Raymarine

Raymarine Limited

RAY 240 VHF Radio

Technical Description

FCC ID PJ5RAY240

IC: 4069B-RAY240

Raymarine Limited. Registered in England. Company no. 1177969

Registered Office: Anchorage Park, Portsmouth P03 5TD

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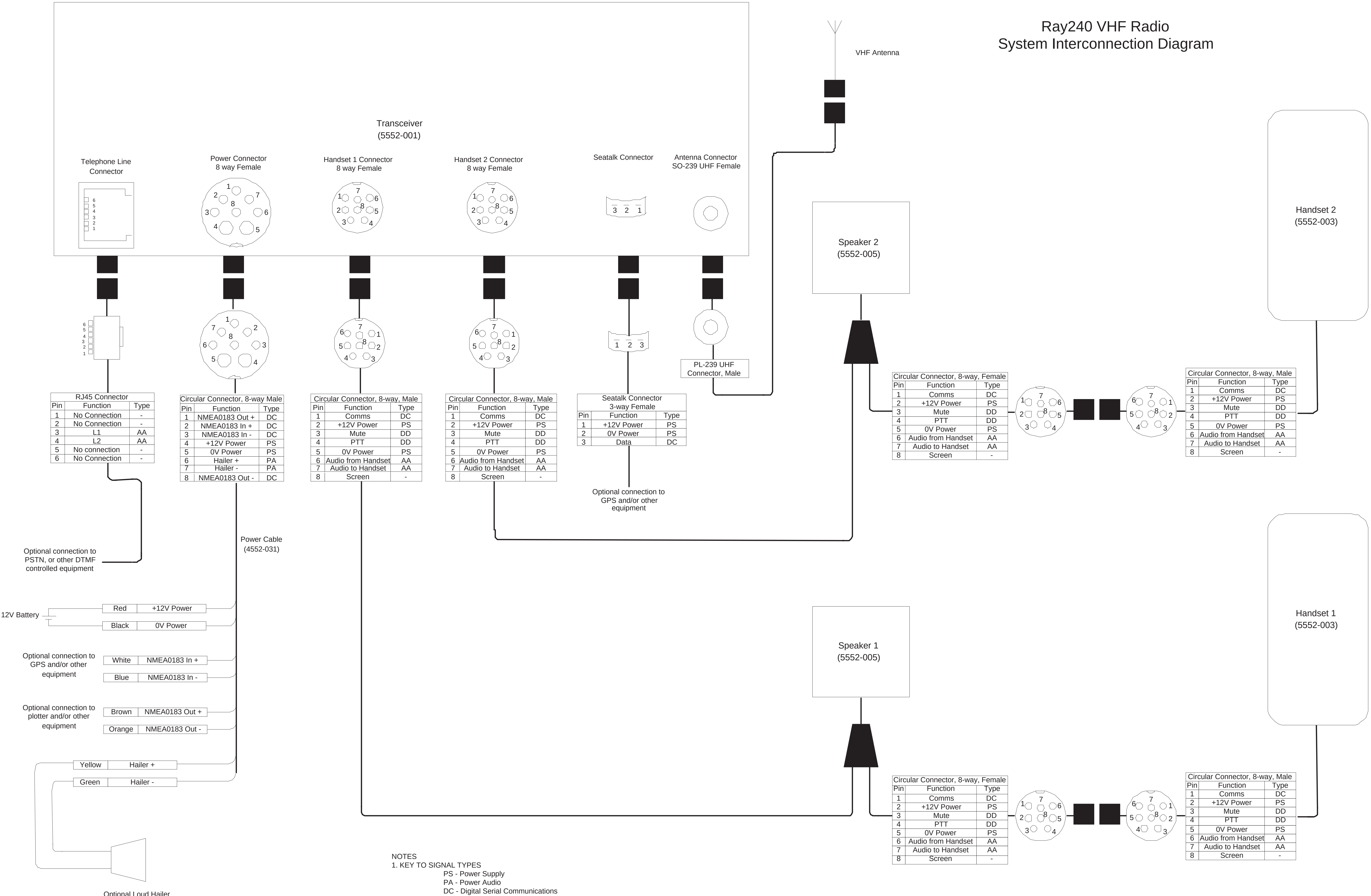
Ray240 VHF Radio
System Interconnection Diagram



RJ45 Connector

Pin	Function	Type
1	No Connection	-
2	No Connection	-
3	L1	AA
4	L2	AA
5	No connection	-
6	No Connection	-

Circular Connector, 8-way Male (Power)

Pin	Function	Type
1	NMEA0183 Out +	DC
2	NMEA0183 In +	DC
3	NMEA0183 In -	DC
4	+12V Power	PS
5	0V Power	PS
6	Hailer +	PA
7	Hailer -	PA
8	NMEA0183 Out -	DC

Circular Connector, 8-way, Male (Handset 1)

Pin	Function	Type
1	Comms	DC
2	+12V Power	PS
3	Mute	DD
4	PTT	DD
5	0V Power	PS
6	Audio from Handset	AA
7	Audio to Handset	AA
8	Screen	-

Circular Connector, 8-way, Male (Handset 2)

Pin	Function	Type
1	Comms	DC
2	+12V Power	PS
3	Mute	DD
4	PTT	DD
5	0V Power	PS
6	Audio from Handset	AA
7	Audio to Handset	AA
8	Screen	-

Seatalk Connector 3-way Female

Pin	Function	Type
1	+12V Power	PS
2	0V Power	PS
3	Data	DC

Circular Connector, 8-way, Female (Speaker 2)

Pin	Function	Type
1	Comms	DC
2	+12V Power	PS
3	Mute	DD
4	PTT	DD
5	0V Power	PS
6	Audio from Handset	AA
7	Audio to Handset	AA
8	Screen	-

Circular Connector, 8-way, Male (Handset 2)

Pin	Function	Type
1	Comms	DC
2	+12V Power	PS
3	Mute	DD
4	PTT	DD
5	0V Power	PS
6	Audio from Handset	AA
7	Audio to Handset	AA
8	Screen	-

Circular Connector, 8-way, Female (Speaker 1)

Pin	Function	Type
1	Comms	DC
2	+12V Power	PS
3	Mute	DD
4	PTT	DD
5	0V Power	PS
6	Audio from Handset	AA
7	Audio to Handset	AA
8	Screen	-

Circular Connector, 8-way, Male (Handset 1)

Pin	Function	Type
1	Comms	DC
2	+12V Power	PS
3	Mute	DD
4	PTT	DD
5	0V Power	PS
6	Audio from Handset	AA
7	Audio to Handset	AA
8	Screen	-

NOTES
1. KEY TO SIGNAL TYPES
PS - Power Supply
PA - Power Audio
DC - Digital Serial Communications
DD - Digital Discrete/Logic Switch
AA - Line Level Audio
PA - Power Audio
2. Connectors are shown viewed from the front.

Ray240 VHF Radio Transceiver Interconnect Diagram

Telephone Line Connector

Pin	Signal Name	Type
1	no connection	-
2	no connection	-
3	L1	AA
4	L2	AA
5	no connection	-
6	no connection	-

Telephone Board assy no. TBD (connector designation TBD / connector designation TBD)

Board to Board Connector, 12-way

Pin	Signal Name	Type
1	+12V	PS
2	no connection	-
3	+5V	PS
4	0V	PS
5	SCL	DC
6	SDA	DC
7	RING	DD
8	HOOK	DD
9	MUTE	DD
10	no connection	-
11	AUDIO TO TEL	AA
12	AUDIO FROM TEL	AA

Processor Board 4552-002/4552-003 — PL8, SKT1, SKT2, PL5, PL6, PL7

Power Connector 8 way Female — PL4

Pin	Signal Name	Type
1	NMEA OUT+	DC
2	NMEA IN+	DC
3	NMEA IN-	DC
4	+12V	PS
5	0V	PS
6	HAILER+	PA
7	HAILER-	PA
8	NMEA OUT-	DC

Handset 1 Connector 8 way Female — SKT1

Pin	Signal Name	Type
1	COMMS	DC
2	+12V	PS
3	MUTE	DD
4	PTT	DD
5	0V	PS
6	AUDIO FROM HANDSET	AA
7	AUDIO TO HANDSET	AA
8	SCREEN	-

Handset 2 Connector 8 way Female — SKT2

Pin	Signal Name	Type
1	COMMS	DC
2	+12V	PS
3	MUTE	DD
4	PTT	DD
5	0V	PS
6	AUDIO FROM HANDSET	AA
7	AUDIO TO HANDSET	AA
8	SCREEN	-

Handset 3 Connector 8 way Female — SKT3

Pin	Signal Name	Type
1	COMMS	DC
2	+12V	PS
3	MUTE	DD
4	PTT	DD
5	0V	PS
6	AUDIO FROM HANDSET	AA
7	AUDIO TO HANDSET	AA
8	SCREEN	-

Seatalk Connector — PL5

Pin	Signal Name	Type
1	+12V	PS
2	0V	PS
3	DATA	DC

Interconnect Board 4552-021 — PL4, SKT1, SKT2, SKT3, PL5, PL1

Card Edge Connector, 62-way (PL1 to SKT1)

Pin	Signal Name	Type
1	+12V	PS
2	0V	PS
3	+12V	PS
4	0V	PS
5	+12V	PS
6	0V	PS
7	+12V	PS
8	0V	PS
9	+12V	PS
10	0V	PS
11	+12V	PS
12	0V	PS
13	HAILER+	PA
14	HAILER-	PA
15	HAILER+	PA
16	HAILER-	PA
17	NMEA OUT+	DC
18	NMEA OUT-	DC
19	0V	PS
20	0V	PS
21	NMEA IN+	DC
22	NMEA IN-	DC
23	N2000 V-	PS
24	no connection	-
25	N2000 LO	DC
26	ST1 V-	PS
27	N2000 HI	DC
28	ST1 V+	PS
29	N2000 V+	PS
30	STALK1	DC
31	no connection	-
32	HS COMMS	DC
33	0V	PS
34	0V	PS
35	0V	PS
36	0V	PS
37	0V	PS
38	0V	PS
39	SPKR1 MUTE	DD
40	HS1 PTT	DD
41	AUDIO FROM HS1	AA
42	AUDIO TO HS1	AA
43	0V	PS
44	0V	PS
45	0V	PS
46	0V	PS
47	0V	PS
48	0V	PS
49	SPKR2 MUTE	DD
50	HS2 PTT	DD
51	AUDIO FROM HS2	AA
52	AUDIO TO HS2	AA
53	0V	AA
54	0V	AA
55	0V	AA
56	0V	AA
57	0V	AA
58	0V	AA
59	SPKR3 MUTE	DD
60	HS3 PTT	DD
61	AUDIO FROM HS3	AA
62	AUDIO TO HS3	AA

Board to Wire Connector, 2-way (SKT2 to +12V pad / 0V pad)

Pin	Signal Name	Type
1	+12V	PS
2	0V	PS

Board to Board Connector, 12-way (PL5 to SKT1)

Pin	Signal Name	Type
1	0V	PS
2	+5V	PS
3	ALL CH NOISE	AN
4	ALL CH RSSI	AN
5	CH70 NOISE	AN
6	CH70 RSSI	AN
7	TX POWER MON	AN
8	VSWR FWD	AN
9	VSWR REV	AN
10	MOD TO RADIO	AA
11	AF FROM RADIO	AA
12	CH70 AF	AA

Board to Board Connector, 12-way (PL6 to SKT2)

Pin	Signal Name	Type
1	SPI EE CS	DC
2	SPI DAC CS	DC
3	SPI SYNTH CS	DC
4	SPI DATA TO RADIO	DC
5	SPI DATA FROM RADIO	DC
6	SPI CLOCK	DC
7	VCO ADJUST 0	DD
8	VCO ADJUST 1	DD
9	VCO ADJUST 2	DD
10	VCO LOCKED	DD
11	VCO TX RX	DD
12	no connection	-

Board to Board Connector, 12-way (PL7 to SKT3)

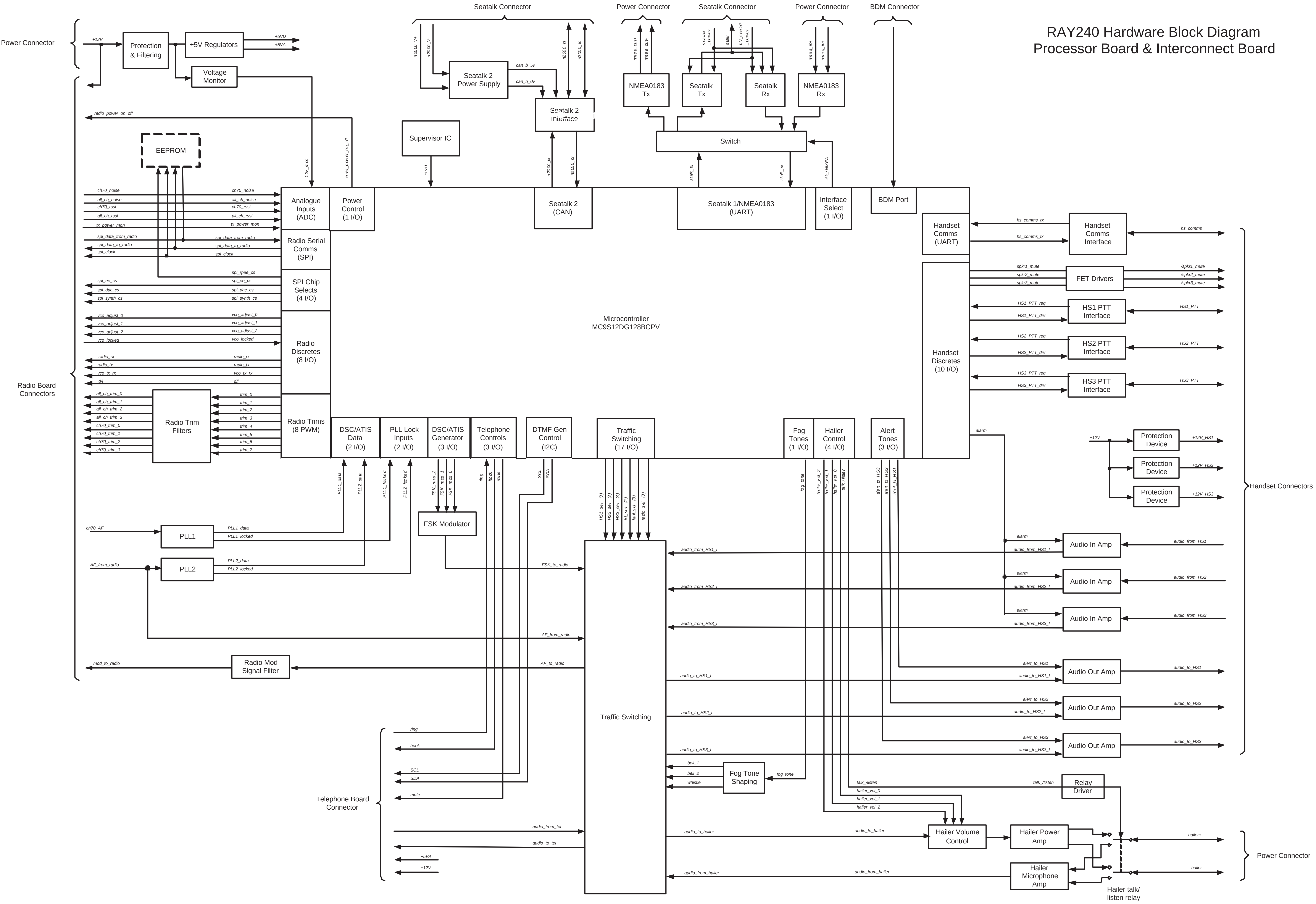
Pin	Signal Name	Type
1	ALL CH TRIM0	AN
2	ALL CH TRIM1	AN
3	ALL CH TRIM2	AN
4	ALL CH TRIM3	AN
5	CH70 TRIM0	AN
6	CH70 TRIM1	AN
7	CH70 TRIM2	AN
8	CH70 TRIM3	AN
9	RADIO RX	DD
10	RADIO POWER ON OFF	DD
11	RADIO TX	DD
12	D/L	DD

Radio Board 4552-001 — +12V pad, 0V pad, SKT1, SKT2, SKT3, CXTP1

Antenna Connector SO-239 UHF Female — CXTP1

NOTES
1. KEY TO SIGNAL TYPES
PS - Power Supply
PA - Power Audio
DC - Digital Serial Communications
DD - Digital Discrete/Logic Switch
AA - Line Level Audio
PA - Power Audio
2. Connectors are shown viewed from the front.

RAY240 Hardware Block Diagram
Processor Board & Interconnect Board



RAY 240 Processor and Interconnect PCBs Circuit Description

Introduction

The processor board is the central control unit of the Ray240 VHF system. It controls the system in response to commands received from the handsets and, conversely, reports the system status to the handsets for display.

In addition, the processor board provides power supply filtering; the auxiliary external communications functions, Seatalk and NMEA0183; the loudhailer function and optional plug-in telephone line interface.

An edge connector on the processor board accepts the interconnect board through which connections to the handsets, power source and external interfaces are made. Three further board-to-board connectors mate with the radio board, which contains the rf functions.

The interconnect board may be considered an extension to the processor board on which the transceiver's external connectors are mounted. The interconnect board is central to the EMC design strategy, having the EMC or "clean" ground plane to which signals entering and leaving the transceiver are filtered and shields terminated.

The processor and interconnect board hardware are shown in the block diagram.

Power Supply

The 12V battery supply enters the transceiver at the power connector on the interconnect board. The battery supply is protected with a 10A automotive style fuse in the positive line, located on the interconnect board and accessible without removing the transceiver cover. In the event of reverse supply connection a power diode conducts and blows the 10A fuse.

After filtering on the processor board the 12V supply is distributed to the radio board and handsets. The handset supplies are individually protected with 1.8A reset-able fuses, located on the interconnect board.

The voltage monitor sends a dc level proportional to the supply voltage to one of the microcontroller's analogue to digital converters. This allows software to detect an over-voltage condition, for example connection to a 24V supply. When an over-voltage is detected the microcontroller disables the transmitter and receiver modules on the radio board, to prevent damage, and alerts the user with a message on the handset display.

On the processor board the 12V supply is regulated to 5V to supply the electronics. Two regulators are used: one for the digital circuits and one for the analogue. The hailer power amplifier, NMEA0183 transmitter and handset communications interface are powered from the unregulated 12V supply. The processor board draws 75mA typ. from the 12V supply.

Microcontroller

The processor board is built around a 16-bit microcontroller, Motorola MC9S12DG128CPV. It has 128kbyte flash memory that is programmed via the BDM (background debug mode) port, 8k RAM, 2k EEPROM and a variety of on-chip peripherals that are used to control and monitor the system.

The microcontroller uses a 14MHz crystal oscillator. Provision is made to fit an additional off-chip EEPROM should expansion be required.

Reliable reset at power-on and during brown-out conditions is assured by the supervisor IC.

Radio Interface

The radio interface comprises a collection of signals that control the radio module i.e. transmitter, all-channel receiver and Channel 70 receiver. The signals can be divided into groups:

- Analogue inputs to microcontroller ADCs: indicating noise levels and received signal strength from each of the receivers and transmitter power level.
- SPI data link to the synthesiser, DAC and EEPROM on the radio board: the microcontroller reads calibration data from the radio board EEPROM and sets the VCO frequency by commanding the synthesiser; it coarse tunes the VCO and local oscillators by writing to the DAC.
- DC voltages that trim the receiver tuning filters: The microcontroller generates these voltages based on calibration data read from the radio board EEPROM. The PWM signals are converted to dc levels, with negligible ripple, by the radio trim filters.
- Discrete signals: to enable and disable the transmitter and receivers, power down the radio module, coarse trim and monitor the locked status of the VCO.

Traffic Switching and Audio Amplifiers

The traffic switching block routes audio signals between the “talkers and listeners” in the system: the “talkers” are the audio sources i.e. handset microphones, radio receivers, hailer microphone amplifier, FSK modulator and telephone; the “listeners” are audio destinations in the system i.e. handset speakers, radio transmitter, hailer power amplifier, telephone.

Each listener has a multiplexer capable of selecting any one of the talkers as its audio source. This flexible arrangement allows multiple audio paths to be selected concurrently; half duplex for radio and hailer communications, full duplex for intercom and telephone.

Audio signals into and out of the processor board are buffered with audio amplifiers.

The audio output amplifiers mix the alert tones, generated by the microcontroller with the audio signal, and apply the –6dB/octave de-emphasis characteristic.

The radio mod signal filter band limits the audio signal for transmission to 3kHz prior to modulating the rf carrier.

DSC and ATIS Functions

ATIS and DSC signals are encoded using frequency shift keying (FSK), where data 1 = 1300Hz and 0 = 2100Hz. The FSK modulator takes three digital signals from the microcontroller, switched in a pre-defined sequence, and converts them into a stepped approximation to a sinewave. The stepped sinewave is filtered to produce a purer sinewave with typically 3% total harmonic distortion that then modulates the rf carrier. The filtering also applies a +3dB/octave pre-emphasis characteristic. The frequency of the FSK signal is determined by very accurately controlling the rate at which the digital inputs to the FSK modulator are switched.

DSC signals received on channel 70 appear as FSK at the receiver output and are passed to a phase locked loop (PLL1). PLL1 is configured to demodulate FSK, and the recovered DSC message data is passed to the microcontroller for processing. PLL1 also generates an interrupt, alerting the microcontroller, when it is locked to an incoming signal.

A second phase locked loop (PLL2), monitors the audio signal from the all channel receiver. Radios destined for the European market have PLL2 configured the same as PLL1 to detect FSK, in this case ATIS signals appended to voice transmissions. In the event that PLL2 detects FSK, it interrupts the microcontroller which then validates the incoming ATIS data and squelches the audio so that the listener does not hear the ATIS burst.

Radios for the US market have no requirement for ATIS detection and PLL2 is instead configured to detect the 1050Hz NOAA weather alert tone.

Handset Interfaces

A handset interface comprises

- Line level audio signals to and from the handset.
- Serial communications line that carries display information to the handset and key-press information from the handset, utilising one of the microncontroller's UARTs.
- Discrete PTT signal that directly indicates when the PTT switch on the handset is pressed
- Discrete mute signal to the active speaker, mutes the speaker in transmit mode

In addition to these functions, the microcontroller can signal an alarm by pulling the audio line from the handset

to 12V. In the active speaker, this over-rides the volume control and forces maximum volume. The alarm signal is issued concurrently with an alert audio tone in the event of special conditions such as receipt of a DSC distress message.

Seatalk & NMEA0183 Communications

The second of the microcontroller's UARTs is used for serial communications with external systems, such as GPS. The UART can be connected either to a Seatalk interface (Raymarine's proprietary single wire half-duplex communications interface) or to an NMEA0183 transmitter and receiver.

The Seatalk interface and NMEA0183 receiver are opto-isolated to prevent ground loops occurring on the vessel. Opto-isolating also protects against damage due to mis-connection of the Seatalk power supply at the Ray240.

Seatalk2 Communications

Provision is made on the processor board to fit, as a future option, an NMEA2000 compliant, "Seatalk2" interface.

Hailer

The processor board can operate a loudhailer in either "talk" or "listen" mode. In talk mode, the talk/listen relay connects the horn to a power amplifier, audio from any handset may be routed via the eight-step hailer volume control, to the power amplifier.

In listen mode the talk/listen relay connects the horn to the input of a small signal amplifier and the horn acts as a directional microphone. The signal from the horn is amplified and routed to the handset and speaker.

The loudhailer may also be used as fog horn. The talk/listen relay is switched to talk and, instead of voice, a fog signal tone, generated by the microcontroller, is routed to the power amplifier. The standard tone is a square-wave “whistle”, but provision is also made to generate a “bell” sounding tone.

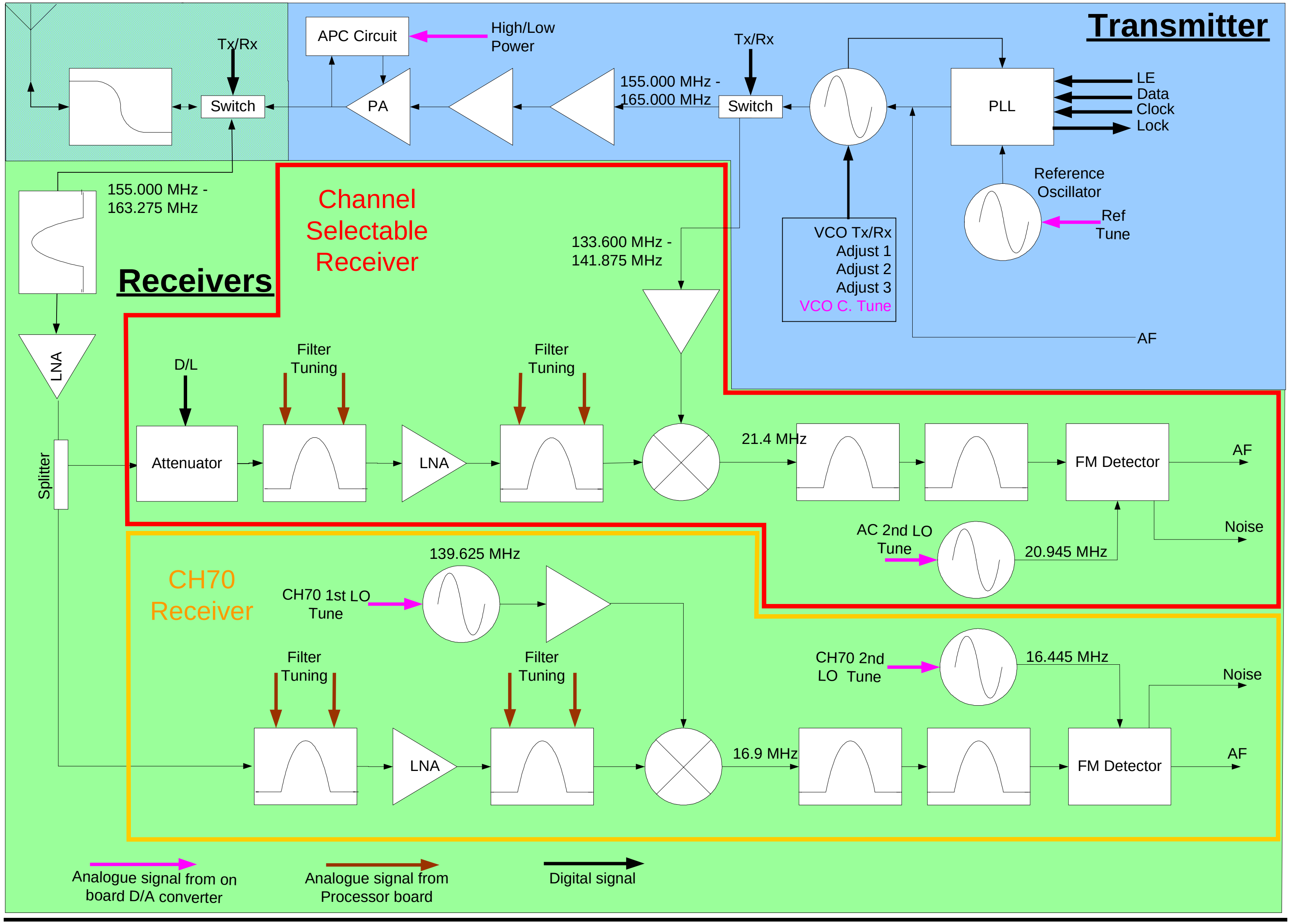
Telephone Interface

The telephone interface is an optional plug-in board that connects the Ray240 to a standard telephone line or DTMF controlled device, enabling the Ray240 to be used as a telephone.

The telephone interface comprises:

- 12V and 5V power
- Audio lines to and from the telephone line
- Discrete signals indicating on-hook/off-hook and ringer status
- A spare discrete nominally called “mute”
- An I2C serial communications interface, used for controlling a DTMF generator on the telephone interface board

RAY 240 RF PCB Block Diagram



Ray240 RF PCB Circuit Description

The RF PCB is the FM transmitter and receiver section for the Ray240 marine VHF radio with Class "D" digital selective calling, and has one transmitter, one 'channel selectable' receiver (for audio purposes) and one fixed frequency receiver which is used solely for the reception of digitally encoded messages on Channel 70. The radio can only be in either a transmit or receive mode, and cannot do both at the same time. As a result of this, there is a central VCO/Synthesiser whose output is used as the transmit carrier when the radio is transmitting and LO for the first down converter for the Channel selectable receiver. Below is brief summary detailing the main performance criteria of the radio.

Power Supply	
Supply voltage +12V	Rx mode: 200 mA Max., Tx mode: 6 A Max
Supply voltage +5V	10 mA Max
Transmitter	
Transmitter Frequency Range	155.00 to 165.00 MHz with 25 kHz channel spacing
Transmitter Output Power	25 Watts, switchable to 1 Watt
Modulation	Frequency modulated at 16F3 (±4.5 kHz at 1kHz)
Receiver	
Receiver Frequency Range	155.00 to 163.275 MHz with 25 kHz channel spacing
Receiver Usable Sensitivity	-3 dbµV (emf) or –116 dBm
Channel selectable 1st IF	21.4 MHz
CH 70 1st IF	16.9 MHz
Channel selectable and CH70 2nd IF	455 kHz

The RF PCB goes through an electronic alignment/set up procedure, and the resulting data from this alignment process is stored in an EEPROM located on the PCB.

VCO/synthesiser

The VCO is phase locked to a 21.85 MHz crystal oscillator by using an LMX2306 synthesiser from National Semiconductor. The frequency of the reference oscillator is fine tuned with a varacter diode. The voltage across the diode is controlled be a D/A converter.

The synthesiser is programmed (via an SPI link) to enable the VCO to change its output frequency in 12.5 kHz steps. When the radio is transmitting, the VCO operates between 155.000 MHz and 165.000 MHz, and when the radio is in receive mode, operates between 133.600 MHz and 141.875

MHz. Digital signals control the band of operation of he VCO, by switching in/out capacitors in the VCO circuitry.

The synthesiser controls the frequency of the VCO by altering a voltage level on a varacter diode. To reduce the phase noise in the adjacent channel, this tuning voltage is kept between 3 and 4 volts. This tuning voltage is coarsely controlled by the switched capacitors mentioned above and another varacter diode, which is controlled by a D/A converter.

The output of the VCO is switched between the transmit chain and the mixer in the Channel Selectable receiver.

Transmitter

The transmit chain is comprised of two amplifiers. Firstly a buffer amplifier is used to increase the power of the signal from 0 dBm to +18 dBm. This amplifier is heavily compressed to ensure the input power to the main PA module remains constant. This signal is then amplified by the main PA module to either 1Watt (+30 dBm) or 25 Watts (+44 dBm), with an RA35H1516M power amplifier module from Mitsubishi. This device has a gain control pin, which in conjunction with an automatic power control loop, controls the output power of the radio

Antenna switch/filter

A PIN diode switch connects the antenna connector of the radio to either the transmitter or the receiver. To ensure the receiver is not damaged when the radio is transmitting at 25 Watts, the switch has a high degree of isolation between the transmitter and the receiver. The antenna terminal of this switch is connected to a low pass filter. This ensures that the harmonics of the output signal from the Mitsubishi amplifier are attenuated to a level less than 0.25 µW (–36 dBm).

Receiver

The receiver port of the antenna switch is connected to a bandpass filter and a low noise amplifier. The bandpass filter is tuned to 160.000 MHz and has a 3 dB bandwidth 10 MHz. This filter prevents the LNA from being saturated by large out of band signals.

The output signal of the LNA is then split between the channel selectable receiver and the CH70 receiver. An attenuator can be switched into the channel selectable path allowing the user to desensitise the radio when in the presence of high power signal levels

Both the receivers are comprised of the same blocks, and these are described below.

Bandpass filters and LNA

The main purpose of the bandpass filter is to attenuate the 1st image frequency of the receiver. This is defined as *Nominal frequency of the receiver – (2x 1st IF frequency).*

As the nominal frequency of the channel selectable receiver can change, the bandpass filter has the ability to be tuned accordingly. This is achieved by four varacter diodes, which are controlled by voltages generated by the processor PCB.

The filters for the CH70 receiver are tuned using the method mentioned above, however these voltages remain at a fixed level. The processor PCB also generates these voltages.

Mixer

The received signal is down converted to the 1st IF by mixing it with an LO frequency.

For the channel selectable receiver, the LO signal is generated by the VCO/Synthesiser. The nominal frequency of the receiver is defined as *LO Frequency + 1st IF Frequency*

For the CH70 receiver, the LO signal is generated by a crystal controlled oscillator at 46.524 MHz, and then tripled to produce the 139.625 MHz signal.

Crystal bandpass filter

The crystal filters have a centre frequency equal to the 1st IF frequency of the receiver. These filters are designed to attenuate two different frequencies. The 2nd image frequency of the receiver is attenuated by this filter, which is defined as *Nominal frequency of the receiver – (2x 2nd IF frequency).*

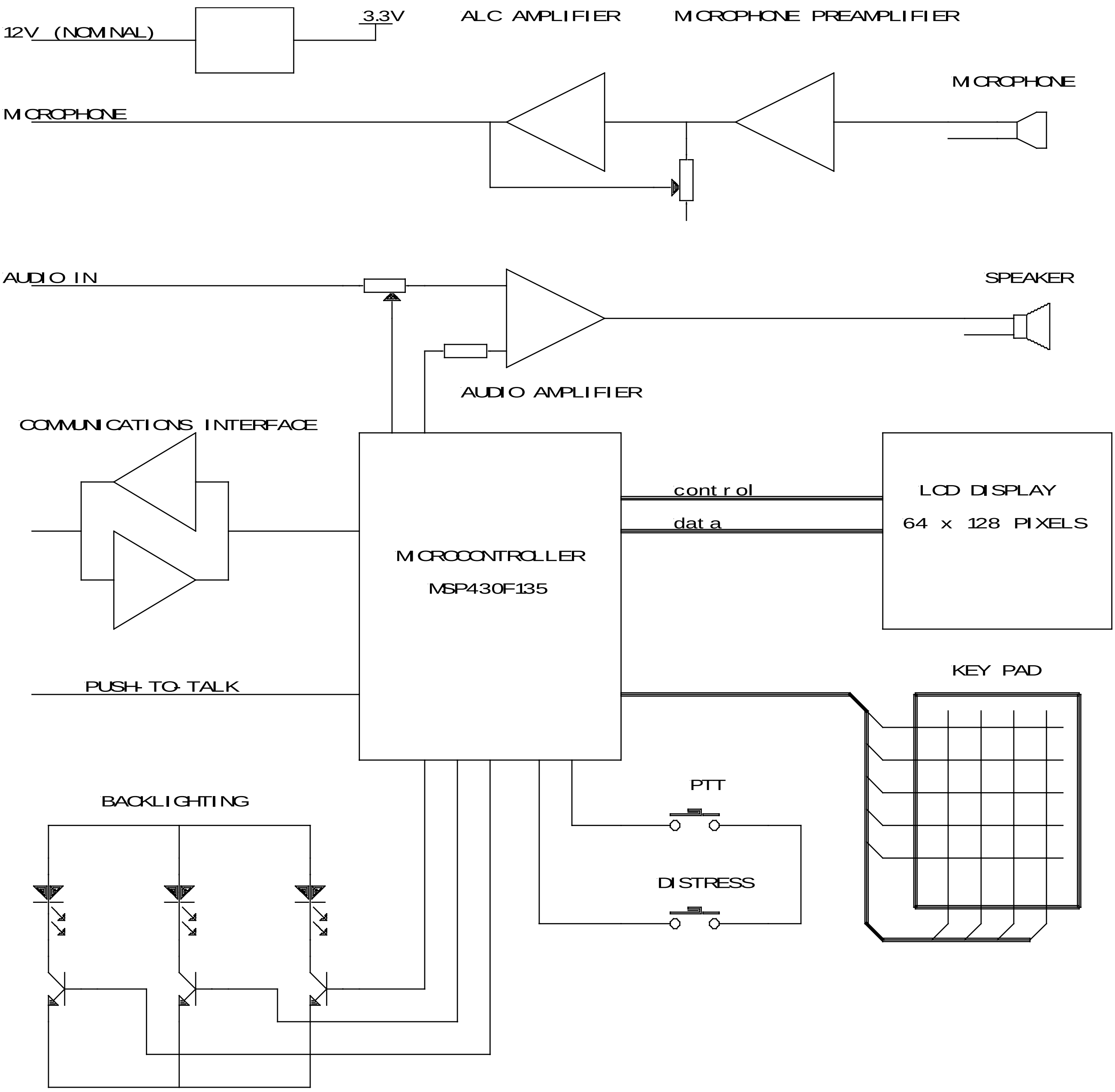
The filters also attenuates signals >25 kHz away from the nominal frequency of the receiver (ie the adjacent channel).

Detector IC

The outputs of the crystal filters are connected to a BA4116FV detector IC from Rohm. This device down converts the 1st IF frequency to the 2nd IF frequency by using a crystal oscillator. This down converted signal is then demodulated by a quadrature detector to produce the received audio signal

This device has an output pin whose voltage is relative to how noise the received signal is. This voltage is used by the processor PCB to determine whether the squelch should be opened or closed.

RAY 240 Handset Block Diagram



RAY 240 Handset Circuit Description

Power Supply

Power is supplied to the handset from the main radio via an extension lead and waterproof connector. There is no provision for reverse supply protection, as this is impossible if the connectors are fitted correctly. Provision for reverse polarity protection is provided inside the main radio. As such, the polarity of the voltage to the handsets should always be correct.

The power supply can range from 9V to 25V, accounting for the wide range of voltages that can be obtained from a discharged, or fully charged nominal 12V lead-acid battery, up to inadvertently connecting the unit to a 24V system.

An on-board 3.3V regulator reduces the voltage to that necessary for the microprocessor, display and ancillary equipment to run. Because of the low current requirements placed on the 3.3V supply, an external heat sink for the supply regulator can be dispensed with, even allowing for the high volt drop across the regulator. The raw 12V (nominal) voltage is also used to drive the LED backlighting where relatively high currents are required, where this reduces the load on the 3.3V regulator, and for the Seatalk interface where 12V is required to attain the signal level required. If the system is connected to a 24V supply, the LCD backlighting is disabled as excessive heat dissipation in the transistor drivers (TR15,TR16,TR17)will result if the LED's are lit.

Micro-controller

The micro-controller is a Texas Instruments MSP430F135. This is a very low-power 16-bit micro-controller with 16kBytes of Flash memory and 512 Bytes of RAM. The on-board 12bit ADC converter is unused in this application. The micro-controller reads the keyboard, drives the LCD display, and the backlighting. In addition, it communicates to the main processor in the radio box via a Seatalk interface, operates the PTT and audio volume controls, and provides provision for a 'key-click' audio indication. It operates from a 3.3 supply derived from the main battery supply of 12V nominal by the LM317 regulator.

Display.

The display is a 128 pixel by 64 pixel full graphic monochrome FSTN LCD display module. The module is a Chip On Glass (cog) construction with interconnections to the processor via a 30 way flat ribbon connection. The controller chip is attached directly to the glass substrate of the display and runs from a 3.3V supply. This greatly reduces the number of interconnections required between the display and processor. The display requires 4 control lines in addition to the 8 data lines to send information onto the screen. The rest of the connections are used for the capacitors required by the on-chip voltage generator circuitry of the controller chip.

Keyboard.

The handset contains a total of 27 pushbuttons, of which only 25 are in the key-matrix. The remaining two keys are DISTRESS and PTT. These keys are read separately by the processor on dedicated input ports. The key matrix can thus be driven to allow only one key to be active at any time and will not 'lockout' the distress key or PTT key if any other key on the keypad is pressed.

Seatalk Interface:

The interface that the system uses to communicate to the main processor is based on the Seatalk interface that is widely used in Raymarine equipment. The hardware configuration has been based very closely on that used on many other Raymarine equipment, with some slight resistor changes to ensure correct operability with a 3.3V processor supply.

Backlighting.

Backlighting is split into 3 different sections, which can be independently controlled. The display backlighting comprises 4 green LED's situated behind the LCD display, the keypad backlighting comprises 24 green LED's and the backlighting for the distress button comprises a single green LED. The output from the micro-controller is a PWM signal that adjusts the brightness of the LED's. The supply to the LED chains comes from the +12V(nom) battery supply, and so the circuit limits the current flowing through the LED's to a safe level if the signal from the micro-controller is at a constant high level. Because of the constant current drivers, the LED's do not change their brightness appreciably when the battery supply fluctuates over the range 10.8 to 15.6 Volts. The PWM signal is driven at approximately 20kHz to ensure that there are no audio artifacts from the backlighting apparent in the handset speaker.

Microphone Pre-amplifier

The microphone pre-amplifier is a 2-stage circuit. The first stage amplifies the small signal levels from the electret-condenser microphone (approx 4mV for 94dBA spl) to a level sufficient for the second stage. The first stage also applies pre-emphasis to the signal as required for transmission of audio signals over an FM radio link. The second stage comprises an automatic level control circuit that soft-limits loud audio signals to prevent over-modulation of the output signal. RPT1 sets the gain of the first stage to ensure uniform output signals for differing microphone characteristics. RPT2 is used to set the level at which soft-limiting occurs. The gain of the first stage is relatively low to ensure that the output of the first stage does not clip for large audio input signals.

Audio Amplifier.

The audio amplifier is a Philips TDA8552 1W Bridge tied load amplifier with integral volume control. A single pin on the device is used to control the volume. The volume is adjustable in 64 steps from –60dB to +20dB in 1.25dB increments. On power up, the amplifier volume control setting is set at –20dB. A positive pulse on the volume control pin increments the volume by 1, whilst a negative pulse on the volume control pin decrements the volume control by 1. The volume control is driven by a single pin on the processor. The output of the amplifier is fed into an 8R 1W miniature 13mm diameter speaker .

Key-beep.

A key-beep facility is provided, whereby every press of the keypad can be accompanied by a beep from the handset speaker. Because of the integral volume control within the amplifier chip, the volume of the key-beep is dependent on the setting of the volume control. The key-beep is provided as a square-wave signal from the microprocessor pins at the frequency of the beep required. Adjusting the mark-space ratio of the signal waveform will alter the apparent loudness of the signal. In this way, the microprocessor can produce a key-beep that apparently sounds at the same set level no matter what the setting of the volume control pin, by matching the volume control setting with an increase or decrease of key-beep signal level.

On-Hook/Off-Hook sensor.

A uni-polar hall effect device provides a method where the system can detect if the handset is placed in its cradle or not. It provides a logic level output suitable for feeding into a port pin of the microprocessor when either pole of a magnet produces a magnetic level of at least 55 gauss within its vicinity. A ferrite magnet placed within the body of the cradle is used to activate the sensor when the handset is attached to the cradle.

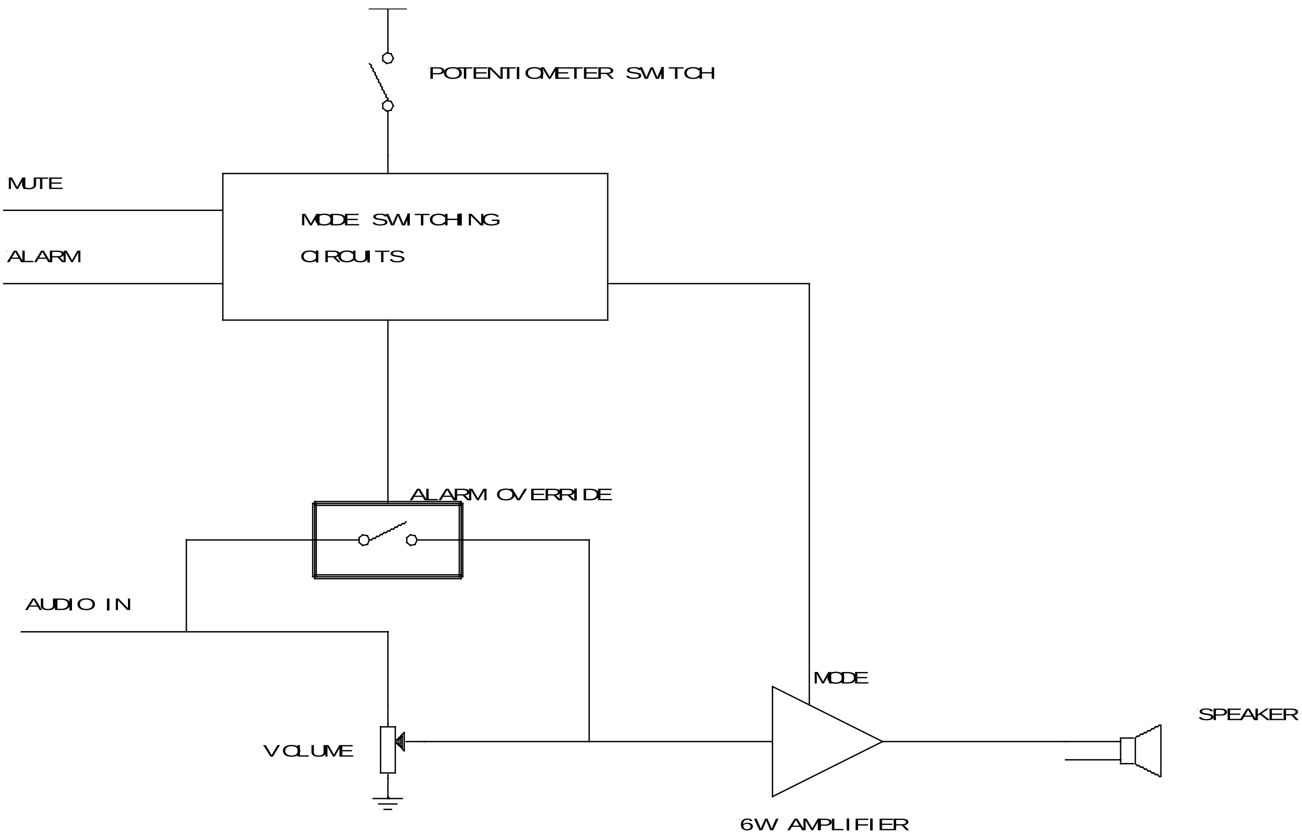
Distress Button

The distress button is used to send DSC distress messages. It is monitored directly by a separate processor pin so that's its operation cannot be masked by any other key press.

PTT (Push to Talk)

The PTT line from the main processor is used to set the transmitter into transmit mode whenever the PT button is pressed by pulling the PTT line low. However, the PTT line is also used to set up initial communications between the radio processor board and handset at power on, and a data stream is sent down this line at this time. The data stream is interpreted by the micro-controller during initialization. The PTT switch is monitored by the processor and is therefore ignored if pressed whilst initial setup is undergone. After initialization has completed, the PTT switch position is echoed onto the PTT line by TR10, operated by the micro-controller.

RAY 240 Active Speaker Block Diagram



RAY 240 Active Speaker Circuit Description

The RAY240 Active speaker amplifies the audio signal from the RAY240 base unit to the handsets to allow operators to listen to incoming traffic without the need to listen to the handset. A volume control is accessible from the front of the unit to adjust the volume of the speaker from off to a maximum of 5W output power. Additionally, two extra control lines are controlled by the RAY240 base station. One control allows the output of the speaker to be muted, whilst still allowing the audio signal to be routed on to the handset. This is especially useful when intercom mode is selected to prevent 'howl-round' of the audio signals in this full-duplex mode. The second control overrides the volume control setting, even when the unit is switched to the off position, to output an alarm sound when DSC distress calls are received on the RAY240 radio. The unit will produce an alarm output in excess of 80 dB spl at 1m. Turning the volume fully anti-clockwise will set the unit into standby mode, and current consumption of the unit is then less than 10mA.

Power Supply

Power is supplied to the active speaker from the main radio via an extension lead and waterproof connector. There is no provision for reverse supply protection, as this is impossible if the connectors are fitted correctly. Provision for reverse polarity protection is provided inside the main radio. As such, the polarity of the voltage to the active speaker should always be correct.

The power supply can range from 9V to 25V, accounting for the wide range of voltages that can be obtained from a discharged, or fully charged nominal 12V lead-acid battery, up to inadvertently connecting the unit to a 24V system.

The amplifier used in the Active Speaker is thermally protected from overload and output short circuit protected for supply voltages up to 18V. The amplifier can tolerate supplies up to 25V, but at supply voltages above 18V it should be ensured that the audio to the input of the amplifier is off to ensure that damaging current do not circulate in the output stages of the amplifier.

A COMS 4066 analogue switch is incorporated in the amplifier. Its supply is zener limited to 15V to ensure it will not be damaged when the amplifier supply exceeds 18V All the other devices in the amplifier are tolerant to 25V.

The amplifier is capable of pulling peak currents of 2A from the supply. With an 830mV rms 1kHz sine wave applied to the input of the active speaker, the current consumption of the unit should be just less than 1A. Current consumption in standby mode is less than 10mA.

Audio Amplifier

The amplifier is a Philips 8943SF single channel bridge tied load audio amplifier with an output power of 6W into an 8ohm load with a 12V supply. The outputs are protected by an internal thermal shutdown protection mechanism and short circuit protection. A mode selection pin allows the amplifier to enter 3 separate states by applying the proper DC voltage to it. These three modes are: Standby, Mute and Operating.

In STANDBY mode the current consumption is very low and the outputs are floating. The device is in standby mode when the mode pin of the amplifier is between (VCC − 0.5 V) and VCC. The power consumption of theTDA8943SF will be reduced to <0.18 mW.

In the MUTE mode the amplifier is internally powered but the audio output circuits are disabled. The DC level of the input and output pins remain on half the supply voltage. The device is in mute mode when the mode pin is at a voltage greater than 3V and less than (VCC − 1.5 V).

In the OPERATE mode the amplifier is operating normally. The operating mode is activated when the mode pin is less than 0.5 V.

The gain of the amplifier is fixed at 32dB. An input attenuator (including the volume control) ensures that the input presented to the amplifier will produce a rated power output of 5W at the speaker for 830mV rms 1kHz sine wave at the input to the active speaker.

MUTE

The mute signal is floating for normal operation, and low when the unit is muted. If the volume control switch is not in the OFF position, i.e., such that the integral switch in the volume control is closed, then the mode pin on the amplifier is held at mid-supply rail by a couple of 10k resistors. The output of the amplifier is the MUTED. The mute operation is overridden by the volume control switch, such that the system can be placed into STANDBY mode when the switch is in its off position, irrespective of the level on the mute pin. In standby mode there is no output from the amplifier. The mute mode is also overridden by the ALARM mode.

Alarm Override

An alarm override control is fitted to the amplifier such that it is possible to override the mute and volume control settings to output a DSC alarm condition. When the Alarm mode is activated the amplifier will output an alarm mode in excess of 80dB spl at 1m. Operation of the alarm can only be cancelled from the RAY240 handset. Turning the volume control knob will have no effect in alarm mode. The alarm mode signal is carried on the same wire as the microphone signal from the RAY240 handset. The microphone signal will never achieve a signal level greater than 3.3V, since the signal is supplied from a single ended op-amp running from a 3.3V supply. This is not a sufficient voltage to trigger the alarm mode in the speaker. Alarm mode is activated in the RAY240 main processor box by pulling the signal line high t0 12V. When the signal exceeds approximately 6V, the alarm mode in the amplifier is entered.