



GE
TRANSPORTATION
SYSTEMS

GLOBAL SIGNALING DIVISION

COE Communications Engineering Document

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Title: **12RII FCC TECHNICAL MANUAL**

12R
SERIES II



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1. Scope

This document provides the necessary technical information to comply with the requirements for FCC certification. This document will be superseded by the 12RII Service Manual when issued.

2. Revision History

REV	DATE	BY	COMMENTS
A	3/8/02	KLK	Initial Release FCC distribution only.
	3/19/02	JCK	Added FCC Information to the User

3. Reference Documents

AAR Communication Manual – Section 12
12RII Part Number Assignment Document
TK-790/(B) Service Manual

4. Abbreviations and Acronyms

12RII-LC	12RII Local Control Radio (Control Panel Installed)
12RII-RC	12RII Remote Control Radio (Interface to Standard AAR Control Head)
12RII-SR	12RII Serial Remote Control Radio (Interface to Serial Remote Control Head)
AAR	Association of American Railroads
DTMF	Dual Tone Multi-Frequency (standard telephone tones).
FCC	Federal Communication Commission
FM	Frequency Modulation
FP	Front Panel Assembly
FPB	Front Panel Board
GETS	General Electric Transportation Systems
GS	Global Signaling
GSPN	Global Signal Part Number
PC	Personal Computer
PSB	Power Supply Board
PTT	Push – To - Talk
RCB	Radio Control Board
RPM	Radio Processor Module

5. 12RII Radio Systems

The 12RII radio supports 3 major types of FM voice radio systems or applications. AAR Remote Control (RC), Locomotive Clean Cab (LC) and Serial Remote (SR). All have similarities in basic radio operation. The major difference between the RC and LC applications is the type of user interface. The RC uses the AAR standard interface for remote control radios. This interface is defined in section 12-10 of the AAR C&S Manual. The LC radio has a built in control panel on the front of the radio. Interfaces to the LC radio are defined in section 12-2 of the AAR C&S Manual. The SR radio system is identical to the standard LC radio except that the front panel is installed in a remote mounted control head.

Note 1: This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

Note 2: Changes or modifications to this device not expressly authorized by the manufacture could void the user's authority to operate the equipment.

Note 3: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Note 4: FCC RF Radiation Exposure Statement

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and your body.

Note 5: Professional installation of radio and antenna system is required to ensure proper operation and installation of this equipment. To conform to FCC RF Radiation Exposure limits the installer must remain at least three meters away from the transmitting antenna when the unit is transmitting. The antenna must be mounted on the top of the train engine as directed in the installation guide.

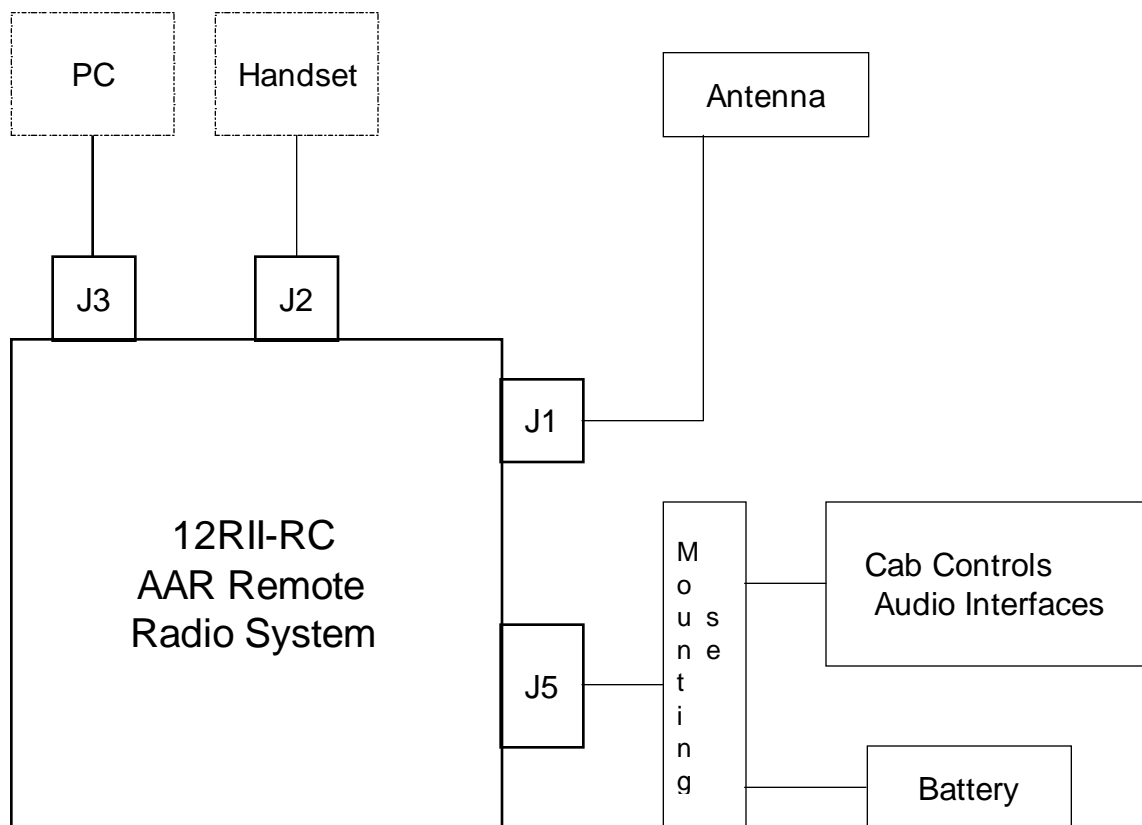
5.1. AAR Remote Radio System

5.1.1. General Description

The 12RII-RC radio is compatible with the current 12R-RC radio in all its existing AAR Remote Applications. Refer to the block diagram in the following section. In the AAR Remote application the primary interface for controls and audio signals is with an external AAR compatible Control Head or Control Panel. Optionally an AAR handset can be connected to the rear of the radio at J2. Antenna connection is provided through J1.

The 12RII-RC radio will mount onto the standard 12MT-1 AAR mounting adaptor. The radio will get locked into the 12MT-1 adaptor tray and they are installed as a unit onto a standard AAR Mounting Base such as the 1MB-1. The Mounting base provides terminal blocks that allow the train wiring from the control panel and battery to be interfaced into a standard cable supplied with the 1MB-1. This cable mates to J5 on the 12RII radio and provides power and control interface.

5.1.2. AAR Remote Radio System Block Diagram



5.1.3. Basic Operation

The AAR Remote Radio is capable of performing all standard radio functions associated with transmitting and receiving radio signals. The operator selects channels 1-12 from a channel selector. The channel selector drives 5 parallel channel lines to the appropriate logic levels to cause the radio to go to the desired channel. A PTT (Push-To-Talk) signal line provides radio TX control request from the operator. Other input control lines that may be applicable and associated with handset cradle or hang-up functions are Mute, Quiet Line Disable, and Channel Revert. Additionally, certain customer applications require outputs that provide indications of radio status such as Standby, Busy or TX.

The audio interfaces available at the J5 connector are microphone transmit audio, 10 watts speaker audio and a low level receive audio signal. All audio levels are fixed.

The radio handset connector provides interface to a standard AAR handset. The handset interface provides for a PTT transmit control signal, microphone audio, and receive audio.

The radio receives power from the locomotive or car battery. Battery input voltages are 74VDC for freight and locomotive applications, and 37VDC in some light rail applications. A 13V battery input is also an option which is to be used for . The radio typically supplies an output voltage of 13VDC to power the remote control head.

A connector is provided on the radio to interface to a standard personal computer (PC). This is a standard RS-232 interface used to upload and download radio configuration files, radio status or diagnostics, and radio firmware. These functions are supported through a special application program "12RIISETUP" program which is loaded on the PC.



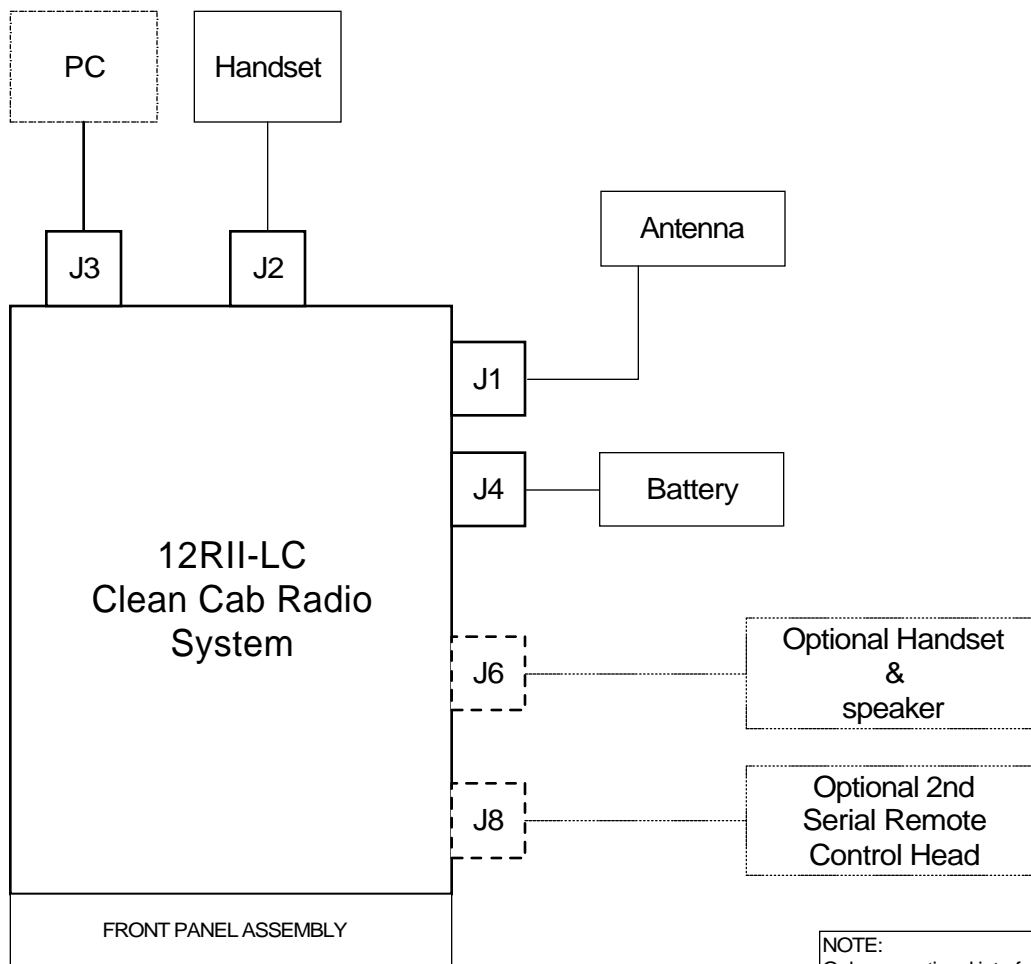
5.2. Clean Cab Radio systems

5.2.1. General Description

The 12RII-LC radio is compatible with the current 12R-LC radio in all its existing clean cab Applications. Refer to the block diagram in the following section. In the clean cab application the primary interface for controls and audio signals is a front panel located on the front of the radio. The radio also supports the standard Handset connector and program connector. Antenna connection is provided through J1.

The 12RII-LC radio mounts onto the standard 17MT-1 AAR mounting Tray. The Mounting tray is typically located in an enclosure similar to one specified in the AAR C&S manual in section 12-2. Power to the radio is provided through connector J4. Typical locomotive battery voltage is 74VDC. Some transit light rail cab cars may provide 37VDC as the primary radio voltage.

5.2.2. Block Diagram



NOTE:
Only one optional interface;
Accessory Option (J6) or Secondary
Serial Remote (J8) may be installed
at the same time.

5.2.3. Basic Operation

The Clean Cab Radio is capable of performing all standard radio functions associated with transmitting and receiving radio signals. The operator controls are via buttons on the front panel. Front panel controls allow for a variety of channeling controls, volume, PTT, and various special functions. The front panel also supports a full 12-character phone pad interface for DTMF



signaling. Audio interfaces on the front panel include a front panel microphone, which is activated with the front panel PTT button, and a radio speaker.

Optionally, the radio may have an accessory connector (J6) that is used for external controls and audio interfaces or an interface to a serial control head (J8). J8 provides the necessary serial, audio and control lines necessary to support a front panel assembly that is packaged in a Remote Control Head.

J6 provides a second handset or microphone input, a second speaker output, and some I/O lines that can provide control inputs or indication output signals depending on the customer application. As inputs these control lines can be programmed to provide functions associated with handset cradle or hang-up functions such as Mute, Quiet Line Disable, and Channel Revert. Additionally, certain customer applications require outputs that provide indications of radio status such as Standby, Busy or TX.

The radio can support only the Accessory J6 connector or the Optional second control head on J8, not both at the same time without compromised performance. Audio signals are shared between the two options. However it is not likely that both options would ever be required in a given application. The radio may have both connectors installed, but only one interface is likely to be active at a time. This will allow for a “standard” radio to be installed in either of the identified optional installation configurations.

The radio receives power from the locomotive or car battery. Battery input voltages are 74VDC, or 37VDC. The radio provides 13VDC outputs to power the accessory audio circuitry if necessary and to power the Serial Remote Control Head.

A connector is provided on the radio to interface to a standard personal computer (PC). This is an RS-2323 interface used to upload and download radio configuration files, radio status or diagnostics, and radio firmware. These functions are supported through a special application program “12RIISETUP” program which is loaded on the PC.



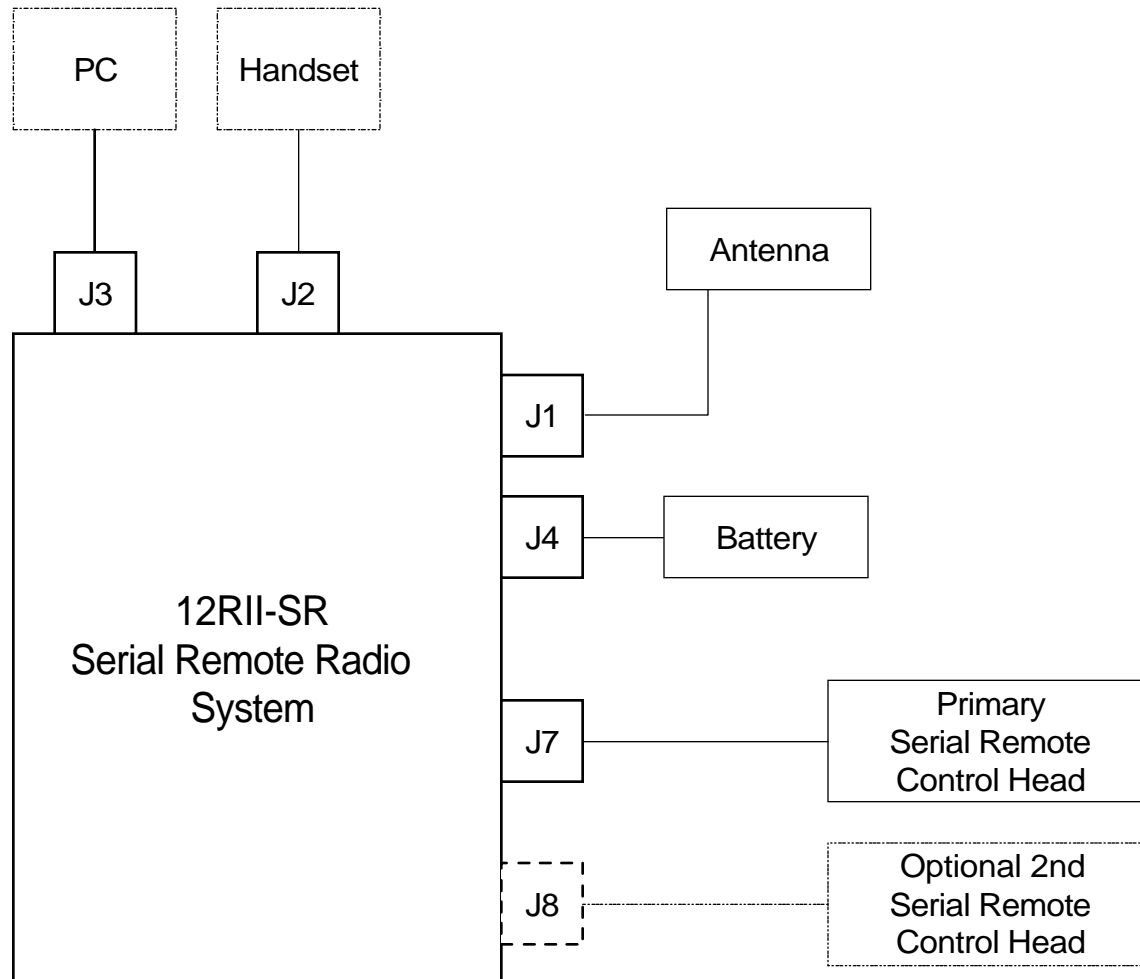
5.3. Serial Remote Radio Systems (Future Option)

5.3.1. General Description

The standard 12RII-SR radio is identical in operation to the 12RII-LC radio except that it is not mounted in the typical brake stand enclosure. The Serial Remote Control Head that is used in conjunction with the 12RII-SR radio is mounted in the control stand location. The radio is mounted in a locker or in the nose of the engine. A Serial Interface Cable is used to connect the radio to the control head.

Optionally the radio supports the connection of a second control head on J8 and a radio handset at J2. Program connector J3 is also standard as on the other radio systems.

5.3.2. Block Diagram



5.3.3. Basic Operation

Operation of the 12RII-SR radio is identical to the 12RII-LC radio. The front panel assembly is identical in both radio systems.

5.4. Radio Final Assembly Parts List

251303-0000	ASSY 12RII-LC 74V VHF						X
251303-0001	ASSY 12RII-LC 74V VHF W/J6					X	
251303-0100	ASSY 12RII-LC 36V VHF				X		
251303-0101	ASSY 12RII-LC 36V VHF W/J6			X			
251303-1000	ASSY 12RII-RC 74V VHF		X				



251303-1100	ASSY 12RII-RC 36V VHF	X					
GSPN	DESCRIPTION	QTY	QTY	QTY	QTY	QTY	QTY
017157-402	PWR SPLY VICOR 74V		1			1	1
017157-401	PWR SPLY VICOR 36V	1		1	1		
227409-000	ASSY POWER SUPPLY BOARD 74V		1			1	1
227409-001	ASSY POWER SUPPLY BOARD 36V	1		1	1		
180381-790	KIT 12RII TK-790 PARTS	1	1	1	1	1	1
227408-000	ASSY RADIO CONTROL BOARD	1	1	1	1	1	1
202926-000	ASSY RADIO PROCESSOR MODULE	1	1	1	1	1	1
227410-000	FRONT PANEL ASSEMBLY			1	1	1	1
065373-200	CHASSIS	1	1	1	1	1	1
027105-000	HANDLE	1	1	1	1	1	1
123306-100	BOTTOM COVER	1	1	1	1	1	1
123305-100	TOP COVER	1	1	1	1	1	1
022206-002	BLANK FRONT COVER PLATE	1	1				
123348-100	SIDE COVER PLATE (BLANK)			1	1	1	1
123348-100	SIDE COVER PLATE W/J5	1	1				
123347-101	COVER PLATE J6	1	1		1		1
123347-100	COVER PLATE J4	1	1				
202150-611	CABLE ASSY RCB/FPB	1		1	1	1	1
202150-610	Cable Assy PSB/RCB	1	1	1	1	1	1
202150-510	CABLE ASSY (J5)	1	1				
202150-410	CABLE ASSY J6			1		1	
202150-110	CABLE ASSY (J4)			1	1	1	1
202150-210	CABLE ASSY (J2&J3)	1	1	1	1	1	1
202150-010	CABLE ASSY 3" RED W/ferrite	1	1	1	1	1	1
202150-005	CABLE ASSY 3" BLK RA/RG	1	1	1	1	1	1
013496-3410	SCREW 4-40 X 5/16 PPH ITL SS	51	51	47	47	47	47
013496-3416	SCREW 4-40 X 1/2" PPH ITL SS	7	7	7	7	7	7
013496-3610	SCREW 6-32X5/16 PPH ITL SS	9	9	9	9	9	9
013492-3616	SCREW 6-32 X 1/2 PPH SS	4	4	4	4	4	4
202174-002	ASSY XFORMER	1	1				
013492-3716	SCREW 8-32 X 1/2 PPH SS	2	2				
013002-014	WASHER 8 INTL SS	2	2				
013009-3701	NUT 8-32 HEX SS	2	2				
013008-021	WASHER #8 FLT SS	2	2				
113114-000	CAM LOCK	1	1	1	1	1	1
013492-3912	SCREW 10-32 X 3/8 PPH SS	2	2	2	2	2	2
013030-008	WASHER 10 SPL SS	2	2	2	2	2	2
013002-011	WASHER 6 INTL SS	2	2	2	2	2	2
013009-3602	WASHER #6 FLT SS	2	2	2	2	2	2
013678-412	SCREW 4-40X3/8 CTSK SS	2	2	2	2	2	2
005035-001	CLAMP CABLE .187 DIA	1	1	1	1	1	1
005019-017	CABLE TIE 4L NAT	5	5	3	3	3	3

5.5. Radio Front Assembly Parts List (LC version Only)

227410-000	ASSY 12RII FRONT PANEL
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GSPN	DESCRIPTION	QTY	REF DES / DIN
227410-100	ASSY 12RII FRONT PANEL BOARD	1	1
202926-000	ASSY 12RII PROCESSOR MODULE	1	2
022207-100	Keypad Left	1	6
022207-200	Keypad Numeric	1	7
022207-300	Keypad Right	1	8
006128-000	Foam 12R Speaker insert	1	15
006128-001	Foam 12R Mic insert	1	16
123363-001	GRILLE 12R SPEAKER 3.35	1	14
202298-100	PANEL 12RII FRONT W/LENS	1	5
013492-3810	SCREW 10-24X5/16 PPH SS	4	12
013496-3410	SCREW 4-40 X 5/16 PPH I	12	10
227173-001	ASSY SPEAKER 4 OHM	1	4
202167-001	ASSY LCD 12RII 2x16	1	3



6. Radio Architecture

The radio and control head architecture is depicted in the following block diagrams for each of the radio applications. The radio deck in all applications is built around a common chassis.

Radio architecture was determined largely by the requirement to integrate in the TK-790 RF modules, and the need to integrate circuit functions into fewer boards.

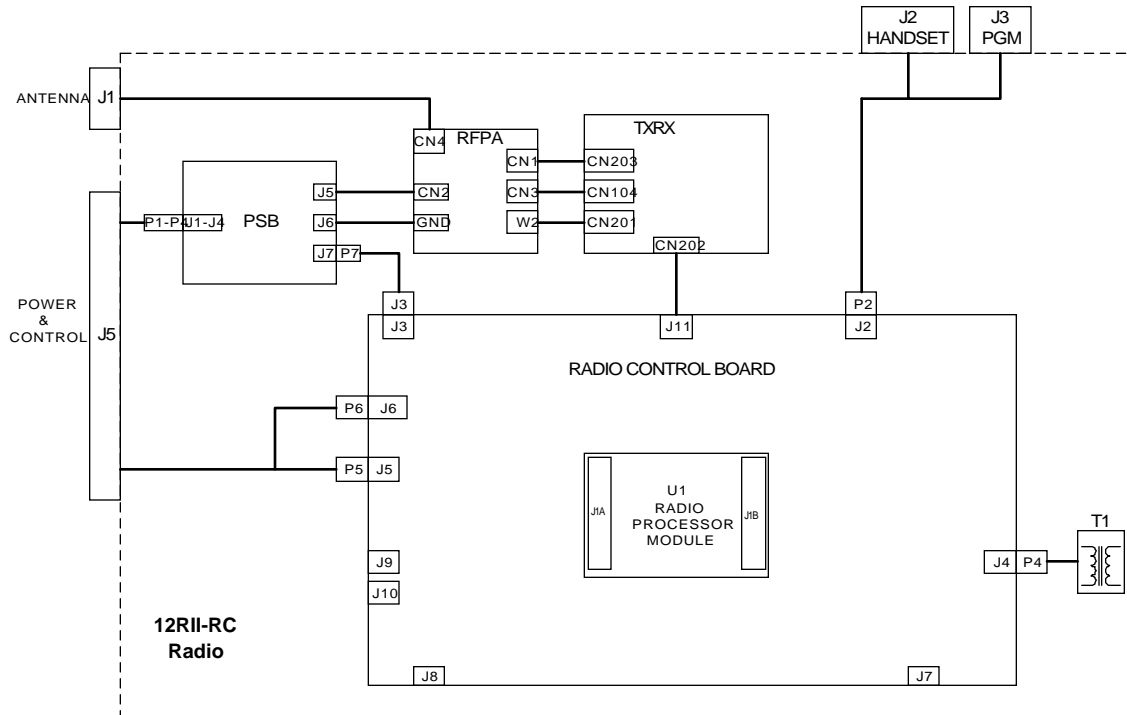
Standard radio modules for the radio deck are the Power Supply Board (PSB), RF Power Amplifier (RFPA), Transmit/Receive Board (TXRX), Radio Control Board (RCB), and Radio Processor Module (RPM).

Standard connectors for all radios are; J1-Antenna, J2-Handset and J3-program connectors. Application or radio type specific connectors are J4, J5, J6, J7 & J8.

The front panel assembly is made up of the Front Panel Board (FPB), RPM, LCD and Speaker assemblies. The front panel assembly is installed on the front of the radio chassis for an LC radio. The front panel is also packaged in a remote mounted enclosure to make a Serial Remote Control Head.

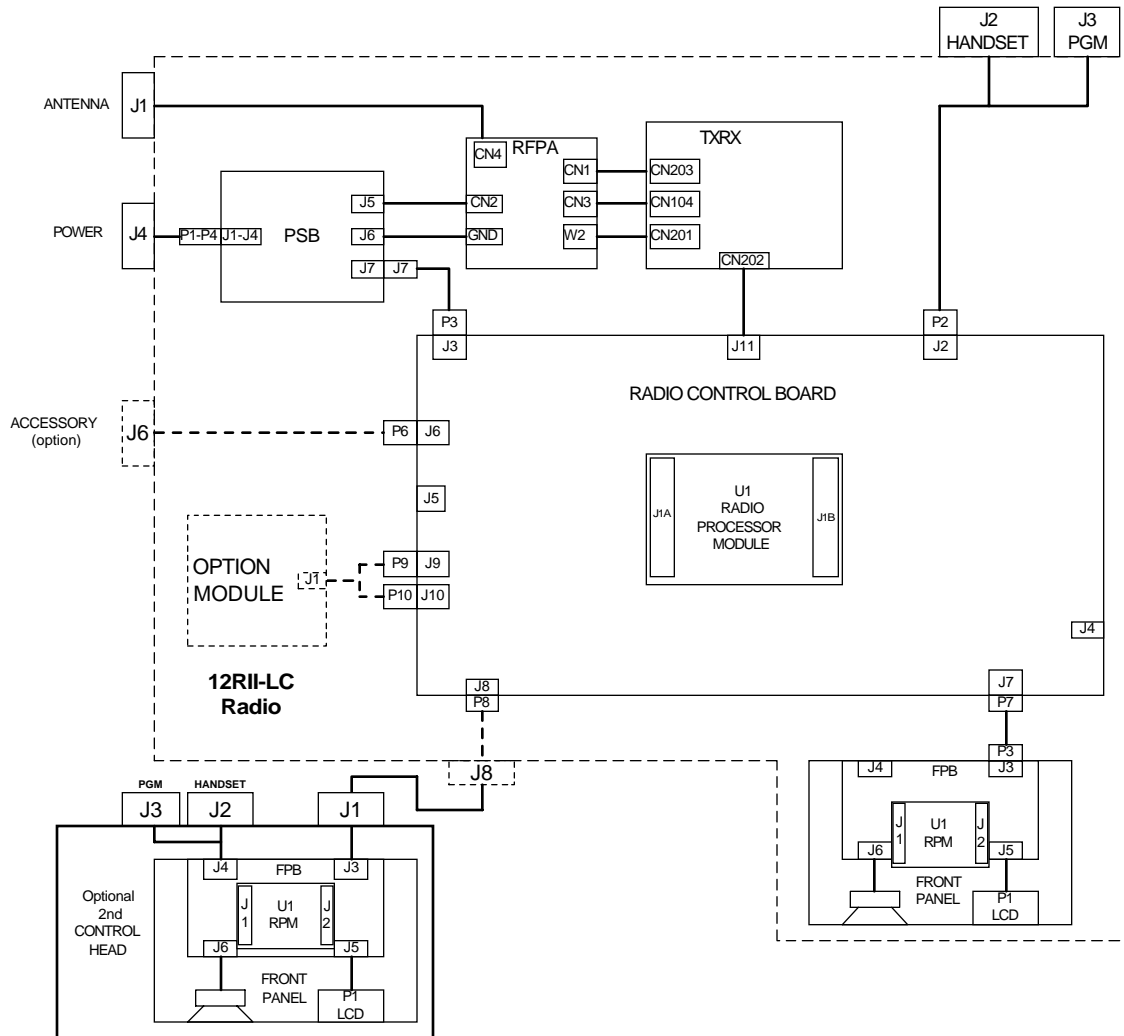


6.1. RC Radio Block Diagram



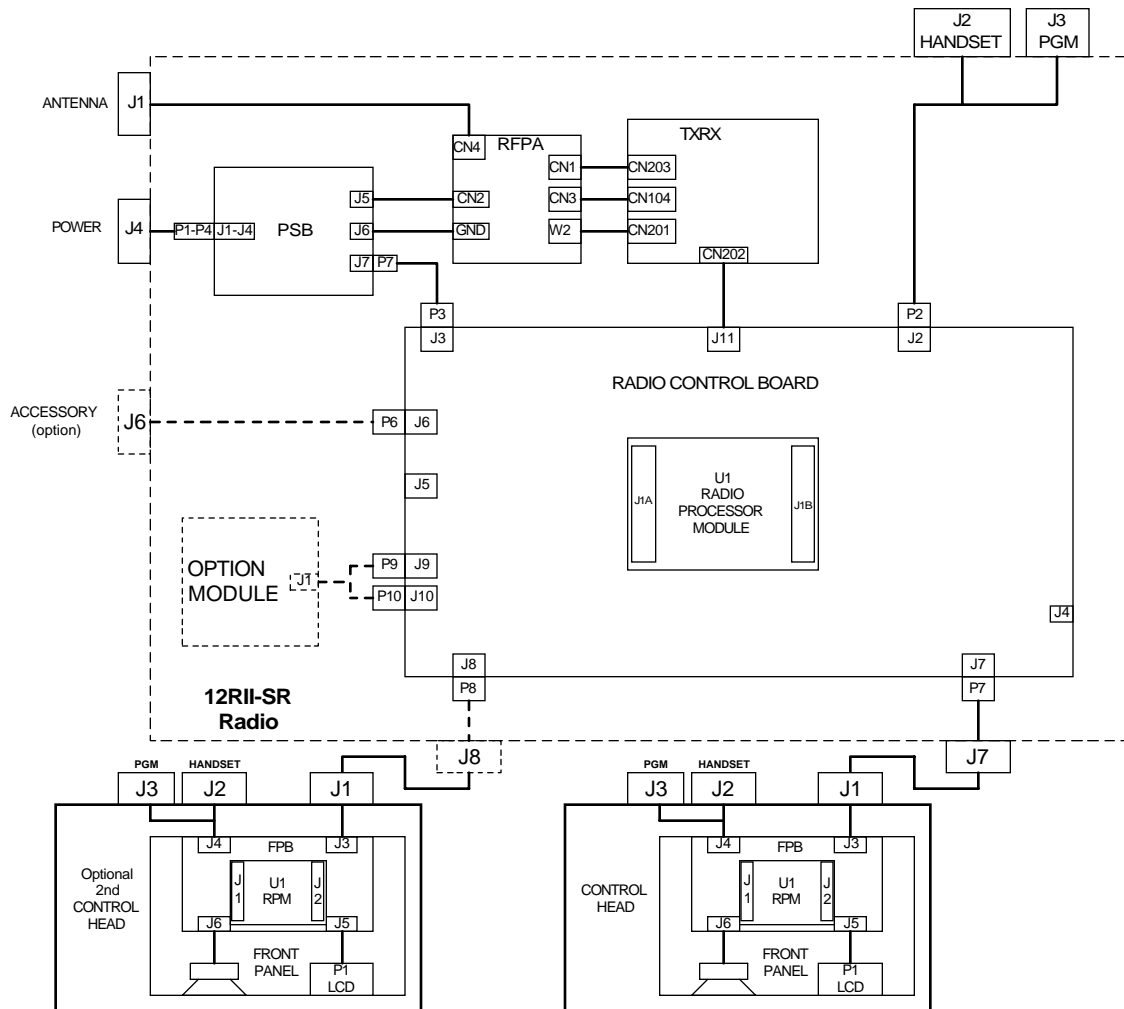


6.2. LC Radio Block Diagram





6.3. SR Radio Block Diagram





6.4. Radio Interfaces Signals

This section identifies the Interface signals associated with each connector used in the radio system(s).

6.4.1. External Connector Configurations

The following table shows the standard radio connectors associated with each of the typical RC, LC & SR radio systems. Although other connector options are possible, this list covers all possible applications known to date.

Radio Model Description	J1 Antenna	J2 Handset	J3 PGM	J4 4-Pin	J5 23-Pin	J6 ** 12-Pin	J7 Serial 1	J8 Serial 2
RC – AAR Remote	X	X	X		X			
LC – Clean Cab	X	X	X	X				
LC – Clean Cab W/Access	X	X	X	X		X		
LC – Clean Cab W/ 2 nd Control Head	X	X	X	X				*X
SR – Serial Remote	X	X	X	X			X	
SR – Serial Remote W/2 nd Control Head	X	X	X	X			X	X
* J8 may be physically mounted on radio in the location typically used by J6. This is to allow for connection to existing cables which may be too short to reach J8 location on the chassis.								
** In some applications J6 is a 15 pin connector.								

6.4.2. J1 Antenna

J1 is an industry standard UHF (SO-49) connector used to interface to the voice radio antenna. J1 connects to CN4 on the RFPA board with a short piece of wire. This connector is common to all radio systems.

6.4.3. J2 6-Pin Handset

J2 supports an interface to a standard AAR 6-pin handset. Connector Pins, Signal Names, and descriptions are shown in the table below. This connector is standard on all radio systems and interfaces in a common cable with J3 Program connector to J2 on the RCB.

J2 AAR HANDSET SIGNAL INTERFACE				
J2-Pin	Signal	Description	Mating Connector	
A	Mic-Audio	Modulation Input from the handset condenser.	RCB	J2-1
B	Mic-Com	Microphone Audio return (common with radio chassis).	RCB	J2-2
C	PTT	Push-To-Talk radio key input.	RCB	J2-3
D	PTT-Com	PTT Return (common with radio chassis).	RCB	J2-4
E	Rec-Audio	Audio output to receiver element in handset.	RCB	*J2-5
F	HK	Optional "Off Hook signal input.	RCB	*J2-6
* Either of these signals may be connected to J2-10 if interfacing to a DTMF Palm Mic which requires B+ voltage.				

6.4.4. J3 9-Pin Program

J3 provides an interface to a PC used for uploading and downloading firmware, radio statistics or configuration files. This is a standard 9-pin Mini-D connector. This connector is standard on all radio systems and interfaces in a common cable with J2 Handset connector to J2 on the RCB. J3 interface signals are shown below.



J3 PROGRAM SIGNAL INTERFACE				
J3-Pin	Signal	Description	Mating Connector	
2	Rx Data	RS-2323 Serial Receive Data Input	RCB	J2-7
3	TX Data	RS-2323 Serial Transmit Data Output	RCB	J2-8
5	Com	Signal Common (common to radio chassis).	RCB	J2-9

6.4.5. J4 4-Pin Power Connector

J4 is used for primary and secondary input voltages for the 12RII-LC and 12RII-SR radio systems. The J4 cable plugs into J1-J4 on the Power Supply Board. J4 typical signal interfaces are shown in the table below.

J4 4-PIN POWER SIGNAL INTERFACE				
J4-Pin	Signal	Description	Mating Connector	
A	+74VDC	Primary isolated input voltage	PSB	J1 / J2
B	13 VDC Com	Common (radio chassis).	PSB	J4
C	-74VDC	Primary isolated input voltage return.	PSB	J2 / J1
D	+13 VDC	Secondary (Test) radio input voltage.	PSB	J3

6.4.6. J5 23-Pin Power & Control

J5 is used for input power, control and audio signal interfaces on the 12RII-RC radio. The J5 cable assembly plugs into J1-J4 on the Power Supply Board and J5 & J6 on the Radio Control Board.

The Following tables are the currently defined power interfaces used on 74V, 37V and 13V AAR Remote Control Radio systems.

Standard 74 & 37 Volt Power Input.

J5 23-PIN POWER SIGNAL INTERFACE (STD)				
J5-Pin	Signal	Description	Mating Connector	
1	-		-	-
2	* +VIN	Isolated input voltage	PSB	J1
3	* -VIN	Isolated input voltage return	PSB	J2
4	+13VDC	13V Output	PSB	J3
5	13V COM	13V Common (radio chassis)	PSB	J4

* Radio must be specified as either 74V or 37V.

Alternate 37V Power Input.

J5 23-PIN POWER SIGNAL INTERFACE (37V ALT.)				
J5-Pin	Signal	Description	Mating Connector	
1	-		-	-
2	-		-	-
3	* -VIN	Isolated input voltage return	PSB	J2
4	* +VIN	Isolated input voltage	PSB	J1
5	13V COM	13V Common (radio chassis)	PSB	J4

* These are for an alternate 37V Battery Interface.

13V Power Input.

J5 23-PIN POWER SIGNAL INTERFACE (13V Only)				
J5-Pin	Signal	Description	Mating Connector	
1	13V RTN	Non-Isolated input voltage return	PSB	J1
2	+13V	Non-Isolated Input voltage	PSB	J2
3	-		-	-
4	+13VDC	13V Output	PSB	J3
5	13V COM	13V Common (radio chassis)	PSB	J4



The following table illustrates the standard control and audio signals.

J5 23-PIN CONTROL & AUDIO SIGNAL INTERFACE				
J5-Pin	Signal	Description	Mating Connector	
6	Mic-Com	Remote Microphone audio return	RCB	J6-2
7	Mic-Audio	Remote Microphone audio input	RCB	J6-1
8	8 Ohm Audio Out	10W 8 ohm audio speaker output	RCB	J5-3
9	PTT	Remote PTT input	RCB	J6-3
10	CH1	AAR Channel 1 Input Select Line	RCB	J5-4
11	CH2	AAR Channel 2 Input Select Line	RCB	J5-5
12	CH3	AAR Channel 3 Input Select Line	RCB	J5-6
13	CH4	AAR Channel 4 Input Select Line	RCB	J5-7
14	* TX Ind.	I/O 1- transmit indication output	RCB	J6-9
15	Rec-Audio	Remote low level receive audio output	RCB	J6-5
16	Audio Return	Audio Common (radio chassis)	RCB	J6-7
17	* Standby	I/O 2 - Standby indication output	RCB	J6-10
18	Channel Return	AAR Channel Return Input	RCB	J5-8
19	N.C.		-	-
20	13V Com	Common (radio chassis)	RCB	J6-8
21	+13V Out	Low Power 13V Output, fuse protected	RCB	J6-6
22	* QL Disable	I/O 3 - QL disable input	RCB	J5-1
23	*Mute	I/O 4 - Speaker Mute	RCB	J5-2
* I/O signals are programmable for user configurations. Signal functions are shown for reference only.				



6.4.7. J6 12-Pin Accessory

The 12-Pin Accessory connector is a typical option on the 12RII-LC radio. The J6 cable assembly plugs into J6 on the Radio Control Board. The typical interface signals are shown below.

Note: As an alternate for some applications a 15 pin connector is supplied. Signal interface is identical except for pins M & N. Speaker outputs are replaced with I/O-3 & I/O-4 signals.

J6 12-PIN ACCESSORY SIGNAL INTERFACE				
J6-Pin	Signal	Description	Mating Connector	
A	Mic-Audio	Remote Microphone audio input	RCB	J6-1
B	Mic-Com	Remote Microphone audio return	RCB	J6-2
C	PTT	Remote PTT input	RCB	J6-3
D	PTT Return	PTT common (radio chassis).	RCB	J6-4
E	Rec-Audio	Remote low level receive audio output	RCB	J6-5
F	+13V Out	Low Power 13V Output, fuse protected	RCB	J6-6
H	Audio Return	Audio Common (radio chassis)	RCB	J6-7
J	13V Com	Common (radio chassis)	RCB	J6-8
K	* TX Ind.	I/O 1- transmit indication output	RCB	J6-9
L	* Standby	I/O 2 - Standby indication output	RCB	J6-10
#M	Speaker +	Remote Speaker Output	RCB	J6-11
#N	Speaker -	Remote Speaker Output	RCB	J6-12
* I/O signals are programmable for user configurations. Signal functions are shown for reference only.				
# On alternate 15 pin connector these signals are I/O-3 & I/O-4 respectively, mating to J5-1 & J5-2 on the RCB.				

6.4.8. J7 Primary Control Head

J7 is installed on the standard 12RII-SR radio as the primary control head interface. The J7 cable assembly plugs into J7 on the Radio Control Board. Interface signals are shown in the table below.

J7 19-PIN CONTROL HEAD SIGNAL INTERFACE				
J7-Pin	Signal	Description	Mating Connector	
J	B+	13V output to control head, fused.	RCB	J7-1
M	Common	13V Return	RCB	J7-2
U	RS485-A	Serial Interface, differential current loop output	RCB	J7-3
S	RS485-B	Serial Interface, differential current loop output	RCB	J7-4
A	Mic-Audio	Control Head 1 Mic audio input to radio	RCB	J7-5
V	Rec-Audio	Low level receive audio to control head 1	RCB	J7-6
F	I/O	I/O-3 ID signal to Control Head 1	RCB	J7-7
T	I/O	I/O-4 Master/Slave or Enable signal to Control Head 1	RCB	J7-8
K	Speaker +	Speaker output signal to Control Head 1	RCB	J7-9
L	Speaker -	Speaker output signal to Control Head 1	RCB	J7-10
N	N.C.	Not Connected	RCB	J7-11
E	Shield	Serial Cable Shield (radio chassis)	RCB	J7-12

6.4.9. J8 Secondary Control Head

J8 is an optional connector on 12RII-LC and SR radios to add a second control head interface. The J8 cable assembly plugs into J8 on the Radio Control Board. Interface signals are shown in the table below.



J8 19-PIN CONTROL HEAD SIGNAL INTERFACE

J8-Pin	Signal	Description	Mating Connector	
J	B+	13V output to control head, fused.	RCB	J8-1
M	Common	13V Return	RCB	J8-2
U	RS485-A	Serial Interface, differential current loop output	RCB	J8-3
S	RS485-B	Serial Interface, differential current loop output	RCB	J8-4
A	Mic.-Audio	Control Head 1 Mic audio input to radio	RCB	J8-5
V	Rec-Audio	Low level receive audio to control head 2	RCB	J8-6
F	I/O	I/O-1 ID signal to Control Head 2	RCB	J8-7
T	I/O	I/O-2 Master/Slave or Enable to Control Head 2	RCB	J8-8
K	Speaker +	Speaker output signal to Control Head 2	RCB	J8-9
L	Speaker -	Speaker output signal to Control Head 2	RCB	J8-10
N	N.C.	Not connected	RCB	J7-11
E	Shield	Serial Cable Shield (radio chassis)	RCB	J8-12



7. Kenwood RFPA & TXRX Modules

The Radio Control Board interfaces the TXRX modules on J11 flex circuit connector. All controls to the RF modules are through this connection. See the Appendix on Kenwood modules for descriptions and block diagrams.

8. POWER SUPPLY BOARD

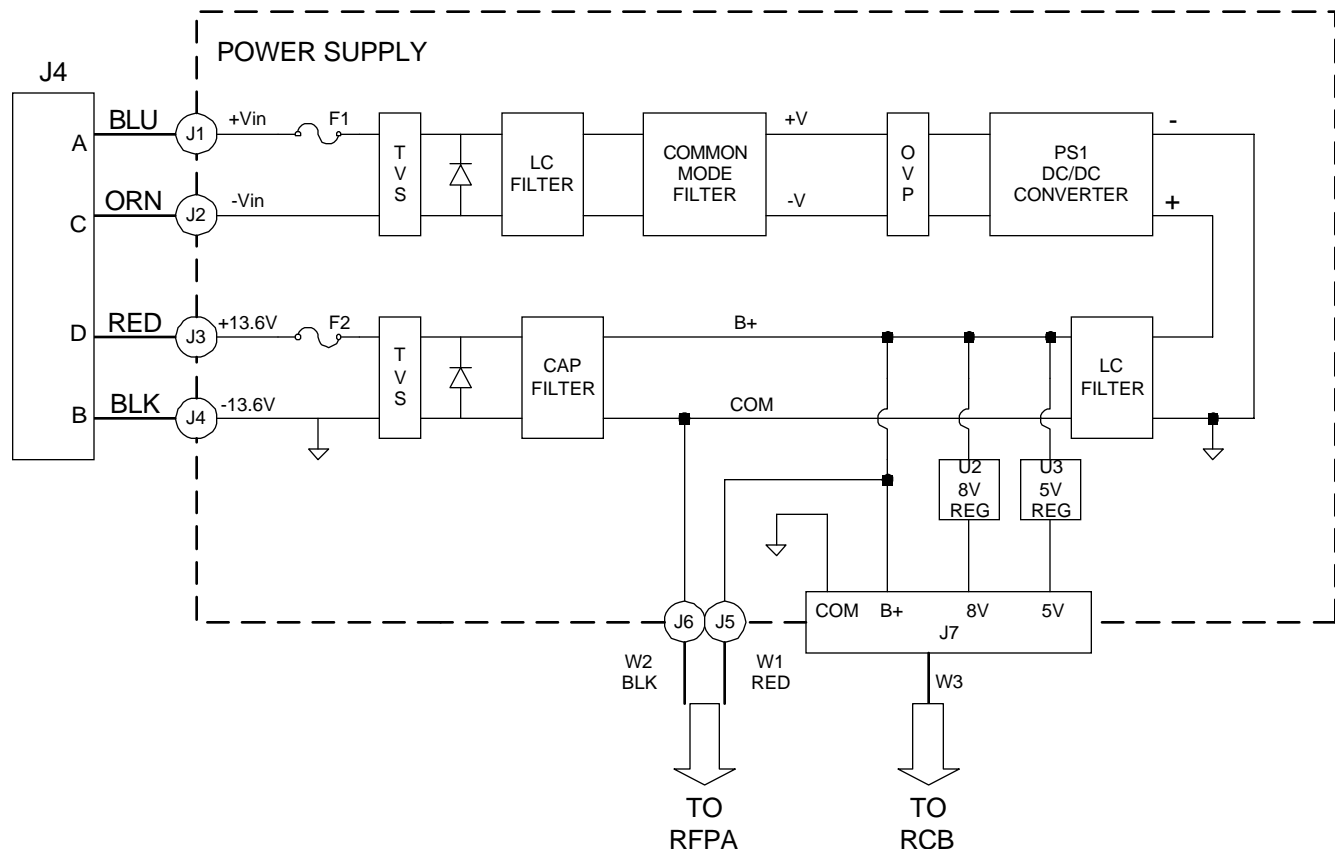
8.1. General Description

The 12RII Power Supply Board (PSB) provides the regulated voltages necessary from the host battery input voltage of 74VDC found on most locomotives, or 37VDC found on typical transit cars. The primary battery inputs voltages are isolated from the radio chassis and internal voltages by the DC/DC converter module.

The primary battery input as well as the secondary 13V input is protected against reverse polarity. The DC/DC converter is protected with Transient Voltage Suppression (TVS), filtering, and Over Voltage Protection (OVP) circuits to avoid damage of the converter or the internal radio circuitry.

The PSB provides regulated 13VDC, 8VDC and 5VDC signals to power the internal radio modules.

8.2. Block Diagram





8.3. Board Interface Signals

8.4. External Interface Voltages

External voltages are connected to the PSB on terminals J1-J4. These voltage signals can come from Radio Connector J4 in a 12RII-LC or 12RII-SR radios. In a 12R-RC radio they are connected to radio connector J5

8.4.1. J1 (+Vin)

The primary battery positive voltage is connected to this input terminal.

8.4.2. J2 (-Vin)

The primary battery negative voltage is connected to this input terminal.

8.4.3. J3 (B+)

This terminal can be used for an input or an output. To be used as an output, the proper primary battery voltage must be applied to terminals J1 & J2. The regulated output of the DC/DC converter is available at this terminal. If this terminal is to be used as a B+ (12 – 15VDC) test input for the radio, there cannot be a primary battery signal connected to terminals J1 or J2.

8.4.4. J4 (Com)

This terminal is used to connect to the radio ground or common signal. It is also connected to radio chassis.

8.5. RFPA Interface Voltages

8.5.1. J5 (B+)

This terminal is used to supply the high current regulated B+ voltage directly to the RFPA Module.

8.5.2. J6 (Com)

This terminal is used to connect circuit common directly to radio chassis.

8.6. RCB Interface Voltages

8.6.1. J7-1, 2, & 3, (B+)

Three circuit pins are used to connect the regulated 13.4VDC of the DC/DC converter to the RCB board.

8.6.2. J7-4 (+5V)

This circuit pin is used to provide +5VDC to the RCB module.

8.6.3. J7-5 (+8V)

This circuit pin is used to provide +8VDC to the RCB module.

8.6.4. J7-6, 7, & 8(Com)

These three circuit pins are used to connect the radio common to the RCB module. Circuit common is also connected to radio chassis.



8.7. Power Supply Board Parts List

227409-001	ASSY 36V POWER SUPPLY BRD		X	
227409-000	ASSY 74V POWER SUPPLY BRD	X		
GSPN	DESCRIPTION	QTY	QTY	REF DES / DIN
001011-002	CAP ALUM 35V 220UF RAD LS 5	1		C21
001011-205	CAP ALUM 200V 10UF 0.2RAD L/S	2		C8-9
001011-110	CAP ALUM 100V 33UF 0.2RAD L/S		2	C8-9
001026-021	CAP CER 500V .01UF 20%Z5U DISC	2	2	C6-7
001129-2024	CAP CER DISK 3000V .01UF 20%	4	4	C1-2 C18-19
001152-081	CAP TANT SOL 20V 10UF 10% AX	2	2	C24-25
001152-087	CAP TANT 25V 1UF 10% AXIAL	1	1	C12
001152-227	CAP TANT SOL 25V 47UF 10% AU	2	2	C13-14
001258-024	CAP CER SPIN 100V 1000PF 10%	3	3	C10 C17 C20
001258-062	CAP CER SPIN 50V .1uf 10% X7R	7	7	C11 C16 C22-23 C26-28
001284-100	CAP PYEST 250V .47UF 5% .59RAD	1	1	C3
001387-101	CAP ALUM 200V 1500UF SNP 35X40	2		C4-5
001387-102	CAP ALUM 100V 3300UF SNP 35X40		2	C4-5
002129-7109	RES CF 1/2W 1 OHM 5%	2	2	R1-2
003227-000	IC LM340T VOLTAGE REGULATOR 5V	1	1	U3
003227-002	IC LM340T COM 8VREG TO220	1	1	U2
010001-028	FUSE 3AG 250V 4A SLO BLO GLA	1		F1
010001-035	FUSE 3AG 250V 6.25A SLO BLO GLA		1	F1
010021-001	MOV 14VRMS 1000A 4J .3" RAD	1	1	RV2
010042-006	MOV 130VRMS 6500A 70J .3" RAD	1	1	RV1
010101-005	FUSE FAST BLO 15A AUTOMOTIVE	1	1	F2
011013-043	DIODE 1N6288A 1.5KE51A TS PL	2		D3-4
011013-029	DIODE 1N6281A 1.5KE27A TS PL		2	D3-4
011144-001	DIODE MR756 RECT 600V 6A	2	2	D1-2
016244-000	IND 140UH 40AMP	1	1	L3
016258-000	IND 15uH	1	1	L4
016246-013	INDUCT CM CHOKE 2MH 7.5A 4RAD	1	1	T2
016263-003	INDUCTOR 285UH	2		L1-2
016263-010	INDUCTOR 100UH		2	L1-2
029749-000	RTV	0.02	0.02	6
032507-000	TERMINAL .250 TAB	6	6	J1-6
032022-008	CONN 8CKT 2MM HEADER	1	1	J7
032003-000	SOCKET VICOR MAXI SMT 4-PIN OUTPUT	1	1	2
032003-001	SOCKET VICOR MAXI SMT 5-PIN INPUT	1	1	3
032866-003	FUSEHOLDER PC VERT MT H	1	1	5
132222-000	SCKT FUSE CLIP AUTO 15A	2	2	4
062311-000	PCB 12RII POWER SUPPLY	1	1	1
135630-000	SCHEM 12RII POWER SUPPLY	REF	REF	



8.8. Power Supply Board Schematic

See attached drawing 135630-000

9. RADIO CONTROL BOARD

10. General Description

The Radio Control Board is separated into 3 major functional areas. These three major functional areas are;

- 1) Microprocessor & serial interfaces
- 2) Audio Interfaces
- 3) External I/O Interfaces.

All External Interfaces terminate at the Radio Control board with the exception of the primary input voltage, which terminates in the Power Supply Board and the Antenna connection that terminates in the RFPA Module.

10.1. Microprocessor & Digital Interface

10.1.1. Radio Processor Module

The Radio Processor Module (RPM) used in the 12RII Radio is an RCM2020 from Rabbit Semiconductor. This module contains an 8-bit microprocessor with RTC, 128K RAM, 256K FLASH, and power up supervisory circuitry. The RCB provides filtered +5V to the RPM. The RPM provides 5 8-bit programmable ports which are used on the RCB to provide serial interface and digital control of the support circuits on the RCB and interfaces to other radio modules.

The FLASH memory on the RPM contains the radio operating firmware as well as the Radio Configuration File (RCF). The RCF allows modification of the radio operating frequencies, audio parameters, Front Keypad operation (LC version Only) and I/O programming.

10.1.2. Non-Volatile Memory

The RCB provides for non-volatile storage of board specific parameters in a serial EEPROM device. Also contained is the board ID number and customer ID number.

10.1.3. Temperature Sensor

An onboard temperature sensor is used to provide temperature information for diagnostic purposes and for allowing some radio parameters to be varied over temperature.

10.1.4. Serial Interfaces

The RCB supports the following External Serial Interfaces. All external serial interfaces are asynchronous.

RS-485

The RS-485 interface is used to communicate to the Front Panel Board in LC and SR radios. This interface is not used on the RC version of the radio.



RS-232 (2)

Two RS-232 ports are provided. The primary RS-232 port is connected to radio connector J3. This port is connected to a PC, for uploading and downloading the Radio Configuration File and for executing the dynamic tuning of radio parameters stored in EEPROM. The second RS-232 port is for future use.

10.2. Audio Circuits

The RCB audio circuits provides the necessary audio interfaces, routing, audio processing and gain control necessary for the radio operation. Circuitry is also provided to generate & decode necessary radio tones for dispatch call, Sub-Audible Squelch, and MSK data signals (future).

10.2.1. Transmit Audio Inputs

Three audio inputs (HSMIC, MIC1, and MIC2) are used for transmit modulation. The HSMIC signal comes from the radio handset interface (J2). MIC1 signal comes from the Front panel, and MIC2 comes from the Remote Interface or the second serial control head (Optional). These transmit audio input signals will be applied to the TXRX module modulation inputs MB & MO after processing and filtering. The TXRX module uses a dual point modulation scheme hence the two input signals required.

10.2.2. Receive Audio Input

The primary receive signal input is the "DET" signal from the TXRX module. This is the discriminator output from the radio receiver. In Normal operation this receive signal will be processed and applied to the appropriate audio output device such as the radio speaker or handset element.

An optional input signal "DET2" is provided for in the Option Module connection at J9. This is for future use.

10.2.3. Audio Outputs

The RCB transmit audio outputs are the "MO" and "MB" signals. These signals are applied to the TXRX module to provide the required dual port modulation.

Normal radio receive audio outputs signals are applied to the radio speaker (located on the front panel) and handset receive element. These interface signals are "SPKR1" and "HSAUD". Additionally a Remote Handset and second speaker are supported by "AUD2" and "SPKR2" signals. "AUD1" signal is used to provide low level receive audio to a Control Head in the SR Radio system.

10.2.4. Transmit Audio Pre-emphasis

The standard 750us pre-emphasis circuit of the radio is made up from the inverting amplifier in U10 and associated components R21 and C7.

10.2.5. Receive Audio De-emphasis

The standard 750us de-emphasis circuit is made up from the inverting amplifier in U9 and associated components R12, C5 & C47.

10.2.6. Routing, Processing & Gain Control

The audio routing, processing and gain control of the audio circuitry are controlled by software through the use of mixed signal audio processing integrated circuits (IC's). The radio configuration file contains audio maps for each of the primary operating modes in the radio. The audio maps allow the signal paths and gains to be adjusted for different radio modes and applications. These devices and primary functions are listed below;

The MX029 is a digital controlled gain device that allows for input and output selection as well. This device is primarily used for transmit signal input selection and receive audio output selection as well as providing gain control. Each MX029 also contains an analog inverting amplifier.



The MX829 device provides audio processing and filtering, for transmit audio signals. It also contains a precise limiting circuit for maximum transmit deviation control. Digital Attenuators provide for electronic adjustment of the transmit signals. The device contains a normal 300 Hz High Pass filter and 3000 Hz. Low pass filter for normal radio band pass audio requirements. A 2500 Hz. low pass filter may also be selected for radio narrow band operation.

The MX829 also contains an MSK data radio modem capable of 1200 or 2400 Hz modulation and a DTMF tone generator.

The MX828 device contains circuitry for sub-audible tone encoding and decoding as well as select call tone encoding and decoding. This device is used as the primary receive audio path and contains a digital band pass filter. The High Pass filter contained in the MX828 has sharper roll off to eliminate and sub-audible signals from being passed on the the receive audio devices.

The MX839 contains two digital gain amplifiers, four A/D, and three D/A circuits. Two of these digital amplifiers (U3) are used to adjust split the main transmit modulation signal and level adjustment for the dual port modulation scheme. The amplifiers of the second device (U6) are used to select the appropriate receive audio signal as well as provide a fine resolution gain setting. The A/D and D/A circuits are used for various input and output functions.

10.2.7. Dispatch Call Tone Generation

The tone modes used for dispatch call functions are the select call tones generated in the MX828 or the DTMF tones generated in the MX829. The programming in the RCF determines which tone method is used. The appropriate tone output is enabled and routed to the TXRX modulation inputs.

10.2.8. Sub-Audible Encode/Decode

The MX828 device provides the necessary sub-audible tone encoding and decoding. The channel attribute parameters in the RCF determine if the selected radio channel is to have sub-audible squelch tones applied. They can be independent for transmit and receive functions. Both traditional analog CTCSS and digital DCS code formats are available.

10.2.9. Digital Tuning

In addition to the digital gain control provided for in the audio processing the RCB also provides for digital tuning voltages. The parameters below are under software "digital" tuning control. The data for these controls is stored in the onboard EEPROM. All of the digital tuning settings are adjusted for each radio.

Radio Frequency Adjustment

Radio frequency adjustment is accomplished with the DAC output 1 of U3. This output is dc coupled on the MB modulation input that is connected to the TCXO in the TXRX module.

RF Power Control

RF Power Control is handled by U3 DAC output 2. This output is set to the value stored in EEPROM when ever the radio is put in transmit mode. Two power levels are available (High and Low), selectable on a per channel basis. These levels are assigned in the RCF channel attribute data.

Front End Tuning Voltage

Front end selector tuning is accomplished with U3 DAC output 3. This level is set to a fixed level at the specified tuning frequency. A firmware table adjusts this voltage to allow the front end filter to track the selected receive frequency.

10.2.10. Radio Squelch Operation

The TXRX module provides a filtered noise signal "SQL". This signal is processed by an A/D 1 input of U3. Software processes the noise level and compares the sampled input against preset levels for Squelch Open and Squelch Close thresholds.



10.2.11.Receive Signal Strength Indication (RSSI)

The RSSI output of the TXRX module is applied to A/D 2 input of U3. This input is processed by software and used during scan operations to provide quick channel busy detection. The RSSI signal level is also displayed as a graphic during channel occupancy for information to the user.

10.2.12.MSK Digital Data

The MX829 device provides from 1200/2400 MSK data encoding and decoding. This will be used for radio ANI broadcast or data transmission at a future time. MSK modulation encoding for 1200 baud signal will generate one cycle of 1200 Hz. for a logic "1" and one and a half cycles of 1800 Hz. for a logic "0". MSK modulation encoding for a 2400 baud signal will generate a half cycle of 1200 Hz for a logic "1" and one cycle of 2400 Hz for a logic "0". Data modulation is not routed through the pre-emphasis circuit. It does pass through the standard audio BPF and limiter circuitry in the MX829 device.

10.2.13.Radio TX Signal Paths

Voice Transmission

Voice transmission is initiated by activation of the HS-PTT, REM-PTT or a serial PTT command from a control head. The appropriate audio map is loaded which will select the assigned input to U10-CH1 (HSMIC, MIC1 or MIC2). The standard voice transmission audio map will set the gain of U10-CH1 and enable output B. The voice signal will be applied to the pre-emphasis circuit and be routed through U10-CH2 to be applied to the MIC input of U13 (MX829). Internal to the MX829 the signal will be filtered. The radio channel programming will determine if the filtering is for wide or narrow band channel operation. The signal will then pass through a limiter typically set for 80% of maximum system deviation. The output of the limiter stage is applied to a summing amplifier. The summing amplifier output is routed through two stages of digital attenuators which are used to set the maximum deviation level. The modulation signal output is applied to inputs of the two digital amplifiers of U3. Amplifier 1 drives the MB (TCXO) modulation signal and amplifier 2 drives the MO (VCO) modulation signal.

10.2.14.Radio RX Signal Paths

In Receive mode the output of the TXRX module is applied to analog channel 1 input of U6. The output of this amplifier is applied to the RX input of U14 (MX828). The input amplifier of U14 amplifies the signal. The output is coupled internally to the input of the audio Band Pass Filter and to the sub-audible and tone decoders for decoding if necessary. The external output of the amplifier is connected to the Demodulation Input of U13. This input is coupled to the MSK decoder in data applications. The output of the BPF in U14 is routed to the input of Mod. 1 Attenuator of U14. If the squelch criteria has been satisfied, the Mod 1 output is enabled and the receive signal passes through the de-emphasis network, amplified by CH3 of U9 and applied to U9-CH1, U9-CH2, U17-CH1, and U17-CH2 input #2. Depending on the Audio Map loaded for receive mode, the outputs of U9 and U17 are enabled with the proper gains to drive the appropriate audio speaker or device.

10.3. Audio Drivers

10.3.1. Low Level Audio Drivers

Amplifiers U7-A, U7-B and U12-A are used as low level drivers. Each of the amplifiers is connected an output of U9 or U17. The amplifiers are non-inverting DC amplifiers with a gains of 3. The outputs are cap coupled through a series impedance of 604 ohms before connection to their respective load devices. The series impedance is used to buffer the low impedance of handset elements to the driver amplifier. HSAUD signal drives the radio handset element at connector J2. AUD1 signal is used as low-level audio to control head 1. AUD2 signal is used to drive a remote handset connected to J6 or control head 2 audio.

10.3.2. Speaker Drivers

Two independent speaker drivers, U15 and U16 are used for different applications. Each speaker amplifier has a standby input that is used to mute the speaker when the radio is not receiving. This signal is controlled by the radio processor module. The amplifiers also contain a diagnostic signal output which indicates when the amplifier is clipping or has been shut down due to an output fault condition. These diagnostic signals are monitored by the RPM.



A standard clean cab (LC) radio uses Speaker 1 to drive the front panel speaker.

A standard AAR remote radio uses Speaker 2 output coupled through transformer T1 to drive an 8 ohm grounded speaker. The level is fixed and volume control is external to the radio.

A clean cab radio with optional interface uses Speaker 2 output to drive an external radio speaker. In this application the external speaker level can be fixed where external volume control is used or it can track the radio volume control used for Speaker 1 output. This is determined by settings in the radio configuration file.

If a second control head is used, the speaker 2 output is used to drive the speaker in the optional control head. The speaker output level will track the volume adjustments made from control head 2 independent from the volume controls made in the radio front panel or control head 1.

10.4. External I/O Interfaces

10.4.1. Handsets & PTT Inputs

The radio handset (J2) input signals are the PTT and Hook Switch. The PTT input goes low to activate the transmitter when the handset PTT button is pressed. The Hook Switch input is connected to a cradle switch and used for various controls such as a channel monitor, Scan Start/Stop, and Channel Revert. Each of these circuits for these two signals are the same. A small value series impedance feeds a pull up resistor and bypass capacitor. The input is then dc blocked by a series diode that only allows current to flow out the input. This protects the digital radio processor module input that is pulled up to +5V.

The HPTT and HK inputs are monitored by the RPM and will initiate a radio transmission if HPTT goes low or provide the necessary function assigned to HK should it go active.

The Remote PTT input is the primary PTT input used in the AAR Remote radio through connector J5 interface. This input is also available in the clean cab version with option accessory connector J6 for interface into a remote communication panel. This input circuit uses a comparator device (U19-A) to convert 13V logic to 5V logic. A series impedance (R67) is used to feed the input bypass cap (C77) and pull-up resistor R4. Diode D4 is used to clip small signal transient spikes lower than radio common or higher than B+. The input is coupled into U19-A positive input at pin 3. If this input is lower than the reference voltage at the negative input at pin 2, the output will go low. The RPTT signal is monitored by the RPM and will initiate radio transmit.

10.4.2. Programmable I/O

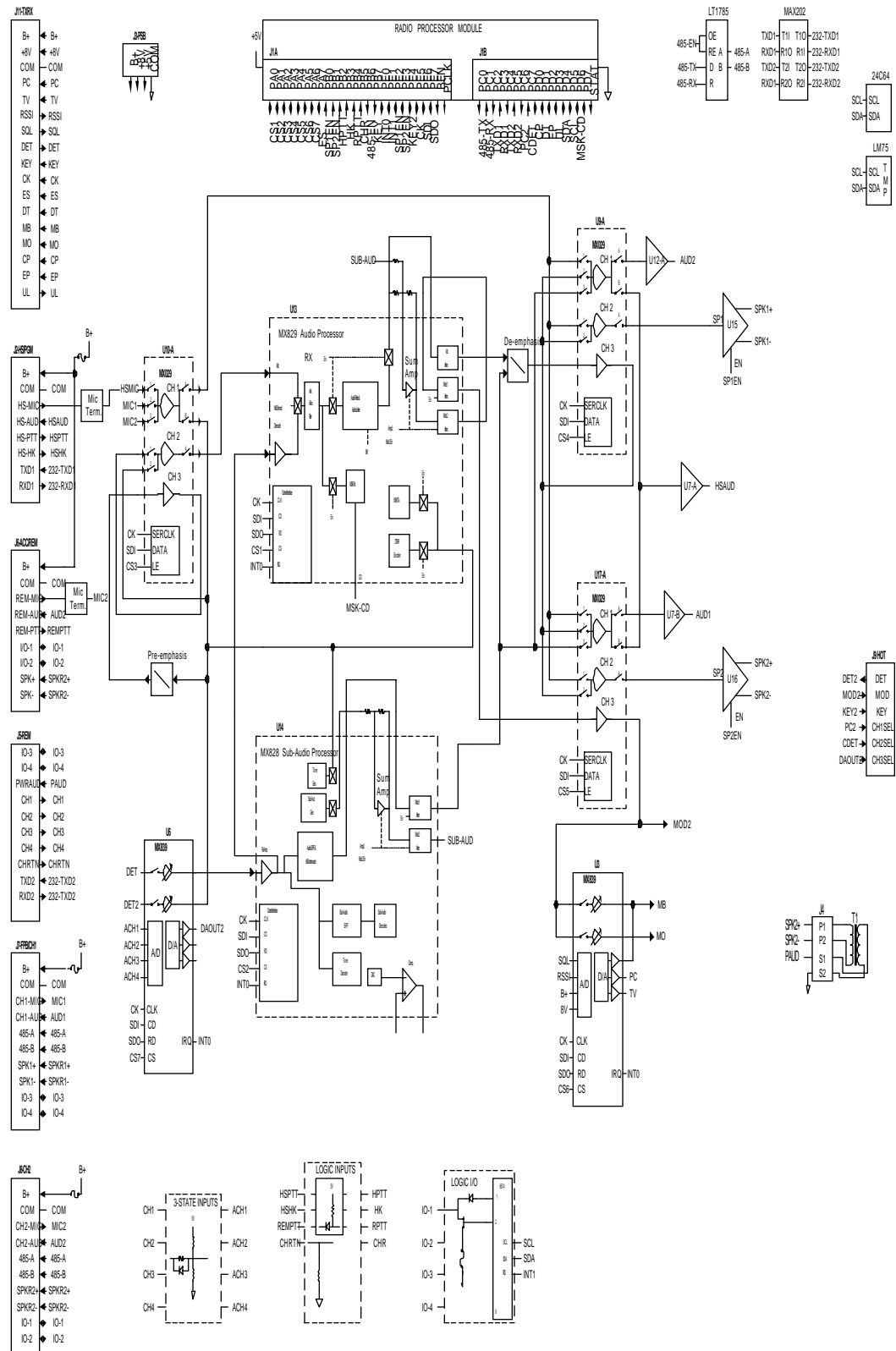
IO-1, IO-2, IO-3, and IO-4 signals are provided to allow for custom input and output interfaces. The function of each of the I/O signals is set in the radio configuration file. All four I/O signals are available in Remote connector J5 for use in an AAR Remote radio. IO-3 and IO-4 are used in normal front panel operation for identification and enabling of the front panel operation. IO-1 and IO-2 are used in the clean cab radio optional accessory connector interface or for the optional second control head identification and enabling. Each of the I/O circuits is identical. IO-1 circuit operation is as follows;

10.4.3. AAR Channel Inputs

The AAR channel selection is done with 5 input lines. These 5 lines are separated into 4 channel select lines and a channel return line. 12 Channel remote control is defined per AAR channel table logic.

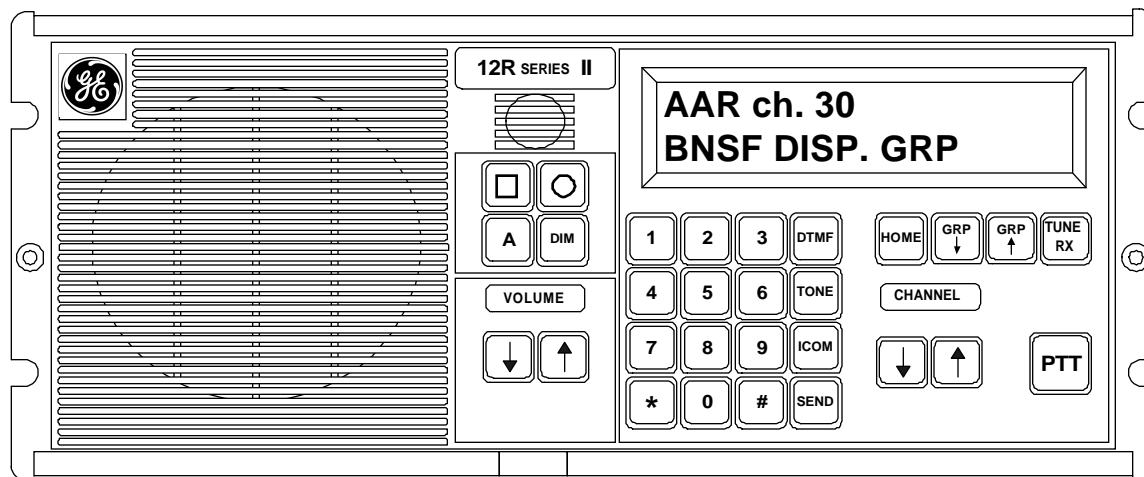


11. Block Diagram





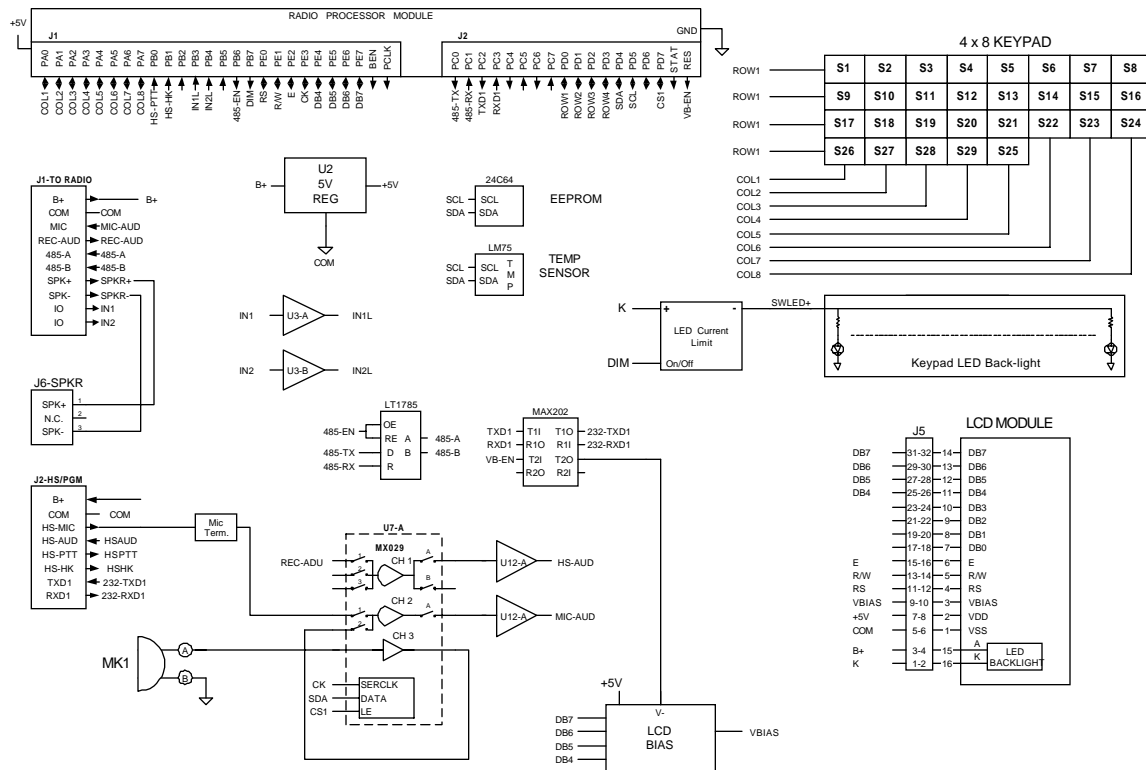
12. FRONT PANEL



Standard 12RII Front Panel Controls

LCD DISPLAY	Displays Channel & Group Names as well as operator prompts and status messages.
Front Panel Mic	Used when the Front Panel PTT switch is depressed to make a transmission.
Volume Up/Dn	Adjust level of audio heard over the speaker. Display indicates numeric setting when adjusted.
Channel Up/Dn	Used to scroll through the available channels (displayed on top line of LCD) available in the selected channel group (displayed on bottom line of LCD).
Numeric Keypad	0 – 9, * and # used to generate DTMF dispatch call tones. Keypad will transmit DTMF tones when key is pressed if button is activated for direct tone generation.
Home	Resets radio channel & group to designated “home” location.
GRP ^ & GRP v	Used to Scroll up and down through the available channel groups;
Tune RX	Active in AAR GROUP only. Used to create “split” channels (TX & RX different). Press to activate and use “channel buttons” to select desired RX channel.
PTT	Used to make a radio transmission using the Front Panel Microphone. Press “PTT” button to activate transmitter, (LCD display will indicate when radio is transmitting), and speak into the Front Panel Mic opening.
“SQUARE”	User assigned. Typically assigned for SCAN operation.
“CIRCLE”	User assigned. Typically assigned for Add/Delete function to add or remove channels from the scan list.
DIM	Alters intensity of backlit keypads and LCD for night viewing.
“A”	User assigned. Typically assigned for channel monitor. Press to disable radio squelch (audio mute function). Used to test for proper volume setting (hear noise), or keep receiver squelch open if a reception is breaking up.
DTMF	Used to select a stored DTMF “phone number string” or to allow entry of a new string of numbers for auto-send function.
TONE	Used to select the preprogrammed dispatch call tone for auto-send function
ICOM	Takes radio to Intercom mode. Pressing again will take out of Intercom mode.
SEND	Causes radio to transmit and selected tone signal to be broadcast based on preset timing parameters.

Block Diagram





12.1. Front Panel Parts List

227410-000 ASSY 12RII FRONT PANEL			
GSPN	DESCRIPTION	QTY	REF DES / DIN
227410-100	ASSY 12RII FRONT PANEL BOARD	1	1
202926-000	ASSY 12RII PROCESSOR MODULE	1	2
022207-100	Keypad Left	1	6
022207-200	Keypad Numeric	1	7
022207-300	Keypad Right	1	8
006128-000	Foam 12R Speaker insert	1	15
006128-001	Foam 12R Mic insert	1	16
123363-001	GRILLE 12R SPEAKER 3.35	1	14
202298-100	PANEL 12RII FRONT W/LENS	1	5
013492-3810	SCREW 10-24X5/16 PPH SS	4	12
013496-3410	SCREW 4-40 X 5/16 PPH I	12	10
227173-001	ASSY SPEAKER 4 OHM	1	4
202167-001	ASSY LCD 12RII 2x16	1	3



12.2. Front Panel Board Parts List

227410-100 ASSY 12RII FRONT PANEL BOARD			
GSPN	DESCRIPTION	QTY	REF DES / DIN
001358-101	CAP CER CHIP 50V 100pF 0805	5	C17-18 C41 C44-45
001360-102	CAP CER CHIP 50V 1000pF 10% 0805	8	C3-8 C10-11
001360-104	CAP CER CHIP 50V .1UF 10% 0805	20	C2 C9 C12-13 C15-16 C19-22 C25 C27-30 C35 C37-40
001377-229	CAP TANT CHIP 1.0uF 20% 16V TANT3216	3	C14 C26 C32
001377-232	CAP TANT CHIP 4.7uF 20% 16V TANT3528	4	C23-24 C36 C42
001377-252	CAP TANT CHIP 10uF 20% 25V 7343	2	C1 C31
002266-5681	RES CHP 1/10 680 OHM 5% 0805	2	R41-42
002266-5823	RES CHP 1/8W 82K 5% 805	5	R37 R47 R86-88
002278-1002	RES 10.0K OHM 1/10 W 1% 0805	16	R22 R25 R29 R35 R39 R43 R72 R75-79 R81 R84 R89-90
002278-1009	RES 10.0 OHM 1/10 W 1% 0805	2	R32-33
002278-1210	RES 121 OHM 1/10 W 1% 0805	5	R34 R36 R49-50 R82
002278-1241	RES 1.24K OHM 1/10 W 1% 0805	48	R1-21 R26 R30 R45 R48 R51-70 R73- 74 R80
002278-2430	RES 243 OHM 1/10 W 1% 0805	4	R23 R27-28 R71
002278-4022	RES 40.2K OHM 1/10 W 1% 0805	7	R24 R31 R38 R44 R46 R83 R85
002278-4750	RES 475 OHM 1/10 W 1% 0805	1	R40
003377-010	IC MC33072 IND DUAL OPAMP SOIC8P	1	U6
003444-075	IC LM75 A/D TEMP SENSOR MSOP8	1	U9
003574-004	IC 8KX8 I2C SER EEPR SO8	1	U8
003732-002	IC +5V REG LM10861	1	U2
003738-005	IC LT1785IND RS485 XCVR60V	1	U5
003758-029	IC MX029TN IND DIG TSSOP24	1	U7
003759-000	IC MAX 202 +5V RS-232 TRANSCEIVER	1	U4
004204-000	XSTR MMBT3904 NPN SOT-23	2	Q1 Q3
004253-003	XSTR NDT3055LOGIC NFET3.5A S	1	Q2
009330-000	SWITCH SPST MOM W/LED SMT	29	S1-29
011040-002	DIODE MMBD7000LT1 DUAL SWITCHING SOT-	7	D1-7
011233-000	LED ORN CHP 50MW 0805SMT 50M	4	DS1-4
018132-001	MIC EM100T PC MOUNT	1	MK1
018132-102	MIC 100E RUBBER BOOT	1	2
032022-203	CONN HDR 1X3 PIN MAL 2mm SMT	1	J6
032022-210	CONN HDR 1X10 PIN MAL 2mm SMT	1	J4
032022-212	CONN HDR 1X12 PIN MAL 2mm SMT	1	J3
032290-9009	SCKT SNGL .019DIA TIN CLOSED	2	J7-8
132360-220	CONN SCKT 2x20 2mm SMT	2	J1-2
132360-216	CONN SOCKET 32P SMT BOTTOM ENTRY	1	J5
062312-000	PCB 12RII FRONT PANEL BRD	1	1
135631-000	SCHEM 12RII FRONT PANEL BRD	ref	



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12.3. Front Panel Schematic

See Attached drawing 135631-000