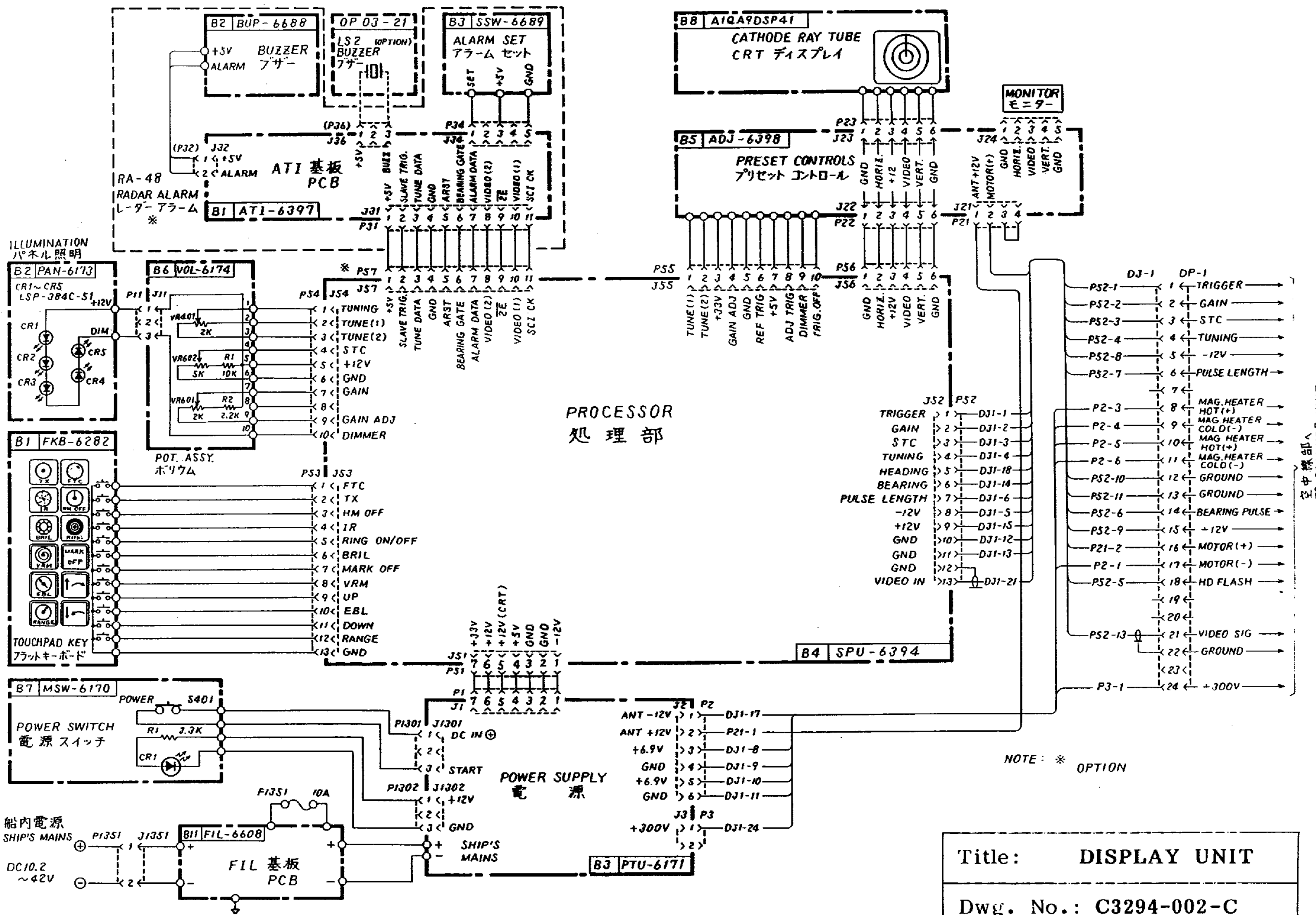
Title:	SCANNER UNIT
Dwg. No.: C3289-009-D	



NOTE 1. ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.

Title:	IF AMPLIFIER
Dwg. No.: C3289-010-B	

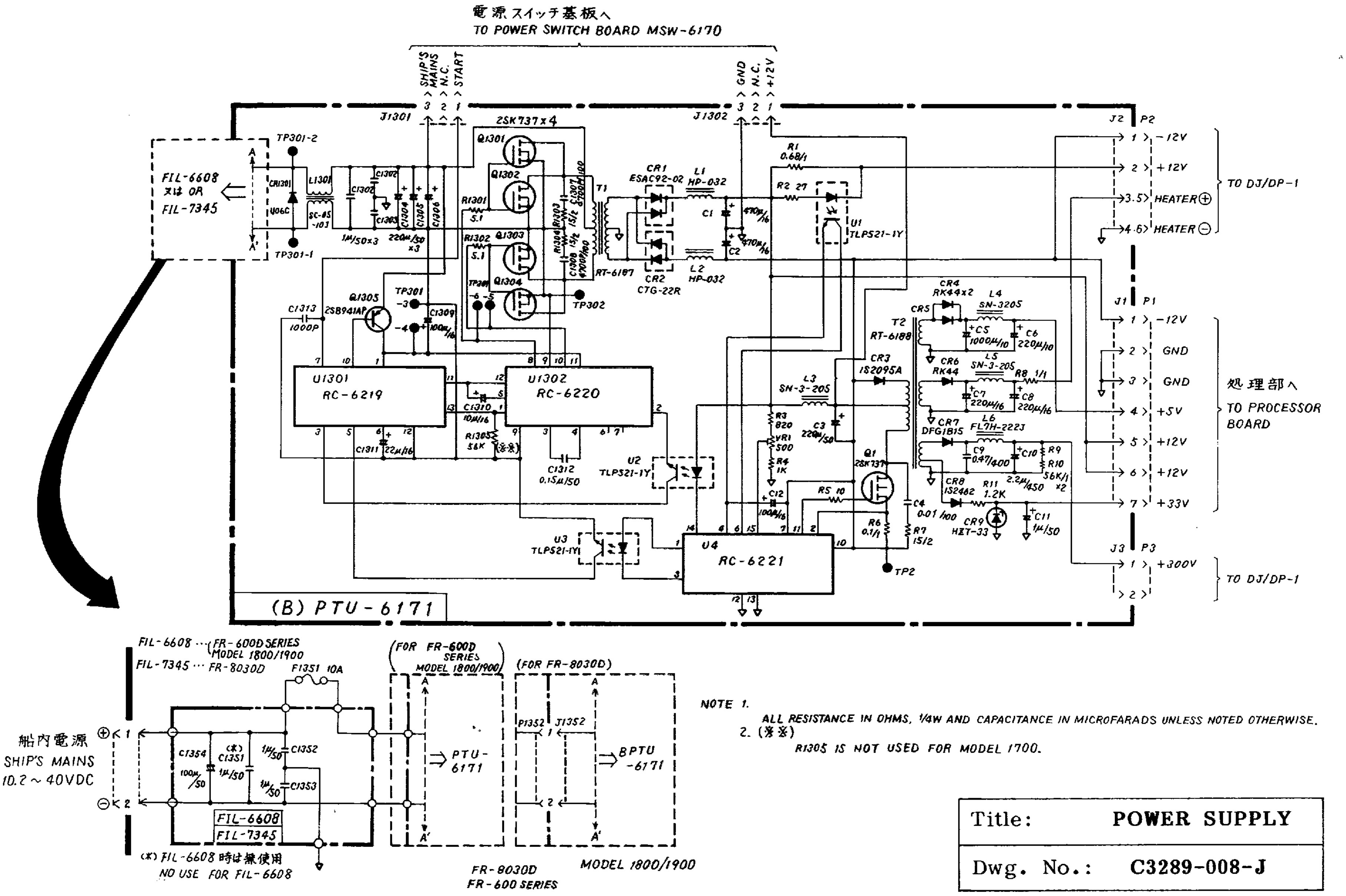
S-3



NOTE: ※ OPTION

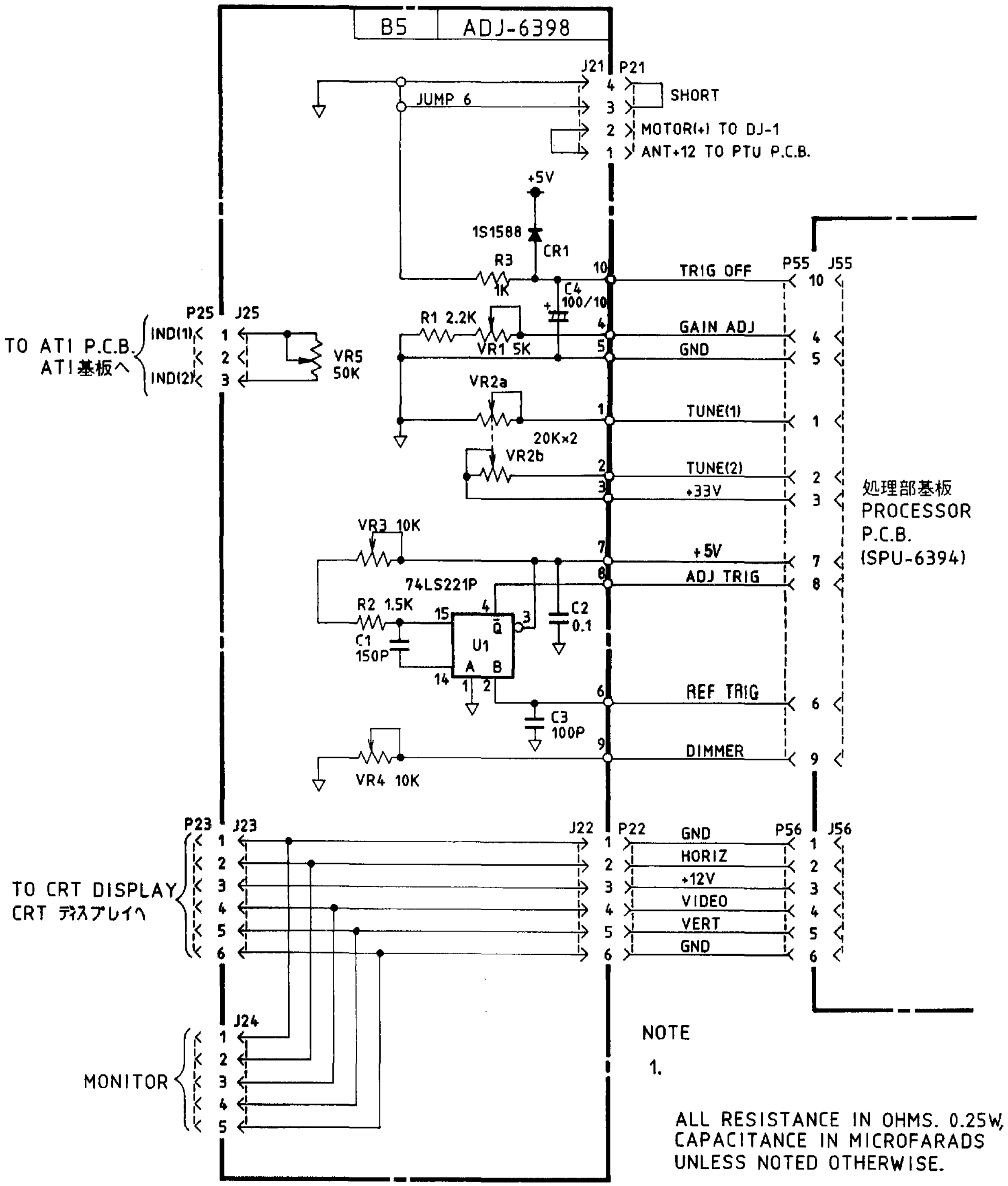
Title:	DISPLAY UNIT
Dwg. No.:	C3294-002-C

S-4



NOTE 1. ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.
2. (※※) R1305 IS NOT USED FOR MODEL 1700.

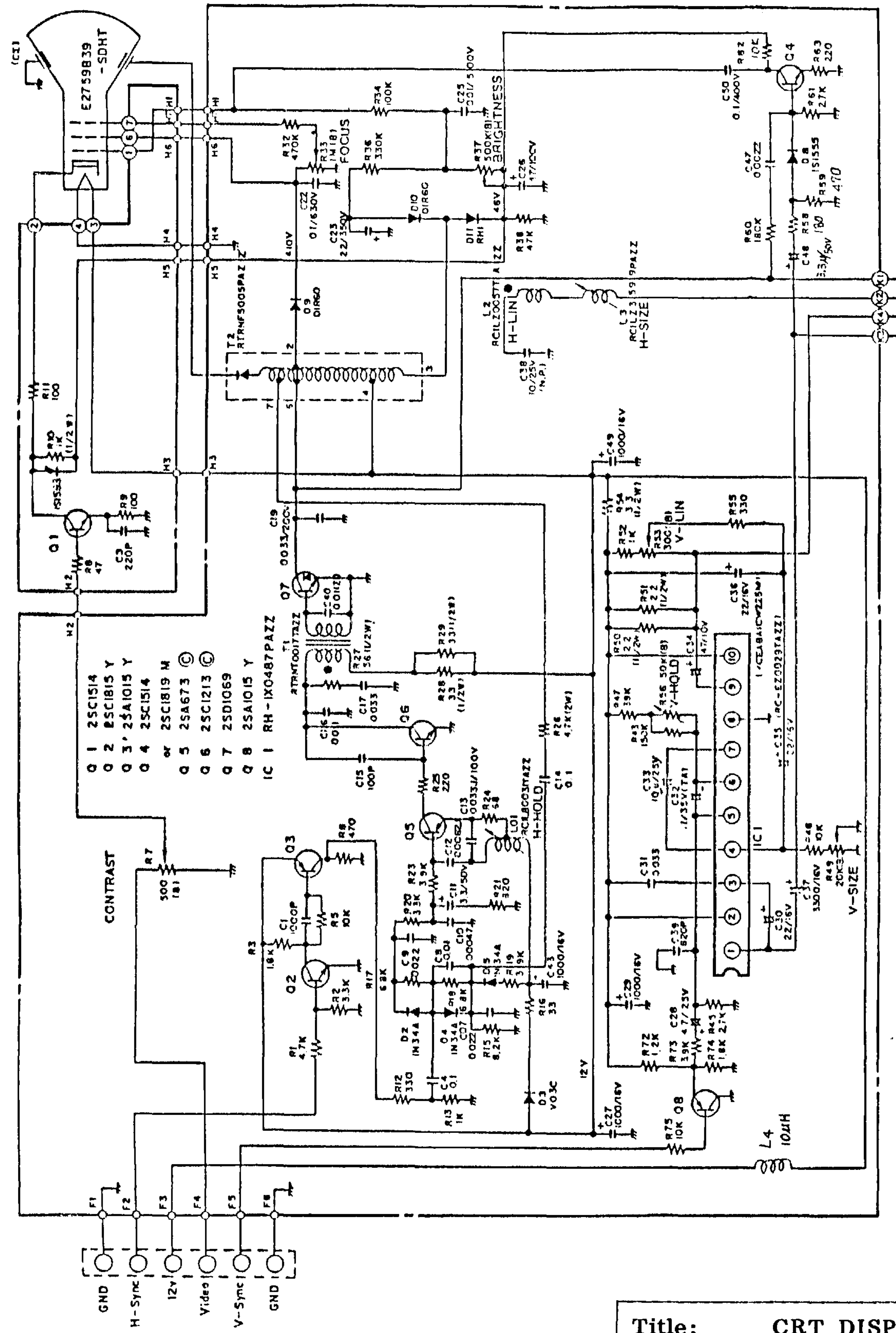
Title:	POWER SUPPLY
Dwg. No.:	C3289-008-J



NOTE

1\. ALL RESISTANCE IN OHMS. 0.25W, CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.

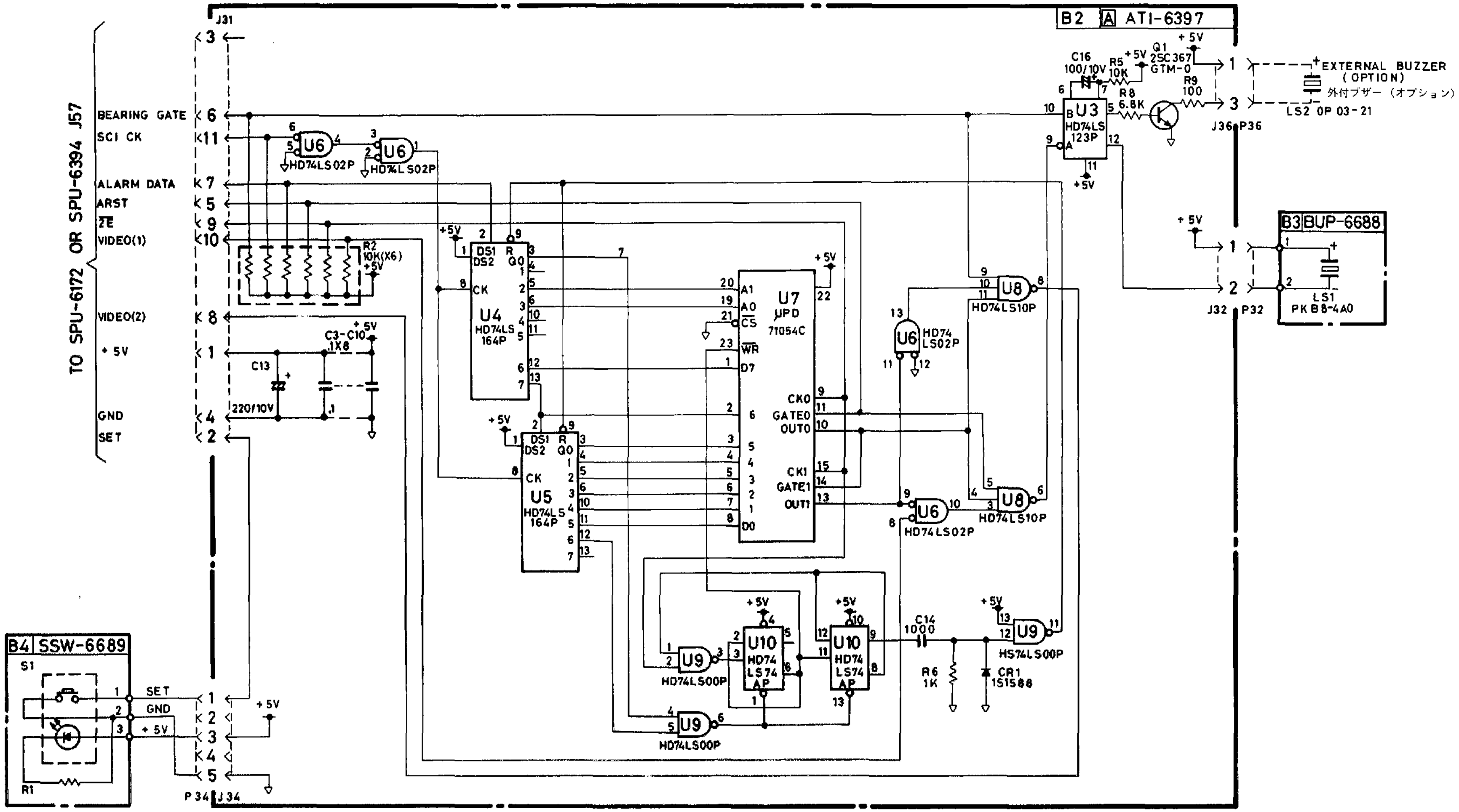
Title;	ADJ-6398 PRESET CONTROL
Dwg. No.;	C3289-025-B



NOTE 1

ALL RESISTANCE IN OHMS, 0.25W, CAPACITANCE IN FARADS UNLESS NOTED OTHERWISE.

Title;	CRT DISPLAY
Dwg. No.:	C3289-016-A



Title:	RA-48 RADAR ALARM (OPTION)
Dwg. no.:	C3019-001-B

NOTE 1.
ALL RESISTANCE IN OHMS, 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.