

MARINE RADAR
JMA-2344
SYSTEM DESCRIPTION

THE JRC RADAR JMA-2344 is two-piece radar system consisting of 10 inches monochrome raster scan display unit and scanner unit interconnected by a single cable.

The MTR is installed within a scanner unit. The scanner weight is approximately 24.0kg.

The antenna is rotated 27 rpm by its driving motor. This has a 2-degree horizontal beam width and 30-degrees for vertical.

The transmitter operates with 4 pulse-lengths and 4 pulse-repetition-frequencies. The magnetron, MSF1422B, rated output is 6 kW and is driven by solid-state modulator.

The receiver has a microwave-front-end, containing the low-noise amplifier, mixer, local oscillator, IF amplifier and detector.

The display unit consists of a 10" CRT with its Monitor Main Control circuit, Main Control circuit, Power Supply circuit, Main Panel circuit and Soft Key Panel circuit.

The Main Control circuit generates necessary timing signal and processing the video signal.

This circuit controls the CRT display and the input/output signals of the scanner unit, MTR unit, Keyboard unit and North Stabilized Kit unit.

The Main Panel circuit and Soft Key Panel circuit provide electronic directions to the Main Control circuit to determine the display functions.

The Power Supply circuit, operated at about 70 KHz, converts the ships input power to the necessary DC voltages required in the radar system.

The following specifications summarize the characteristics of the JMA-2344 Radar system.

Specifications

1 General

(1) Scanning mode	Raster scanning, PPI
(2) Display unit	10-inch square monochrome CRT
(3) Display color	Green
(4) Ranges	
JMA-2343	0.125, 0.25, 0.5, 0.75, 1.5, 3, 6, 12, 24, 36, 48 NM
JMA-2344	0.125, 0.25, 0.5, 0.75, 1.5, 3, 6, 12, 24, 36, 48, 64 NM
(5) Range resolution	25m maximum
(6) Minimum range	25m maximum
(7) Bearing accuracy	$\pm 1^\circ$ maximum
(8) Bearing discrimination	
JMA-2343	4.2°
JMA-2344	2.2°
(9) Bearing measurement mode	True/Relative bearing
(10) Environmental condition	
• Temperature	Scanner unit -15°C to $+55^\circ\text{C}$ Display unit -15°C to $+50^\circ\text{C}$
• Relative humidity	93% maximum at 40°C
• Relative wind velocity	
Scanner unit	36.0m/sec (70 knots)
(11) Power consumption	
• DC input (12,24,32V)	
JMA-2343	Approx. 60W
JMA-2344	Approx. 65W
• AC input ^(Note)	Approx. 100VA (100/110/115/200/220/230V, 50/60Hz single phase)
(12) Input power range	DC10.8V to DC42V
(13) Preheating time	Approx. 90 seconds
(14) Warm-up time	Approx. 3 seconds maximum

(Note) The following rectifiers need be used when AC input is to be used : NBA-797A

2 Scanner Unit (NKE-249/250)

(1) Dimensions	
NKE-249	
• Diameter	620mm
• Height	275mm
NKE-250	
• Swing circle	1220mm
• Height	432mm
(2) Mass	
NKE-249	Approx. 10.5kg
NKE-250	Approx. 24kg
(3) Polarization	Horizontal
(4) Directivity characteristics	
NKE-249	
• Horizontal beam width	4°
• Vertical beam width	25°
• Side lobe level	-21dB maximum (less than $\pm 10^\circ$ from main lobe)
NKE-250	
• Horizontal beam width	2°
• Vertical beam width	30°
• Side lobe level	-23dB maximum (less than $\pm 10^\circ$ from main lobe) -26dB maximum (other than $\pm 10^\circ$ from main lobe)
(5) Rotation	
NKE-249/250	Approx. 27 rpm
(6) Transmitter frequency	$9410 \pm 30\text{MHz}$
(7) Peak power	
NKE-249	4kw
NKE-250	6kw
(8) Transmitter tube	
NKE-249	Magnetron : MSF1421B
NKE-250	Magnetron : MSF1422B
(9) Pulse length/PRF	
NKE-249	$0.08 \mu\text{s} / 2250\text{Hz}$ (0.125, 0.25, 0.5, 0.75, 1.5NM) $0.25 \mu\text{s} / 1700\text{Hz}$ (1.5, 3 NM) $0.5 \mu\text{s} / 1200\text{Hz}$ (3, 6 NM) $1.0 \mu\text{s} / 650\text{Hz}$ (6, 12, 24, 36, 48 NM)

NKE-250	0.08 μ s/2250Hz (0.125, 0.25, 0.5, 0.75, 1.5 NM)
	0.25 μ s/1700Hz (1.5, 3 NM)
	0.5 μ s/1200Hz (3, 6 NM)
	1.0 μ s/650Hz (6, 12, 24, 36, 48, 64 NM)
(10) Modulator	Solid state modulator driver
(11) Duplexer	Circulator and diode limiter
(12) Mixer	MIC front-end
(13) IF amplifier	
• Intermediate frequency	60MHz
• Band width	20/6/3MHz
• Characteristic	Semi-log characteristic
(14) Noise figure	6dB maximum

3 *Display Unit (NCD-4170)*

(1) Dimensions																																								
• Width	278mm																																							
• Height	242mm																																							
• Depth	275mm																																							
(2) Mounting	Table-top mounting																																							
(3) Mass	Approx. 9kg																																							
(4) Cathode-ray tube	10-inch square monochrome CRT																																							
(5) Range scales	<table><tr><td>Range (NM)</td><td>Range ring interval (NM)</td><td>Number of rings (NM)</td></tr><tr><td>0.125</td><td>0.0625</td><td>2</td></tr><tr><td>0.25</td><td>0.125</td><td>2</td></tr><tr><td>0.5</td><td>0.25</td><td>2</td></tr><tr><td>0.75</td><td>0.5</td><td>3</td></tr><tr><td>1.5</td><td>0.25</td><td>6</td></tr><tr><td>3</td><td>0.5</td><td>6</td></tr><tr><td>6</td><td>1</td><td>6</td></tr><tr><td>12</td><td>2</td><td>6</td></tr><tr><td>24</td><td>4</td><td>6</td></tr><tr><td>36</td><td>6</td><td>6</td></tr><tr><td>48</td><td>8</td><td>6</td></tr><tr><td>64</td><td>16</td><td>4</td></tr></table>	Range (NM)	Range ring interval (NM)	Number of rings (NM)	0.125	0.0625	2	0.25	0.125	2	0.5	0.25	2	0.75	0.5	3	1.5	0.25	6	3	0.5	6	6	1	6	12	2	6	24	4	6	36	6	6	48	8	6	64	16	4
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12	2	6																																						
24	4	6																																						
36	6	6																																						
48	8	6																																						
64	16	4																																						
Only JMA-2344																																								
(6) Range ring accuracy	±0.9% of selected range or ±8m, which is greater.																																							
(7) VRM	VRM1/VRM2																																							
JMA-2343	0 to 48 NM, digital numeric display of 3 figures																																							
JMA-2344	0 to 64 NM, digital numeric display of 3 figures																																							
(8) EBL	EBL1/EBL2																																							
	0° to 359°, digital numeric display of 3 figures																																							
(9) Tuning mode	Manual or automatic																																							
(10) Bearing scale	360° scale graduated at intervals of 1°																																							
(11) Ship's heading marker	Electronic																																							
(12) Sea surface clutter suppression	Manual or automatic																																							
(13) Rain and snow clutter suppression	Manual or automatic																																							
(14) Radar wakes display	15 sec/30 sec/1 min/3 min/6 min/15 min/30 min/ continuous																																							
(15) Center move	66% maximum of PPI's radius																																							

(16) Keys/Controls

• Main panel

STBY/OFF  key

X-MIT/OFF  key

[TUNE] control

[GAIN] control

[SEA] control

[RAIN] control

RANGE  key

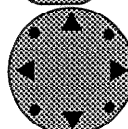
VRM  key

EBL  key

BRIL/HL OFF  key

MENU  key

ENTER  key

Cross key 

• Software key panel

(17) Software key function

Software key : 4

- DISPLAY Screen expansion [EXP]
Center move [CENTER]
Fixed range rings [RR]
Cursor [CUR]
- PROCESS Clutter suppression
[AUTOOFF/A-SEA/A-RAIN]
Interference rejection [IR]
Tune mode [TUNE]
Radar wakes [WKS]
- GUARD Zone make [MAKE]
Alarm setting [ALM]
Sensitivity [SENS]
Alarm mode [ALM]

(18) Menu

• FUNCTION

EBL1/VRM1 mode setting [EBL1/VRM1]
(Fix [FIX]/Float [FLOAT]/Parallel line [PLINE])

EBL2 setting [EBL2]

VRM2 setting [VRM2]

EBL read out [EBL READOUT]

Zooming of echo image on PPI [ZOOM]

True motion/Relative motion [TM*/RM]

Heading mode [HDG MODE]

(Head-up [H-UP]/North-up [N-UP]*/

Course-up [C-UP]*)

Image process [PROCESS]

• DISPLAY

Position display [POSITION]

(Own ship [L/L or TD]/Cursor [CUR L/L]/

Waypoint [WPT L/L])*

Waypoint display [WAYPOINT]

Range unit [RANGE]

(NM/KY/KM)

Timed transmission [TIMED TX]

(Transmission period [TX PERIOD]/

Stand-by period [STBY PERIOD])

• RADAR SET-UP 1

Buzzer volume [BUZZER]

Panel dimness [DIMMER]

Transmitter pulse width [TX PLSE]

(1.5NM/3NM/6NM)

Bearing reference [BEARING]

(Magnetic bearing [MAG]/True bearing [TRUE])*

Multi display unit setting [MULTI DISPLAY]

• RADAR SET-UP 2

Language

(English/Japanese/Chinese/Francais/ Espanol/

Italiano/Norsk/Deutsch/Korea)

(19) Input from external device

GPS (NMEA0183)

Electric compass or GPS compass (NMEA0183)

NMEA0183 version : v1.5, v2.1, v2.3

Latitude/Longitude : GGA, RMA, RMC, GLL

Waypoint : RMB, BWC

Speed : VTG, RMA, RMC, VHW

Course : VTG, RMA, RMC

Ship's head : HDT, VHW, HDM, HDG

VARIATION : HDG, RMA, RMC

TD (LoranC time difference) : GLC, GTD, RMA

(20) Output to external device

Cursor data (Bearing/Range)

NMEA0183 RSD sentence**

Sub monitor

(Vertical/Horizontal synchronous signal,
video signal)

* You need a connection with navigation device or bearing sensor.

** Data output only when pushing ENTER key.

Circuit explanation of display unit type NCD-4170

The display unit type NCD-4170 is composed of the following circuit block.

- a) Main control circuit
- b) Power supply circuit
- c) Main panel circuit
- d) Soft key panel circuit
- e) Monitor control circuit

The input power supply range of the display unit is between DC+10.2V and DC+42V, and the signal composition between the display unit and the scanner unit is as mentioned in the following.

- a) Power supply : Between DC+10.2V and DC+42V.
- b) Transmitting trigger : 8Vp-p, Frequency depends on radar range.
- c) Radar video : Approx.1.8Vp-p_{max}
- d) Rotation pulses : 2048pulses/rev, 5Vp-p
- e) Bearing signal : 1 pulse/rev, 5Vp-p
- f) Communication line : RS-485, Half duplex

1 . Power supply circuit(CBD-1596)

This circuit is the DC-DC converter power supply of the fly-back form, and supplies various voltages to each circuit inner the display unit.

Input voltage range is between DC+10.2V and DC+42V, and when the input voltage is less than 9V or more than 46V, the oscillation of the converter is stopped to protect the circuit by the over-voltage, low voltage protection circuit. Furthermore, when connection of the input power supply is reverse, the circuit is protected with protection diode CD1 and the fuse F1.

The output voltage are +12V (1.5A max), +3.3V(1.5A max) and -4.7V (0.1A max), and the output of +3.3V is adjusted in the precision of $\pm 0.05V$ using the volume RV1'+3.3V ADJ'. The switching frequency is 70kHz, which is controlled by the oscillator IC (IC1), and the regulation of the output voltage is made using feedback of the output of +12V.

And, this circuit has the sensor of the output of +3.3V to protect a circuit for the occurrence of an unexpected unusual voltage. When +3.3V output exceeds +3.6V, oscillation of the converter is stopped, and the power supply circuit stops the function.

And, this circuit has the relay 'K1' which controls a power supply to the scanner unit. This relay works with the output of +12V, when the relay switch on, the ship's main is supplied to the scanner unit through the noise filter and the fuse'F2'.

2 . Main control circuit(CMC-1156)

This circuit controls the main system of the radar with the micro-chip (IC2) which CPU core is SH3 (manufactured by Hitachi), and with the program memory (IC5) and the work memory (IC7).

The main functions of this circuit are radar signal processing, screen drawing and an interface with the outside.

Almost all the radar signal processing is done by the signal processing ASIC (IC12) with digital style. After adjustment of reference level, the radar video signal sent from the scanner unit is inputted to IC12 as an analog signal. The inputted video signal is changed into the digital signal by the eight bits A/D converter included inside at the sampling rate of about 50MHz. The suppression of sea and rain clutter signal by technique of the STC and the FTC, and the radar interference rejection are carried out at the digitized video signal. After sweep average and gain processing are carried out more, the video signal is stores in the built-in buffer memory.

In the STC, the gain of the radar video signal is restrained as low as near distance which sea clutter signal is contained, with STC parameter selected by antenna height setting via maintenance menu and position of the sea knob on the operation panel.

And, the basic data of STC parameter are transferred to IC12 from the CPU after power on of the display unit, and STC parameter is calculated at a speed which is the same as the sampling rate of the above-mentioned A/D converter one after another inside IC12.

In the FTC, the rain clutter signal is suppress by the high pass filter processing which characteristics depends on the position of the RAIN knob on the operation panel.

In the interference rejection processing, a rank filter technique is done with three sweep video signals stored in memories with built-in IC12, and the rejection level, when strong is IR2, weak is IR1, is selectable by soft key on the operation panel.

The IR1 is suitable to reject of comparatively weak interference signals, it works as median filter which outputs the middle level signal in the data of three sweep.

On the other hand, the IR2 is suitable to reject of comparatively strong interference signals, it outputs the minimum level signal in the data of three sweep.

The video signal stored in the buffer memory inside IC12 is sent to ASIC (IC10) for screen drawing, and processing of scan correlation and the echo trail are done on the XY coordinate.

In conversion from the polar coordinate to the XY coordinate, the coordinate of the each video signal is calculated one after another based on the PPI center coordinate set up from the CPU in the address generator part inside IC10, and the address of the memory (IC11) for the video signal is controlled.

The video signal that the above-mentioned processing of scan correlation and echo trail were done on the XY coordinate is stored in the memory (IC11).

The scan correlation processing averages the level of the last processing result stored in of the memory (IC11) and this raw data, referring to the operation table stored in RAM inside IC10.

After processing of the scan correlation and the echo trail, zoom processing is carried out in the video signal. Then the video signal data is mixed with the graphic data, and is stored in the buffer memory inside IC10.

The signal stored in the buffer memory inside IC10, is changed into the analog signal by the D/A converter part, and it is supplied to the monitor unit through the monitor interface part.

The signal specifications that it is supplied to the monitor unit are as mentioned in the following.

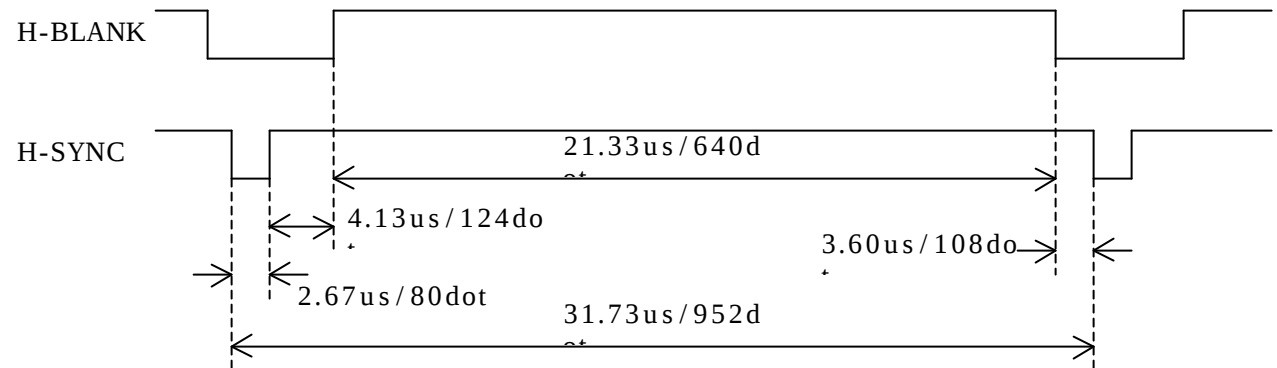
For monitor signal timing

Dot clock: 30MHz

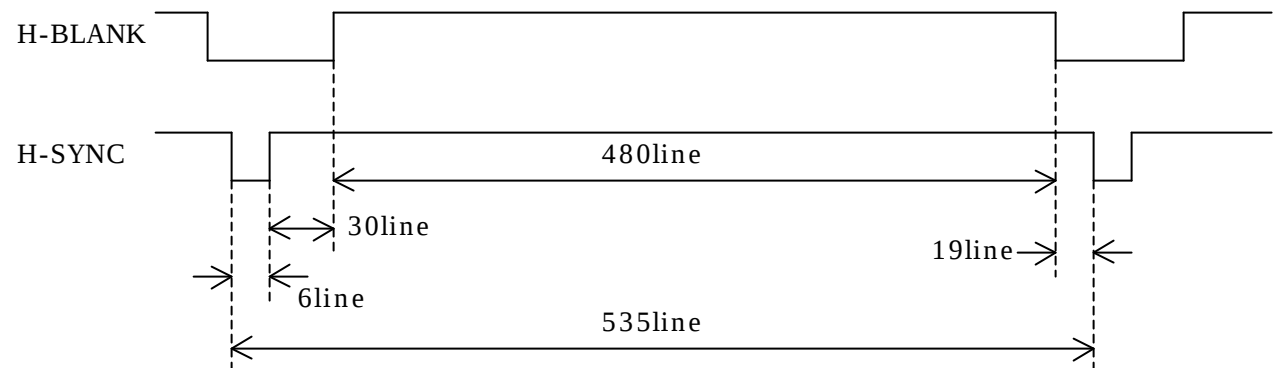
Horizontal synchronous frequency: 31.51kHz

Vertical synchronous frequency: 58.9Hz

Horizontal



Vertical



The serial communication data with the scanner unit is transmitted or received through the RS-485 interface (IC16 and IC29). The communication speed is 9600bps. The main communication data are as follows.

No.	Contents	Direction	Remarks
1	Tune indication level	From scanner to display	
2	Scanner identification	From scanner to display	
3	Tune voltage level	From display to scanner	
4	Selection of transmitting pulse	From display to scanner	
5	Selection of receiver band width	From display to scanner	
6	Pulse repetition frequency	From display to scanner	
7	Selection of radar range	From display to scanner	
8	Others	Both direction	

3 . Control panel(CCK-872/CCK-873)

The control panel is composed by the main control panel circuit(CCK-873) and the soft key panel circuit(CCK-872).

The main control panel circuit is composed of 4 volumes, 17 switches and 48 LEDs for the lighting, and the soft key panel circuit is composed of 4 switch.

The key condition is recognized by key scanning of the time interval of about 30ms.

And, a volume output voltage is taken into the micro-chip with the A/D converter of CMC-1156-IC2 by sampling of the time interval of about 50ms.

4 . Monitor unit(7WZRD0041)

This monitor unit is non-interlace type with 10 inches monochrome CRT.

It is composed of monitor internal connection (CRT with the deflection yoke ; CKJ-159) and monitor control circuit (CCN-366).

The main specifications are as follows.

Input power : $11.5V \pm 0.5V$

Resolution : 640x480(VGA)

Dot clock : 30MHz

Horizontal synchronous frequency : 31.51kHz

Vertical synchronous frequency : 58.9Hz

Maximum brilliance : more than 400cd/m^2 (when input signal is $2.2V_{p-p}$)

Circuit explanation of Scanner unit type NKE-249/NKE-250

1. Circuit explanation of Modulator circuit (CME-307,308)

Ship's mains pass through the relay inside display unit and is inputted to the scanner unit. That power supply passes through the noise removal filter of input part and is inputted to step-down chopper circuit. Feedback circuit (IC3 etc) and PWM control IC (IC1) controls output voltage of step-down chopper circuit to be stabilized in about 7.5 (V).

Push-pull converter (IC2, T1 etc) supplies four kinds of voltages as follows on the basis of 7.5(V).

+8(V) : Mainly, for the power supply of IF amplifier ,LOG amplifier and front end

+15(V) : Mainly, for the motor drive circuit

-7(V) : Mainly, for the Magnetron heater voltage

+330(V)(JMA-2343)? +365(V)(JMA-2344): High voltage for modulator

PW1~ 3 signal from receiver unit forms pulse width(4 pulses) in transmitting pulse forming circuit (TR7, RV1 etc). Voltage of this pulse passes through transmitting pulse drive circuit(TR9,10 etc) and is increased by pulse transformer(T2). After that ,it is supplies to magnetron.

In the case of JMA-2343, +12(V) is supplied from voltage regulator to motor, for the purpose of the number of antenna rotation which became stable. The power supply of motor is turned on or off by MCT(pulse signal) signal that is supplied from receiver unit to modulator unit.

In the case of JMA-2344, duty of MCT is controlled by BP(Bearing pulse signal), and MCT is supplies from receiver unit to modulator unit. On the basis of it, motor drive circuit(TR19,20) controls switch of power supply of motor, for the purpose of the number of antenna rotation which became stable.

2.Circuit explanation of Receiver circuit (CAE-457,457-1)

IF signal(60MHz) that was outputted from MIC(E101) is divided into three at terminal of IF signal output line.

The first signal is inputted to weaker signal line. This signal is amplified by IF amplifier1,2,3(TR3,4,5 etc) and inputted to pulse width selection circuit that is changed three band width by selection signal (BS1~ 3) from CPU(IC4). After that, the signal pass through bandwidth filter and is inputted to LOG amplifier(IC2,3). Low pass filter(R129? C69) keeps that LOG amplifier is not saturated terminal output signal with white noise.

The second signal is inputted to stronger signal line and is decreased voltage by R31 and R35 , for the purpose of not become of MIC saturation level. Gain of the signal is adjusted by IF amplifier 4 (TR6 etc) for the purpose of composite signal of weaker and stronger signal line which got linear performance at the composite point. Adding circuit (TR12,13 etc) adds weaker and stronger signal line's electric current that is amplified by LOG IC. After that, the signal pass through buffer circuit(TR14,15 etc) and is send to display unit as video signal.

The third signal is inputted to tuning indication circuit. IF signal's voltage level is decrease by TUNE_L from D/A converter (IC11). Main bang signal inside of IF signal is amplified by TR8 and that's bandwidth is limit to center frequency of weaker signal line by bandwidth filter(TR4 etc). TUNE_F from D/A converter is able to make fine adjustment center frequency of this bandwidth. After that, the signal is detected by TR9 and reformed to a DC voltage(+5V).That signal's peak is held by C63 and CD18 etc and is inputted to A/D converter inside of CPU as tuning indicating signal (TNI).

In addition that, D/A converter output MIC's tuning voltage (TUNEV) and control local frequency of MIC.

As it is stated before, transceiver (IC7,18) communicate with Display unit so that CPU(IC4) controls BS1~ 3, D/A converter and tuning voltage.