

TECHNICAL DESCRIPTION of RAY215

1. Power Supply Section

1.1

This equipment is rated for 13.2 VDC but can operate within a voltage range of 10.8 - 15.6 VDC. In case the input supply voltage exceeds 15.6 VDC, the over-voltage detection circuit (D18, Q27) cuts off the relay (RL1) to the main power supply. Reverse connection of the power supply is protected by a diode (D17) in the relay circuit.

1.2.

Pressing the Power switch on the main unit turns on the power supply via the relay circuit (consisting of Q26, Q301, D301 and IC305). Only the CPU system is powered on. The RF circuit (Q29, Q30 and Q331) remains off until the power switch is pressed on the handset. At that time, the full system is operational.

2 Receiver Section

The RAY215 is actually equipped with two receiver units, one exclusively for Channel 70 and another for All Channels.

2.1 ANT switch

The RF-signal passes through the low-pass filter to the RF pre-amplifier (Q16) via the ANT switch. After receiving a signal, the switch diode (D1-D2) becomes non-conductive.

2.2 Receiver

2.2.1 RF Amplifier

The RF amplifier consists of the FET amplifier (Q18) and a BPF having variable bandwidth by a variable capacitance diode (D12-D16). The bandwidth is automatically corrected by the control voltage supplied from the CPU to a proper value corresponding to the receive frequency. The BPF is provided with an attenuation characteristic of 15 dB or larger at the detuning point 3 MHz lower than the lower limit of the receive frequency (156 MHz). Then the RF signal, having been mixed with the 1st local signal* by the 1st mixer (Q19) after passing the BPF, is converted to the 1st IF signal (21.6 MHz).

* **Note:** The 1st local signal generated by a synthesizer has a frequency lower than the desired frequency by 21.6 MHz. The 1st local signal is fed to the 1st mixer (Q19) after being

amplified by the buffer amplifier (Q14).

2.2.2. 1st IF

The 1st IF signal of 21.6 MHz supplied via the crystal filter (F1) is amplified by the 1st IF amplifier (Q20).

2.2.3 2nd IF

The 1st IF signal, having been mixed with the 2nd local signal (21.145 MHz) in the IC (IC7 Mix, Osc, Amp, Limit, Det) for the 2nd IF, is converted into the 2nd IF signal with a frequency of 455 kHz. Further, after subjected to amplification and successive amplitude limitation via the ceramic filter (F2), the signal is demodulated by the Quad detector (quadrature detection) into an audio signal.

2.2.4 De-Emphasis

An audio signal is subjected to a correction in the frequency characteristic to -6 dB/oct by the de-emphasis circuit (IC8).

2.2.5 Squelch

High frequency noises outside the voice band among the DISC outputs are amplified with the noise amplifier (IC7) and converted into a DC voltage by the detection circuit. Then, the converted voltage is further amplified by the DC amplifier (IC314) to a BUSY1 signal, which is fed to the squelch control port (A/D). The operation level of the squelch is determined by the electronically controlled volume (IC313) and the set value for the A/D action of the CPU.

2.3 WX alert (Weather Channel)

The tone decoder (IC11) detects the 1050 Hz tone signal in the Weather Channel mode.

2.4 DSC decoding (Channel 70)

The DSC signal of 1200 bps is demodulated by the FSK Modem-2 (IC309).

3 Transmitter Section

3.1 IDC Circuit

After pre-emphasis of a 6 dB/oct in the IDC circuit (IC6), the microphone, DSC, and ATIS signals from the control system are supplied to an amplitude-limiting circuit. Then the signals

are modulated through the fifth low-pass filter for splatter prevention and supplied to the VCO. The maximum frequency deviation is set by VR3.

3.2 Buffer driver amplifier

The carrier frequency from the VCO is supplied via the diode switch (D7) to the buffer (Q2). The carrier is then amplified up to about 200 mW, and finally boosted to 25 W by the RF pre-amplifier (IC1) at the final stage. The transmitting power is supplied to the antenna by operating the ANT switch (D1) via the LPF.

3.3 APC circuit

The transmitting power is subjected to DC-detection in the detection circuit (D5), then compared with the standard set value of the output at the comparator circuit (IC2). This output controls both the PA and the driver by two-staged DC amplifiers (Q5 and Q6) so that a stable transmitting power can be supplied to the ANT. The switchover of power between 25 W and 1 W is effected with the output changeover switch (Q7). The output is set with the VR: VR1 for 1 W or VR2 for 25 W.

3.4 DSC Encoding

The FSK modulating signal of 1200 bps is produced in the FSK Modem-1 (IC308). The modulation index is 2.0 for DSC.

4. PLL Circuit

The standard PLL frequency of 12.8 MHz is oscillated and de-multiplied into 25 kHz (= 1/512) by the PLL IC (IC4). The oscillation frequency of the VCO, which has been de-multiplied into 25 kHz just like the standard, is subjected to phase comparison by a phase comparator within an IC, producing a pulse output corresponding to the deviation. The output pulse is converted into a DC value through the externally installed charge pump circuit (Q11 and Q12) and a loop filter. It is supplied to the control terminal of the VCO as a frequency control voltage. A part of the output from the VCO is fed back to the PLL IC (Fin) via the buffer amplifier (Q13). The loop filter is provided with a time-constant changeover-switch using the IC3 to meet the requirement for high-speed response by accelerating the rise characteristic at the time of transmission/reception changeover and frequency changeover. The detection circuit (IC5) enables the PLL unlocking signal to output without fluttering.

5 AF Control Section

5.1 AF Selection

An AF signal is input to matrix switch (IC309), selected by the operation of radio then output.

5.2 Application of AF signal:

AF signal in the transmitting system

- Fist-microphone AF-signal
- Hand-set microphone AF signal
- FSK signal

AF signal in the receiving system

- AF Out-1 signal

5.3 Selection/ output of each signal in radio operation

Radio in receiving state:

Selection of AF Out-1 signal connected to No.18 pin is made, providing output to No.7 and 8 pins.

Radio in transmitting state-1 (in case RAY215 main takes priority of operation):

Fist-microphone AF signal connected to No.31 pin is selected, providing an output to No.30 pin via an automatic level control circuit furnished inside the IC309

Radio in transmitting state-2 (in case the Full Function Hand-set takes priority of operation) :

Hand-set microphone AF-signal connected to IC309 pin 25 is selected, providing an output to pin No.30.

DSC in transmitting state :

FSK-signal connected to No.19 pin is selected, providing an output to No.30 pin.

5.4 Amplifier of speaker

AF Out-1 signal given by IC308 pin 8 is supplied respectively to IC312 (amplifier for the internal speaker) and IC311 (amplifier for the fist-microphone/ speaker) via the audio volume control.

Both IC312 and IC311 are respectively provided with a mute switch as following for muting the signal :

Mute switch Q312 for IC312

Mute switch Q311 for IC311

6 RF Control

6.1 Setting data for PLL

Setting the data for PLL is effected by control signals for PLL LE, PLL DAT and PLL CK based on the control data of respective CPUs (P03, P96, and P95)

6.2 Squelch level adjustment

Turning the Squelch knob on the front panel adjusts the output level of a potentiometer (IC304), then the level value is fed back to the RF panel, where the squelch operating point is set.

6.3 Busy1

For quickening detection of squelch output (BUSY1) on All-CH the output is amplified by AMP (IC303), thereafter the squelch is detected through A/D converter (CPU: P100).

6.4 Detection/ transmission of DSC signal

6.4.1 Detection of DSC

A DSC signal modulated by FSK is demodulated by FSK Modem (IC305), then the demodulated signal is supplied to CPU (IC307) P87, where the DSC is detected.

6.4.2 Transmission of DSC signal

A signal for DSC generated by CPU (IC307) is modulated by FSK Modem (IC305), then output from IC305 pin 5.

7 Handling hand-set/ fist-microphone

7.1 Change-over between hand-set/ fist-microphone

Back connector (J305) of the unit is a common connector for the hand-set and the fist-microphone. When the fist-microphone is connected, J305 pin 4 is connected to GND (grounding) and the internal connection circuit of relays (RL301, 302) is changed-over to the fist-microphone by controlling Q309 and Q310.

1) Signals during use of the hand-set

H-AF, H-MIC, H-PTT, H-TXD, H-RXD

2) Signal during use of the fist-microphone

F-SP, F-USE, F-PTT/ MIC, F-KEY1, F-KEY2

7.2 Audio I/O

1) Hand-set

- H-AF : Low impedance for signal (IC310) to the Hand-set from the unit main.

- H-MIC : Low impedance for signal to the unit main from the hand-set.

2) Fist-microphone

- F-SP : Speaker output 0.5 W/ 8Ω.
- F-PTT/MIC : Detection of microphone signal and PTT condition (Q306).

7.3 Digital I/O

1) Hand-set

- H-TXD : Data (Q306) from the unit main to the hand-set.
- H-RXD : Data from the hand-set to the unit main.

Signal is received by photo-coupler (PC302) with anti-noise characteristics taken into consideration, then after rectification of its wave form (Q305) undergoes data processing by CPU.

8 Generation of beep

Regarding beep for confirming key operation, error alarm at key operation and weather alert alarm, their signals are produced by CPU and supplied to monitor circuit. Level of Beep-1 can be set at two steps (Q303).

9 NMEA Interface

Basic interface is composed using photo-coupler (PC301).

Detected data is processed at the serial data receive port (P91) of CPU.

10 Delivery of data in LCD display

The data in LCD display is delivered in serial-clock synchronizing method to the LCD driver (CPU: P63, P60, and P57).

11 "Write" Data Operation

ROM data can be written into CPU having a flash-type memory from the Terminal (J303).

12 EEPROM

Even in the power-off state, status data requiring backup can be preserved (IC308).

13 Resetting the power supply

To secure resetting the power supply to CPU a reset circuit (IC302) is provided.

15 Front Panel Section

On the front panel are equipped with the following components to be respectively connected to the control section of the unit for effecting functions assigned; all operation keys, LED display, squelch knob, audio volume knob, power switch, channel select encoder, monitor speaker, fist-microphone connector.

15.1 Power supply system

The power supply system consists of a 13.6 VDC for LED display and a 5 VDC for other controls.

15.2 Operation key

The following keys are connected to respective systems; 16/9, MON/1/25, WX/INT, D/L/IC, SCAN/MEM, and DSC/PRI:

- 1) 16/9: Uses the common port P105 with J402-7 (16/9/DOWN)
- 2) MON/1/25, WX/INT, D/L : Each key detection at P102 (A/D conversion)
- 3) DIM, SCAN/MEM, DSC/PRI: Each key detection at P101 (A/D conversion)

15.3 LCD display function

LCD display controller • driver (IC401) is used to actuate LCD 401 in 1/3 duty of 1/2 bias-mode. Data communication with CPU is effected in serial-clock synchronizing method.

15.4 LED display function

Two function types are available; LCD back-light type and key-light type. The LCD back-light type can be set at three-steps of brightness level (D401-404). While, the key-light type functions only for putting on/ out (D405-409)

15.5 Squelch knob

A DC voltage (infinitely variable within a range of 0 V through 5 V) adjusted by VR402 is supplied to CPU terminals (IC307, P104) on the control panel.

The supplied DC voltage undergoes A/D conversion inside the CPU.

Using this A/D converted value, the CPU controls the electronic controlling system on the control panel, adjusting the squelch operation point of the RF panel. The above-mentioned value is also used as data for the squelch bar-graph on the LCD display.

15.6 Audio volume knob

Receive audio-volume is adjusted with the knob VR402.

Adjusting this knob enables to regulate the audio volumes of both the internal and external speakers.

Further, by adjusting the knob VR402 a DC voltage corresponding to the adjustment is supplied to CPU (IC307, P103) on the control panel. DC voltage supplied to the CPU undergoes A/D conversion inside the CPU, then it is used as data for a volume bar-graph on the LCD display.

15.7 Power supply switch

The power supply switch (SW402) is of a push-type, also used for audio volume adjustment. Turning on the switch SW402 activates the switch Q302 on the control panel, then the relay on/off circuit (J1-15) on the RF panel becomes ready for control function, at the same time the main power supply is turned on.

15.8 Channel select encoder

Channel select encoder (SW401) supplies a channel up/down pulse to CPU (IC307, P15/P84) on the control panel. In case of channel "Up" pulse, the indicated channel is increased. While, in case of channel "Down" pulse, the indicated channel is decreased. At the same time, CPU outputs PLL data conforming to the channel indication.

15.9 Monitor speaker

Monitor speaker (SP401) provides output of receiver ($2W/4\ \Omega$), monitoring talk through the hand-set (Intercom operation).

2. SPECIFICATIONS

4.4.1 Transmitter

Channels	All available US,International and Canada VHF Marine band
Frequency Stability	+/- 10PPM(+/- 0.001%) (-20°C to +50°C)
Frequency Range	156.025 to 157.425MHz
Channel Spacing	25 kHz Increments
Power Output	25 Watts switchable to 1 Watt into 50 Ohms at 13.6 VDC
Modulation	Frequency modulated 16F3 (+/-4.5kHz at 1000Hz)
Modulation Audio Response	Shall not vary +1/-3 dB from true 6 dB pre-emphasis from 300 to 2500Hz, reference 1000Hz. Audio frequencies 3-20 kHz shall be attenuated(at 1 kHz by 60 log f/3 dB. Above 20kHz by 50dB)
FM Hum & Noise level	Less than -40dB below audio
Audio Distortion	Less than 10% at 1kHz for 3kHz deviation
Spurious & Hamonic	Attenuated at least 43+10log Po(below ratd radiated carrier Emissions power) per FCC Rules Part 2 & 80
Antenna Impedance	50 Ohm
Transmitter Protection	Shall survive open or short circuit of antenna system without damage(10 min.test)

4.4.2 Receiver

Channels	All available US, International, Canadian VHF Marine Band
Frequency Range	156.025 to 163.275 MHz in 25 kHz increments
Frequency Stability	+/- 10 PPM(+/- 0.001%) from -20°C to +50°C
Usable Sensitivity	0.35 μ V for 12dB(SINAD)
Squelch Sensitivity	0.2 μ V or better
Threshold	1.0 μ full squelch
Adjacent Channel Rejection	70dB
Spurious Image Rejection	70dB
Inter-modulation Rejection	70dB
Audio Output	2 Watt or more at 10% or less distortion into 4 Ohm load(INTERNAL)
Hum & Noise in Audio	Less than -40dB

4.4.3 Operating Requirement

Input Voltage	13.6 VDC +/- 15%(11.6 to 15.6 VDC)
Current Required	Typical 6 amp at 25 Watts
Transmit	Typical 2 amp at 1 Watt
Operating Temperature	-20°C to +50°C
Humidity	100% at 50°C for 8 hours

4.4.4 Radio Dimensions

Height	80mm
Width	195mm
Depth	170mm
Weight	1.3kg typical