MOTOROLA

Radius i20R

Repeater Controller

Service Manual

6880904Z40-A
August, 1996

Table Of Contents

Foreword

Servicing Information

Appendix A

Appendix B
GR300, M120 and i20R Setup

List of Tables

List of Figures

Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date are incorporated by instruction manual revisions. These revisions are added to the manuals as the engineering changes are incorporated into the equipment.

Model and Kit Identification

This equipment is specifically identified by an overall model number on the rear panel. If additional options are ordered, the option will be indicated either on the circuit board if a hardware option, or on a sticker affixed to an EPROM if a firmware option.

Service

Motorola's National Service organization offers one of the finest nationwide installation and maintenance programs available to communication equipment users. This organization includes:

Well over 900 authorized Motorola Service Subcontractors (MSS's) and Company- Owned Service Centers (COCS's) nationwide.

- A staff of highly trained technicians who are thoroughly up-to-date on Motorola systems and products.
- Local Service Representatives who initiate, maintain and nurture customer service relationships.
- Local Service management teams who promote service consistency throughout the national service network.

Should you wish to purchase a service agreement which ensures timely preventative maintenance, priority response to emergencies and has pre-established rates for parts and labor to simplify budgeting, contact your local Service Representative or write to:

National Service Manager
Motorola Communications and
Electronics, Inc.
Schaumburg, Illinois 60196

Replacement Parts Ordering

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part and sufficient description of the desired component to identify it. Parts should be ordered from:

Service Parts Manager
Instrument Associates
2455 Harbor Avenue
P.O. Box 13127
Memphis, TN 38113
1-800-442-4782

Notice Concerning FCC Approval

WARNING:
This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measure necessary to correct the interference.

General Safety Information

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard which applies to the use of this equipment. Proper precautions in the use of this equipment will result in exposure below the OSHA limit. The following precautions are recommended:

1. DO NOT operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meters) of the antenna.
2. DO NOT operate the transmitter of a fixed radio (base station, microwave, and rural telephone RF equipment) or marine radio when someone is within two feet (0.6 meters) of the antenna.
3. DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition:

DO NOT operate this equipment near electrical caps or in an explosive atmosphere.

All equipment must be properly grounded according to Motorola installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

Refer to General System Lightning Protection Considerations and Safe Handling of CMOS Integrated Circuit Devices for additional pertinent safety information.

General System Lightning Protection Considerations

The damage done by lightning is due to potential differences developed between equipment, between equipment and the power source, between equipment and the outside telephone line, and between equipment and earth ground. Two things are imperative if lightning damage is to be minimized.

1. All equipment at a site should be bonded frame-to-frame with adequately sized conductors. This common ground should be bonded to the utility entrance ground cable and the telephone entrance ground, if different from the utility entrance ground. Bear in mind that lightning is essentially RF and, as such, does not like long leads and will not tolerate sharp bends, as it "sees" this as a high impedance. If a tower is used, it is essential that the common ground system also be bonded to the tower. At a site where these various components are encountered (tower, utility ground, telephone ground), it is suggested that #6 bare copper be used as a minimum.
2. After bonding, the degree of insurance against lightning is almost directly related to the **resistance** of the earth ground(s) used. All grounds connected in parallel (tower, utility, and telephone, if independent) contribute to lowering the net ground resistance. For "hot" sites (sites where lightning is known to cause damage regularly) it is well to use multiple ground rods spaced several feet apart and bonded together with #6 or better wire. If the soil is sandy or rocky, the local utility company can usually provide excellent advice if their engineering office is contacted relative to the local methods used to obtain a low resistance ground. Many times these utility engineering departments will measure your site effective ground resistance with their specialized equipment, if approached in the right way. Remember — the potential of lightning is what does the damage, and the lower the ground resistance, the lower the lightning potential.

Safe Handling of CMOS Integrated Circuit Devices

Many of the integrated circuit devices used in communications equipment are of the CMOS (Complementary Metal Oxide Semiconductor) type. Because of their high open circuit impedance, CMOS ICs are vulnerable to damage from static charges. Care must be taken handling, shipping, and servicing them and the assemblies in which they are used.

Even though protection devices are provided in CMOS IC inputs, the protection is effective only against overvoltage in the hundreds of volts range such as is encountered in an operating system. In a system, circuit elements distribute static charges and load the CMOS circuits, decreasing the chance of damage. However, CMOS circuits can be damaged by improper handling of the modules, even in a system.

To avoid damage to circuits, observe the following handling, shipping, and servicing precautions:

1. Prior to and while servicing a circuit module, particularly after moving within the service area, momentarily touch both hands to a bare metal, earth-grounded surface. This will discharge any static charge which may have accumulated on the person doing the servicing.

Note

Wearing Conductive Wrist Strap (Motorola No. RSX-4015A) will minimize static build-up during servicing.

2. Whenever possible, avoid touching any electrically conductive parts of the circuit module with your hands.

3. Power down the unit before installing or removing a circuit module.

4. When servicing a circuit module, avoid carpeted areas, dry environments, and certain types of clothing (silk, nylon, etc.) because they contribute to static build-up.

5. All electrically powered test equipment should be grounded. Apply the ground lead from the test equipment to the circuit module before connecting the test probe.

   Similarly, disconnect the test probe prior to removing the ground lead.

6. If a circuit module is removed from the system, it is desirable to lay it on a conductive surface (such as a sheet of aluminum foil) which is connected to ground through 100k of resistance.

WARNING

If the aluminum foil is connected directly to ground, be cautious of possible electrical shock from contacting the foil at the same time as other electrical circuits.

7. When soldering, be sure the soldering iron is grounded.

8. Prior to connecting jumpers, replacing circuit components, or touching CMOS pins (if this becomes necessary in the replacement of an integrated circuit device), be sure to discharge any static build-up as described in procedure 1.

   Since voltage differences can exist across the human body, it is recommended that only one hand be used if it is necessary to touch pins on the CMOS device and associated board wiring.

9. When replacing a CMOS integrated circuit device, leave the device in its conductive rail container or conductive foam until it is to be inserted into the printed circuit module.

10. All low impedance test equipment (such as pulse generators, etc.) should be connected to CMOS device inputs after power is applied to the CMOS circuitry. Similarly, such low impedance equipment should be disconnected before power is turned off.

11. Replacement modules shipped separately from the factory will be packaged in a conductive material. Any modules being transported from one area to another should be wrapped in a similar material (aluminum foil may be used). **Never use non-conductive material** for packaging these modules.

General Specifications

- **DC input voltage:**
  10.5 to 16VDC
- **Input from radio receiver:**
  typical 300mV RMS
- **Ouput level to transmitter:**
  80mV RMS nominal
- **DC input current:**
  less than 100mA
- **Audio frequency response:**
  ±3dB, 300-3000Hz from 1kHz ref.
- **Hum and noise:**
  -45dB from 1kHz ref. using 30kHz LPF, 300mV RMS into RX audio input(s)
- **Audio distortion:**
  3% max., 1kHz tone
- **Humidity range:**
  95% relative himidity at 50° C
- **Weight:**
  3 pounds max.
- **Dimensions:**
  7"w x 5.2"d x 1.5"h

Appendix A
Schematics, Layouts and Parts List

Basic Operation

Description

The i20R is an enhanced repeater controller designed to interface between two Radius GM300 mobile radios in the GR-series repeater housings. The repeater can operate in either uni-directional mode, or bi-directional mode. The repeater can be "in-band" (UHF-UHF) or "cross band" (UHF-VHF). A temporary or emergency repeater may also be quickly assembled by plugging two mobiles, via their modular microphone connectors into the modular jacks located on the rear of the i20R.

Features include programmable time-out timer, "over" beep, battery power indicator beep, drop-out timer, TPL/DPL cross-coding, and automatic CWID. All features are programmable via Radio Service Software (RSS). The i20R supports up to 10 TPL or DPL codes for multiple group usage.

Front panel LEDs indicate the status of Power, COR/TX, and RPTR (refer to Figure 1-1).

Figure 1-1. Front Panel

Installation

Mounting

The i20R can be mounted in any of the GR-series housings, using the supplied mounting hardware. Before permanently mounting, it is recommended that the i20R remain unmounted for operational tests. It is also imperative that JU551, inside the GM300 receive radio, is in the "A" position for any application where the i20R will be decoding TPL/DPL. This is also required in the transmit radio, for bi-directional repeaters, where the i20R is required to decode TPL/DPL signals.

Additionally, 16 channel GM300, and M200 radios must be properly programmed (operating frequencies, COR, TPL/DPL codes, etc.) prior to placing into service.

Connect the cable from the receive radio to the 16 pin connector marked RX, on the rear of the i20R (PR5). Connect the cable from the transmit radio to the connector marked TX, on the rear of the i20R (PR3). The cables are supplied as part of the GR-series repeater package.

After the system is tested and operational, slide the i20R into the top position of the GR-series repeater housing and secure with the 2 machine screws provided. The radios are mounted in a similar manner in the slots below the i20R.

CAUTION

Install connectors with locking tabs "UP" Refer to Figure 1-2. Ensure the i20R connectors, RX and TX, are programmed to match the radios before connection. Failure to do so could damage the i20R and/or the radios.

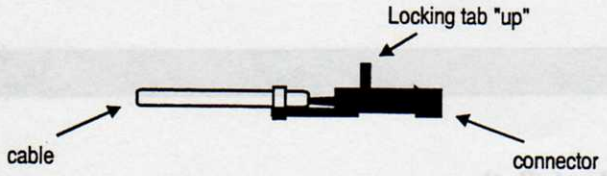


Figure 1-2. Locking Tab

Uni-Directional Operation (Normal Repeat Mode)

In this mode, the i20R operates as a normal split-channel repeater (both receiver and transmitter in the same VHF or UHF band). Parameter programming is made via RSS. TPL or DPL will not be retransmitted through the repeater.

Table 1-1. Standard Repeat Modes with TPL/DPL Regeneration

GM300 Jumper	Transmit Radio Jumper Position	Receive Radio Jumper Position
JU551	"A" for Bi-directional repeat "x" for Uni-directional	"A"
JU651	"A"	"A" for Bi-directional repeat "x" for Uni-directional
JU701	"B"	"A" for Bi-directional repeat "x" for Uni-directional
"x" = jumper may be in either "A" or "B" position		

Bi-Directional Operation

In this mode, both radios operate as cross-band transceivers. That is, one radio typically operates on a VHF frequency, while the other operates on a UHF frequency. Parameter programming is made via RSS.

Note

The drop-out timer should be programmed in RSS to the minimum of 100ms for both forward and reverse repeater drop-out time.

Programming Radio Jumpers

If it is required that the i20R regenerate DPL, or TPL, jumper JU701 on the Expanded Logic Board should be in the "B" position. This will be considered the norm for most installations. Refer to Table 1-1 for jumper settings.

i20R programming

The i20R must also be programmed to determine the operating mode. Select "Repeat Method" from the Unidirectional/Forward Repeater Table screen in Radio Service Software (RSS). If Bi-directional mode is used you must also select "Repeat Method" from the Reverse Repeater Table screen.

Select either "Strip RX PL and Repeat" or "Repeat w/Alternate PL" Selecting "Strip RX PL and Repeat" will cause the i20R to regenerate received TPL/DPL codes. Selecting "Repeat w/Alternate PL" allows TPL/DPL cross-coding (a different code is transmitted than is received).

Transparent Repeat Mode

Description

This method should be used for special applications when it is not required to regenerate TPL or DPL.

Table 1-2. Transparent Repeat Mode

GM300 Jumper	Transmit Radio Jumper Position	Receive Radio Jumper Position
JU551	"A" for Bi-directional repeat "x" for Uni-directional	"A" for Uni-directional and Bi-directional
JU651	"A"	"A" for Bi-directional repeat "x" for Uni-directional
JU701	"A"	"A" for Bi-directional repeat "x" for Uni-directional
"x" = jumper may be in either "A" or "B" position		

Radio Jumpers

When it is desired to use the repeater in the Transparent Repeat Mode, the GM300 Expanded Logic Board Jumper JU701 must be in the "A" position. Also, the receiver radio logic board jumper, JU551, should be in the "A" position to supply discriminator (not de-emphasized and muted) receiver audio. The radio is shipped with jumper JU551 in the "B" position. Do not place radio transmit radio logic board jumper JU701 in the "B" position for Transparent Repeat Mode as the supplied level will be insufficient for full modulation. Refer to Table 1-2 for jumper settings.

i20R Programming

The transmit radio must be programmed for carrier squelch (CSQ) using RSS. This allows the data that is received to be re-transmitted, without introducing an added TPL/DPL code. To enable Transparent Repeat, using RSS, select "Transparent Repeat" under "Repeat Method" parameter. Selecting Transparent Repeat will disable the receive de-emphasis in the i20R and pass the audio essentially unaltered to the flat input of the repeater transmitter. The range of the levels will be reduced to accommodate the levels required for the GM300 radio when the logic board jumper JU701 is set for the "A" position.

TPL/DPL Cross Coding

The i20R may be programmed to cross code a received TPL or DPL code. This function may be enabled in Uni-Directional or Bi-Directional operation. Cross coding allows a different TPL or DPL code to be sent to a mobile. Received input can be a TPL code and transmitted output a DPL code, or vice-versa. If regeneration of the desired TPL/DPL signal is desired, the i20R can be programmed to encode the same code it receives.

If operating in Unidirectional mode, program RSS parameters in the Unidirectional/Forward Repeater table.

If operating in Bi-Directional mode, program RSS parameters in the Reverse Repeater table.

Level Setting

Normal Repeat Level Setting

If "Strip RX PL and Repeat" (or "Strip PL and Repeat with Alternate PL") has been selected in the RSS, the level of the TPL or DPL modulation should be adjusted after POT3 FWD RPTR LVL, and POT1, REV RPTR LVL (if used), has been set. Modulate an RF generator, on to the forward receiver frequency, with a 1000Hz tone, at 60% system deviation. Enter Diagnostics Test 1. Adjust POT3 for the 60% system modulation from the forward transmitter.

If reverse repeat is also required, enter Internal Diagnostic Test 2 and perform a procedure similar to the one above, injecting the RF signal into the reverse receiver. While monitoring the reverse transmitter, adjust POT1 for 60% system modulation.

Turn off the 1000Hz tone before setting the TPL/DPL level. Enter Diagnostic Test 3 for FORWARD TPL, or Test 4 for FORWARD DPL, and set the TPL or DPL modulation with POT2 for approximately ±750Hz deviation, as indicated on a Communications Service monitor.

Transparent Repeat Level Setting

Pot 2 adjusts the level of the flat audio to the repeater transmitter. It should normally be set to produce a 1:1 repeat ratio in the Transparent mode. Cause the system to repeat, by generating a modulated carrier (1kHz tone) on the receive frequency. While monitoring the transmitter with a Communications Service monitor set to measure deviation, adjust POT2 to produce ± 3kHz deviation of the transmitter, for ± 3kHz deviation from the generator, in a ± 5kHz system.

Note

If either TPL or DPL is also to be repeated transparently (not regenerated by the i20R), POT2 should be adjusted to produce a repeat ratio of 60/50.
Example: In a 5kHz system, setup an FM RF generator as follows:
±3kHz deviation of a 1000Hz tone
RF level at 1000 micro-volts
Adjust POT2 to produce ±2.5kHz deviation of the transmitter.

Accessories

If an accessory, such as a TRA100R, or Local Control Deskset is used, insert the cable connector into PR4, marked ACC, on the rear of the unit.

CAUTION

Before connecting any device to the ACC connector, ensure the connector is configured as required using Radio Service Software (RSS). Failure to do so might damage the i20R and/or accessory device.

A local control dispatch microphone or handset may be plugged into the front panel 8-pin modular connector. This connector conforms to the standard Motorola pin-out.

Temporary Repeater

The i20R may be assembled as a limited capability (emergency) repeater.

Note

The i20R must be programmed for VOX operation to validate mobile carrier using RSS. Jumpers in the radio must provide muted, post de-emphasized audio to the i20R (JU551 in the "B" position for the GM300 radios).

Connect the 8 pin modular microphone port interface cable, between the front panel microphone jack (J11) and P1 RX. Connect another 8 pin modular microphone port interface cable between the front panel microphone jack of the transmitter radio, and P2 TX located on the rear panel of the unit.

Connector Charts

The following charts list the default, programmable pin functions for PR5, PR3, and PR4 of the i20R.

PR5 - RX connector

Pin #	Default Function
3	PTT
4	External Alarm
6	null input
8	RX COR
9	Emergency Switch
12	null input
14	null input

PR3 - TX connector

Pin #	Default Function
3	PTT
4	null input
6	null input
8	null input
9	null input
12	null input
14	TX COR

PR4 - Accessory Connector

Pin #	Default Function
6	output follows state of pin PR5-6
8	output follows state of pin PR5-8 (RX COR)
12	output follows state of pin PR5-12
14	output - follows state of pin PR5-14

Optional Functions

Serial Billing Interface

Serial Billing Interface identifies radio users in both forward and reverse operations. Serial output is via the 8 pin modular program connector, which uses standard Motorola RIB logic levels.

The output is a 9600 BPS serial format. The output will be displayed in the following format:

Forward/Unidirectional Mode (where *x* is the user #)	F*x*
Reverse Mode (where *x* is the user #)	R*x*

The end user is responsible for providing PC software to utilize this data for billing purposes.

Operator Instructions

Repeater Enable/Disable

The front panel contains a manual override for repeater "enable" or "disable" ("disable" does not prevent local control operation of the station). Pressing the RPTR button will enable or disable the repeater. The status of the repeater is indicated by the amber LED on the front panel. If the LED is lit, the repeater is enabled, if the LED is not lit, the repeater is disabled.

Remote Repeater Disable or Enable

Remote Repeater Disable

To remotely disable a repeater that is enabled, the mobile initiates a RapidCall Call Alert to the receive radio, using the receive radio's ID number. If the receive radio has been programmed to transmit an Emergency Alert (using RSS), the alert will be transmitted to indicate that the repeater is disabled. If the receive radio has not been programmed to transmit an Emergency Alert, no indication will be sent to the mobile.

Remote Repeater Enable

To remotely enable a repeater that is disabled, the mobile initiates a Call Alert to the receive radio, using the receive radio's ID number. No acknowledgment will be sent to the mobile radio, however, the repeater being operational will confirm its enabled state.

> **Note:**
> For remote repeater controller, the receive radio must be programmed to transmit on the receive frequency with RapidCall enabled.

Internal Diagnostics

The i20R has been designed with several diagnostic tests to assist you in set-up and troubleshooting. Enter the diagnostic mode by pressing the TEST button.

To step to another test once the diagnostic mode has been entered, press the TEST button again.

Each time a new test is selected, a test timer is set to 15 minutes. If this timer reaches zero, the unit resets itself to idle.

Test 1

Test 1 performs the following tasks:

1. Forward audio (RX audio from RX radio) is repeated based on programming. If repeater is programmed for VOX operation, PTT is activated based on VOX detection. If repeater is programmed for logic carrier detect, PTT is activated based on COR detection.

2. RPTR button is used to toggle between VOX based repeat and COR based repeat.

3. EXTERNAL ALARM input, when active, causes transparent repeat operation (when not in VOX operation). When EXTERNAL ALARM is inactive, audio is routed to mic input of TX radio.

Note

The EXTERNAL ALARM function must be programmed into an input pin of PR5 to allow selecting transparent repeat operation.

4. LED functions (refer to Figure 1-1):

   PWR LED on when in VOX repeat mode

   COR/TX LED on when not in VOX mode and repeat audio is being high-pass filtered (non-transparent repeat operation)

   RPTR LED on when in VOX operation and VOX detected

5. The reference voltage for VOX detection is set by the user. The user must enter "SET VOX" from PC running terminal emulation software, with the RIB connected. When the i20R has set the VOX threshold, the unit will reset. During this test, no audio should be input to PR3-11 or through the modular connector (J2).

Test 2

Test 2 performs the following tasks:

1. Reverse audio (RX audio from TX radio) is repeated based on programming. If repeater is programmed for VOX operation, PTT is activated based on VOX detection, if repeater is programmed for logic carrier detect, PTT is activated based on COR detection.

2. RPTR button is used to toggle between VOX based repeat and COR based repeat.

3. EXTERNAL ALARM input, when active, causes transparent repeat operation (when not in VOX operation). When EXTERNAL ALARM is inactive, audio is routed to mic input of RX radio.

Note

The EXTERNAL ALARM function must be programmed into an input in of PR5 to allow selecting transparent repeat operation.

4. LED functions (refer to Figure 1-1):

   PWR LED on when in VOX repeat mode

   COR/TX LED on when not in VOX mode and repeat audio is being high-pass filtered (non-transparent repeat operations)

   RPTR LED on when in VOX operation and VOX detected

Test 3

Test 3 performs the following tasks:

1. Forward audio (RX audio from RX radio) is constantly repeated from PR5-11 to PR3-2 (high-pass filtered & de-emphasized).

2. The i20R generates TPL and adds it to the forward audio.

3. The i20R decodes TPL on the RX channel. If the TPL decoded matches the TPL being generated, the RPTR LED is lit.

Note

To decode TPL, JU551 in the receive radio must be in the "A" position.

4. Pressing the RPTR button will cause the i20R to step to generating the next TPL tone frequency.

5. If the EXTERNAL ALARM input is active, the generated TPL signalling will be phase shifted 180 degrees. (**Note**: This requires that one of the PR5 input pins be programmed for the EXTERNAL ALARM function.)

Test 4

Test 4 performs the following tasks:

1. Forward audio (RX audio from RX radio) is constantly repeated from PR5-11 to PR3-2 (high-pass filtered & de-emphasized).

2. The i20R generates DPL and adds it to the forward audio.

3. The i20R decodes DPL on the RX channel. If the DPL decoded matches the DPL being generated, the RPTR LED is lit and the DPL digits are transmitted through the programming port.

Note

To decode DPL, JU551 in the receive radio must be in the "A" position.

4. Pressing the RPTR button will cause the i20R to step to generating the next DPL code from Table 1-3.

5. If the EXTERNAL ALARM input is active, the generated DPL signalling will be inverted. (**Note:** This requires that one of the PR5 input pins be programmed for the EXTERNAL ALARM function.)

Note

The EXTERNAL ALARM function must be programmed into an input pin of PR5 to allow setting LOW BATTERY threshold.

Test 5

Test 5 performs the following tasks:

1. Beep tone is transmitted from TX radio.

2. Pressing the RPTR button will raise the beep tone frequency by 100Hz (the range is 400-2000Hz).

3. RS232 data (alternating 0xaa and 0x55 values) will be looped from TX to RX SCI ports. If the received data matches the transmitted data, the PWR LED will be lit.

4. If the power supply voltage falls below the programmed LOW BATTERY voltage threshold, the RPTR LED will light.

5. Activating the EXTERNAL ALARM input will force the unit to sample the power supply threshold and set it as the new LOW BATTERY voltage threshold

Note

The EXTERNAL ALARM function must be programmed into an input pin of PR5 to allow setting LOW BATTERY threshold.

Test 6

WARNING

The i20R must be disconnected from the radios during Test 6. Failure to do so could cause damage to both the i20R and the radios.

Note

During this test, PR5-4 must be connected to PR5-9 with a pull-up on PR5-9. Also, PR3-4 must be connected to PR3-9 with a pull-up on PR3-9.

Test 6 performs the following functions:

1. All connector pins are tested. The LEDs give a binary representation of the connector being tested (PR5 or PR3). PR4-6, 8 are tested with PR5; PR4-12, 14 are tested with PR3.

2. The test consists of writing a value to the pins and verifying that the same value is read back in. This is done 10 times.

3. The connector being tested toggles between PR3 and PR5 by pressing the RPTR button.

4. If an error is detected during this test, the LEDs will begin flashing. The pins which have produced the error will be listed via data output through the programming port.

Test 7

Test 7 performs the following:

1. Decodes TPL and DPL on the selected radio.

Note

To decode TPL, JU551 in the receive radio must be in the "A" position.

2. LED functions (refer to Figure 1-1):

   PWR LED lit steadily if decoding from RX radio, flashing if decoding from TX radio

   COR/TX LED lit if TPL has been decoded on the channel

   RPTR LED lit if DPL has been decoded on the channel

3. If the i20R is programmed for bi-directional repeat operation, pressing the RPTR button before TPL is decoded will switch to decoding the opposite radio.

4. Pressing the RPTR button after TPL is decoded will store decoded TPL into the first entry of the applicable repeater table (forward or reverse) and reset the unit.

Table 1-3. DPL Code Chart

0 = 023	27 = 172	54 = 431	81 = 734
1 = 025	28 = 174	55 = 432	82 = 743
2 = 026	29 = 205	56 = 445	83 = 754
3 = 031	30 = 223	57 = 464	84 = 036
4 = 032	31 = 226	58 = 465	85 = 053
5 = 043	32 = 243	59 = 466	86 = 122
6 = 047	33 = 244	60 = 503	87 = 145
7 = 051	34 = 245	61 = 506	88 = 212
8 = 054	35 = 251	62 = 516	89 = 225
9 = 065	36 = 261	63 = 532	90 = 246
10 = 071	37 = 263	64 = 546	91 = 252
11 = 072	38 = 265	65 = 565	92 = 255
12 = 073	39 = 271	66 = 606	93 = 266
13 = 074	40 = 306	67 = 612	94 = 274
14 = 114	41 = 311	68 = 624	95 = 325
15 = 115	42 = 315	69 = 627	96 = 332
16 = 116	43 = 331	70 = 631	97 = 356
17 = 125	44 = 343	71 = 632	98 = 446
18 = 131	45 = 346	72 = 645	99 = 452
19 = 132	46 = 351	73 = 654	100 = 454
20 = 134	47 = 364	74 = 662	
21 = 143	48 = 365	75 = 664	
22 = 152	49 = 371	76 = 703	
23 = 155	50 = 411	77 = 712	
24 = 156	51 = 412	78 = 723	
25 = 162	52 = 413	79 = 731	
26 = 165	53 = 423	80 = 732	

Theory of Operation

Microcontroller

The i20R utilizes a 68HC11 MCU to manage timing, audio paths, DPL decoding, and status/CWID tone generation. Customizing the i20R for individual system requirements is accomplished using Radio Service Software (RSS). Operating parameters are stored in a non-volatile EEPROM contained within the 68HC11.

Microcontroller U1, clocked from Y1, is divided internally deriving the 4MHz E-clock. Power-up reset, to initialize the HC11, is provided by U5c, U5d, D1, D104, and associated components. As long as B+ remains above the zener voltage of D104 (plus threshold of U5-13), the reset line remains high. If B+ drops, C4 is discharged through D1, twice inverted and buffered by Schmitt-trigger U5f and e, which results in RES_D being pulled low, causing an MCU reset. Upon power up, C4 is recharged through R24, and the RES_D input is high, allowing MCU initialization. U1 operates in "normal expanded" mode, determined by pull-up resistors R2 and R3 on the MODA and MODB pins. This allows the processor to be used with external memory.

Audio Paths

Audio path control is derived from serial-in, parallel-out data latch U10, under MCU control, via the serial peripheral interface (SPI) bus. This serial bus is also used to communicate with U3, sub-audible processor module and the radio I/O connections.

In the conventional repeat path, receive audio enters the controller via PR5-11 and is routed through analog multiplexer U14A to U3 (a sub-audio signaling processor). U3 generates and decodes the TPL under MCU control. It also performs filtering and data conditioning for TPL tones and DPL data (below 300Hz).

Filtered audio from U3-11, is gated by U13 and combined with tones (beeps, CWID, or status) in summing amplifier U11a. Q7, Q8 and Q9 comprise an audio gate, for the audio path to the forward repeater transmitter.

Q10, Q11, and Q12 perform a similar function for the reverse repeater transmit path. In the "transparent repeat" mode, receive audio originating from either station receiver discriminator, is routed to the flat input of the station transmitter as selected through analog multiplexers U13b, U14a and U14b, where it becomes input to U11b. From there it becomes input to the "flat" input of the transmitter.

Forward repeat audio level is set manually by POT1, while reverse repeat audio level is set by POT3. The transparent repeat audio level is set by POT2.

Accessory transmit audio is routed, either to the flat modulation input, or the pre-emphasized input (EIA) of the station transmitter, via Jumper JU11. Accessory receive audio is derived directly from the station receiver (PR5-11) or "transmitter" RX audio (PR3-11) via selection of jumper JU11.

TPL/DPL Functions

U3, a sub-audible signal processor, decodes the CTCSS (TPL) tones from the system mobiles. It also generates the required CTCSS (TPL) tone derived from ECLK. DPL data originates from the MCU and is conditioned by U3 and output at U3-9. TPL or DPL is gated by U14B/G2 where it becomes an input to U11b. DPL data polarity is determined by U14-9/G3, selecting either the inverting or non-inverting input of U11b.

Data Modulation inverter/buffer U11b, provides up to 200mV RMS into a high impedance load. There it becomes an input to the "FLAT" (non-preemphasized) input of the station transmitter. The required TPL/DPL level is set manually by potentiometer POT2.

DC Power Supply

DC input power is surge protected by R130 and reverse voltage protected by D101. Over-voltage protection is provided by D103.

Series pass transistors Q13, and Q14 regulate the 5V digital source, under control of U12d. Reference is provided by D102. R140 and C32 filter the 5VD source, providing a pure 5V analog source.

A 2.5V reference, provided by U3, is buffered by U12b. R4, and C3 provide a filtered VRH (Volts Reference High) at 5V for the analog to digital (A-D) converter inputs to the MCU.

Low battery sense is provided by sampling the DC input voltage via precision network R87, R88, and R89, then routing it to the internal A-D converter within U1. This will cause low battery alarm tones to be generated, if enabled with RSS.

VOX Operation

Precision rectifiers U12a and U12b comprise VOX detectors for the forward and reverse repeat paths respectively. A sample of the receive audio, derived from the station receiver(s), is referenced against the 2.5V, becoming an input to the MCU FWD_VOX and REV_VOX, where it is validated. If VOX is selected with RSS, and there is no other inhibit, then, a PTT is generated by the MCU to the opposite radio.

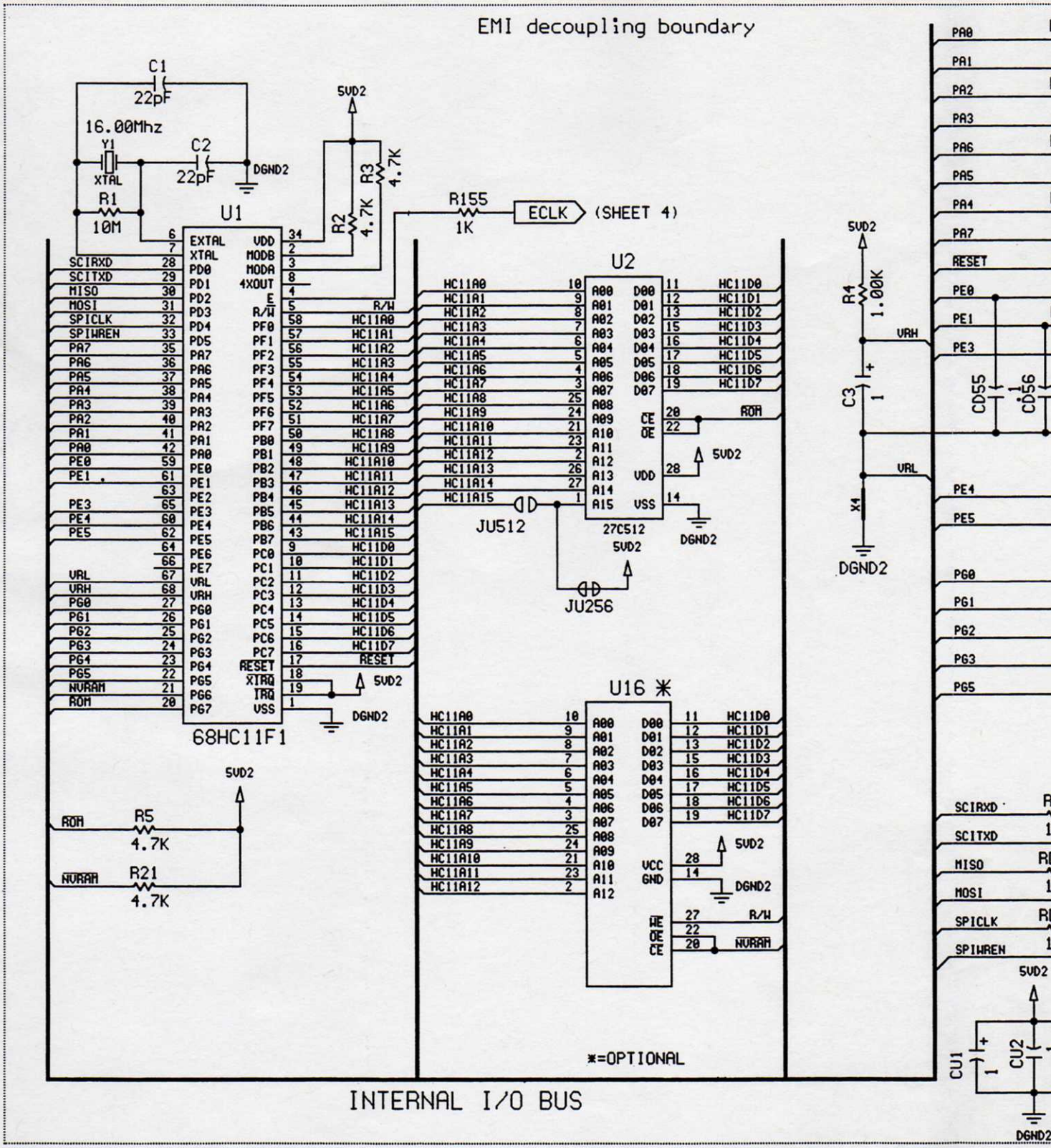
Miscellaneous Functions

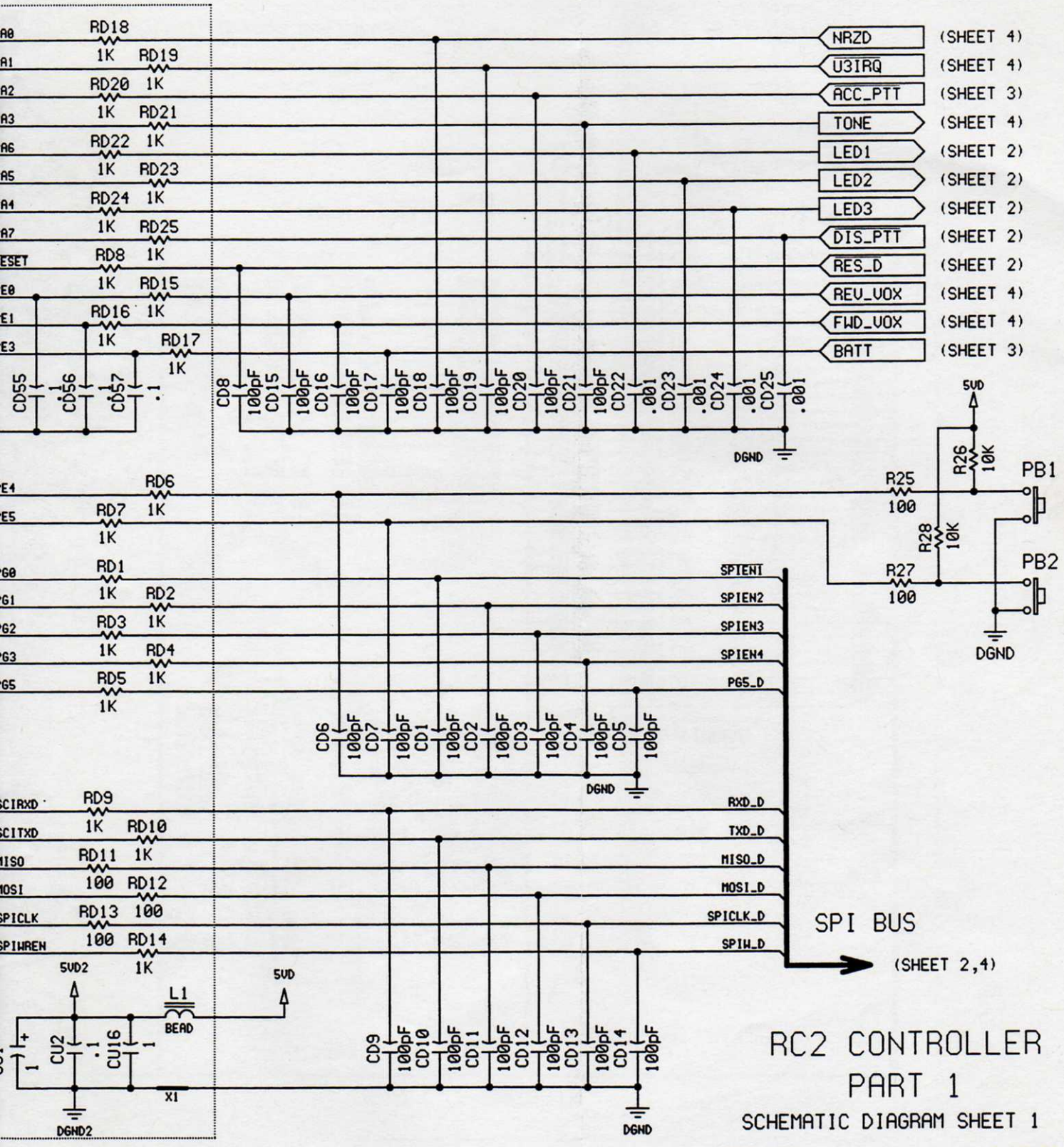
Each LED has its own driver, Q4-Q6, all under MCU control. Button presses normally pulled high by R26 and R28, are detected by MCU logic inputs PE4 and PE5.

ESD and surge protection for all I/O lines is provided by an extensive complement of diodes (eg. D10 D15 for analog I/Os), while zener diodes protect logic I/Os (eg. D40 D56, etc). RFI/EMI protection is provided on all processor I/O bus lines, by a low-pass filter consisting of RD1 RD22, and CD1 CD25. Digital 5V supply decoupling is provided by L1 and CU1 2.

Programming Interface

J6 is normally used for a local dispatch microphone or handset. Programming and reading of system parameters is also through J6. RSS programming data is interfaced through the Radio Interface Box (RIB) by the Serial Communications Interface port (SCI), a bi-directional, "wired Or" serial port formed by U5a and Q3. Parameters are stored in the MCU's nonvolatile EEPROM.

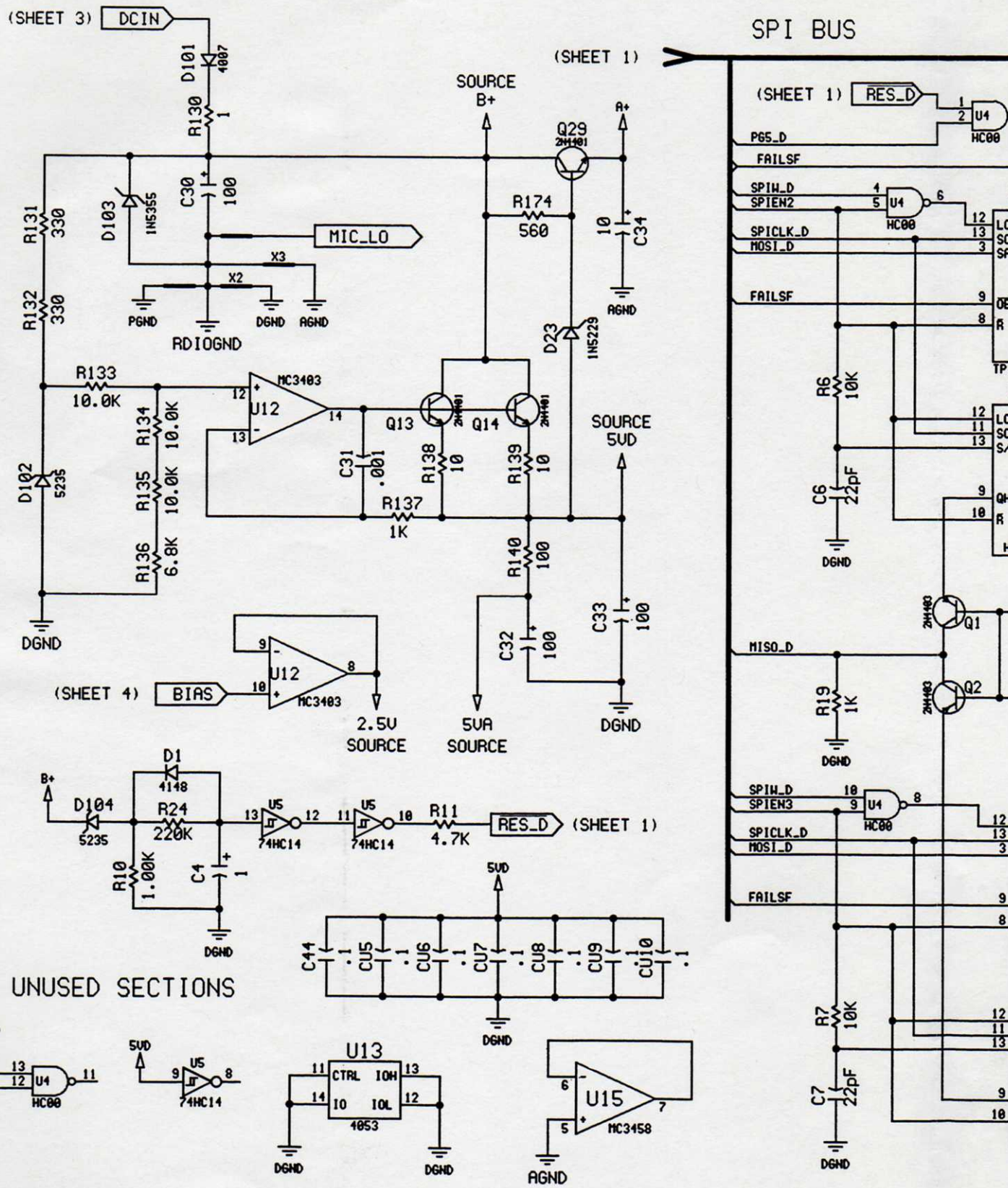

EMI decoupling boundary
C1
22pF
16.00Mhz
Y1
XTAL
C2
22pF
DGND2
R1
10M
5VD2
R3
4.7K
R2
4.7K
R155
1K
ECLK
(SHEET 4)
U1
68HC11F1
U2
27C512
JU512
JU256
U16 *
*=OPTIONAL
R5
4.7K
R21
4.7K
R4
1.00K
C3
VRH
VRL
X4
CD55
CD56
CU1
CU2
INTERNAL I/O BUS

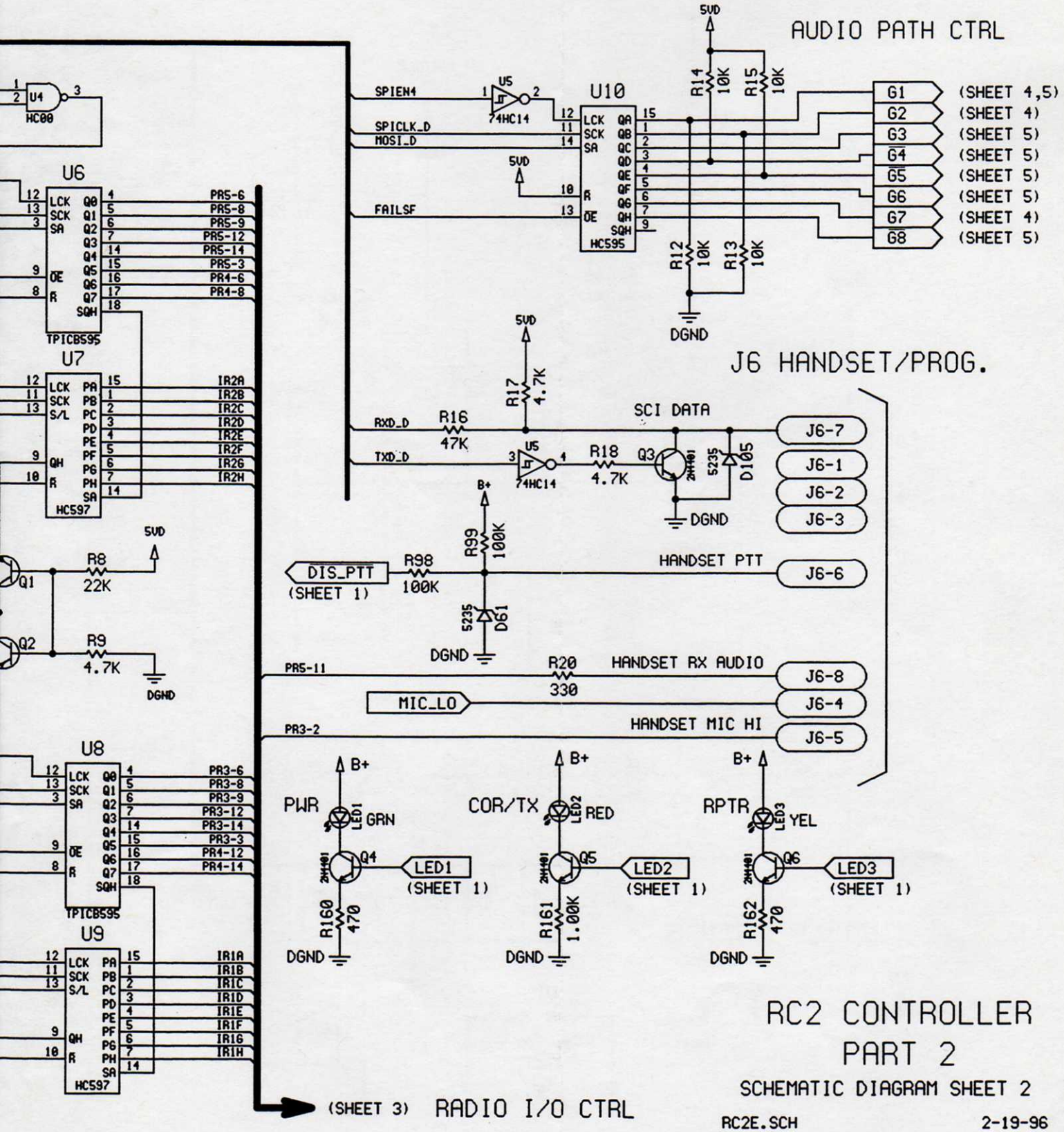


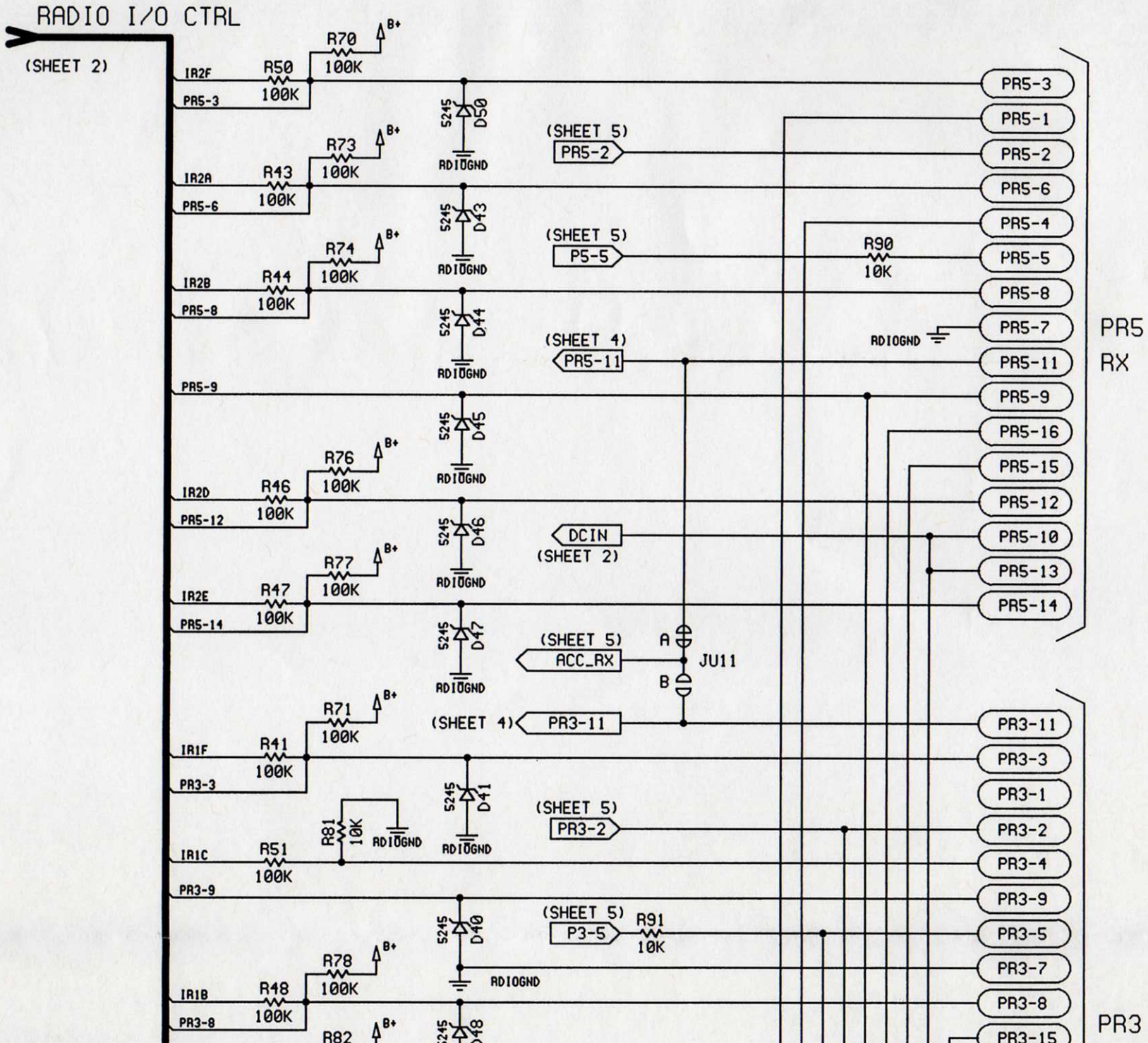
RC2 CONTROLLER
PART 1

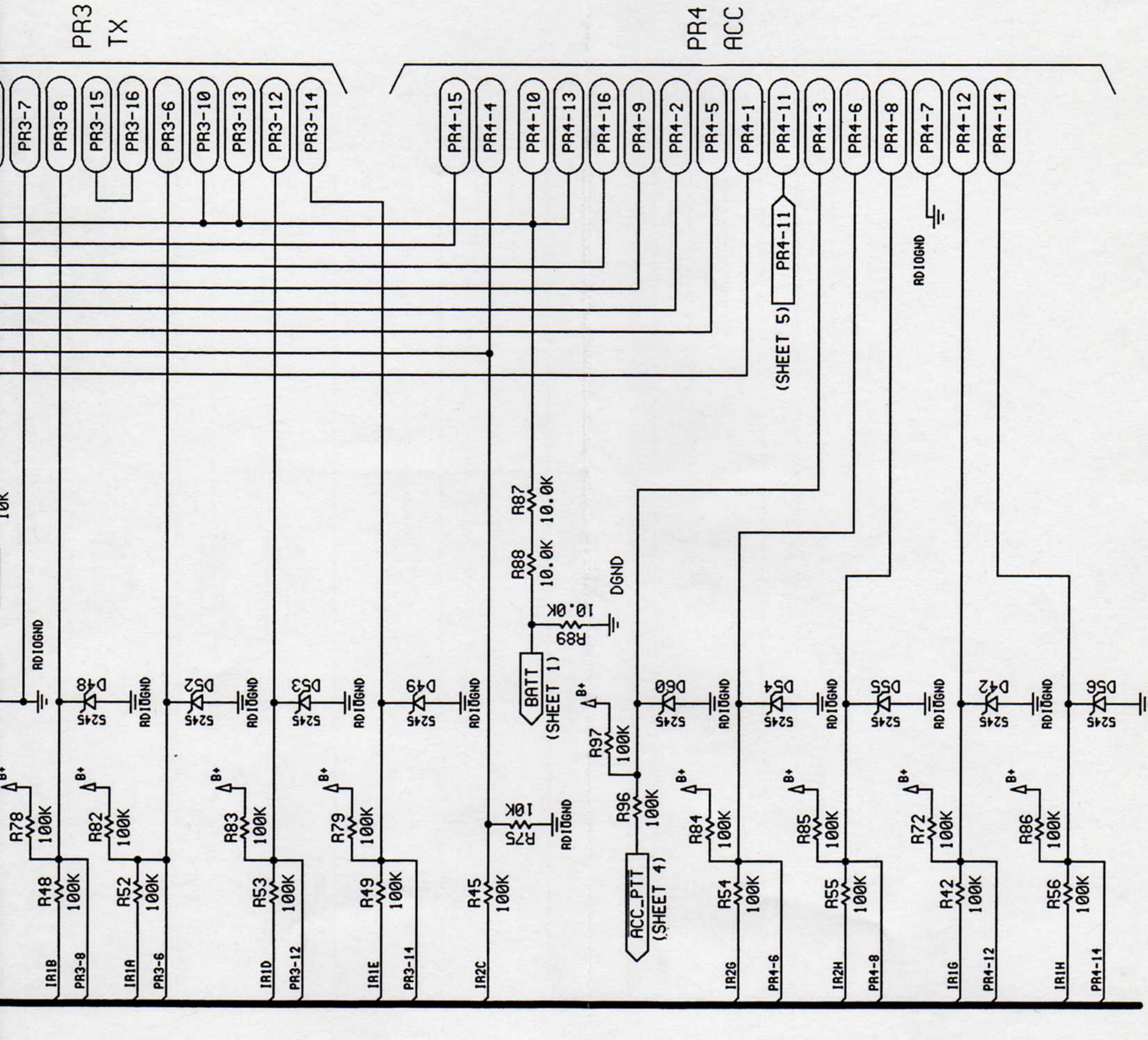
SCHEMATIC DIAGRAM SHEET 1

RC2E.SCH 2-19-96


(SHEET 3) DCIN
D101
4007
R130
1
SOURCE B+
(SHEET 1)
Q29
2N4401
A+
R131
330
R132
330
D103
1N5355
C30
100
MIC_LO
X3
X2
PGND
DGND
AGND
RDIOGND
R174
560
10
C34
D23
1N5229
R133
10.0K
U12
MC3403
Q13
Q14
2N4401
R134
10.0K
R135
10.0K
R136
6.8K
D102
5235
C31
.001
R138
10
R139
10
R137
1K
SOURCE 5VD
R140
100
C32
100
C33
100
DGND
(SHEET 4)
BIAS
2.5V SOURCE
5VA SOURCE
D1
4148
B+
D104
5235
R24
220K
U5
74HC14
R11
4.7K
RES_D
(SHEET 1)
R10
1.00K
C4
1
DGND
5VD
C44
.1
CU5
CU6
CU7
CU8
CU9
CU10
UNUSED SECTIONS
U4
HC00
U13
CTRL
IOH
IO
IOL
4053
U15
MC3458
AGND
SPI BUS
(SHEET 1)
RES_D
PG5_D
FAILSF
SPIW_D
SPIEN2
SPICLK_D
MOSI_D
R6
10K
C6
22pF
Q1
Q2
MISO_D
R19
1K
SPIEN3
R7
10K
C7
22pF


AUDIO PATH CTRL
U4
HC00
U6
TPICB595
U7
HC597
U8
TPICB595
U9
HC597
U10
HC595
U5
74HC14
5VD
DGND
R14 10K
R15 10K
R12 10K
R13 10K
SPIEN4
SPICLK_D
MOSI_D
FAILSF
G1 (SHEET 4,5)
G2 (SHEET 4)
G3 (SHEET 5)
G4 (SHEET 5)
G5 (SHEET 5)
G6 (SHEET 5)
G7 (SHEET 4)
G8 (SHEET 5)
J6 HANDSET/PROG.
R17 4.7K
RXD_D
R16 47K
SCI DATA
TXD_D
R18 4.7K
Q3
D105
J6-7
J6-1
J6-2
J6-3
B+
R99 100K
DIS_PTT
(SHEET 1)
R98 100K
HANDSET PTT
J6-6
D61
R8 22K
Q1
Q2
R9 4.7K
PR5-11
R20 330
HANDSET RX AUDIO
J6-8
MIC_LO
J6-4
PR3-2
HANDSET MIC HI
J6-5
PWR
LED1 GRN
Q4
LED1
(SHEET 1)
R160 470
COR/TX
LED2 RED
Q5
LED2
(SHEET 1)
R161 1.00K
RPTR
LED3 YEL
Q6
LED3
(SHEET 1)
R162 470
(SHEET 3) RADIO I/O CTRL
RC2 CONTROLLER
PART 2
SCHEMATIC DIAGRAM SHEET 2
RC2E.SCH
2-19-96


RADIO I/O CTRL
(SHEET 2)
IR2F
PR5-3
R50
100K
R70
100K
B+
5245
D50
RDIOGND
(SHEET 5)
PR5-2
IR2A
PR5-6
R43
100K
R73
100K
D43
P5-5
IR2B
PR5-8
R44
100K
R74
100K
D44
PR5-9
D45
IR2D
PR5-12
R46
100K
R76
100K
D46
DCIN
(SHEET 2)
IR2E
PR5-14
R47
100K
R77
100K
D47
ACC_RX
JU11
A
B
(SHEET 4)
PR3-11
IR1F
PR3-3
R41
100K
R71
100K
D41
PR3-2
IR1C
PR3-9
R51
100K
R81
10K
D40
P3-5
R91
10K
IR1B
PR3-8
R48
100K
R78
100K
D48
R82
R90
10K
PR5-3
PR5-1
PR5-2
PR5-6
PR5-4
PR5-5
PR5-8
PR5-7
PR5-11
PR5-16
PR5-15
PR5-12
PR5-10
PR5-13
PR5-14
PR5
RX
PR3-11
PR3-3
PR3-1
PR3-2
PR3-4
PR3-9
PR3-5
PR3-7
PR3-8
PR3-15
PR3

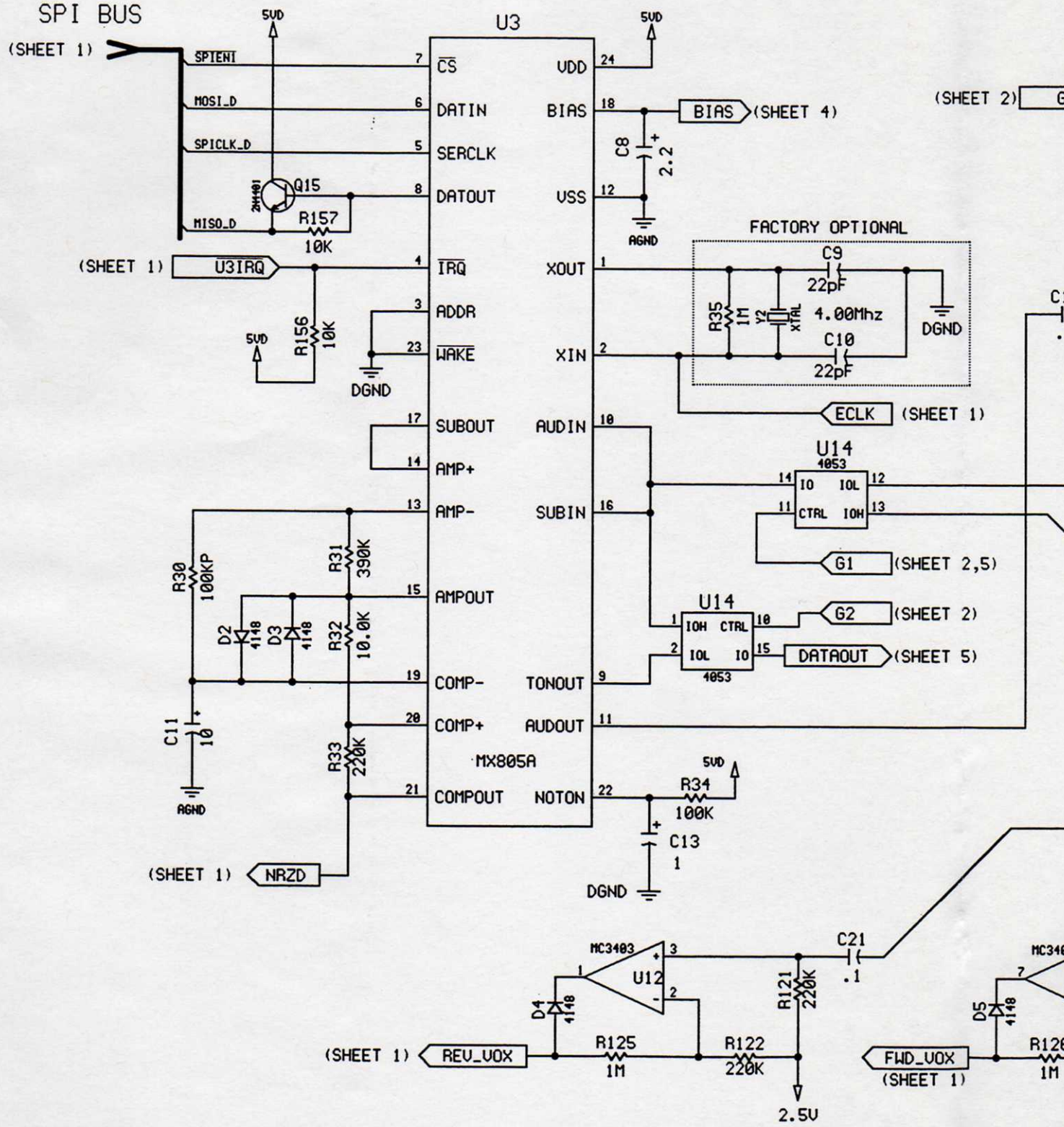


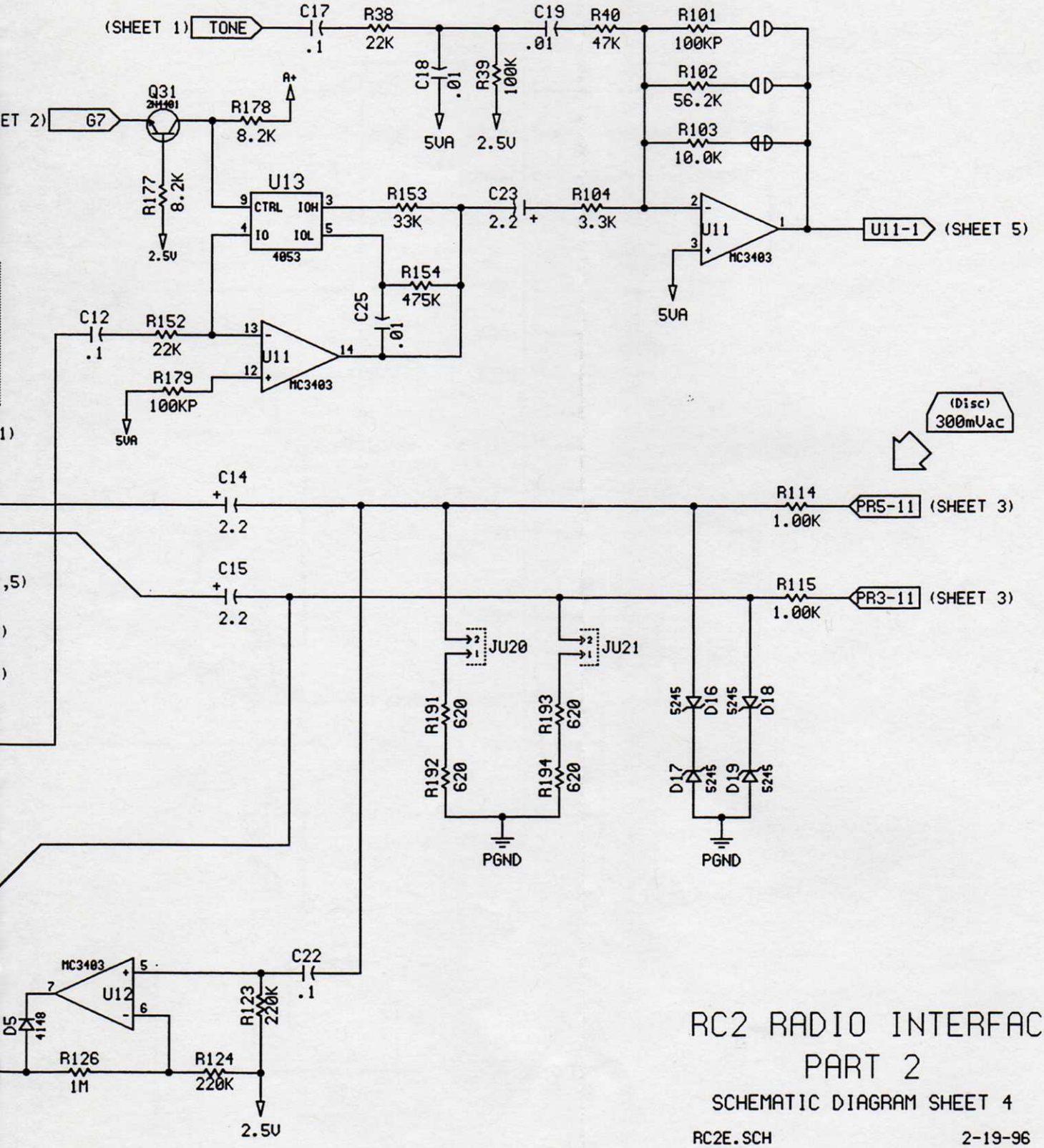
RC2 RADIO INTERFACE

PART 1

SCHEMATIC DIAGRAM SHEET 3

RC2E.SCH 2-19-96

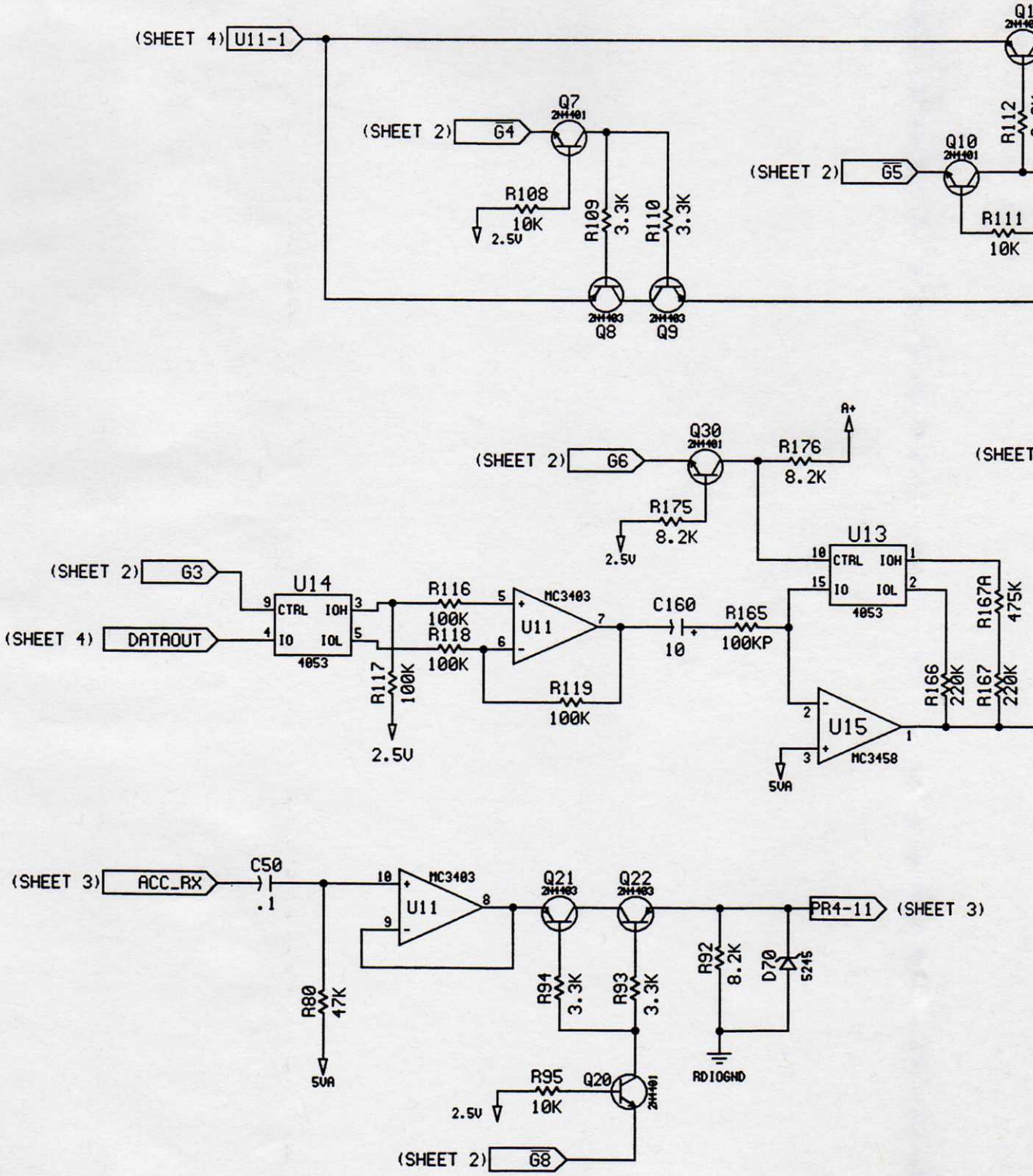

SPI BUS
(SHEET 1)
SPIENI
MOSI_D
SPICLK_D
MISO_D
5VD
Q15
2N4401
R157
10K
U3
CS
DATIN
SERCLK
DATOUT
IRQ
ADDR
WAKE
SUBOUT
AMP+
AMP-
AMPOUT
COMP-
COMP+
COMPOUT
MX805A
VDD
BIAS
VSS
XOUT
XIN
AUDIN
SUBIN
TONOUT
AUDOUT
NOTON
(SHEET 1) U3IRQ
R156
10K
DGND
C8
2.2
AGND
BIAS (SHEET 4)
(SHEET 2)
FACTORY OPTIONAL
C9
22pF
R35
1M
Y2
xTAL
4.00Mhz
C10
22pF
ECLK (SHEET 1)
U14
4053
IO
IOL
CTRL
IOH
G1 (SHEET 2,5)
G2 (SHEET 2)
DATAOUT (SHEET 5)
R30
100KP
R31
390K
D2
4148
D3
4148
R32
10.0K
C11
10
R33
220K
R34
100K
C13
1
(SHEET 1) NRZD
MC3403
U12
D4
4148
R121
220K
C21
.1
(SHEET 1) REV_VOX
R125
1M
R122
220K
2.5V
FWD_VOX
(SHEET 1)
D5
4148
R126
1M

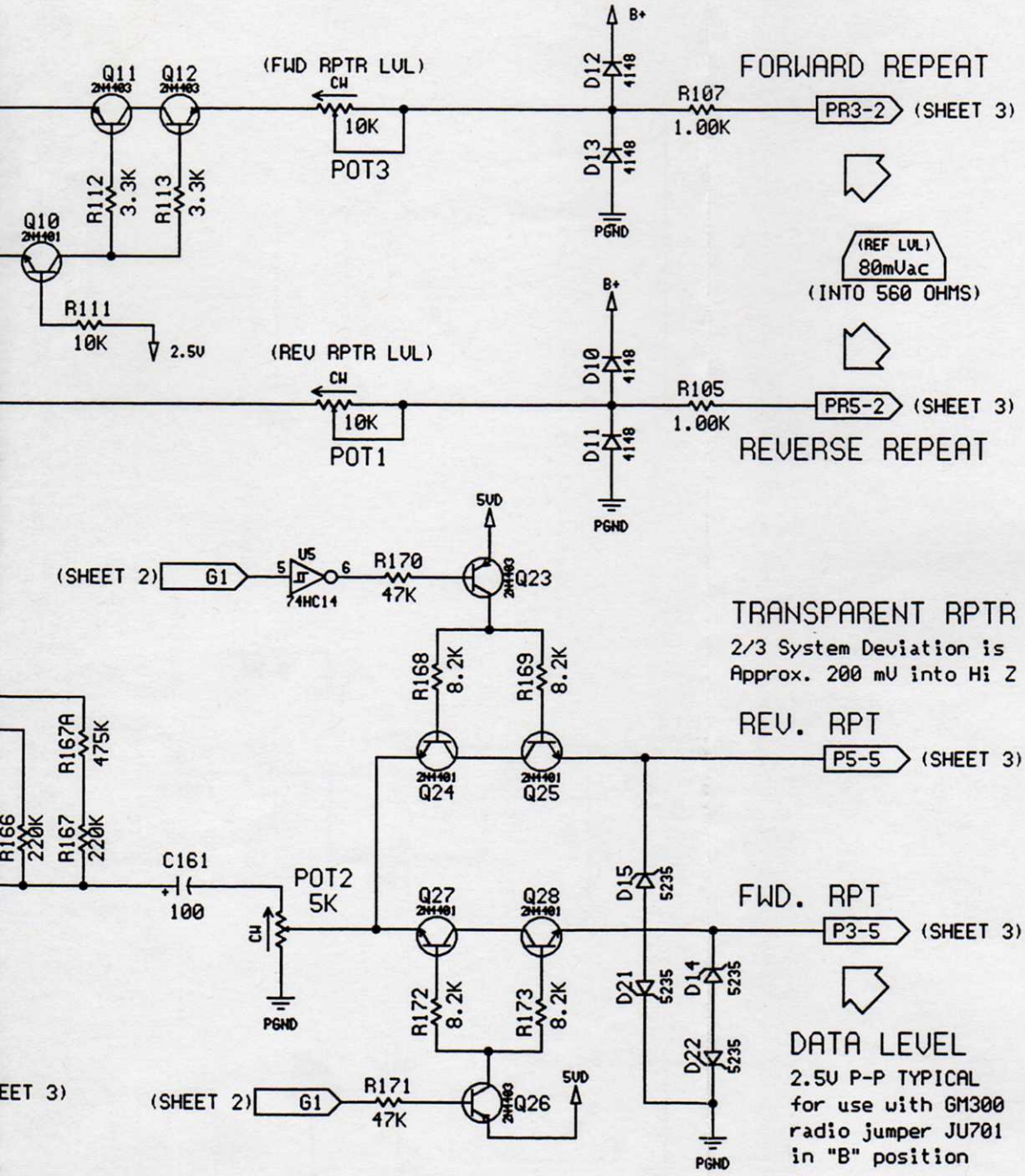


RC2 RADIO INTERFACE
PART 2

SCHEMATIC DIAGRAM SHEET 4

RC2E.SCH 2-19-96

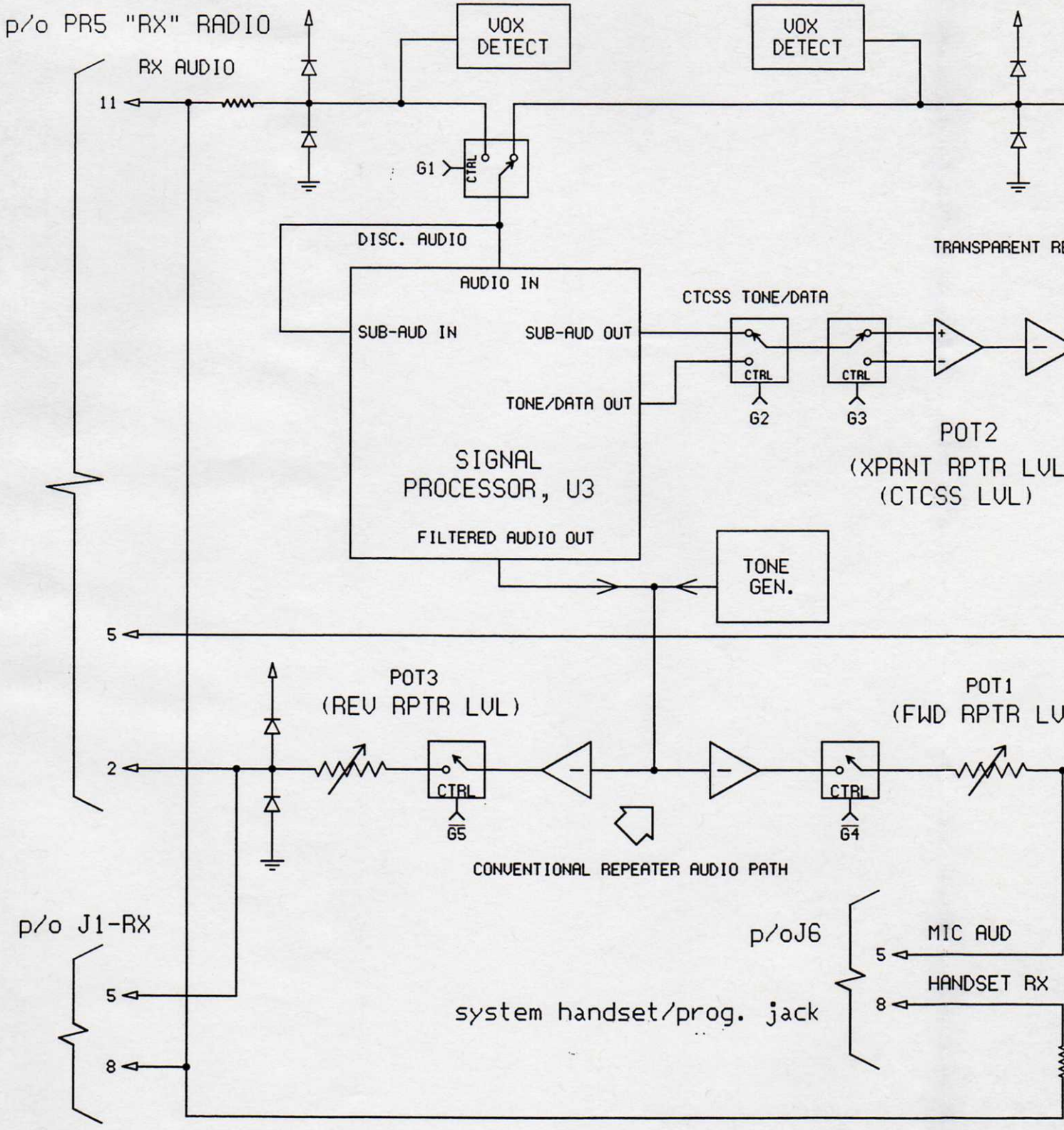

(SHEET 4) U11-1
(SHEET 2) G4
Q7
2N4401
R108
10K
2.5V
R109
3.3K
R110
3.3K
Q8
Q9
2N4403
(SHEET 2) G5
Q10
2N4401
R112
R111
10K
(SHEET 2) G6
Q30
R176
8.2K
A+
R175
8.2K
2.5V
U13
CTRL IOH
IO IOL
4053
(SHEET 2) G3
(SHEET 4) DATAOUT
U14
R116
100K
R118
100K
R117
100K
2.5V
MC3403
U11
C160
10
R165
100KP
R119
100K
R166
220K
R167
220K
R167A
475K
U15
MC3458
5VA
(SHEET 3) ACC_RX
C50
.1
R80
47K
5VA
Q21
Q22
R94
3.3K
R93
3.3K
R92
8.2K
D70
5245
RDIOGND
PR4-11
(SHEET 3)
R95
10K
Q20
2.5V
(SHEET 2) G8

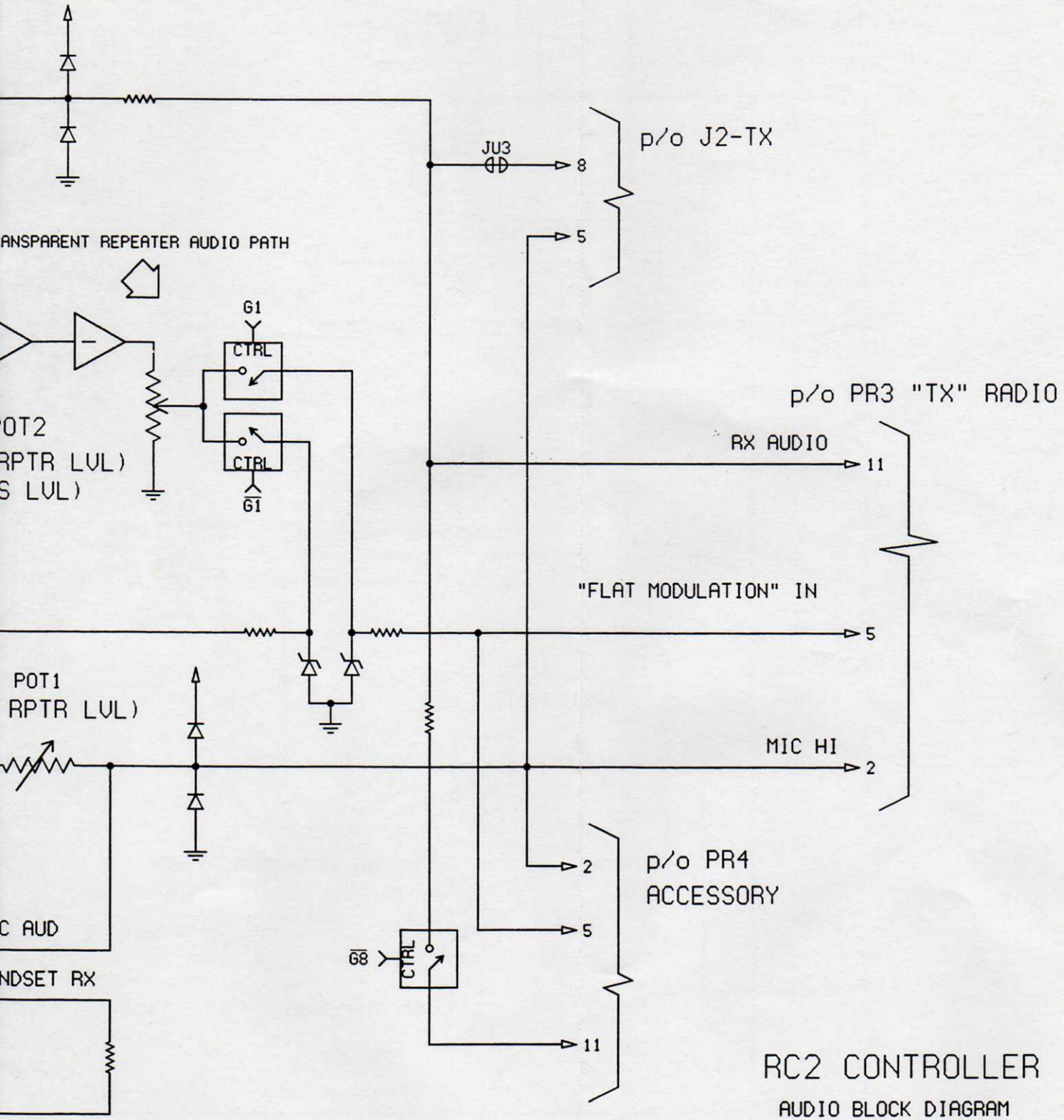


RC2 RADIO INTERFACE
PART 3

SCHEMATIC DIAGRAM SHEET 5

RC2E.SCH 2-19-96

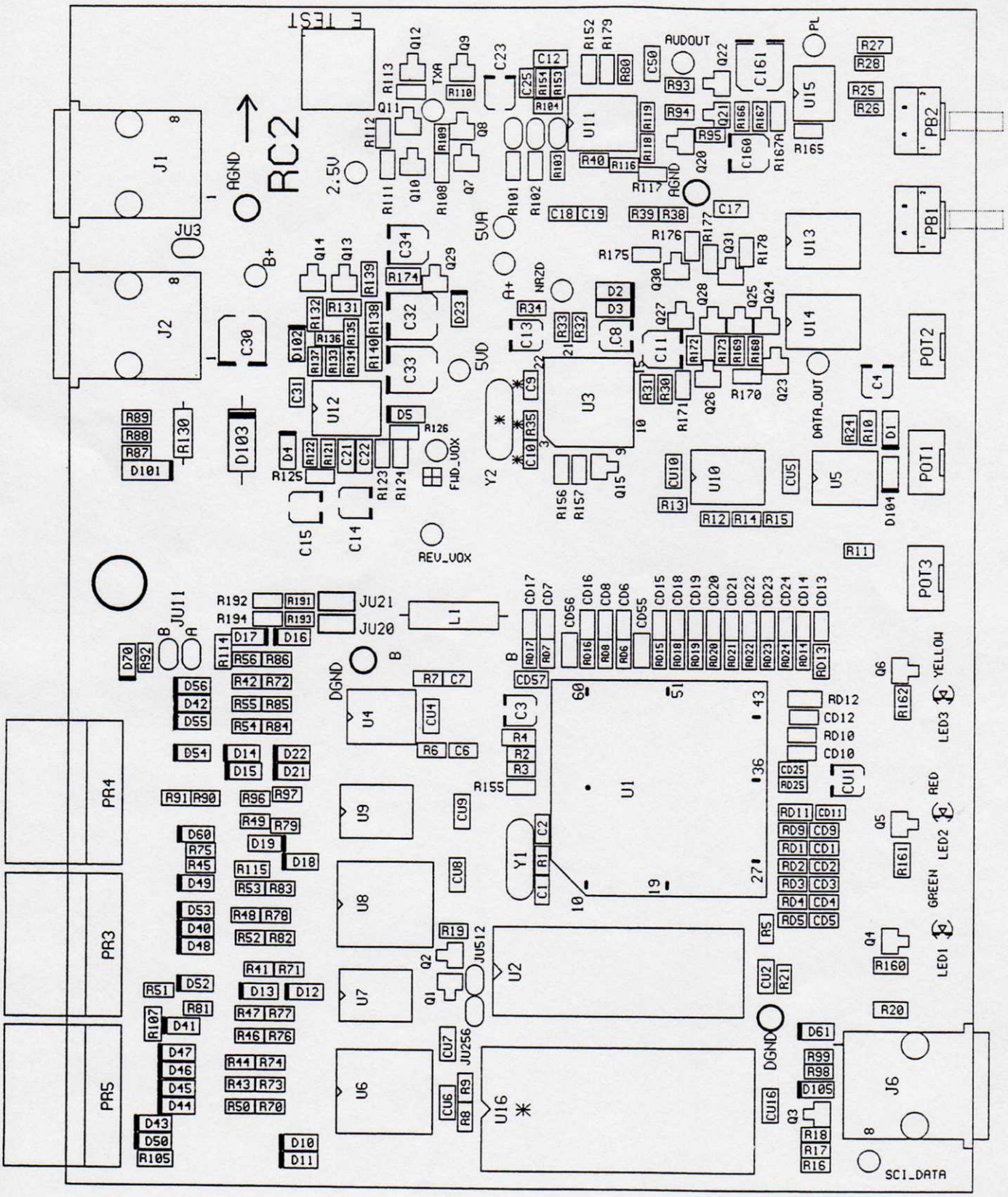

p/o PR5 "RX" RADIO
RX AUDIO
11
VOX DETECT
VOX DETECT
G1
CTRL
DISC. AUDIO
TRANSPARENT RE
AUDIO IN
SUB-AUD IN
SUB-AUD OUT
TONE/DATA OUT
CTCSS TONE/DATA
CTRL
CTRL
G2
G3
POT2
(XPRNT RPTR LVL
(CTCSS LVL)
SIGNAL PROCESSOR, U3
FILTERED AUDIO OUT
TONE GEN.
5
POT3
(REV RPTR LVL)
POT1
(FWD RPTR LV
2
CTRL
CTRL
G5
G4
CONVENTIONAL REPEATER AUDIO PATH
p/o J1-RX
p/oJ6
MIC AUD
5
HANDSET RX
8
system handset/prog. jack
5
8



RC2 CONTROLLER

AUDIO BLOCK DIAGRAM

RC2E.SCH 2-19-96


RC2
E TEST
J1
J2
J3
J4
J5
J6
PR4
PR3
PR5
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
U14
U15
U16
POT1
POT2
POT3
PB1
PB2
PL
L1
Y1
Y2
AGND
DGND
2.5V
5VA
5VD
B+
A+
AUDOUT
DATA_OUT
FWD_VOX
REV_VOX
SCI_DATA
LED1
LED2
LED3
GREEN
RED
YELLOW

RC2 parts list

Reference No.	IAI Part No.	Part Name
integrated circuits		
U1	9201-10268-04	68hc11f1cfna
U2	3311-30028-00	ico-286-s8a-t 28pin
U2	4601-10190-00	27c256-25 256k eprom
U3	9201-50026-00	mx805alh
U4	9201-10165-00	74hc00adr2
U5	9201-10112-00	74hc14
U6	9201-50016-00	tpicb595
U7	9201-50013-00	74hc597
U8	9201-50016-00	tpicb595
U9	9201-50013-00	74hc597
U10	9201-50007-00	see 9201-10170-00
U11	9201-10214-00	3403 quad op amp
U12	9201-10214-00	3403 quad op amp
U13	9201-10021-00	4053 analog multiplexer
U14	9201-10021-00	4053 analog multiplexer
U15	9201-10225-00	mc3458
resistors, fixed: ±5%, 1/4w		
R16, R40	9203-04702-10	47k 0805 pkg
R80	9203-04702-10	47k 0805 pkg
R170, R171	9203-04702-10	47k 0805 pkg
R20, R131	9203-03300-12	330 1206 pkg
R132	9203-03300-12	330 1206 pkg
R191, R192	9203-03300-12	330 1206 pkg
R2, R3, R5	9203-04701-10	4.7k 0805 pkg
R9, R11	9203-04701-10	4.7k 0805 pkg
R17, 18	9203-04701-10	4.7k 0805 pkg
R21	9203-04701-10	4.7k 0805 pkg
R19, R37	9203-01001-10	1k 0805 pkg
R155	9203-01001-10	1k
RD1, RD23	9203-01001-10	1k 0805 pkg
RD3	9203-01001-10	1k 0805 pkg
RD4, RD5	9203-01001-10	1k 0805 pkg
RD6	9203-01001-10	1k 0805 pkg
RD7, RD8	9203-01001-10	1k 0805 pkg
RD9	9203-01001-10	1k 0805 pkg
RD10, RD14	9203-01001-10	1k 0805 pkg
RD15	9203-01001-10	1k 0805 pkg
RD16, RD17	9203-01001-10	1k 0805 pkg
RD18	9203-01001-10	1k 0805 pkg
RD191	9203-01001-10	1k 0805 pkg
RD201	9203-01001-10	1k 0805 pkg
RD21	9203-01001-10	1k 0805 pkg
RD25	9203-01001-10	1k 0805 pkg
R8, R38	9203-02202-10	22k 0805 pkg
R25, R27	9203-01000-12	100 1206 pkg
R140	9203-01000-12	100 1206 pkg
RD11, RD12	9203-01000-12	100 1206 pkg
RD13	9203-01000-12	100 1206 pkg
RD22, RD24	9203-01001-10	1k 0805 pkg
RD23	9203-01001-10	1k 0805 pkg

RC2 parts list

Reference No.	IAI Part No.	Part Name
resistors, fixed: ±5%, 1/4w		
R138, R139	9203-00100-12	10 1206 pkg
R24, R331	9203-02203-10	220k 0805 pkg
R121	9203-02203-10	220k 0805 pkg
R122, R123	9203-02203-10	220k 0805 pkg
R124	9203-02203-10	220k 0805 pkg
R166, R167	9203-02203-10	220k 0805 pkg
R125, R126	9203-01004-10	1M 0805 pkg
R130	9203-00010-10	1 ohm
R93, R94	9203-03301-10	3.3k 0805 pkg
R104	9203-03301-10	3.3k 0805 pkg
R113	9203-03301-10	3.3k 0805 pkg
R31	9203-03903-10	390k 0805 pkg
R136	9203-06801-10	6.8k 0805 pkg
R1	9203-01005-10	10M 0805 pkg
R153	9203-03302-10	33k 0805 pkg
R160, R162	9203-04700-12	470 1206 pkg
R92	9203-08201-10	8.2k
R168, R169	9203-08201-10	8.2k
R172, R173	9203-08201-10	8.2k
R175, R176	9203-08201-10	8.2k
R177, R178	9203-08201-10	8.2k
R174	9203-05600-12	560
resistors, fixed: ±1%, 1/4w unless otherwise specified		
R34, R39	9204-01003-10	100k 0805 pkg
R30, R41	9204-01003-10	100k 0805 pkg
R42, R43	9204-01003-10	100k 0805 pkg
R44	9204-01003-10	100k 0805 pkg
R45, R46	9204-01003-10	100k 0805 pkg
R47	9204-01003-10	100k 0805 pkg
R48, R49	9204-01003-10	100k 0805 pkg
R50	9204-01003-10	100k 0805 pkg
R51, R52	9204-01003-10	100k 0805 pkg
R53	9204-01003-10	100k 0805 pkg
R54, R55	9204-01003-10	100k 0805 pkg
R56	9204-01003-10	100k 0805 pkg
R70, R71	9204-01003-10	100k 0805 pkg
R72	9204-01003-10	100k 0805 pkg
R73, R74	9204-01003-10	100k 0805 pkg
R76	9204-01003-10	100k 0805 pkg
R77, R78	9204-01003-10	100k 0805 pkg
R79	9204-01003-10	100k 0805 pkg
R82, R83	9204-01003-10	100k 0805 pkg
R84	9204-01003-10	100k 0805 pkg
R85, R86	9204-01003-10	100k 0805 pkg
R96, R97	9204-01003-10	100k 0805 pkg
R98, R99	9204-01003-10	100k 0805 pkg
R101	9204-01003-10	100k 0805 pkg
R116, R117	9204-01003-10	100k 0805 pkg

resistors, fixed: ±1%, 1/4w unless otherwise specified

R118, R119	9204-01003-10	100k 0805 pkg
R165, R179	9204-01003-10	100k 0805 pkg
R6, R7, 12	9204-01002-10	10.0k 1/8W 0805 pkg
R13, R14	9204-01002-10	10.0k 1/8W 0805 pkg
R15	9204-01002-10	10.0k 1/8W 0805 pkg
R26, R28	9204-01002-10	10.0k 1/8W 0805 pkg
R32	9204-01002-10	10.0k 1/8W 0805 pkg
R75, R81	9204-01002-10	10.0k 1/8W 0805 pkg
R87	9204-01002-10	10.0k 1/8W 0805 pkg
R88, R89	9204-01002-10	10.0k 1/8W 0805 pkg
R90, R95	9204-01002-10	10.0k 1/8W 0805 pkg
R91, R103	9204-01002-10	10.0k 1/8W 0805 pkg
R108	9204-01002-10	10.0k 1/8W 0805 pkg
R133, R134	9204-01002-10	10.0k 1/8W 0805 pkg
R135	9204-01002-10	10.0k 1/8W 0805 pkg
R135	9204-01002-10	10.0k 1/8W 0805 pkg
R156, R157	9204-01002-10	10.0k 1/8W 0805 pkg
R4, R10	9204-01001-12	1.0k 1206 pkg
R105, R107	9204-01001-12	1.0k 1206 pkg
R114, R115	9204-01001-12	1.0k 1206 pkg
R161	9204-01001-12	1.0k 1206 pkg
R102	9204-05622-10	56.2k 0805 pkg
R154, R167A	9204-04753-10	475k 0805 pkg

capacitors

C16	9206-01003-12	.1uF mono 1206 pkg
C17, C50	9206-01003-12	.1uF mono 1206 pkg
C21, C22	9206-01003-12	.1uF mono 1206 pkg
CU2, CU4	9206-01003-12	.1uF mono 1206 pkg
CU5. CU6	9206-01003-12	.1uF mono 1206 pkg
CU7, CU8	9206-01003-12	.1uF mono 1206 pkg
CU9, CU10	9206-01003-12	.1uF mono 1206 pkg
CU16	9206-01003-12	.1uF mono 1206 pkg
CD55, CD56	9206-01003-12	.1uF mono 1206 pkg
CD57	9206-01003-12	.1uF mono 1206 pkg
CD1, CD2	9206-01000-00	100pF 0805 pkg
CD3	9206-01000-00	100pF 0805 pkg
CD4, CD5	9206-01000-00	100pF 0805 pkg
CD6	9206-01000-00	100pF 0805 pkg
CD7, CD8	9206-01000-00	100pF 0805 pkg
CD9	9206-01000-00	100pF 0805 pkg
CD10, CD11	9206-01000-00	100pF 0805 pkg
CD12	9206-01000-00	100pF 0805 pkg
CD13, CD14	9206-01000-00	100pF 0805 pkg
CD15	9206-01000-00	100pF 0805 pkg
CD16, CD17	9206-01000-00	100pF 0805 pkg
CD18	9206-01000-00	100pF 0805 pkg
CD19, CD20	9206-01000-00	100pF 0805 pkg
CD21	9206-01000-00	100pF 0805 pkg
C11, C34	9206-00010-35	10uF elect 35V
C160	9206-00010-35	10uF elect 35V
CD22, CD23	9206-01001-00	.001 mono 0805pkg
CD24	9206-01001-00	.001 mono 0805pkg
CD25, CD31	9206-01001-00	.001 mono 0805 pkg

capacitors

C18, C19	9206-01002-00	.01 mono 0805 pkg
C25	9206-01002-00	.01 mono 0805 pkg
C1, C2, C6	9206-00220-00	22pF mono 0805 pkg
C7	9206-00220-00	22pF mono 0805 pkg
C8, C14	9206-41204-00	2.2uF elec
C15, C23	9206-41204-00	2.2uF elec
C3, C4, C13	9206-09025-00	1uF elec 16/25V
CU1	9206-09025-00	1uF elec 16/25V
C30, C32	9206-10010-00	100uF elec 16/V
C33, C161	9206-10010-00	100uF elec 16/V
C31	9206-01001-10	0.001uF

diodes

D1, D2, D3	9202-20008-00	1n4148 silicon signal
D4, D5	9202-20008-00	1n4148 silicon signal
D10	9202-20008-00	1n4148 silicon signal
D11, D12	9202-20008-00	1n4148 silicon signal
D13	9202-20008-00	1n4148 silicon signal
D16	9202-20008-00	1n4148 silicon signal
D14, D15	9202-20010-00	1n5235 smt
D21, D22	9202-20010-00	1n5235 smt
D103	3302-20005-00	1n5355a 18V zener
D102, D104	9202-20010-00	1n5235 6.8V zener
D105	9202-20010-00	1n5235 6.8V zener
D101	9202-20029-00	1n4007 1 amp 100V rectifier
D16, D17	9202-20040-00	mll5245 15V
D18, 19	9202-20040-00	mll5245 15V
D40, D41	9202-20040-00	mll5245 15V
D42, D43	9202-20040-00	mll5245 15V
D44, D45	9202-20040-00	mll5245 15V
D46, D47	9202-20040-00	mll5245 15V
D48, D49	9202-20040-00	mll5245 15V
D50, D52	9202-20040-00	mll5245 15V
D53, D54	9202-20040-00	mll5245 15V
D55, D56	9202-20040-00	mll5245 15V
D60, D61	9202-20040-00	mll5245 15V
D70	9202-20040-00	mll5245 15V
D23	9202-20014-00	1n5229b

transistors

Q3, Q4	9209-44010-00	2n4401
Q5	9209-44010-00	2n4401
Q6, Q7	9209-44010-00	2n4401
Q10	9209-44010-00	2n4401
Q13, Q14	9209-44010-00	2n4401
Q15, Q20	9209-44010-00	2n4401
Q29, Q30	9209-44010-00	2n4401
Q31	9209-44010-00	2n4401
Q1, Q2	9209-44030-00	2n4403
Q8	9209-44030-00	2n4403
Q9, Q11	9209-44030-00	2n4403

transistors

Q12	9209-44030-00	2n4403
Q21, Q22	9209-44030-00	2n4403
Q23, Q26	9209-44030-00	2n4403
Q24, Q25	9209-44010-00	2n4401
Q27, Q28	9209-44010-00	2n4401

miscellaneous

LED1	4602-01503-00	green LED
LED2	3306-00750-00	red LED
LED3	4602-01400-00	yellow LED
J1, J2, J6	4611-52025-14	8pin modjack
JU11	4611-10003-10	3pin connector
JU20, JU21	4611-10002-10	2pin header
PB1, PB2	4612-01210-00	kslov211
PB1, PB2	4612-00750-49	switch cap for kslov211
PR3. PR4	4621-80923-01	16pin pcb mt 28-80323v01
PR5	4621-80923-01	16pin pcb mt 28-80323v01
POT1, 3	3305-01002-10	10k pot
POT2	3305-05001-00	5k pot
L1	3307-00099-40	choke bead 2673000701

Appendix B
GR300, M120 and i20R Setup

GR300 Repeater Assembly

The procedures that follow will help you assemble the Radius GR300 repeater with the M120 radios and the i20R Onsite Repeater Controller. Before assembling your GR300 repeater, the following steps should be performed:

1. Place the jumpers inside the radios in the correct positions. Please refer to Table B-1.

Table B-1. Radio Jumper Settings

Jumper	Default	Receive Radio	Transmit Radio
JU551	B	A	A or B
JU651	A	A or B	A

2. Place the switch on the bottom of the power supply in the proper position (115 Vac or 230 Vac).

3. Place jumper JU20 in the i20R in the "N" position (default).

Refer to the "GR300/GR500 Repeater Stations" service manual (6880903Z42) for the assembly of your GR300.

Programming

Motorola GM300/GR300 RSS (HVN8177) is used to program the radios. Please refer to the "Radius M120/M10 Mobile Radios RSS Manual" (6880903Z28). Instrument Associates RSS (HVN9085) is used to program the i20R. Please refer to the "Radius i20R Repeater Controller RSS Manual" (6880904Z55).

Transmit Radio

1. Connect the RIB programming cable to the transmit radio. Turn on the GR300 power supply. Start the GM300/GR300 RSS.

2. From the "Main Menu" press **F3** (GET/SAVE) then press **F2** (READ CODEPLUG).

3. When the computer has finished reading the codeplug, press **ESC** to return to the "MAIN MENU"

4. Press **F4** (CHANGE/VIEW CODEPLUG MENU) then press **F5** (MODE).

5. In the appropriate highlights:

   a. Enter the receive frequency, equal to the transmit frequency

   b. Enter the transmit frequency for the repeater.

   c. Set the "Rx Squelch Type" and the "Tx Squelch Type" to "CSQ"

   d. Set the "Time Out Timer (s)" to OFF (enter "000" seconds).

6. Press **Esc** to return to the "MAIN MENU"
7. Press **F3** (GET SAVE).
8. Press **F8** (PROGRAM CODEPLUG) then press **F2** (CONTINUE) to program the transmit radio.
9. Press **F7** (SAVE FILE). Press **F8** to save the data to a disk file.

Receive Radio

1. Move the RIB programming cable to the receive radio.
2. From the "Main Menu", press **F3** (GET/SAVE) then press **F2** (READ CODEPLUG).
3. When the computer has finished reading the codeplug, press **ESC** to return to the "MAIN MENU"
4. Press **F4** (CHANGE/VIEW CODEPLUG MENU) then press **F5** (MODE).

   a. Enter the receive frequency.

   b. Enter the transmit frequency as "BLANK"

   c. Set the "Rx Squelch Type" to "CSQ"

   d. Use "Local" mode instead of "DX" mode to reduce interference ("IM hits").
5. Press **Esc** to return to the "MAIN MENU" screen.
6. Press **F3** (GET SAVE).
7. Press **F8** (PROGRAM CODEPLUG) then press **F2** (CONTINUE) to program the receive radio.
8. Press the **F7** (SAVE FILE). Press **F8** to save the data to a disk file.

i20R Controller

1. Move the RIB programming cable to the i20R. Start the i20R RSS.
2. From the "Main Menu" press **F3** (GET/SAVE), press **F2** (READ Data) then press **F8** (READ i20R).
3. When the computer has finished reading the codeplug, press **ESC** to return to the "MAIN MENU"
4. Press **F4** (CHANGE/VIEW MENU), press **F3** (Installation Parameters) then press **F3** (Radio Characteristics).
5. Set the "Operational Mode:" to "Uni Dir" and the "Carrier Detect Type" to "Log Carr Dct" The "Time-Out Timer" and "DPL from RX Radio is Inverted" are application dependent. Press **F10** (EXIT).
6. Press **F4** (Radio Connector Settings), then press **F3** (RX Radio Connector). Define pin 8 as "RX Carr Dct" with "ACT LEVEL" as "Low" Press **F10** (EXIT).
7. Press **F5** (TX Radio Connector). Define pin 8 as "TX Carr Dct" with "ACT LEVEL" as "Low" and pin 14 as "Null Input" Press **F10** (EXIT) twice to return to the "Installation Parameters" menu.
8. Press **F5** (REPEATER SETTINGS). To enable TPL/DPL decode by the i20R or more than one user for the repeater operation, set the "Forward Carrier Repeat Operation:" to "Disabled" The other parameters are dependent upon your application. Press **F10** (EXIT).
9. Press **F6** (Unidirectional/Forward Repeater Table). To add a user, press **F4**(ADD ENTRY). To remove a user, press **F3** (DELETE ENTRY). To change the information of a user, select the user (highlight the user number with the up/down arrow keys) and press F7 (EDIT ENTRY).

10. If the i20R is to regenerate the same TPL or DPL that the field radios transmit to the repeater, in the "Unidirectional/Forward Repeater Table" select "Repeat Method:" as Repeat w/ Alternate PL" You must then complete the information that appears at the bottom of the screen.

11. From the "CHANGE/VIEW MENU" you can select **F4** (Battery Parameters) for a battery revert/backup system, **F5** (Dispatcher Settings) for local operation with a desk microphone or, **F6** (CWID Settings) to define the operation of the Morse Code Station Identification.

12. When you have finished defining the parameters, press **Esc** to return to the "MAIN MENU"

13. Press **F3** (GET/SAVE).

14. Press **F8** (PROGRAM Data) then press **F8** (Program Target i20R) to program the i20R.

15. Press **F7** (SAVE FILE). Press **F8** to save the data to a disk file.

i20R Adjustments

The following steps should be performed with a Communications Service Analyzer (CSA) that is capable of generating a duplex signal at the frequency of the receive radio while monitoring the output frequency of the transmit radio. Such a piece of equipment is the Motorola R2000 series.

1. Place the i20R in test/setup mode #1 by pressing the "TEST" push-button on the front panel one time.

2. Modulate the duplex signal with a 1 kHz tone at 60% rated system peak deviation. Adjust the "FWD" Audio Level on the i20R for **50%** peak deviation of the transmit radio. The lower deviation of the repeated audio is necessary to prevent "clipping" of the TPL or DPL signal in the transmit radio. Turn off the 1 kHz tone.

3. Press the "TEST" push-button two more times to place the i20R into test/setup mode #3.

4. Adjust the "SIG" Audio Level potentiometer for 750 Hz peak deviation of the test TPL tone.

5. Simultaneously press the "TEST" and "RPTR" push-buttons to end the test/setup modes.