11 TECHNICAL DESCRIPTION OF EQUIPMENT (FCC Rules §2.983)

11.1 Function of Each Semiconductor or Active Device (FCC Rule §2.983 (d)(6))

ANTENNA UNIT
TRANSCEIVER MODULE (RTR-063)

Modulator Trigger PCB 03P9243 (RFC)

CR1 - CR4, CR6 - CR9:	Over-Voltage & Reverse-Voltage Protection
CR5:	Reverse-Voltage Protection
Q1 - Q12, Q15:	Current Amplifier
Q13 - Q14:	Buffer Amplifier
U1:	+5 V Regulator
U2:	Inverter Gate
U3:	Monostable Multivibrator
U4:	PLD
U5:	Oscillator
U6:	NAND Gate
U7:	Regulator
U8:	Photo-Coupler
U9 - U10:	Comparator

Modulator PCB 03P9244 (MD)

CR1 - CR3, CR5:	Reverse-Voltage Protection
CR4:	Rectifier
Q1-Q4, Q21:	Switching
Q5 - Q20:	FET Gate Driver
U1:	Regulator
U2:	Photo-Coupler

Chassis Mounted Parts

CR870 - CR871:	Clipper
CR880:	Limiter
HY801:	3 Ports Circulator
U801:	MIC Frequency Converter with Limiter
V801:	Magnetron

IF Amplifier PCB 03P9232 (IF)

CR601-CR607:	Switching
CR608:	Over-Voltage Protection
CR609:	Protector
CR616:	DC Restoring
CR622:	Thermal Compensation
CR626:	Clamp
CR629-CR630:	Over-Voltage Protection
Q601-Q602:	IF Amplifier in Cascade Connection
Q603:	Switching
Q609-Q610:	IF Amplifier in Cascade Connection
Q614-Q615:	IF Amplifier in Cascade Connection
Q616:	Bias Fix
Q617:	Detector
Q618:	Current Buffer
Q619 - Q620:	Tuning Indication Amplifier
Q625-Q628:	Video Amplifier
Q630:	Emitter-follower Amplifier
Q631:	Over-Voltage Protection
Q635-Q636:	Switching
U601-U603:	IF Amplifier
U604:	Band Width Select Comparator
U605-U609:	DC Regulator
U610:	IF Amplifier
U611:	Pulse Generator
U612:	Inverter

Bearing Signal Generator PCB MP-3795

Q901 - Q902:	Pulse Amplifier
U901:	Photo Interrupter
U902:	Comparator

11.2 Description of the circuits employed for suppression of spurious radiation, for limiting or shaping the control pulse, and for limiting or controlling power

(FCC Rule §2.983 (d) (11))

ANTENNA UNIT

TRANSCEIVER MODULE (RTR-063)

Modulator Trigger Circuit 03P9243 (RFC)

The modulator trigger generates the pulses that fire the modulator FETs.

The pulse forming circuit of U2 to U6 produces the four trigger pulses TRIG1 to TRIG4, the pulselength of which differ depending on the setting of pulselength (P/L A, P/L B and P/L C). For short pulse 1 (SP1), TRIG1 to TRIG4 have same length (0.12 μs). For short pulse 2 (SP2), middle pulse 1 (MP1), middle pulse 2 (MP2) and middle pulse 3 (MP3), TRIG1 to TRIG4 have different length (between 0.10 to 1.04 μs). For long pulse (LP), TRIG1 to TRIG4 have same pulselength (1.2 μs). These pulses are sent to the modulator board.

U4 also produces the bandwidth selection signals (BW:S, BW:L), which are sent to the IF amplifier for bandwidth selection.

The circuit composed of U7, U8 and Q15 is provided to regulate the magnetron heater voltage.

The U10 is a current amplifier to detect the average magnetron current.

Modulator Board 03P9244 (MD)

The function of the modulator board is to produce a high tension pulse that drives the magnetron.

The high voltage (TX-HV) is charged into C1 to C4 through R1/R2 while the magnetron is inactive. This high voltage is discharged through the pulse transformer T801 when FETs Q1 - Q4 are conductive. T801 boosts the voltage and makes the magnetron oscillate.

Because the magnetron oscillates only when the FET is conductive, transmission pulselength can be changed by the pulselength fed to the gates of FETs.
Also the magnetron current is proportional to the discharging current via the FETs, thus the transmission power can be changed by the number of FETs conductive.

The four pulses TRIG1 to TRIG4 are produced on the modulator board and applied to the gates of Q1/Q2/Q3/Q4 via the current amplifier Q7/Q11/Q15/Q19.

The relay K1 and coil L1 are provided to eliminate the ringing at the trailing edge of the transmission pulse across the primary winding of T801. This relay is active when the short pulse 1 (SP1) is selected.

Duplexer and Mixer

Since the radar system uses a single antenna for transmission and reception, and efficient device is required for switching the transmitter and the receiver, this radar employs circulator HY801. The circulator HY801 is a passive directional coupler with three ports. The incoming signal is bent in the specific direction and emerges from another port with little loss, the other port being isolated. In the same manner, the received signal entering into another port is transferred to the other port, isolating one port. This operation of the circulator protects the receiver during transmission and minimizes loss of the received signal during reception.

The diode limiter is a self-activating switch made of two PIN diodes. Its function is to attenuate the strong transmission signals from the magnetron and other boat radars through the antenna and to protect the MIC (microwave IC) U801. The PIN diode conducts at a certain level of microwave power. When the diode is the cut-off state, the input impedance of the diode limiter matches the impedance of the waveguide, and the microwave energy is delivered to the MIC. When the diode is put into a conductive state, the waveguide is short-circuited and most of the input energy is reflected back to the transmitter side. The strong signal is thus weakened down to about 50 mW by the diode limiter.

U801 is a microwave IC (MIC) incorporating a local oscillator and mixer diodes. The received microwave signal of 9410 MHz coming from the diode limiter is mixed with the local oscillation signal in the mixer diodes and converted to IF signal of 60 MHz.

IF Amplifier 03P9232 (IF)

The IF signal of 60 MHz coming from the MIC is amplified and converted into a video signal, which is delivered to the display unit.

The IF amplifier is composed of six major circuits; Linear Amplifier (Q601/Q602/Q609/Q610), Logarithmic Amplifier(U601/U602/U603/U610), Video Amplifier (Q625/Q626/Q627/Q628), Bandwidth Selector (U604, CR601 to CR607), Tuning Indicator Circuit (Q614 to Q620) and Main Bang Suppression Circuit (Q630, Q631,Q603, CR631, CR626, CR608, CR609, U611, U612).

The signal applied to the base of Q601 is amplified in cascade by Q601 and Q602, and sent to the bandwidth selector.

The IF amplifier operates in narrow or wide bandwidth mode depending on the settings of the RANGE switch and TX touchpad. For short ranges, a wide bandwidth (27 MHz) is selected, since the levels at pin #3 of U604 and pin #6 of U604 go high, thus CR602 to CR605 and CR607 are conductive and CR601/CR606 are cut off, causing the signal to pass through CR603/CR604. On the contrary, CR602 to CR605 and CR607 are cut off and CR601/CR606 are conductive, which causes the signal to pass through T603/T604, selecting a narrow bandwidth (3 MHz) on medium and long ranges.

The signal through the bandwidth selector is coupled to the logarithmic amplifier, amplified and detected by U601/U602/U610. Thus, the detected signals are fed to Q625/Q626 to be amplified further, and then sent to the display unit via buffers Q627, Q628.

The IF signal of 60 MHz is amplified by Q609/Q610, U603, Q614/Q615 and detected by Q617. Then the detected signal (Tuning Indicator Signal) is sent to the display unit via Q618 to Q620.

On the other hand, Q609/Q610 and U603 are additional amplifier circuits to make the dynamic range of the IF signal wider, causing the discrimination of the target echoes to get better. The IF signal from the MIC is fed to Q609/Q610 as well as through resistor R651 which is employed to attenuate the signal level. Therefore, Q609/Q610 amplifies even a strong signal which may be saturated in Q601/Q602 and U601/U602, and then sent to logarithmic amplifier U603. This signal is added to the saturated signal in U601/U602, causing the saturation level of the IF signal to become high.

The purpose of main bang suppression circuit is to minimize transmission leakage near the center spot on the screen.

When the magnetron current pulse generated in Modulator board 03P9244 is fed to inverter U612, pulse generator U611 produces a modified rectangular pulse.

This pulse is fed to the emitter of Q603 through Q630 as a main bang suppression waveform, then Q602 turns off during transmission to eliminate direct reception of the strong TX energy (main bang).

Bearing Signal Generator MP-3795

The bearing signal generator produces a square wave signal that is used to synchronize the sweep rotation with that of the antenna.

U901 is a photo interrupter composed of a light emitting diode and a photo transistor. It has a configuration in the shape of "U" shape. The light emitting diode is mounted on one wall of the "U" shape and the photo transistor on the other wall. A rotating timing disc is arranged between the two walls.

The timing disc is provided with 60 silts at regular intervals along its circumference. It is fitted on the scanner motor shaft and rotated at a speed of 144 rpm by the 24 rpm scanner motor.

The photo transistor receives the light emitted by the light emitting diode through each slit of the timing disc and converts it into electric current. The output of the photo transistor across R903 is a half-rectified sine wave at a frequency of 144 Hz. This signal is amplified, reshaped and sent to the display unit for display echo synchronization.