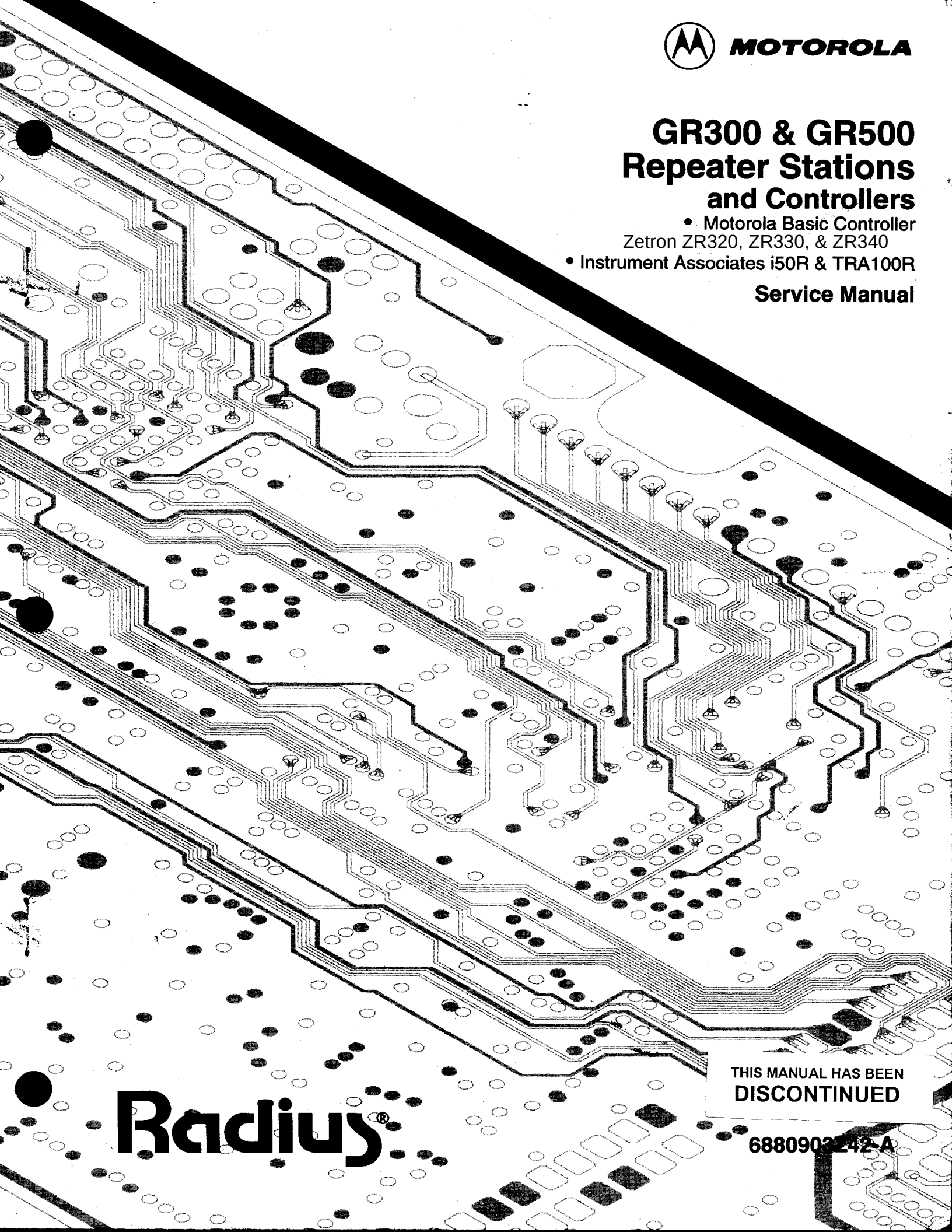
MOTOROLA

# GR300 & GR500 Repeater Stations and Controllers

- Motorola Basic Controller
  Zetron ZR320, ZR330, & ZR340
- Instrument Associates i50R & TRA100R

**Service Manual**



THIS MANUAL HAS BEEN
**DISCONTINUED**

Radius®

6880903242-A

Radius®

# Table of Contents

## Foreword



## Section 1
## Introduction to Repeaters and Components



## Section 2
## GR300 Repeater Station

## Section 3
## GR500 Repeater Station



## Section 4
## Basic Repeater Controller

## Section 5
## i50R Basic Interconnect Repeater Controller



## Section 6
## ZR340 Advanced Interconnect Repeater Controller

## Section 7
## ZR320 Selective Calling Interconnect Controller

## Section 8
## ZR330 Remote Telephone Interface



## Section 9
## TRA100R Tone Remote Adapter Repeater Controller

## Section 10
## Troubleshooting

## Schematic Diagrams and Parts Lists



## Glossary



(Page viii is blank)

## 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 revision. These revisions are added to the manuals as the engineering changes are incorporated into the equipment.

## How To Use This Manual

This series of manuals consists of a Service Manual (6880903Z42) and a Programming Guide (6880903Z43) for the GR Series repeaters and the controllers available for them. These two manuals can be used in conjunction with the service manual and RSS manual for the mobile radios in your repeater station.

## Other Documentation

Table 1 lists the locations for other documentation you may need to set up or configure the GR Series repeaters and controllers.

*Table 1. Other Documentation*

| Information | Location |
|---|---|
| GM300 Operation/Maintenance | GM300 Service Manual (6880902Z32) |
| M120 Operation/Maintenance | M120 Service Manual (6880902Z98) |
| M10 Operation/Maintenance | M10 Service Manual (6880903Z03) |
| GM300 General Programming Information | GM300 RSS Manual (6880902Z36) |
| M120 and M10 General Programming Information | M120/M10 RSS Manual (6880903Z28) |
| i750R Operation/Maintenance | i750R Service Manual (6880904Z39) |
| i750R General Programming | i750R RSS Manual (6880904Z45) |
| i20R Operation/Maintenance | i20R Service Manual (6880904Z40) |
| i20R General Programming | i20R RSS Manual (6880904Z55) |
| ZR310 Operation/Maintenance/ Programming | ZR310 Service Manual (6880904Z64) |
| GR300/GR500 Programming Information (includes Basic, i50R, ZR320, ZR330, ZR340, and TRA100R Controllers) | GR Series Programming Guide (6880903Z43) |

## Technical Support

To obtain technical support, you can call Motorola's Radius Product Services (refer to address and phone number under "Ordering Replacement Parts"). When you call, we ask that you have ready the model and serial numbers of the applicable GR Series Repeater Station, the mobile radios, and the applicable Repeater Controller(s).

## Service Policy

If malfunctions occur within 30 days that cannot be resolved over the phone with Radius Product Services, a defective "major" component (such as a repeater controller or the power supply) should be returned. You must obtain authorization from Radius Product Services before returning the component. After 30 days, you must return any defective component to the location shown in Table 2. Make sure that the component is shipped in its original packaging or using careful packing procedures, to eliminate the possibility of damage while en route. During the warranty period, we will either repair or replace the component as required. If the component is out of warranty, you must pay a service fee.

*Table 2. Service After 30 Days*

| Major Component* | Repair Location |
|---|---|
| HPN8393 (GR300 Power Supply) | Astron |
| HPN9005 (GR500 Power Supply) | Star Werks, Inc. |
| HLN3948_ (Basic) | Motorola Radius |
| HLN8388_ (ZR310) | Zetron |
| HLN9004_ (i50R) | Instruments Associates |
| HLN9119_ (ZR340) | Zetron |
| HLN8389_ (ZR320) | Zetron |
| HLN8390_ (ZR330) | Zetron |
| HLN9121_ (TRA100R) | Instruments Associates |
| HLN9120_ (i750R) | Instruments Associates |
| HLN9447_ (i20R) | Instruments Associates |

* Obtain authorization from the applicable repair location before returning the component

We do not generally recommend that you make repairs to the piece part level on the controller components. However, we recommend that you keep spare station components (or a complete station) available at all times, so that once you have identified a defective component you can immediately replace it, getting the repeater back in service within a few minutes. If a radio should fail in the transmit or receive role, you can use a mobile radio from your normal inventory.

## Ordering Replacement Parts

You can order additional components and some piece parts directly through your Radius price pages. When ordering replacement parts, include the complete identification number for all chassis, kits, and components. If you do not know a part number, include with your order the number of the chassis or kit which contains the part, and a sufficient description to identify the desired component. If a Motorola part number is identified on a parts list, you should be able to order the part through Motorola Parts. If only a generic part is listed, the part is not normally available through

Motorola. If no parts list is shown, generally, no user-serviceable parts are available for the kit.

The following is a list of addresses and phone numbers to contact for replacement parts:

**Technical Support**
Radius Product Services
Hwy. 34 West
Mt. Pleasant, IA 52641 USA
1-800-356-1520
319-385-5395 (International)

**Radius 30 Day Warranty**
Radius Repair Depot
Attention: Warranty Return
1000 W. Washington Street
Mt. Pleasant, IA 52641 USA
1-800-356-1520
319-385-5395 (International)

**Radius Major Component Repair**
Radius Repair Depot
1000 W. Washington Street
Mt. Pleasant, IA 52641 USA

**IAI Major Component Repair**
**(for i50R, i20R, i750R, and TRA100R)**
Instrument Associates
2455 Harbor Ave.
P.O. Box 13127
Memphis, TN 38113-0127 USA
1-901-948-1490

**Zetron Major Component Repair**
**(for ZR310, ZR320, ZR330, and ZR340**
Zetron Inc.
12335 134th Court N.E.
Redmond, WA 98052-2433 USA
1-206-820-6363

**Astron Major Component Repair**
**(for GR300 power supply)**
Astron Corporation
9 Autry
Irvine, CA 92718 USA
1-714-458-7277

**Star Werks Inc.**
**(for GR500 Power Supply)**
2040 E. Algonquin Rd. (Suite 504)
Schaumburg, IL 60173
847-397-3600

**Motorola Parts**
Worldwide System and
Aftermarket Products Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Worldwide System and
Aftermarket Products Division
Attention: International Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196 USA

*Customer Service:*
1-800-422-4210
1-708-538-8198 (FAX)

*Parts Identification:*
1-708-538-0021
1-708-538-8194 (FAX)

## Regulatory Requirements

In the United States, the FCC regulates licensing of RF frequencies. The terms of the FCC radio license for a particular operation will determine the frequencies, output power, and antenna height(s) for a given situation. The applicable "Part" of the FCC Rules and Regulations must be consulted before a Radius GR300, GR400, or GR500 Repeater Station is activated. In countries other than the United States, contact the local government for licensing rules.

Any telephone interconnect equipment sold in the U.S. must comply with Part 68 of the FCC rules. On the repeater controller housing there is a label that lists the FCC registration number and ringer equivalence number (REN) for this equipment. You must, on request, provide this information to your telephone company. In other countries additional compliance information or testing may be required. Contact Radius Product Services for further information.

The ringer equivalence number (REN) is useful in determining the quantity of devices you may connect to your telephone line and still have all of those devices ring when your telephone number is called. In most, but not all areas, the sum of the RENs of all devices connected to one line should not exceed five. Contact your local telephone company to determine the maximum REN for your calling area.

If your telephone equipment causes damage to the telephone, the telephone company may discontinue your service temporarily. If possible, they will notify you in advance, but, if advance notice is not practical, you will be notified as soon as possible. In such a case, you will be informed of your right to file a complaint with the FCC.

Your telephone company may make changes in facilities, equipment, operations, or procedures that could affect the proper functioning of your equipment. If it does, you will be notified in advance to give you an opportunity to maintain uninterrupted telephone service.

If any interconnect equipment malfunctions, the telephone company may ask you to disconnect it from the

network until the problem has been corrected or until you are sure that the equipment is no longer malfunctioning.

Interconnect equipment cannot be used on coin service provided by the telephone company. Connection to party lines is subject to tariffs.

**CAUTION**

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manuals, can cause interference to radio communications. It has been tested and found to comply with the limits for a "Class A" computing device pursuant to Part 15 of FCC Rules which are designed to provide reasonable protection against such interference when the equipment is 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 is necessary to correct the interference.

## DOC Requirements

The Canadian Department of Communications label identifies certified equipment. The certificate means that the equipment meets certain protective, operational, and safety requirements of the telecommunications network. The Department does not guarantee the equipment will operate to a user's satisfaction.

Before installing this equipment, make sure you are permitted to connect it to the facilities of the local telecommunications company. You must also install the equipment using an acceptable method of connection. In some cases you may extend the company's inside wiring for a single line individual service by means of a certified connector assembly (telephone extension cord). You should be aware, however, that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designed by the supplier. Any repairs or alterations made by a user to this equipment, or any equipment malfunctions may give the telephone communications company cause to request the user to disconnect the equipment.

**WARNING**

For your own protection, make sure that the electrical ground connections of the power utility, telephone lines, and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas. Do not attempt to make electrical ground connections yourself. Contact an appropriate electrical inspection authority or electrician.

## DOC Load Number (refer to the FCC label)

The load number (LN) assigned to each terminal device denotes the percentage of the total load to be connected to the telephone loop used by the device to prevent overloading. The termination on a loop may consist of any combination of devices, subject to the requirement that the total of the load numbers of all devices cannot exceed 100.

## DOC Compliance Notice

This digital apparatus does not exceed the Class A limits for radio noise emissions for digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications.

## Avis De Conformation avec le Ministère des Communications du Canada (DOC)

Le présent appareil numerique n'emet pas de bruits radioélectriques dépassant les limites applicables aux appareils numeriques de la classe A, préscitées dans le règlement sur le brouillage radioélectrique edicté par le Ministère des Communications du Canada.

# Section 1
# Introduction to Repeaters and Components

## Overview

This section introduces you to the GR300 and GR500 Repeater Stations; outlines their major components; physical appearance; accessories; general information about duplexers, cables, and antenna spacing; and basic assembly of the repeater stations.

## Repeater Stations

The GR300 and GR500 Repeater Stations are unique producs which provide low cost communications systems. These repeaters are unique because they are designed to use off-the-shelf mobile radios for the transmitter and receiver. This design provides additional benefits of quick repair and minimizing inventory. In the GR300 and GR500 repeaters, all of the necessary components (interface options and mobile radios) are built into one cabinet. Both repeater housings allow space for two mobile radios, two repeater controllers, the power supply, a duplexer, and a preselector.

A few features that distinguish the GR300 Repeater Station:

- **Portability**
  The GR300 repeater is a portable, desktop unit.
- **Fan**
  The GR300 repeater has a variable speed, temperature controlled fan.

A few features that distinguish the GR500 repeater:

- **Mounting**
  The GR500 repeater is a wall-mount unit.
- **Space for Repeater Interface Options**
  The GR500 repeater cabinet has space for **two** repeater interface options.
- **Fan**
  The GR500 repeater has a fixed speed (high: 100 cfm) fan.

## Repeater Controllers

The following repeater controllers are available for use with the GR300 or GR500 Repeater Stations:

- Basic Controller (Basic)
  (identical to R*I*C*K)
- Multiple Tone Community Repeater Controller (ZR310)
- Basic Interconnect Controller (i50R)
- On-Site Repeater Controller (i20R)
- RapidCall Interconnect Controller (i750R)
- Advanced Interconnect Controller (ZR340)
- Selective Calling Interconnect Controller (ZR320)
- Radio/Telephone Interface (ZR330)
  (not a repeater controller)
- Tone Remote Adapter (TRA100R)

Table 1-1 lists these components and the basic function of the GR300 and GR500 repeaters when combined with each component.

*Table 1-1. Repeater Function With Components*

| Component | Repeater Function |
|---|---|
| Basic | Single-User Repeater |
| ZR310 | Community Repeater (for up to 70 groups) |
| i50R | Basic Telephone Interconnect |
| i750R | Full-Feature Telephone Interconnect |
| i20R | Multiple-Tone Panel (up to 10 groups) |
| ZR340 | Advanced Interconnect |
| ZR320 | Full-Featured Telephone Interconnect |
| ZR330 | Telephone Line Extender |
| TRA100R | Tone Remote Adapter |

Each repeater interface component has its own manual. The manuals are listed in Table 1-2.

*Table 1-2. Documentation for Components*

| Component | Service Manual | Software Manual |
|---|---|---|
| Basic | 6880903Z42 | 6880903Z43 |
| ZR310 | 6880904Z64 | |
| i50R | 6880903Z42 | 6880903Z43 |
| i750R | 6880904Z39 | 6880904Z45 |
| i20R | 6880904Z40 | 6880904Z55 |
| ZR340 | 6880903Z42 | 6880903Z43 |
| ZR320 | 6880903Z42 | 6880903Z43 |
| ZR330 | 6880903Z42 | 6880903Z43 |
| TRA100R | 6880903Z42 | 6880903Z43 |

## Mobile Radio Compatibility

### *Using 16-Channel Mobile Radios*

- The 16-channel GM300 radios support all of the repeater controllers.

- Both of the mobile radios must be 16-channel GM300 radios for the RSS "Repeater Mode" to function properly.

### Using 1-, 2-, or 8-Channel Mobile Radios

- The M10, M120, and 8-channel GM300 radios can only be used with either the Basic Repeater Controller (HLN3948), i50R Basic Interconnect Controller (HLN9004), ZR340 Advanced Interconnect Controller (HLN9119), or the TRA100R Tone Remote Adapter (HLN9121).
- RSS for the GM/GR combination must be version RO4.00.00 or later. Use the "Generic Repeater" definition. Both mobile radios must be non-16-channel radios for the RSS "Repeater Mode" to function properly.
- The 8-position modular shorting jacks must be installed in the microphone jacks of both radios.
- Radios may not be operated in the "Monitor" mode.
- JU809 in the transmit radio must be in "Remote" position (also the default shipping position).
- The M10 microphone with LED (HMN3001) should not be used as it degrades repeater performance. The repeater controllers have the capability of providing a transmit indicator, so that any non-LED microphone is compatible when using M10 mobiles.
- In a bidirectional repeater, the receive radio must be a 16-Channel GM300 radio. (Programming is done in the RSS "Radio" mode).

## Physical Description

The following paragraphs describe the physical characteristics of the:

- GR300 Repeater Housing
- GR500 Repeater Housing
- GR300 Repeater Fan Assembly
- GR500 Repeater Fan Assembly
- GR300 Repeater Power Supply
- GR500 Repeater Power Supply
- Repeater Controllers
- Receive and Transmit Radios
- Duplexer

Table 1-9 and Table 1-10 show the physical dimensions and weight of these units. Figure 1-1 shows a completly assembled GR300 repeater using a Basic Repeater Controller. Figure 1-2 shows a completely assembled GR500 repeater using a Basic Repeater Controller.

### GR300 Repeater Housing

The GR300 repeater housing provides mounting for the units that make up a customer's individually tailored, free-standing repeater station. The GR300 repeater is shipped from the factory with the fan assembly, power supply, and base tray already installed in the repeater housing. This is done to conserve space in the packing box. Before you can assemble the GR300 repeater, the housing must be partially disassembled as described in Section 2 of this manual.

### GR500 Repeater Housing

The GR500 repeater housing provides mounting for the units that make up a customer's individually tailored wall-mounted repeater station. The GR500 repeater is shipped from the factory with the fan assembly and the power supply already installed in the repeater housing. To ensure proper orientation when the GR500 repeater is mounted on the wall, the repeater components (radios and controllers) should be assembled upside-down.

### GR300 Repeater Fan Assembly

The temperature-controlled 12 Vdc fan assembly is mounted into the GR300 repeater housing. It keeps the equipment from overheating and causing malfunctions. A sensor connected to the heat sink on the rear of the transmit radio monitors the temperature of the radio and increases the fan speed when necessary.

The fan assembly is mounted in the housing using the rear set of mounting screw holes. The three other sets of mounting screw holes are used only when more room is required inside the housing.

### GR500 Repeater Fan Assembly

A fixed-speed 12 Vdc fan is provided for cooling the assembled GR500 repeater. The fan operates at an air flow rate of approximately 100 cfm.

### GR300 Repeater Power Supply

The GR300 repeater operates using voltages generated by the HPN8393 power supply. The power supply operates from a 115/230 Vac (switch selected) power source. The power supply provides power for the fan assembly, both radios, and the repeater interface component. To secure the power supply to the housing, mounting screw holes are located on each side of the power supply. Connectors, which supply power to the fan assembly and the radios, are located in the rear.

### GR500 Power Supply

The GR500 repeater's power supply HPN9005 operates from a 115/230 V ac (switch selectable) power source. The power supply provides power to the fan assembly, both radios, and up to two repeater control-

lers. Battery backup/revert with trickle charging is a standard feature of the GR500 repeater's power supply. The power supply has three connectors:

- one inside the GR500 repeater, which connects power to the radios (the controllers obtain power from one or both of the radios), and the fan
- one outside the GR500 repeater, which connects to an external battery
- one IEC ac receptacle for various line cords (US standard, 3-prong 115 V ac cord provided).

### Repeater Controllers

Except for the Basic Controller, the other repeater controllers appear almost identical. They each have mounting screw holes on each side with which to secure them to the GR300 or GR500 repeater housing. The Basic Controller, because of its smaller size, cannot be directly installed into the GR300 or GR500 repeater housing. Instead, it comes mounted on a tray which is placed into the GR300 or GR500 repeater housing.

Connectors for cabling between the radios and the repeater controller(s) are located on the back of each component. Operating power for the interface components is obtained from one or both of the radios. LEDs, **Set-Up** controls, and a **Programming** modular jack (where applicable) are located on the front of the repeater controllers.

### Receive and Transmit Radios

We recommend using GM300 16-channel radios. In some applications you may be able to use 8-channel GM300, M120, or M10 radios. It is even possible to use the older Radius M200 or MaxTrac 300 radios, but we do not recommend these alternate radios. Choosing an alternate radio makes RSS programming much more difficult, and affects the following:

- transmit duty cycle
- transmit power slump
- receiver intermodulation performance
- available accessories

The GM300 radios have a mounting screw hole on each side in which to secure the radios to the GR300 or GR500 repeater housing. Connectors for interconnecting the radios between the duplexer and the corresponding repeater controller(s) are located at the back. Controls, indicators, and the microphone connector are located on the front panel. Top and bottom covers provide entrance into the radios for maintenance. You should not remove these covers except for maintenance purposes.

### Duplexer

The duplexer allows the GM300 radios to operate simultaneously in the same frequency band with a single antenna and transmission line. Without the duplexer installed in the GR300 or GR500 repeater, it would be necessary to use two antennas spaced apart, with one connected to the receive radio and the other to the transmit radio. The duplexer mounts inside the repeater housing. The position of the mounting holes can vary, depending upon the type of duplexer used. RF connectors are on the rear of the duplexer, and tuning adjustments are on the front.

## Accessories

Many of the GM300 accessories are compatible with the GR300 and GR500 Repeater Stations. However, some of the accessories which plug into the GM300 radio style accessory connector are not compatible, because some of the functions needed are not available. Table 1-3 shows compatibility for the audio and DTMF accessories with each repeater controller. Table 1-4 shows general compatibility for the other accessories available with the GR300 and GR500 repeaters. Additional accessories may be compatible if custom programming is done on the RSS and/or accessory cables are modified.

## Duplexers, Cables, and Antenna Spacing

### Duplexers

The duplexer "isolates" the receive radio from the transmit radio in the GR300 or GR500 repeater. Without this isolation, the ability of the receive radio to detect weak signals would be severely degraded by the output signal of the transmit radio. Isolation may also be obtained by using separate antennas with proper spacing (distance) between the antennas. Less vertical spacing is needed for a given isolation of land mobile antennas than may be obtained easily with horizontal spacing.

There are two basic types of duplexers:

- bandpass
- bandreject

The bandpass duplexer has two filters connected together such that each filter will "pass" or appear transparent to, a narrow segment of frequencies; the filters are tuned to different frequencies. Any signal within the segment is transferred from or to the antenna while frequencies outside of the segment are "blocked."

*Table 1-3. Accessory Compatibility (Audio & DTMF)*

| Repeater Controller | | | | | | | | | Part No. | Accessory |
|---|---|---|---|---|---|---|---|---|---|---|
| i750R | TRA100R | i20R | Basic | ZR310 | i50R | ZR320 | ZR330 | ZR340 | | |
| X | X | X | X | X | X | X | X | X | HLN3145_ | Public Address |
| X | X | X | X | X | X | X | X | X | L1473_ | Local Deskset |
| X | | X | X | X | X | X | X | X | TDN8300_ | DC Remote Adapter |
| X | | X | X | X | X | X | X | X | TDN8301_ | Tone Remote Adapter |
| | | | | | | | | | L1474_ | DC Remote Deskset |
| | X | | | | | | | | L1475_ | Tone Remote Deskset |
| | | X | X | X | X | | | | HLN8375_ | DTMF Decoder |
| X | X | X | X | X | X | X | X | X | HMN3000_ | Desk Microphone |
| NOT COMPATIBLE | | | | | | | | | | DTMF and LED Microphones * |
| * DTMF and LED microphones "load down" the MIC HI line and are therefore not compatible. | | | | | | | | | | |

*Table 1-4. Accessory Compatibility (General)*

| GR300 Repeater | GR500 Repeater | Part No. | Accessory |
|---|---|---|---|
| X | X | HSN8145 | 7.5 Watt External Speaker |
| | X | HLN9169 | GR500 Wall & 19" Panel Mount |
| X | | HLN9286 | GR300 19" Panel Mount Adapter |
| X | | HLN9136 | GR300 Battery Revert/Float Maintenance Charger |
| X | | HLN8449 | GR300 Front and Back Enclosures with Carry Handle |

The bandreject duplexer has two filters connected together such that each filter rejects, or "blocks," a narrow segment of frequencies. Again, the filters are tuned to different frequencies but any signal outside of the segment is transferred from or to the antenna while frequencies within the segment are "blocked."

The choice of which duplexer configuration to purchase may be dictated by the particular application. If several repeaters and a GR300 or GR500 repeater are to operate at a given location, the bandpass duplexer might provide additional rejection to the signals from the other radios.

### Basic Specifications

The basic specifications for a VHF or a UHF duplexer are:

- Impedance: 50 ohms
- Isolation: 70 dB minimum

  Instead of the term "isolation," the manufacturer of the duplexer may use the terms "Receiver (or Rx) Isolation at the Transmitter Frequency" and "Transmitter (or Tx) Noise Suppression at the Receiver Frequency."

- Power handling: 50 Watts minimum

  Power handling may be called "Continuous Power Input" by the manufacturer. If a Lowband repeater is being assembled with the M200 Series Radius radios, the power handling capability would have to be increased to 100 Watts.

- Insertion loss: 3 dB maximum

  Less insertion loss of the duplexer means the receive radio will be able to discern weaker signals and the transmit radio will deliver more power output to the antenna. The 3 dB specification will result in coverage range being reduced approximately 30%. Typical insertion losses quoted in catalog sheets are 1.5 dB.

- Frequency spacing: Band dependent

  Frequency spacing" is the frequency difference between the operating frequencies of the receiver and the transmitter. Frequency spacing less than 3 MHz can be achieved but the physical size of the duplexer increases dramatically. If a VHF repeater is being assembled, be aware of the minimum frequency spacing that a duplexer can provide when choosing the operating frequencies for the repeater. The VHF duplexers available from Motorola Radius stock are specified at 4.5 MHz minimum spacing. In the United States, the spacing in the 450 MHz to

470 MHz UHF band is 5 MHz and the spacing in the 470 MHz to 512 MHz band is 3 MHz.

If the proper equipment necessary to tune a duplexer is not available, then the duplexer must be pretuned by the manufacturer. Be ready to provide the exact receiver and transmitter frequencies at the time of purchase. Also indicate that the duplexer will be used in a GR500 repeater.

- Connector type-N

  The type BNC connector may be used on the receiver and transmitter inputs but must be avoided for the antenna. The BNC is prone to mechanical movement which can generate noise when the transmitter is operating. Type UHF connectors will suffice for VHF but should be avoided for UHF. The mini-UHF connector, if available for the duplexer, is very good. Other connectors, such as the SMA and the TNC, are very good but may be more expensive, fragile and rather difficult to assemble in the field. The best general performance comes from the type-N.

The cables provided with the Gr300 and GR500 repeaters mate with a type-N at the duplexer end. Any other type of connector will require you to assemble cables.

## Cables

The coaxial cables that connect the radios to the duplexer are fabricated from RG58A/U (the cable that is used with most of the mobile antenna kits). Since RG58A/U does not have a perfect shield, the routing of the cables should allow a physical separation of approximately 1 inch.

Do not use RG58A/U as the coaxial cable that connects the antenna connector of the repeater to the antenna. The rather small size of RG58A/U can introduce excessive losses in the system that will decrease the effective range of the repeater.

Substitute RG400/U for short lengths and RG214/U or 1/2-inch "hardline" for the longer lengths. If the "hardline" is used, connect the duplexer to the end of the "hardline" with a flexible jumper cable to avoid undue stress on the connectors of the cables and the duplexer.

In planning a system, make sure that the various connectors found on the duplexer, feedlines, feedline jumpers and antenna are the correct mating pairs.

Table 1-5 can be used to determine which feedline to choose for a given frequency band and line length to maintain 1.5 dB or less power loss. Table 1-6 is a list of Motorola part numbers for the various connectors and cables.

*Table 1-5. Maximum Feedline Length in Feet (Meters)*

| Band | RG400/U | RG214/U | Hardline |
|---|---|---|---|
| Low (50 MHz) | 55 (17) | 100 (30) | 300 (90) |
| VHF (150 MHz) | 25 (7.5) | 50 (15) | 150 (45) |
| UHF (450 MHz) | 15 (4.5) | 25 (7.5) | 90 (27) |
| 800 MHz | 10 (3) | 20 (6) | 70 (21) |

*Table 1-6. Part Numbers for Connectors/Cables*

| Part | Motorola Part Number |
|---|---|
| mini-UHF male connector | 2884606M01 |
| UHF male connector | 2884579F04 |
| type-N male connector | 2884476G01 |
| type-N hardline male | RRX-4007A |
| type-N hardline female | RRX-4008A |
| RG58A/U coaxial cable | 3000475378 |
| RG400/U coaxial cable | 3084173E01 |
| RG214/U coaxial cable | 3015068A17 |
| 1/2" hardline cable | 3080329A22 |
| 8 ft. jumper cable | TDN8406A* |
| type-N f-f adapter | 5882764A01* |

*Use of the type-N f-f adapter may be required to connect the jumper cable to the main feedline.

## Antenna Spacing

Isolation between the output from the transmitter and the input to the receiver may be obtained with physical distance. Instead of using a duplexer, two antennas may be spaced apart and connected to the receive radio and the transmit radio with separate transmission lines. The separation necessary to yield the desired 70 dB of isolation is dependent upon the frequency band of operation. It is obvious from the following charts that, for all vertically polarized antennas in use for land mobile services, vertical spacing will get the 70 dB more easily than horizontal spacing. The horizontal spacing may be reduced if buildings, hills, or mountains are present between the antennas; the amount of reduction has to be determined by experiment. Table 1-7 shows the vertical spacing and Table 1-8 shows the horizontal spacing,.

**NOTE**

The losses associated with long transmission lines have not been included in the calculations of the spacings. It is readily apparent that horizontal spacing of antennas is somewhat useless; the cost of the transmission lines to the two antennas would be greater than the cost of a duplexer.

**NOTE**
The two antennas will couple to a common metallic support; the position of one of the antennas may have to be varied to attain the desired isolation.

**NOTE**
The following tables contain spacing information about vertically polarized antennas used in land mobile services.

*Table 1-7. Vertical Spacing*

| Frequency | Spacing | |
|---|---|---|
| (MHz) | feet | meters |
| 30 | 295 | 90 |
| 40 | 220 | 68 |
| 50 | 177 | 54 |
| 150 | 59 | 18 |
| 170 | 52 | 16 |
| 400 | 22 | 7 |
| 470 | 20 | 6 |

*Table 1-8. Horizontal Spacing*

| Frequency | Spacing | |
|---|---|---|
| (MHz) | feet | meters |
| 30 | 12,800 | 3,900 |
| 150 | 2,600 | 780 |
| 400 | 960 | 293 |

## Preventive Maintenance

Preventive maintenance of the GR300 and GR500 Repeater Stations consists of:

- visual inspection
- periodic cleaning

### *Visual Inspection*

Check that external surfaces of the equipment are clean, that connecting cables are not damaged, and that connections are firm. A detailed inspection of the interior electronic circuitry is not needed or desired.

### *Periodic Cleaning*

Periodically clean smudges and grime from the exterior housing. Use a soft, non-abrasive cloth moistened in a mild soap and water solution. Rinse the surface using a second cloth moistened in clean water, and clean any dirt or debris from the fan grill.

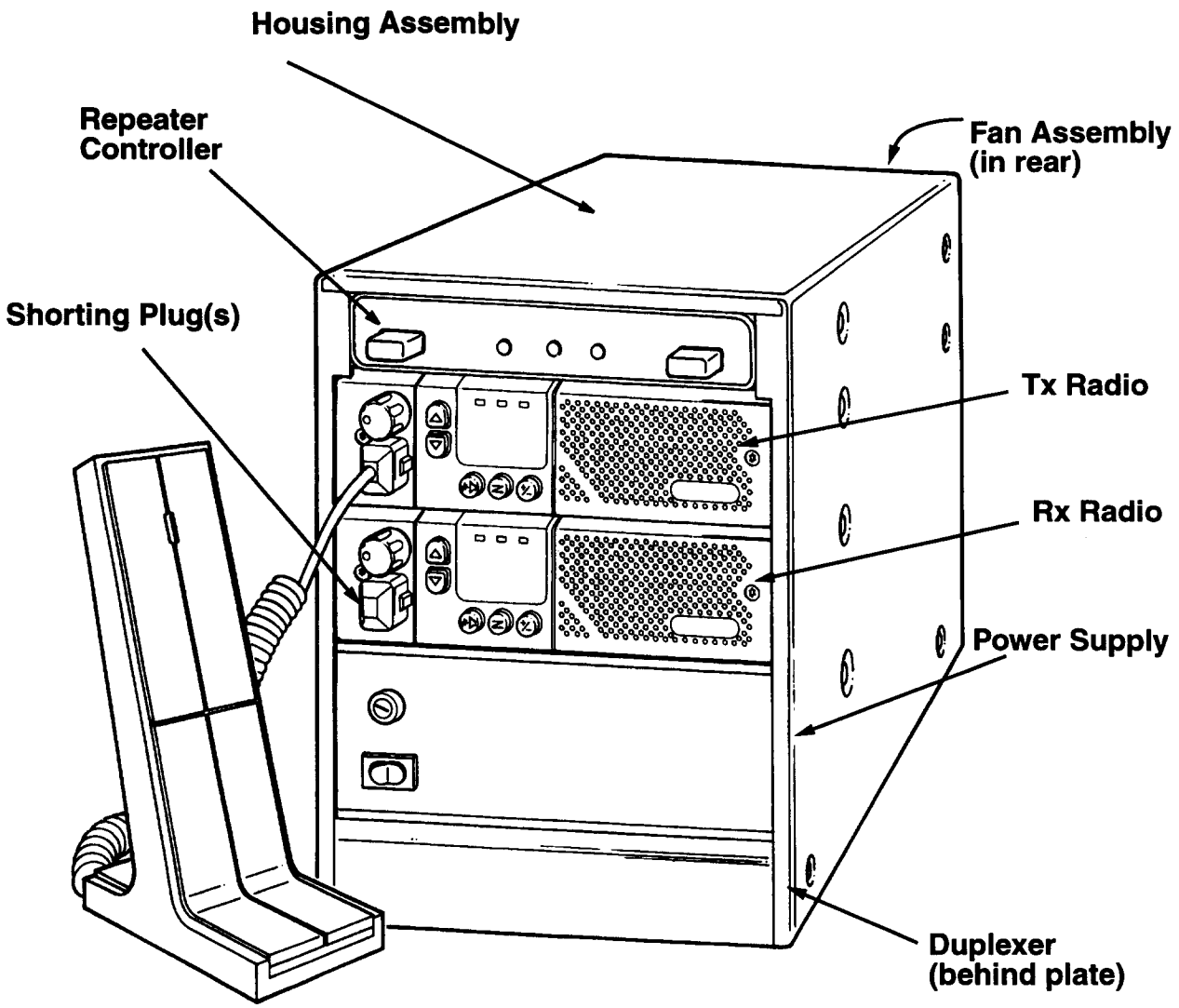



*Figure 1-1. GR300 Repeater Station*

*Table 1-9. GR300 Repeater Equipment Physical Characteristics*

| Major Component/Assembly | Height | Width | Depth | Weight |
|---|---|---|---|---|
| GR300 Repeater Station (includes the weights of all of the components) | 10.4 in. (264 mm) | 7.4 in (188 mm) | 10.4 in. (264 mm) | 34 lbs. (15.44 kg) |
| GM300 Radios (each) | 2.0 in. (51 mm) | 7.0 in. (178 mm) | 7.8 in. (198 mm) | 3.8 lbs. (1.73 kg) |
| Repeater Controllers (except Basic) | 1.3 in. (33 mm) | 7.1 in. (180 mm) | 8.7 in. (221 mm) | 1.7 lbs. (0.77 kg) |
| Basic Repeater Controller | 1.3 in. (33 mm) | 7.1 in. (180 mm) | 6.7 in. (170 mm) | 1.2 lbs. (0.54 kg) |
| Duplexer (maximum dimensions) | 1.3 in. (33 mm) | 6.3 in. (160 mm) | 9.5 in. (241 mm) | 3.5 lbs. (1.59 kg) |
| Power Supply | 2.7 in. (69 mm) | 7.0 in. (178 mm) | 9.8 in. (249 mm) | 12 lbs. (5.45 kg) |
| Fan Assembly | 8.0 in. (142 mm) | 7.4 in. (188 mm) | 3.3 in. (84 mm) | 2.1 lbs. (0.95 kg) |

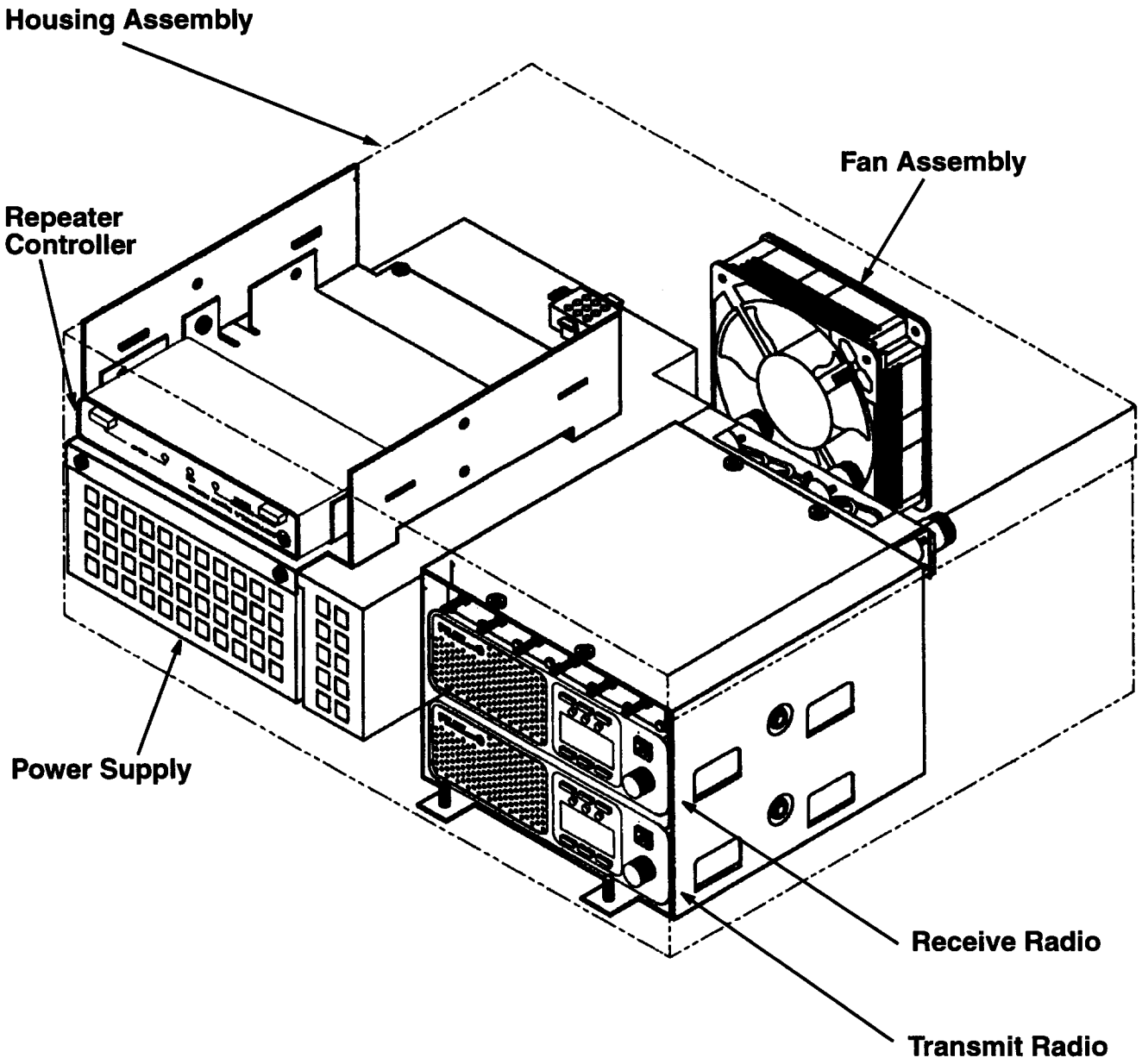



*Figure 1-2. GR500 Repeater Station (before mounting)*

*Table 1-10. GR500 Repeater Equipment Physical Characteristics*

| Major Component/Assembly | Height | Width | Depth | Weight |
|---|---|---|---|---|
| GR500 Repeater Station (includes the weights of all of the components) | 7.4 in. (336 mm) | 17.4 in. (790 mm) | 13.5 in. (613 mm) | 43.3 lbs. (19.66 kg) |
| GM300 Radios (each) | 2.0 in. (51 mm) | 7.0 in. (178 mm) | 7.8 in. (198 mm) | 3.8 lbs. (1.73 kg) |
| Repeater Controllers (except Basic) | 1.3 in. (34 mm) | 7.1 in. (180 mm) | 8.7 in. (221 mm) | 1.7 lbs. (0.77 kg) |
| Basic Repeater Controller | 1.3 in. (33 mm) | 7.1 in. (180 mm) | 6.7 in. (170 mm) | 1.2 lbs. (0.54 kg) |
| Duplexer (maximum dimensions) | 1.3 in. (33 mm) | 6.3 in. (160 mm) | 9.5 in. (241 mm) | 3.5 lbs. (1.59 kg) |
| Power Supply | 3.7 in. (168 mm) | 4.3 in. (195 mm) | 11.6 in. (527 mm) | 12 lbs. (5.45 kg) |
| Fan Assembly | 4.8 in. (218 mm) | 4.8 in. (218 mm) | 1.5 in. (68 mm) | 1.3 lbs. (0.59 kg) |

# Section 2
# GR300 Repeater Station

## Overview

This section contains information about the performance, basic disassembly and assembly of the GR300 Repeater Station, and about tuning the duplexer.

## Performance

The GR300 repeater is not a high performance repeater, but it is designed to withstand constant use. It was designed and tested with GM300 mobile radios. The GR300 repeater package is designed for fixed locations where protection from the elements (snow, rain, etc.) can be provided. The station is intended to be relatively light and portable.

The fan is continuously variable. This variability minimizes noise in office environments while providing maximum cooling at elevated ambient temperatures or during heavy transmit duty cycles. The station is defined as intermittent transmit duty cycle, but it may have a surprisingly lower power slump when keyed for long periods in an office or shop environment.

The GM300 radios used in the station provide a means to program the receiver for two levels of sensitivity. These levels allow the GR300 repeater to be more usable in both urban and rural locations.

## Basic Disassembly/Assembly

In order to conserve space in the packing box, the GR300 repeater housing is shipped completely assembled with the fan assembly, base tray, and (in later models) power supply installed. To gain access to its mounting holes and equipment shelves, **the GR300 repeater housing may have to be completely disassembled.** With the GR300 repeater housing disassembled, you can begin to install the radios and other components before reassembling the housing.

Before beginning installation, remove all items from the packing container and check them against the items referenced in one of the parts lists on page 2-5. This ensures that you have received all items necessary to assemble the GR300 Repeater Station. Immediately report any missing or damaged items to Radius Product Services.

The following steps explain how to disassemble the GR300 repeater housing and how to reassemble it while installing the components (duplexer, transmit and receive radios, repeater controller, power supply [if necessary], and fan assembly).

### *Disassembling the GR300 Repeater Housing*

The following steps cover disassembly of the repeater housing. Refer to Figure 2-8 on page 2-5 for identification of each part and its corresponding reference number.

1. Place the GR300 repeater housing on a flat surface with the fan assembly facing you.

> **NOTE**
> Use one of the small cardboard pieces from the packing material as a "lazy susan" to facilitate disassembly and reassembly.

2. Unscrew the four T15 Torx®, pan head, Taptite screws **(3)** that secure the fan assembly **(17)** to the cover **(2)**.

> **NOTE**
> Older GR300 repeater models use metric M3.5 screws; newer models use English 6-32 screws.

3. Remove the two T15 Torx, pan head, machine screws **(8)** that secure the front plate **(6)** to the cover **(2)**. If the power supply is **not** mounted in the GR300 repeater housing, remove the two rear T15 Torx, pan head machine screws **(8)**.

4. Remove the front plate **(6)** from the cover **(2)**.

5. If the power supply **(9)** is **not** mounted in the GR300 repeater housing, remove the base tray **(5)** from the cover **(2)** with a firm upward motion on the cover to unsnap it from the base tray.

## *Assembling the GR300 Repeater Housing*

The following steps enable you to reassemble the GR300 Repeater Station. Refer to Figure 2-8 on page 2-5 for identification of each part and corresponding reference number.

### Installing the Duplexer

1. Examine the duplexer. If four of the mounting holes contain Pemnuts (threaded inserts), proceed to Step 3.

2. If the duplexer does not have four mounting holes with Pemnuts, place Tinnerman clips over four of the mounting holes of the duplexer (refer to Figure 2-1 for locations) using needle nose pliers. Ensure that the "threaded" sides of the clips are on the connector and tuning sides of the duplexer.

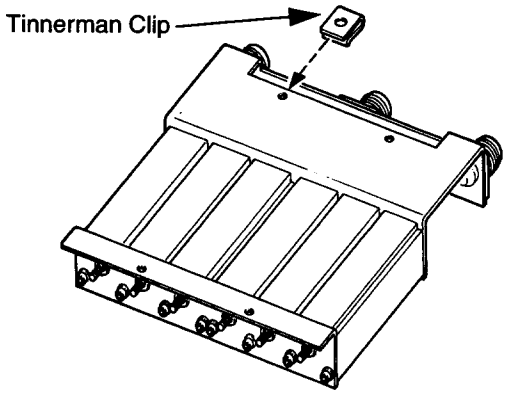



*Figure 2-1. Duplexer, Bottom View*

3. Slide the duplexer into the base tray **(5)** with the six tuning screws facing toward the front (side stamped with the word "FRONT") of the tray.

4. Secure the duplexer to the base tray with four 6-32x1/2" T15 Torx, pan head machine screws **(8)**. Tighten to 0.68 N-m (6 in.-lbs.) for Tinnerman clips or 1.35 to 1.58 N-m (12 to 14 in.-lbs.) for Pemnuts, torque. If the power supply was already mounted in the GR300 repeater housing, skip to "Installing the Receive Radio."

### Installing the Power Supply

**IMPORTANT**

Before installing the power supply into the GR300 Repeater Station, place the primary voltage select switch (on the bottom of the power supply and, possibly, under a protective plate) in the correct position for your application.

1. Place the power supply **(9)** on the base tray **(5)**, using the tabs to assist in aligning it. Refer to Figure 2-8 on page 2-5 for the location of the tabs. The power supply heat sink should be facing toward the back of the base tray.

2. Place the cover **(2)** on the base tray **(5)** making sure that the cover mounting holes are aligned with the base tray mounting holes.

**NOTE**

To leave access to the duplexer controls, you should not yet install the front plate. Since the front mounting holes of the cover and the mounting holes on the front plate are secured to the base tray with the same screws, you should complete the final assembly of the repeater housing after tuning the duplexer.

3. If necessary, reposition the power supply so that its mounting screw holes are aligned with the corresponding M5 mounting holes on the repeater housing.

**NOTE**

Once the cover is attached to the base tray, it is referred to as the "repeater housing."

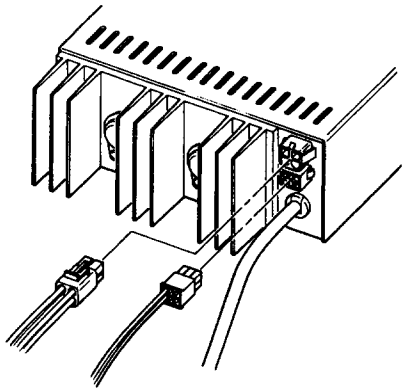


*Figure 2-2. Power Supply, Rear View*

4. Using a T25 Torx screwdriver, secure the power supply **(9)** to the repeater housing **(2)** with two M5 x 0.8 x 8, pan head, machine screws **(7)**.

5. Place two 6-32 x 1/2" or M3.5 x 0.6 x 8, T15 Torx, pan head machine screws **(8)** in the back two mounting holes of the cover and tighten to 1.35 to 1.58 N-m (12 to 14 in.-lbs.) torque.

6. Tighten the M5 x 0.8 x 8, pan head, machine screws **(7)** (that hold the power supply) to 1.58 N-m (14 in.-lbs.) torque.

## Installing the Receive Radio

**IMPORTANT**
You must install a shorting plug in the microphone jack of the receive radio. If you do not, then the repeater may act as a CSQ repeater instead of a PL repeater. The transmit radio may use either a shorting plug or a microphone.

**IMPORTANT**
Before installing the receive radio into the GR300 Repeater Station, be sure to set the jumpers inside the receive radio to the correct positions (refer to your specific controller manual), connect the RF and repeater cables, and make any necessary adjustments to the radios.

1. Remove the 16-pin accessory jumper plug from the receive radio.
2. Connect the mini-UHF end of the first RF cable to the RF connector of the receive radio (refer to Figure 2-3).
3. Connect one end of the first repeater cable to the accessory connector of the receive radio (refer to Figure 2-3).

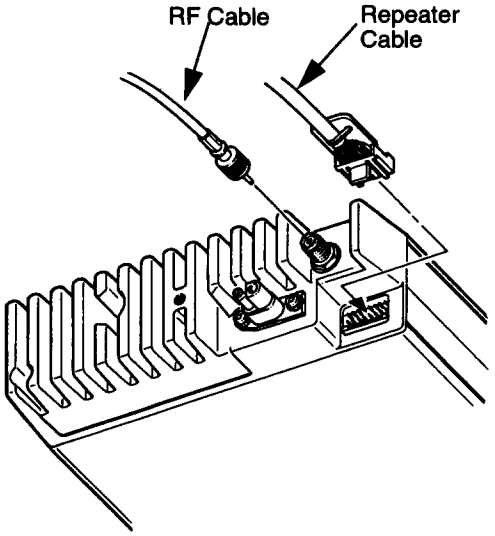



*Figure 2-3. GM300 Receive Radio, Rear View*

4. Place the receive radio on the middle shelf (directly above the power supply) of the GR300 repeater housing.
5. Align the mounting holes of the receive radio with the M5 holes of the housing.
6. Attach the receive radio to the housing with two M5 x 0.8 x 8, T25 Torx, pan head, machine screws **(7)**.

**NOTE**
*DO NOT* tighten the screws at this time.

## Installing the Transmit Radio

**IMPORTANT**
Before installing the transmit radio into the GR300 repeater housing, be sure to set the jumpers inside the transmit radio to the correct positions (refer to your specific controller manual), connect the RF and repeater cables, and make any necessary adjustments to the radios.

1. Remove the 16-pin accessory jumper plug from the transmit radio.
2. Connect the mini-UHF end of the second RF cable to the RF connector of the transmit radio (refer to Figure 2-4).

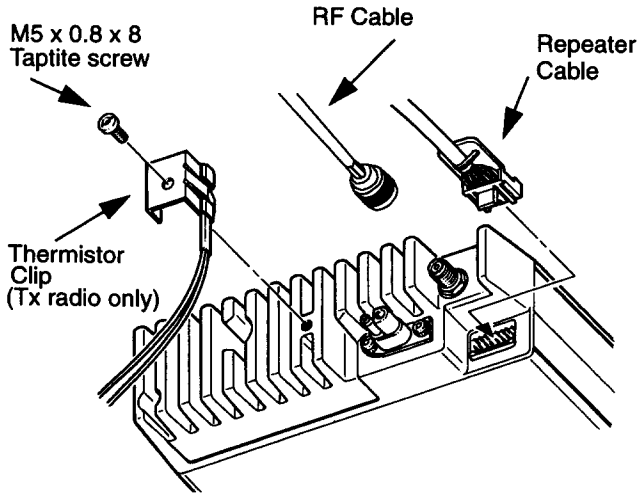



*Figure 2-4. GM300 Transmit Radio, Rear View*

3. Connect one end of the second repeater cable to the accessory connector of the transmit radio (refer to Figure 2-4).
4. Place the transmit radio on top of the receive radio.
5. Align the holes of the transmit radio with the M5 holes of the housing.
6. Attach the transmit radio to the housing with two M5 x 0.8 x 8 T25 Torx, pan head, machine screws **(7)**.

**NOTE**
DO NOT tighten the screws at this time.

7. If necessary, slide the yellow lead of the fan assembly power cable containing the thermistor into the thermistor clip (Figure 2-5).

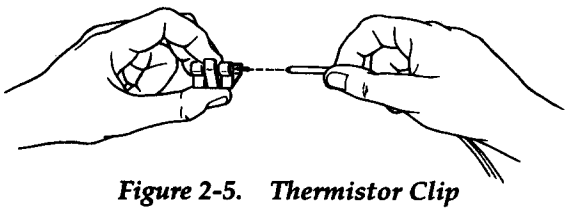


*Figure 2-5. Thermistor Clip*

8. Using a T25 Torx screwdriver, secure the thermistor clip to the mounting hole located on the transmit radio heat sink with a M5 x 0.8 x 8 Taptite screw (Figure 2-4). Tighten to 3.38 to 3.95 N-m (30 to 35 in.-lbs.) torque.

9. Connect the type-N end of the RF cable from the receive radio to the appropriate port of the duplexer (refer to Figure 2-6).

10. Connect the type-N end of the RF cable from the transmit radio to the appropriate port of the duplexer (refer to Figure 2-6).

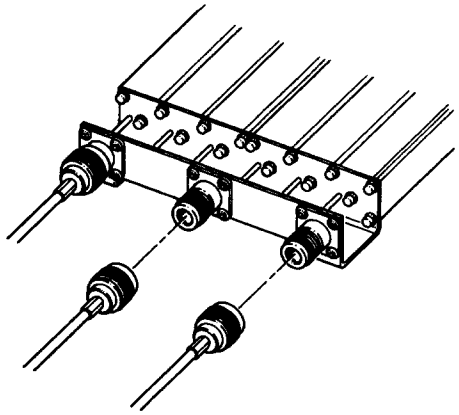


*Figure 2-6. Duplexer, Rear View*

## Installing the Repeater Controller

**IMPORTANT**
Before installing the repeater controller into the GR300 Repeater Station, be sure to set the jumpers inside the receive and transmit radios to the correct positions (refer to your specific controller manual), connect the RF and repeater cables to the radios, and make any necessary adjustments to the radios.

1. Place the repeater controller on the top shelf of the GR300 repeater housing, allowing the rear panel to be partially exposed.

2. Connect the receive radio repeater cable to the component's **Receive** connector (Figure 2-9).

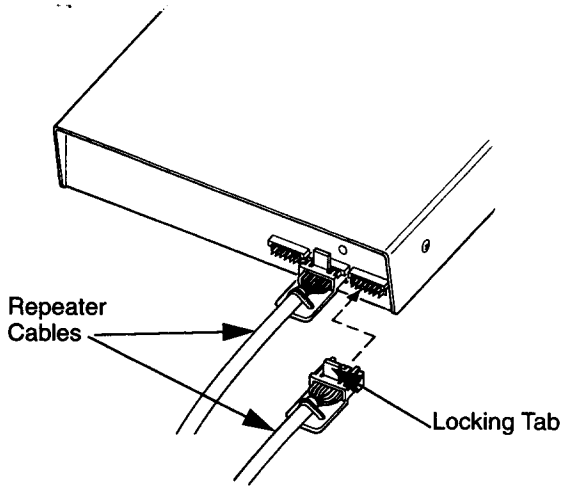



*Figure 2-7. Repeater Controller, Rear View*

3. Connect the transmit radio repeater cable to the component's **Transmit** connector (Figure 2-9).

**CAUTION**
To avoid damage to cable tabs and radio components, install cables with locking tabs up (Figure 2-7).

4. If the repeater controller requires a phone line, connect the line to the jack at the back of the repeater controller.

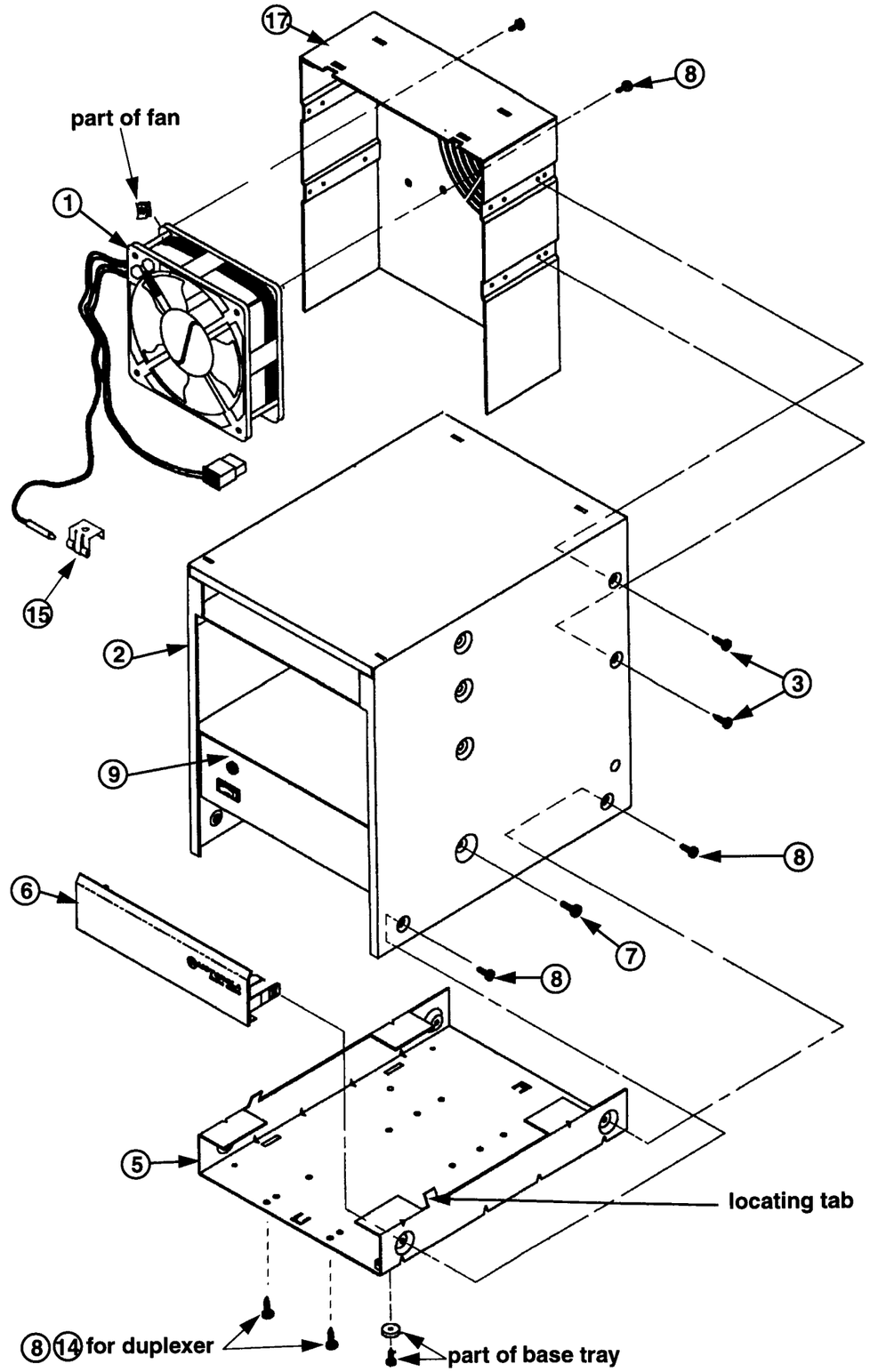
5. If the repeater controller has a grounding wire, use the 1/4"-20 hex nut provided with the GR300 repeater kit to connect the wire to the 1/4" threaded stud on the inside of the GR300 repeater housing. If no grounding wire is present, place the nut on the threaded stud.

**NOTE**
Do not tighten the nut at this time.

6. Position the component so that its mounting screw holes are aligned with the corresponding mounting holes on the repeater housing.

7. Using a T25 Torx screwdriver, secure the component to the repeater housing using two M5 x 0.8 x 8 machine screws **(7)**.

**NOTE**
*DO NOT* tighten the screws at this time.




## Parts List

GR300 Housing Kit HLN3052 PL-941028-A

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 1 | 5980517C01 | FAN DC with 4 #6-32 Tinnerman clips | 1 |
| 2 | 1580675B01 | COVER | 1 |
| 3 | -- | SCREW, Taptite, 6-32 x 3/8" | 4 |
| 4 | 0310943M73 | SCREW, Taptite, M5 x 0.8 x 10mm LG. | 1 |
| 5 | 0780676B01 | BASE TRAY with rubber feet and mounting screws | 1 |
| 6 | 6480495C01 | FRONT PLATE w/ 2 #6-32 Tinnerman clips | 1 |
| 7 | 0310907B08 | SCREW, machine, M5 x 0.8 x 8 | 8 |
| 8 | -- | SCREW, machine, 6-32 x 1/2 | 12 |
| 9 | 0180497C01 (HPN8393C) | POWER SUPPLY (with Power Cable) | 1 |
| 10 | 3080691B02 | CABLE, RF | 2 |
| 11 | 3080137S02 | CABLE, REPEATER | 2 |
| 12 | 3080692B01 | CABLE, DC POWER | 1 |
| 13 | 0180970X01 | PLUG, SHORTING (Not Shown) | 2 |
| 14 | -- | #6-32 "U" TYPE SPEED NUT FASTENER (for duplexer) Tinnerman P/N C8091-632 (Not Shown) | 4 |
| 15 | 0780576C01 | MOUNTING CLIP, THERMISTOR | 1 |
| 16 | -- | TIE WRAP, APPROX. 4" LG. (Not Shown) | 1 |
| 17 | 1580675B02 | FAN BRACKET | 1 |
| 18 | -- | NUT, Stainless Steel 1/4 x 20 | 1 |

*Figure 2-8. GR300 Repeater Housing*

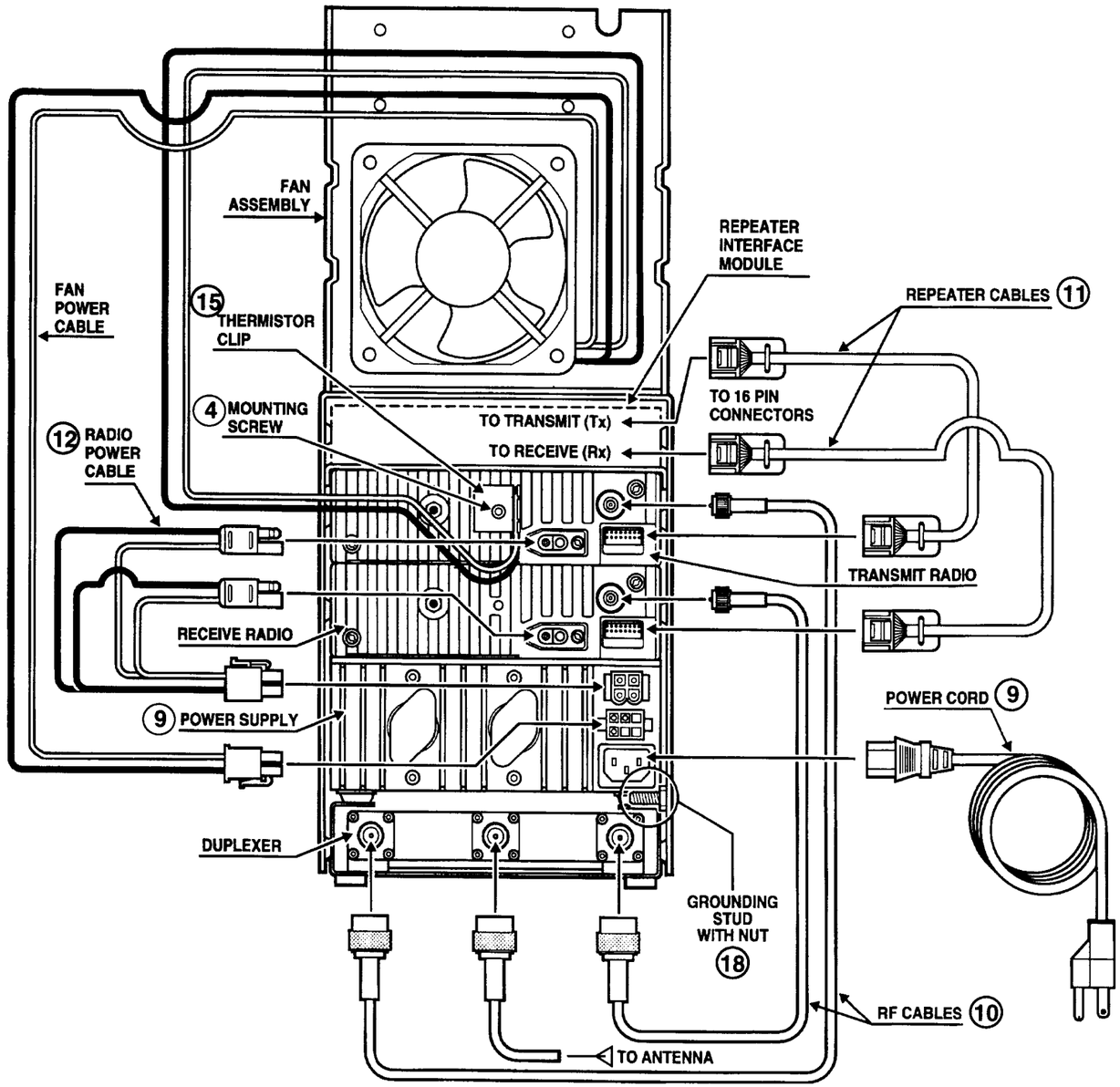



*Figure 2-9. Interconnect Cabling Diagram*

### *Installing the Fan Assembly*

Perform the following steps to reinstall the fan assembly in the repeater housing. Due to a limited amount of space in the back of the repeater housing, you must connect the power cable before installing the fan. To free both hands for easier installation of the power cable, you may want to rest the fan assembly on top of the repeater housing.

1. Connect the 6-position fan assembly power cable connector to the bottom connector of the power supply (Figure 2-9 on page 2-6).

**NOTE**
Older model GR300 repeaters have a 4-position in-line connector assembly. Plug the 6-position connector into the power supply and interconnect the two 4-position connectors.

2. Bundle the cables using the cable tie wrap supplied with the GR300 repeater kit.
3. Dress the cables so they do not extend out the back of the GR300 repeater.

**CAUTION**
If you do not properly dress the cables, they could be damaged by the fan blades or disconnected.

4. Position the fan assembly **(17)** in the repeater housing **(2)**.
5. Align the set of mounting screw holes on the rear of the fan assembly with the corresponding mounting holes on the repeater housing.
6. Using a T15 Torx screwdriver and four Taptite screws **(3)**, secure the fan assembly **(17)** to the repeater housing **(2)** and tighten to 1.35 to 1.58 N-M (12 to 14 in.-lbs.) torque.
7. Using a T25 Torx screwdriver, tighten all M5 screws to 1.58 N-m (14 in.-lbs.) torque.
8. Verify that all screws are tight and all cables have been connected properly (refer to Figure 2-8 and Figure 2-9).

**NOTE**
Do not install the front plate of the repeater housing until you have completed all tests and adjustments under the heading Tests and Adjustments.

## Tuning the Duplexer

Before using your repeater, you must tune the duplexer, using one of the following three methods for ensuring that the duplexer is tuned to the correct frequencies of operation:

- **Pre-Tuned Method (preferred method)**
  Order the duplexer from the manufacturer or supplier pre-tuned to the desired frequencies. This is not a "method" of tuning the duplexer but does not require any test equipment.
- **Visual Method**
  Use a tracking (sweep) generator and spectrum analyzer to adjust the tuning of the passbands and reject bands of the duplexer.
- **"In a Pinch" Method**
  The following paragraphs address a simple method of tuning a "notch" (reject) duplexer such as the TDN7407 UHF duplexer. This is not as accurate a method of tuning as the visual method afforded by the tracking generator/spectrum analyzer sweep setup but it is much less costly. It may be sufficiently good for all but the most exacting applications.
  Use this method only when the operating frequencies of the receive radio and the transmit radio satisfy the requirements of the duplexer. For example, the TDN7407 is designed for a transmitter/receiver frequency spacing of 5 MHz. If the operating frequencies for the repeater are appreciably different than that 5 MHz specification, degraded performance of the repeater will result.

The following procedure assumes that the GR300 repeater is fully assembled and the radios and duplexer are mounted in the GR300 repeater housing. The radios should be connected to the proper ports of the duplexer with the RF coaxial cables provided in the GR300 repeater kit. The duplexer front panel cover plate of the GR300 repeater should be removed to gain access to the tuning screws of the duplexer.

### *Programming the Radios*

1. Program the receive radio with an additional "receive only" mode at the frequency of the transmit radio.
2. Program the transmit radio with an additional "receive only" mode at the frequency of the receive radio.

**NOTE**
Instead of programming additional modes, you can connect the coaxial cables from the radios to the "opposite" ports of the duplexer.

3. Connect a Communications System Analyzer (CSA), such as the Motorola R2000 series, or an RF signal generator to the antenna port of the duplexer. The CSA should be operating in the "Generate" mode. Modulate the RF source with a 1 kHz tone at 60% system deviation to

facilitate "hearing" the signal during the tune-up procedure.

## Tuning the Receive Radio Section

**NOTE**
Tuning the receive radio section of the duplexer begins with the tuning screw closest to the antenna port of the duplexer.

1. Adjust the frequency of the CSA or generator to that of the transmit radio.
2. Place the receive radio on the transmit radio frequency mode defined in Step 1 under "Programming the Radios."
3. Adjust the level of the CSA or generator until a weak signal is heard from the receive radio.
4. Increase the level of the CSA or the generator by approximately 20 dB.
5. Adjust the tuning screw of the duplexer for the greatest rejection of the signal. This will appear as a noisier signal. **If necessary:**

5A. Slightly loosen the locking nuts of the tuning screws to allow the tuning screws to turn more freely (but not "sloppy") **and**

5B. Increase the level of the CSA or the generator to maintain an audible 1 kHz tone.

6. Repeat Steps 4 thru 5B for each of the tuning screws on the receive radio section of the duplexer. Begin with the tuning screw closest to the antenna port and work in order toward the tuning screw closest to the receive radio port.
7. Tighten the locking nuts of the tuning screws.

**CAUTION**
To avoid damage to the tuning screws and to allow fine tuning of the duplexer, do not overtighten the locking nuts.

8. Readjust the tuning screws of the duplexer for the greatest rejection of the signal. This will fine-tune the receive radio section of the duplexer.

## Tuning the Transmit Radio Section

**NOTE**
Tuning the transmit radio section of the duplexer begins with the tuning screw closest to the antenna port of the duplexer.

1. Adjust the frequency of the CSA or generator to that of the receive radio.
2. Place the transmit radio on the receive radio frequency mode defined in Step 2 under "Programming the Radios."
3. Adjust the level of the CSA or generator until a weak signal is heard from the transmit radio.
4. Increase the level of the CSA or the generator by approximately 20 dB.
5. Adjust the tuning screw of the duplexer for the greatest rejection of the signal. This will appear as a noisier signal. **If necessary:**

5A. Slightly loosen the locking nuts of the tuning screws to allow the tuning screws to turn more freely (but not "sloppy") **and**

5B. Increase the level of the CSA or the generator to maintain an audible 1 kHz tone.

6. Repeat Steps 4 thru 5B for each of the tuning screws on the duplexer. Begin with the tuning screw closest to the antenna port and move in order toward the tuning screw closest to the transmit radio port.
7. Tighten the locking nuts of the tuning screws.

**CAUTION**
To avoid damage to the tuning screws and to allow fine tuning of the duplexer, do not overtighten the locking nuts.

8. Readjust the tuning screws of the duplexer for the greatest rejection of the signal. This will fine-tune the transmit radio section of the duplexer.

**CAUTION**
If you connected the coaxial cables from the radios to the 'opposite' ports of the duplexer, do not forget to reconnect them to the 'proper' ports before placing the repeater into operation.

9. Using a T15 Torx screwdriver, remount the duplexer front panel cover plate **(6)** on the GR300 repeater housing **(2)** with two 6-32 x 1/2" machine screws **(8)** and tighten to 0.68 N-m (6 in.-lbs.) torque.

# Final Assembly

To operate the GR300 repeater, you must connect all of the necessary cables and accessories to the back of the GR300 unit:

1. Attach a ground wire from an absolute earth ground to the 1/4" threaded stud on the far left of the GR300 repeater (on the inside at the back of the housing) and tighten to 2.25 to 3.38 N-m (20 to 30 in.-lbs.) torque.

2. Connect lightning arrestors.

**CAUTION**

Lightning can damage the GR300 repeater and its components if the unit is not grounded properly.
For lightning protection, ground the GR300 repeater to an absolute earth ground using at least #6 gauge copper wire, and use adequate lightning arrestors.

3. Connect the antenna lead to the antenna connector at the center of the duplexer.

4. Connect the ac line cord from the GR300 repeater's power supply into an ac mains outlet.

# Section 3
# GR500 Repeater Station

## Overview

This section contains information about the performance of the GR500 Repeater Station, the basic assembly and disassembly, and the steps for tuning the duplexer.

## Performance

The GR500 is not a high performance repeater, but it is designed to withstand constant use. It was designed and tested with GM300 mobile radios. The GR500 repeater package is designed for fixed locations where protection from the elements (snow, rain, etc.) can be provided. The station is intended for permanent wall or rack mounting.

The fan is single speed to provide maximum cooling at elevated ambient temperatures and during heavy transmit duty cycles. The station is defined as intermittent transmit duty cycle, but it may have a surprisingly lower power slump when keyed for long periods in an office or shop environment.

The GM300 radios used in the station provide a means to program the receiver for two levels of sensitivity. These levels allow the GR500 repeater to be more usable in both urban and rural locations.

Provision has been made for mounting a receiver preselector (optional) inside the GR500 repeater housing. The preselector increases the interference rejection of the receive radio to strong signals several MHz away from the desired receive channel.

## Contents of the Kit

The GR500 repeater kit contains two bags of hardware (Bags 1 and 2) for assembling your repeater.

The following is a checklist of the contents of Bag 1 and Bag 2 (with quantities listed in brackets):

*Bag 1*

- ☐ [8] M5 Torx Machine Screw, 8mm long (Blk) (Motorola Part Number 0310907B08)
- ☐ [4] 6-32 x 1/2 Machine Screw, Pan Head, Phillips
- ☐ [4] Tinnerman Clip C8091-632
- ☐ [2] Shorting Plug (Motorola Part Number 0180970X01)
- ☐ [2] Cable, 16-Pin (Motorola Part Number 3080577D02)
- ☐ [2] Tie Wraps, Nylon, 6"
- ☐ [2] Cable (Duplexer to Radio) (Motorola Part Number 3080577D03)
- ☐ [1] Cable (Duplexer to Antenna) (Motorola Part Number 3080577D04)

*Bag 2*

- ☐ [1] ac Line Cord
- ☐ [1] Line Cord Clamp
- ☐ [1] Cover for Battery Terminal Block
- ☐ [2] Nuts and Lockwashers for Ground Lugs

## Assembly/Disassembly

### *Disassembling the GR500 Repeater Housing*

(Refer to Figure 3-2 on page 3-3)

1. Turn the quarter-turn front cover fasteners counterclockwise to open the front cover.
2. Remove the bags of hardware and cables from the housing.
3. With appropriate socket tools perform the following:

3A. Remove the 8-32 nuts that secure the front of the radio/duplexer bracket in the GR500 repeater housing.

3B. Loosen, but do not entirely remove, the 8-32 nuts that secure the back of the radio/duplexer bracket (this is the end of the bracket with notched mounting tabs).

3C. Remove the radio/duplexer bracket.

3D. Remove the two 8-32 screws that secure the repeater controller bracket to the front of the power supply module.

3E. Loosen, but do not entirely remove, the two 8-32 screws that secure the back of the repeater controller bracket to the top of the power supply module (this is the end of the bracket with notched mounting tabs).

3F. Remove the repeater controller bracket.

## Installing the Antenna Cable

1. Remove the nut and lockwasher from the bulkhead connector of the type-N male to type-N female bulkhead cable.
2. Align the flat side of the bulkhead connector with the straight side of the D-shaped hole in the back of the GR500 repeater housing.
3. Push the connector, from the inside to the outside, through the GR500 repeater housing.
4. Secure the bulkhead connector to the GR500 repeater housing using the nut and lockwasher removed in Step 1, and torque to 2.25 N-m (20 in.-lbs.).

## Assembling the GR500 Repeater

**IMPORTANT**
Before installing the radios into the GR500 Repeater Station, set the jumpers inside the radios to the correct positions (refer to your specific controller manual), connect the RF and repeater cables, and make any necessary adjustments to the radios. The GM300 8 Channel, M120, and M10 radios can be used only with the Basic Repeater Controller and the i50R.

1. Place the radio/duplexer bracket on a flat surface with the open end down.

### Installing the Transmit Radio

**IMPORTANT**
You must install a shorting plug in the microphone jack of the receive radio. If you do not install the shorting plug, then the repeater may act as a CSQ repeater instead of a PL repeater. The transmit radio may use either a shorting plug or a microphone.

2. Remove the 16-pin accessory jumper plug from the transmit radio.
3. Connect the mini-UHF end of the first RF cable to the RF connector of the transmit radio.
4. Connect one end of the first repeater cable to the accessory connector of the transmit radio.
5. Place the transmit radio, upside-down, at the bottom (open end) of the bracket. (The rear of the radio must be on the same end of the bracket that contains the slotted tabs for mounting the bracket into the GR500 repeater housing.) Position the radio to align the holes of the radio with the M5 holes of the housing.
6. Attach the transmit radio to the bracket with two M5 x 0.8 x 8 T25 Torx, pan head, machine screws.

**NOTE**
**DO NOT** yet tighten the screws.

### Installing the Receive Radio

7. Remove the 16-pin accessory jumper plug from the receive radio.
8. Connect the mini-UHF end of the second RF cable to the RF connector of the receive radio.
9. Connect one end of the second repeater cable to the accessory connector of the receive radio.
10. Place the receive radio, upside-down, in the middle position of the bracket (directly above the transmit radio). Position the radio to align the mounting holes of the radio with the M5 holes of the bracket.
11. Attach the receive radio to the bracket with two M5 x 0.8 x 8 T25 Torx, pan head, machine screws.

**NOTE**
**DO NOT** yet tighten the screws.

### Installing the Duplexer

12. Examine the duplexer that was ordered for the GR500 repeater model being assembled. If four of the mounting holes contain Pemnuts (threaded inserts), proceed to Step 14. If no Pemnuts are present, continue with Step 13.
13. Using a pair of needle nose pliers, place Tinnerman clips over four of the mounting holes of the duplexer (refer to Figure 3-1).

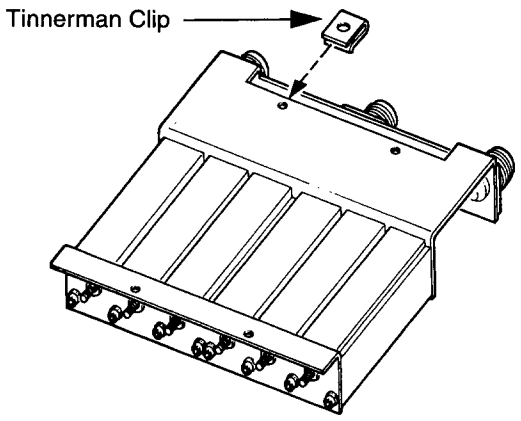



*Figure 3-1. Duplexer, Bottom View*

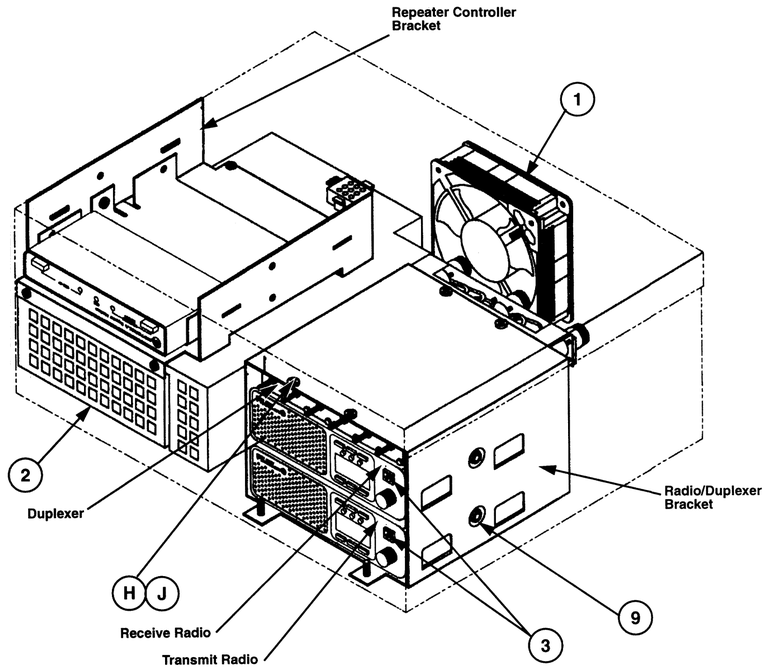



*Figure 3-2. GR500 Repeater Station (before wall mounting) Front View Internal Parts*

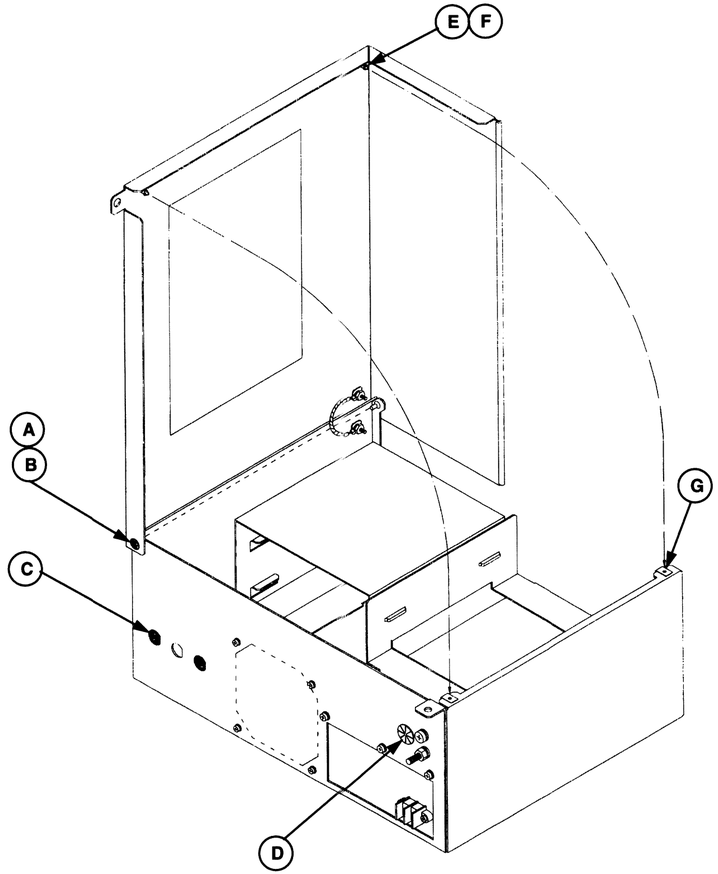



*Figure 3-3. GR500 Repeater Station, Rear Isometric View*

## Parts List

GR500 Housing Kit HLN9117 Replacement Parts List PL-941029-A

| REFERENCE NO. | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| 1 | HLN9291 | FAN w/mounting hardware |
| 2 | HPN9005 | GR500 POWER SUPPLY w/mounting hardware and ac line cord (IEC to U.S. 115 V ac) |
| 3 | HLN9573 | SHORTING PLUG for radio |
| 4 | 3080577D01 | POWER HARNESS, GR500 radios and fan to power supply |
| 5 | 3080577D02 | CABLE, 16-pin to 16-pin |
| 6 | 3080577D03 | CABLE, RF radio to duplexer |
| 7 | 3080577D04 | CABLE, duplexer to antenna connector |
| 8 | 3082933N08 | CORD, ac line (IEC to U.S. 115 V ac) (p/o HPN9005) |
| 9 | 0310907B08 | SCREW, M5 x 0.8 x 8 Torx®, pan head machine (black) |
| 12 | HLN9207 | MISC. HARDWARE KIT (see pages 4 and 6) consists of: |
| A | | RIVET, solid brazier head; 2 used |
| B | | PUSH NUT for 3/16 stud; 2 used |
| C | | PLUG, double "D" 0.625 dia.2 used |
| D | | BUSHING, snap universal 0.875 dia.; 1 used |
| E | | FASTENER, 1/4 turn; 2 used |
| F | | RETAINER, nylon 1/4 turn; 4 used |
| G | | RECEPTACLE, 1/4 turn; 2 used |
| H | | #6-32 x 1/2" screws (for duplexer); 4 used |
| J | | #6-32 "U" type speed nut (for duplexer); 4 used |

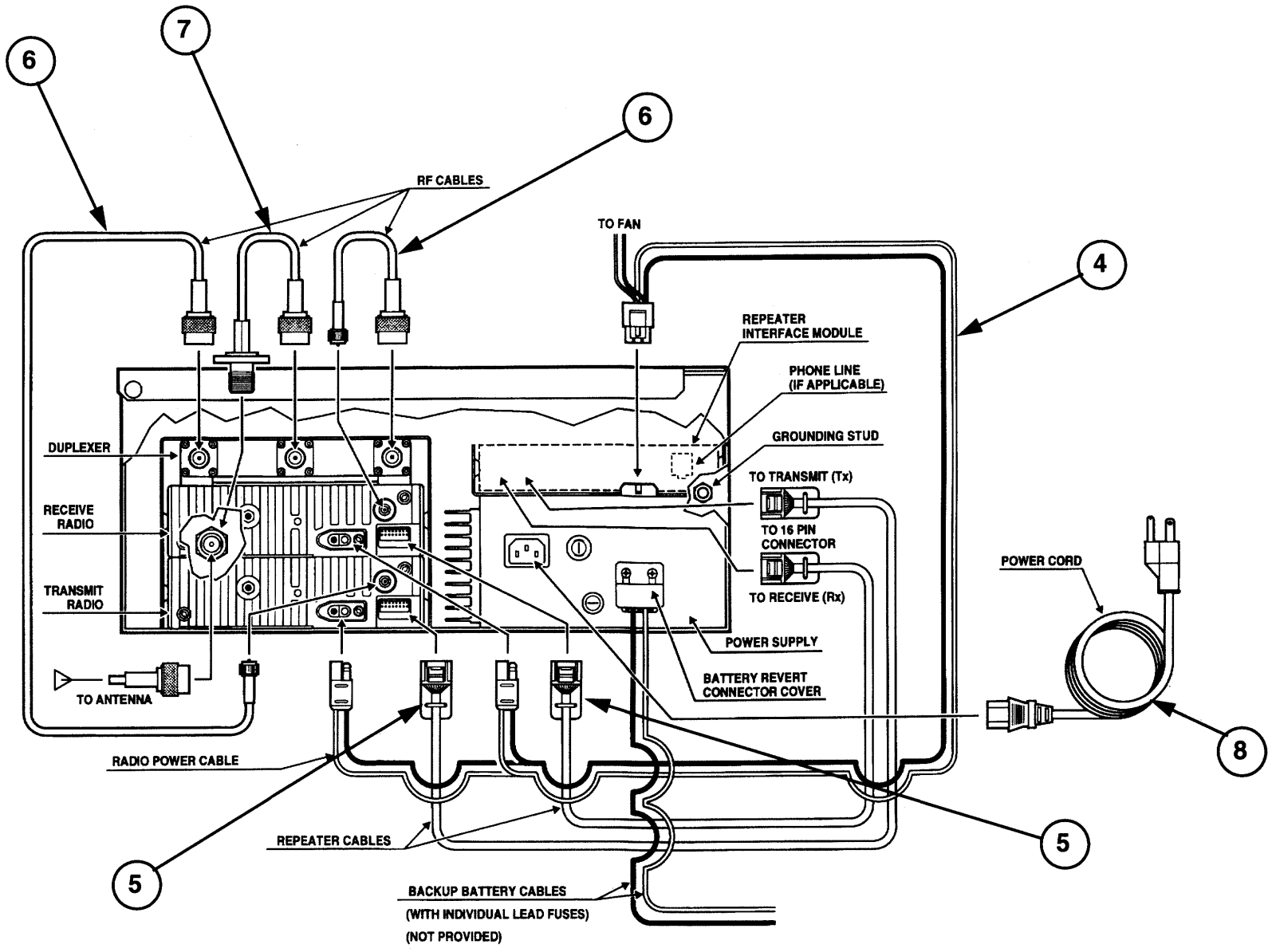



*Figure 3-4. GR500 Interconnect Cabling Diagram*

**NOTE**
The threaded side of each clip should be on the connector/tuning screw side of the duplexer.

14. Place the duplexer in the mounting bracket with the six tuning screws facing in the same direction as the front of the radios. The mounting holes of the duplexer must face upward.

15. Secure the duplexer to the mounting bracket with four 6-32 x 1/2" T15 Torx, pan head machine screws.

16. Tighten all of the M5 machine screws to 1.58 N-m (14 in.-lbs.) torque. Tighten all of the 6-32 machine screws to 0.68 N-m (6 in.-lbs.) torque for the Tinnerman clips or 1.35 to 1.58 N-m (12 to 14 in.-lbs.) for Pemnuts.

17. Connect the type-N end of the RF cable from the transmit radio to the appropriate port of the duplexer.

18. Connect the type-N end of the RF cable from the receive radio to the appropriate port of the duplexer.

### Installing the Radio/Duplexer Bracket

19. Place the assembled radio/duplexer bracket module into the GR500 repeater housing. Tilt the module slightly upward at the front end and slide the rear notched mounting tabs on the radio/duplexer bracket under the 8-32 nuts of the threaded studs toward the back of the GR500 repeater housing.

20. Press the module toward the back of the housing.

**NOTE**
Do not yet tighten the back mounting nuts to attach the radio/duplexer module to the GR500 repeater housing.

21. Slide the front mounting tabs of the radio/duplexer bracket over the 8-32 studs. Reinstall the 8-32 nuts on the studs and tighten to 1.80 to 2.00 N-m (16 to 18 in.-oz.) torque.

22. Tighten the back mounting 8-32 nuts to 1.80 to 2.00 N-m (16 to 18 in.-oz.) torque.

23. Connect the type-N male connector from the bulkhead cable to the antenna connector of the duplexer.

### Installing the Repeater Controller

24. Place the repeater controller bracket on a flat surface with the open end up.

**NOTE**
If you are using the Basic Repeater Controller, before continuing:
- Remove it from its mounting tray and replace it, upside-down, in the tray for proper viewing when the GR500 repeater is mounted.
- Slide the tray up through the open area of the bracket and into position.

25. Place the repeater controller module, upside-down, in the lower mounting position (nearest the power supply).

26. Attach the repeater controller to the bracket with two M5 x 0.8 x 8 T25 Torx, pan head, machine screws, and torque to 1.58 N-m (14 in.-lbs.).

### Installing the Mounting Bracket for the Repeater Controller

27. Place the assembled repeater controller bracket into the GR500 repeater housing. Tilt the module slightly upward at the front end and slide the rear notched mounting tabs of the repeater controller bracket under the 8-32 screws toward the back of the GR500 repeater housing.

28. Press the module toward the back of the housing.

**NOTE**
Do not yet tighten the back mounting screws to attach the repeater controller to the GR500 repeater housing.

29. Using the two 8-32 screws removed in Step 3D under "Disassembling the GR500 Repeater Housing." secure the repeater controller bracket to the front of the power supply.

30. Tighten all four 8-32 screws to 1.58 to 1.80 N-m (14 to 16 in.-lbs.) torque.

31. Connect the repeater cable from the transmit radio to the transmit connector of the repeater controller.

32. Connect the repeater cable from the receive radio to the receive connector of the repeater controller.

33. Install the shorting plugs in the microphone jacks of both radios (or plug a microphone into the jack of the transmit radio, if desired).

# Tuning the Duplexer

Before using your repeater, you must tune the duplexer, using one of the following three methods for ensuring that the duplexer is tuned to the correct frequencies of operation:

- **Pre-Tuned Method (preferred method)**
  Order the duplexer from the manufacturer or supplier pre-tuned to the desired frequencies. This is not a "method" of tuning the duplexer but does not require any test equipment.
- **Visual Method**
  Use a tracking (sweep) generator and spectrum analyzer to adjust the tuning of the passbands and reject bands of the duplexer.
- **"In a Pinch" Method**
  The following paragraphs address a simple method of tuning a "notch" (reject) duplexer such as the TDN7407 UHF duplexer. This is not as accurate a method of tuning as the visual method afforded by the tracking generator/spectrum analyzer sweep setup but it is much less costly. It may be sufficiently good for all but the most exacting applications.
  Use this method only when the operating frequencies of the receive radio and the transmit radio satisfy the requirements of the duplexer. For example, the TDN7407 is designed for a transmitter/receiver frequency spacing of 5 MHz. If the operating frequencies for the GR500 are appreciably different than that 5 MHz specification, degraded performance of the repeater will result.

The following procedure assumes that the GR500 is fully assembled and the radios and duplexer are mounted in the GR500 housing. The radios should be connected to the proper ports of the duplexer with the RF coaxial cables provided in the GR500 kit. The duplexer front panel cover plate should be removed to gain access to the tuning screws of the duplexer.

## *Programming the Radios*

1. Program the receive radio with an additional "receive only" mode at the frequency of the transmit radio.
2. Program the transmit radio with an additional "receive only" mode at the frequency of the receive radio.

**NOTE**
Instead of programming additional modes, you can connect the coaxial cables from the radios to the "opposite" ports of the duplexer.

3. Connect a Communications System Analyzer (CSA), such as the Motorola R2000 series, or an RF signal generator to the antenna port of the duplexer. The CSA should be operating in the "Generate" mode. Modulate the RF source with a 1 kHz tone at 60% system deviation to facilitate "hearing" the signal during the tune-up procedure.

## *Tuning the Receive Radio Section*

**NOTE**
Tuning the receive radio section of the duplexer begins with the tuning screw closest to the antenna port of the duplexer.

4. Adjust the frequency of the CSA or generator to that of the transmit radio.
5. Place the receive radio on the transmit radio frequency mode defined in Step 1 under "Programming the Radios."
6. Adjust the level of the CSA or generator until a weak signal is heard from the receive radio.
7. Increase the level of the CSA or the generator by approximately 20 dB.
8. Adjust the tuning screw of the duplexer for the greatest rejection of the signal. This will appear as a noisier signal. **If necessary:**

8A. Slightly loosen the locking nuts of the tuning screws to allow the tuning screws to turn more freely (but not "sloppy") **and**

8B. Increase the level of the CSA or the generator to maintain an audible 1 kHz tone.

9. Repeat Steps 7 thru 8B for each of the tuning screws on the duplexer. Begin with the tuning screw closest to the antenna port and work in order toward the tuning screw closest to the receive radio port.
10. Tighten the locking nuts of the tuning screws.

**CAUTION**
To avoid damage to the tuning screws and to allow fine tuning of the duplexer, do not overtighten the locking nuts.

11. Readjust the tuning screws of the duplexer for the greatest rejection of the signal. This will fine-tune the receive radio section of the duplexer.

### *Tuning the Transmit Radio Section*

**NOTE**
Tuning the transmit radio section of the duplexer begins with the tuning screw closest to the antenna port of the duplexer.

12. Adjust the frequency of the CSA or generator to that of the receive radio.

13. Place the transmit radio on the receive radio frequency mode defined in Step 2 under "Programming the Radios."

14. Adjust the level of the CSA or generator until a weak signal is heard from the transmit radio.

15. Increase the level of the CSA or the generator by approximately 20 dB.

16. Adjust the tuning screw of the duplexer for the greatest rejection of the signal. This will appear as a noisier signal. **If necessary:**

16A. Slightly loosen the locking nuts of the tuning screws to allow the tuning screws to turn more freely (but not "sloppy") **and**

16B. Increase the level of the CSA or the generator to maintain an audible 1 kHz tone.

17. Repeat Steps 15 thru 16B for each of the tuning screws on the duplexer. Begin with the tuning screw closest to the antenna port and move in order toward the tuning screw closest to the transmit radio port.

18. Tighten the locking nuts of the tuning screws.

**CAUTION**
To avoid damage to the tuning screws and to allow fine tuning of the duplexer, do not overtighten the locking nuts.

19. Readjust the tuning screws of the duplexer for the greatest rejection of the signal. This will fine-tune the transmit radio section of the duplexer.

**CAUTION**
If you connected the coaxial cables from the radios to the 'opposite' ports of the duplexer, do not forget to reconnect them to the 'proper' ports before placing the repeater into operation.

## Mounting the GR500

To mount the GR500 repeater to a wall or other mounting surface, we recommend using the accessory mounting plate (HLN9169). If you use the accessory mounting plate to mount the GR500 repeater, follow the directions included with it. If you do not use the mounting plate, refer to Figure 3-5 (not to scale) for the locations of the wall mounting holes for the GR500 repeater.

**CAUTION**
The GR500 repeater weighs approximately 50 pounds (22.7 kg) when assembled. Lifting improperly can cause injury.
Get help from a second person and use care when lifting the GR500 repeater.

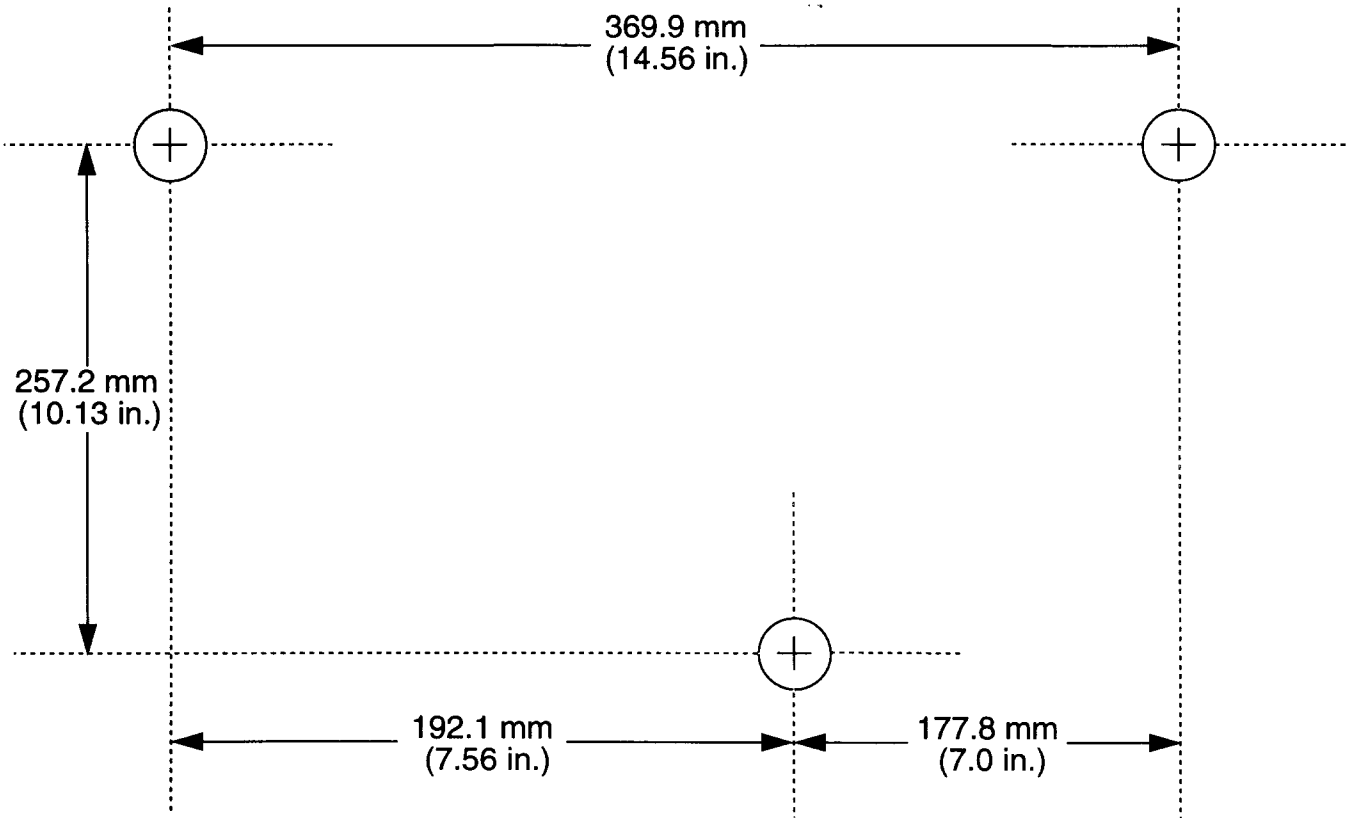
**CAUTION**
The GR500 repeater weighs approximately 50 pounds (22.7 kg) when fully assembled, and can fall if not properly mounted.
Use proper hardware and mount the GR500 repeater only to a structurally sound wall or mounting surface.

**CAUTION**
If the GR500 repeater is mounted in an area of high vibration, incorrect mounting hardware can loosen.
To prevent loosening of the mounting hardware, use high strength fasteners and lockwashers to mount the GR500 repeater.

**CAUTION**
A dirty or plugged fan grill (on the bottom of the mounted unit) can cause overheating or improper operation.
Clean dust and debris periodically from the grill, and allow sufficient air flow to the fan.

**IMPORTANT**
The GR500 repeater is designed for indoor use.
Install in a location that is protected from the weather and outdoor environment.

**IMPORTANT**
To operate the GR500 repeater, the antenna feed line, ac line cord, ground cable, (optional) phone lines, and (optional) battery cables must be connected to the bottom of the unit.
When mounting the GR500 repeater, plan for cable access to the bottom of the unit.




**NOTE:**

This drawing is **not** actual size and **not** to scale. You must make your own template from the measurements indicated.

*Figure 3-5. Locations of Wall Mounting Holes for GR500 (without Mounting Plate)*

## Final Assembly

To operate the GR500 repeater, you must connect all of the necessary cables and accessories to the bottom of the GR500 repeater (refer to Figure 3-4):

1. Attach a ground wire from an absolute earth ground to the 1/4" threaded grounding stud on the far right of the GR500, using one of the lockwashers and nuts provided in Bag 2. Tighten to 2.25 to 3.38 N-m (20 to 30 in.-lbs.) torque.
2. Connect lightning arrestors.

**CAUTION**

Lightning can damage the GR500 repeater and its components if the unit is not grounded properly.
For lightning protection, ground the GR500 repeater to an absolute earth ground using at least #6 gauge copper wire, and use adequate lightning arrestors.

3. Connect the antenna lead to the antenna connector on the far left of the GR500 repeater.
4. If necessary, feed phone line(s) through the vane grommet on the right side of the GR500 repeater and connect to the repeater controller(s).
5. If you are using a repeater controller with a grounding wire, use the remaining lockwasher and nut provided in Bag 2 to connect the wire to the 1/4" threaded grounding stud on the **inside** of the GR500 repeater housing. If no grounding wires are present, place the lockwasher and nut on the threaded stud. Tighten to 2.25 to 3.38 N-m (20 to 30 in.-lbs.) torque.
6. Connect the ac line cord to the GR500 repeater, attach the retaining clip and plug the other end of the cord into the AC main outlet.

**CAUTION**

A retaining clip for the AC power cord is provided with your GR500 repeater to keep the power cord plug in the connector.
To prevent accidental disconnection of the power cord, plug it into the GR500 repeater and attach the retaining clip to the GR500 repeater housing with the center top mounting screw of the power supply before connecting the cord to an AC power source (refer to Figure 3-6).

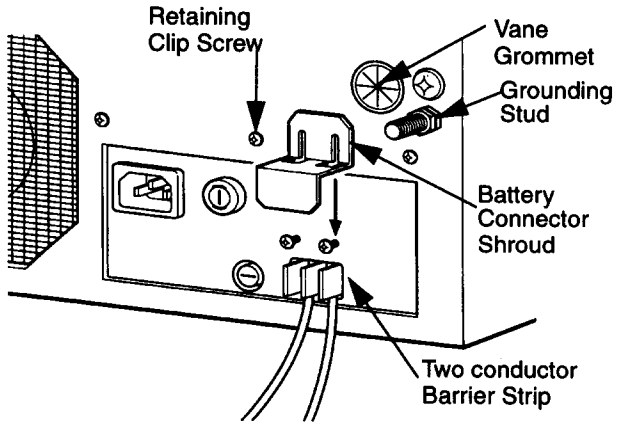



*Figure 3-6. Placement of Battery Connector Shroud*

7. If you are using a battery backup, check the float maintenance charger output voltage:

7A. Connect a digital multimeter to the two-conductor barrier strip.

7B. Adjust the "BAT CHG ADJ" potentiometer, accessible through the round hole in the housing near the barrier strip, for 13.6 Vdc ±0.1 Vdc. This is the recommended value for a sealed, lead acid, gel cell battery. Other batteries may require a different float voltage. Consult the manufacturer's recommendation for other battery types.

**NOTE**
The battery revert is adjustable between 12 and 15 Vdc.

7C. Disconnect the digital multimeter from the battery cable.

**CAUTION**
If the wires leading to the battery are exposed, they can cause shorts or severe damage.
To prevent damage, use a properly fused battery cable.

7D. Attach the positive [+] wire from the battery to the positive [+] pole on the two-conductor barrier strip.

**CAUTION**
If you connect the negative [-] battery wire before connecting the positive [+] wire, shorts or severe damage can occur if the positive wire comes into contact with the GR500 repeater housing or any uninsulated metal connected to the GR500 repeater.
To prevent damage, connect the positive [+] wire **before** connecting the negative [-] wire.

7E. Attach the negative [-] wire from the battery to the negative [-] pole on the two-conductor barrier strip.

8. Install the battery connector shroud, even if you do not connect a backup battery.

**CAUTION**
Contacts on the battery connector are live at all times while the GR500 repeater is attached to an ac power source.
Keep the connector shroud installed at all times.

# Section 4
# Basic Repeater Controller

## Overview

This section describes the system configurations, basic operation, theory of operation, jumper configurations, and adjustments for the Basic Repeater Controller used in a GR Series Repeater Station.

## System Configurations

The Basic Repeater Controller (identical to the R*I*C*K) connects between two Radius mobile radios to construct an intermittent duty radio repeater.

Possible configurations for a GR Series repeater with the Basic Repeater Controller are:

- Single Band RT (unidirectional) Repeater
- Crossband RT (unidirectional) Repeater
- Single Band, Bi-directional Repeater
- Crossband, Bi-directional Repeater

## Basic Operation

Some of the possible uses for a GR Series repeater with the Basic Repeater Controller include:

- Mobile Repeater
- Mobile "Pac-RT Like" Repeater
- "Suitcase" Repeater
- Portable Site Repeater
- "Mountain Top" (Lookout) Repeater
- Fixed (Rural) Site Repeater
- Fixed (Base) Repeater
- Short Term, Substitute RT Repeater
- Link (RA) Repeater

## Theory of Operation

### *Setup/Knockdown (U1A, Q1, Q2, Q3, Q4, Q11 and Q12):*

U1A is one half of an IC dual type-D flip flop, an MC14013B. U1A is configured as a data latch. The CLEAR input, pin 4, is wired low. At power-up, the PRESET input of U1A, pin 6, is momentarily taken high via C2 and R9 and causes the "Q" output, pin 1, to go high and the "not-Q" output, pin 2, to go low. The "Q" output is connected to pin 1 of J6 and the "not-Q" output is connected to pin 3 of J6. If JU1 is across pins 1 and 2 of J6, then the repeater will be in the "Set-up" condition at power-up. If JU1 is across pins 2 and 3 of J6, then the repeater will be in the "Knockdown" condition at power-up.

The electronic switch, Q2/Q3, causes the Set-up/Knockdown action by applying or removing voltage at the ignition control, pin 10, of **J3-TX**. After power-up, the Setup or Knockdown state may be changed remotely with a signal from pin 4 of **J5-RX** or locally with front panel switch S3. S3 is a momentary contact switch that is debounced by the Q11/ Q12 latch circuit. The yellow **SET-UP** LED, CR3, illuminates to indicate the Set-up state.

As the Setup/Knockdown circuit goes from the Knockdown to the Set-up state, Q1 is momentarily turned on by Q3 via the C1/R2 timing circuit. The push to talk (PTT) input of the receive radio, pin 3 of **J5-RX** is pulled low by Q1 and keys the transmitter. The **COR** LED, CR2, will briefly flash during the moment that Q1 is conducting.

The external alarm input of the receive radio, pin 4 of **J5- RX**, is held low by Q4 during the Set-up state. As the Setup/Knockdown circuit changes from Set-up to Knockdown, Q4 turns off. The transmitter of the receive radio will key and send an Emergency Alarm if that feature has been enabled.

### *VOX (Q9)*

Any audio signal present at pin 1 of **J1-RX** or pin 11 of **J5-RX** causes Q9 to conduct. This in turn will activate the drop-out delay and push to talk circuitry.

### *COR Buffer (Q15)*

Q15 is a dc amplifier (buffer) for the COR signal from pin 8, through S2-3, or from pin 14, through S2-2, of **J5-RX**. The output of Q15 is switched from a low state during inactivity of the repeater to a high state with an active low state for the COR signal.

### *Audio Gate (Q6 and Q8):*

The audio gate, Q8, enables and disables the audio from the receive radio. The audio input to Q8 is from pin 1 of **J1-RX** or pin 11 of **J5-RX**. The output of Q8 is applied to pin 11 of **J4-ACC** and potentiometer, R23. The output of R23 is applied to S2-5 and S2-6. S2-5 will route the audio to the flat transmitter audio, pin 5 of **J3-**

TX and **J4-ACC**. S2-6 will route the audio to the microphone transmitter audio, pin 3 of **J2-TX** and pins 2 of **J3-TX** and **J4-ACC**.

R23 is used to adjust the receive radio audio output to the proper level for the transmit radio audio input. The audio gate is enabled with an active dc level low at either pin 8 or pin 14 of **J5-RX**. The gate can also be hard enabled if S2-7 is closed.

## *Dropout Delay and PTT (Q5, Q10, U1B and Q7):*

The dropout delay circuit uses the second half of U1, the MC14013B dual D flip flop, to generate a PTT signal for the transmit radio. The Q output, pin 13, of U1B is low if the repeater is inactive. When an input signal is present at the receive radio, either pin 8 or pin 14 of **J5-RX** will be pulled low and turn off Q15. Q5 will turn on and discharge C3. Q10 will turn on when the voltage across C3 is less than 4.5 Vdc. The output from Q10 pulls the PRESET input of U1B high. The Q output of U1B switches to a high state and turns on Q7. Pin 4 of **J2-TX** and pin 3 of **J3-TX** are pulled low and key the transmit radio PTT. The red **COR** LED, CR2, illuminates.

The dropout delay is generated when Q5 ceases to conduct. Q10 will remain on until the voltage across C3 reaches 4.5 Vdc or greater. S2-10 and S2-11 are used to switch in the appropriate resistance to generate the desired time constant.

S1 on the front panel is used to enable the repeater function and will not allow Q7 to conduct unless it is in the enable (in) position. S1 also interrupts the COR signal from pin 8 or pin 14 of **J5-RX** and the output of the VOX circuit to disable the repeater.

## *Reverse Key-up*

Whenever pin 8 of **J3-TX** goes low, it will pull pin 3 of **J5-RX** low. When the reverse key-up function is being used, as in the bi-directional repeater configuration, S2-3 must be open and no functions can be programmed which will use pin 8 of **J5-RX**. A NULL with active LOW state on pin 8 will prevent any unwanted reverse key-up.

## *Reverse Audio Path*

Audio present on pin 11 of **J3-TX** is routed to either pin 2 or pin 5 of **J5-RX**. S2-8 and S2-9 determine to which pin the audio is routed. As with the forward direction, a potentiometer, R24, is used to adjust the audio level.

## *Accessory Jack (J4-ACC)*

The accessory jack, **J4-ACC**, is connected to **J3-TX** and **J5-RX** such that all of the Radius standard accessories will still be compatible. Furthermore, the standard connections are retained (no new cables need to be made). The only input which causes the Basic Repeater Controller to respond is pin 3 of **J4-ACC** (PTT). A low on the pin will cause a low on pin 3 of **J3-TX** and keying of the transmit radio.

## *DIP Switch (S2) Functions*

DIP Switch positions for the Basic Repeater Controller (* = typical setup):

### S2-1

S2-1 routes the PL/DPL & CSQ I/O signal (active low) from J3 pin 8 of the transmit radio to J3 pin 3 (the PTT) of the receive radio in the bidirectional repeater configurations. For unidirectional repeaters, S2-1 should be OFF.

S2-1 should be set:

- **OFF*** for unidirectional repeaters
- **ON** for bidirectional repeaters.

### S2-2 and S2-3

S2-2 selects pin 14 of J5-RX as the COR input from the receive radio; S2-3 selects pin 8 of J5-RX for the same function. Either S2-2 or S2-3 should be ON with the other switch in the OFF position. However, no harm to the Basic Repeater Controller or the receive radio occurs if both of the switches are accidentally ON. In the bidirectional repeater configuration, continuous keying of the transmitter of the receive radio occurs if S2-3 is ON, therefore S2-2 (pin 14 I/O) must be used.

S2-2 should be set:

- **OFF*** for pin 8 I/O (CSQ or TPL/DPL)
- **ON** for pin 14 I/O (CSQ or TPL/DPL).

S2-3 should be set:

- **OFF** for pin 14 I/O (CSQ or TPL/DPL)
- **ON*** for pin 8 I/O (CSQ or TPL/DPL).

### S2-4

S2-4 enables the remote Setup/Knockdown feature which requires the MDC-1200 RapidCall signalling format with a GM300 16-channel radio for the receive radio. The Basic Repeater Controller supplies operating voltage to J3 pin 10 (the ignition control input) of the transmit radio.

S2-4 should be set:

- **OFF*** for local only repeater Setup/Knockdown
- **ON** to enable remote Setup/Knockdown (MDC-1200).

### S2-5 and S2-6

S2-5 and S2-6 are used to select the routing of the audio from the receiver of the receive radio to the proper audio

input of the transmit radio. If a normal EIA de-emphasized audio response is selected from the receive radio, pre-emphasized audio is required in the transmit radio and S2-6 should be ON (S2-5 should be OFF). If a flat audio response is selected from the receive radio, a flat audio response is required in the transmit radio and S2-5 should be ON (S2-6 should be OFF).

S2-5 should be set:

- **OFF*** for EIA de-emphasized /pre-emphasized audio
- **ON** for flat audio.

S2-6 should be set:

- **OFF** for flat audio
- **ON*** for EIA de-emphasized/pre-emphasized audio.

### S2-7

S2-7 enables the audio path through the audio gate (Q8). S2-7 is ON when VOX is used (EIA de-emphasized/muted audio must be provided by the receive radio).

S2-7 should be set:

- **OFF*** for COR applications
- **ON** for VOX operation.

### S2-8 and S2-9

S2-8 and S2-9 duplicate the functions of S2-6 and S2-5 for the audio input to the transmitter of the receive radio in a bidirectional repeater (note the reverse order for the corresponding functions). The typical bidirectional repeater uses de-emphasized receiver audio from the transmit radio and S2-8 should be ON (S2-9 should be OFF).

S2-8 should be set:

- **OFF** for flat audio
- **ON*** for EIA de-emphasized/pre-emphasized audio.

S2-9 should be set:

- **OFF*** for EIA de-emphasized/pre-emphasized audio
- **ON** for flat audio.

### S2-10 and S2-11

S2-10 and S211 select the desired drop-out delay (hang time). With both switches OFF, the transmit radio unkeys approximately 3 seconds after the receive radio loses the COR indication (J3 pin 8 or pin 14 goes high). The dropout delay is decreased to approximately 1.5 seconds if S2-10 is ON. The shortest dropout delay, essentially "zero" seconds, is enabled by placing S2-11 in the ON position. For a bidirectional repeater, the "0" seconds dropout delay (S2-11 ON and S2-10 OFF or ON) should be used.

S2-10 should be set:

- **OFF*** for 3-second dropout delay
- **ON** for 1.5-second dropout delay

S2-11 should be set:

- **OFF*** for 1.5/3-second dropout delay
- **ON** for 0-second dropout delay.

### S2-12

S2-12 allows the output of the VOX circuit to key the transmit radio. Note that the "zero" dropout delay should not be used with the VOX keying. A delay of 1.5 or 3 seconds should be used to "smooth" the output of the VOX. The audio gate must be enabled by placing S2-7 in the ON position. The VOX circuit operates only in a unidirectional mode (i.e. from the handset audio of the receive radio). The VOX also responds to the noise burst, or "squelch tail," at the end of a transmission and the dropout delay increases by that amount. Use of coded squelch (TPL or DPL) is recommended.

S2012 should be set:

- **OFF*** for VOX disable
- **ON** for VOX enable.

## Jumper Configurations

Table 4-1 lists the jumper settings for GM300 16-channel transmit and receive radios when used with a GR Series repeater and the Basic Repeater Controller. Table 4-2 lists the jumper settings for the GM300 8-channel, M120, and M10 transmit and receive radios when used with a GR Series repeater and the Basic Repeater Controller. Table 4-3 lists the jumper settings for JU1 on the Basic Repeater Controller.

## Adjustments

The following steps should be performed with a service monitor, such as the Motorola R2000 series, connected to the antenna jack of the duplexer (or the transmit radio, if applicable). The service monitor must be operating in the duplex mode. Set the service monitor to monitor the frequency of the transmit radio while generating the duplex signal at the frequency of the receive radio. Refer to the operating instructions of your service monitor.

*Table 4-1. Radio Jumper Settings (GM300 16-Channel Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | X* |
| JU701 | X* | A |

* either A or B

*Table 4-2. Radio Jumper Settings (GM300 8-Channel, M120, and M10 Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | X* |
| JU809 | X* | Remove |

*X = Either position A or B.
**Note:** When using the Basic Repeater Controller, if you encounter cyclical keying of the transmit radio, cut the wire running from the controller to pin 8 of the 16 conductor cable to the transmit radio.

*Table 4-3. Basic Repeater Controller Jumper Setting*

| Jumper | Default | Notes |
|---|---|---|
| JU1 | Setup | Setup = Both radios turn on at power-up (repeater functional).<br>Knockdown = Only receive radio turns on at power up. |

1. Remove the Basic Repeater Controller in its tray from the GR Series repeater then remove the Basic Repeater Controller board from the housing by unscrewing the two long T15 machine screws at the rear of the housing. It will be necessary to unplug the the cables from the board.
2. Reattach the cables to the Basic Repeater Controller board after the board is out of the housing.
3. Before energizing the the power supply or the radios, ensure that the **REPEATER ENABLE** switch of the Basic Repeater Controller is in the released (out) position. Failure to "disable" the repeater will result in keying of the transmit radio.
4. Connect the line cord from the GR Series repeater to a suitable 50/60 Hz ac source.
5. If the repeater is a GR300 or GR400, turn on the power switch on the front panel of the power supply.
6. Turn on the two radios by rotating the volume controls clockwise.
7. If the yellow LED is not illuminated, press the **SET-UP** momentary pushbutton switch.
8. Press the **REPEATER ENABLE** switch to the engaged (in) position; the green LED should illuminate.
9. Modulate the duplex generator of the service monitor with a 1 kHz tone at 60 percent of full rated system deviation.
10. Adjust potentiometer R23 in the Basic Repeater Controller for 60 percent of full rated system deviation of the transmit radio. If you cannot achieve at least 50 percent full rated system deviation with R23 at the maximum setting, change JU651 in the transmit radio to the "B" position and readjust R23.
11. For a bi-directional repeater, apply a signal at the frequency of the receiver of the transmit radio. Modulate the duplex generator of the service monitor with a 1 kHz tone at 60 percent of full rated system deviation.
12. Set the service monitor to monitor the frequency of the transmitter of the receive radio.
13. Adjust potentiometer R24 in the Basic Repeater Controller for 60 percent of full rated system deviation of the receive radio. If you cannot achieve at least 50 percent full rated system deviation with R24 at the maximum setting, change JU651 in the receive radio to the "B" position and readjust R24.
14. Check the settings of the 12 positions of dipswitch S2 for correctness.
15. Unplug the cables attached to the Basic Repeater Controller board.
16. Place the Basic Repeater Controller board into the housing. Attach the front panel with the two long T15 machine screws that were removed in Step 1.
17. Attach the cables to the Basic Repeater Controller.
18. Follow the procedures in this manual to remount the Basic Repeater Controller in its tray in the GR Series repeater housing.

# Section 5
# i50R Basic Interconnect Repeater Controller

## Overview

This section describes the basic operation, system configurations, theory of operation, jumper configurations, and adjustments for the i50R Basic Interconnect Repeater Controller.

## Basic Operation

The i50R allows telephone service to be extended to mobiles and portables.

### *Controls and Indicators*

The front panel of the i50R phone patch contains switches to manually control the operations of the module and LED indicators to display the status of the various functions.

#### Rptr Enable Pushbutton

The **Rptr Enable** button is a latching type switch that enables the various repeater functions within the module when it is in the "in" position and disables those functions when in the "out" position. The **Rptr En** LED reflects the position of the switch at a glance.

In order for the repeater to function, the manual **Rptr Enable** switch must be in the "in" position (enabled as indicated by the LED) and the repeater must be "set up" (either manually by the front panel switch or remotely by signalling to the receive radio). The **COR** LED illuminates when the receive radio is receiving a "system mobile" (with appropriate coding, if applicable). This will cause the repeater to activate, if enabled and setup.

#### Rptr Set-Up Pushbutton Switch

The **Rptr Set-Up** momentary switch is the manual control that alternately sets up or knocks down the repeater. Depending on the SWB-5 and SWB-8 programming switch positions, the repeater will power up in the setup or the knockdown mode and may be controlled remotely. The **Set-Up** LED indicates when the repeater is set up.

#### "PTT" LED

The **PTT** LED will be on any time a PTT signal is being sent to the radio from repeat PTT, patch PTT, or PTT from the accessory input.

#### Patch On/Off Pushbutton Switch

The **Patch On/Off** momentary switch will manually cause an access of a released patch and cause a release of an accessed patch. The **Access** LED indicates when the telephone line has been accessed by the manual pushbutton or by a mobile command.

### *Additional Controls*

When the front panel cover plate is removed, the two banks of programming switches and the repeater level adjustment potentiometer are accessible. The adjustment should be made only by a qualified technician familiar with the detailed operation of the unit since satisfactory system operation depends on the settings.

## Theory of Operation

### *i50R Interface/Patch Interface Circuitry*

The interface circuitry portion of the i50R is straightforward and does not require a detailed examination of the theory of operation.

### *i50R Phone Patch and Microprocessor Circuitry*

#### Digitally Controlled Audio Gain

The digitally controlled audio gain stage consists of IC's U15, U14, U12A, U12C, U29A and U29B. The microprocessor can select the gain stage input by control lines PC0 and PC1 controlling U15, an integrated double pole, four-throw analog switch. When one input to the gain stage is selected, a source for the DTMF decoder is also selected (pins 1, 5, 2, and 4 of U15). The inputs to the gain stage are:

- Switched network on 0X
- Repeater receiver on 1X
- DTMF encoder and/or microprocessor "beep" tone on 2X and 3X

The microprocessor can control the overall gain of the functional block by changing digital lines P10-P17 to the analog multiplier IC U14, allowing a 1 to 255 gain change (gain numbers are limited by firmware to 10-250). The current output of U14 is converted to a voltage by U29A and amplified by U29B. The output of the gain stage is routed to the phone line through analog

switch U12C and/or to the transmit radio through analog switch U12A.

### Peak Reading Voltmeter Circuit

The voltmeter circuit consists of gain switch U12B, U10, U13, and U17. The voltmeter input is always from the variable gain stage. Two levels of gain are controlled by digital line PA5. High gain is used to indicate when a signal is present (VOX) and low gain to measure its present level. The output of the gain stage U10A is fed to the precision rectifier circuit U10D and U10C. The peak of this rectified signal is compared with the voltage generated by counter U17 and the 1R-2R resistance ladder in comparator U10B. If the rectified signal peaks are higher than the voltage from the ladder, oscillator U13C is gated on to increment counter U17, raising the ladder voltage until it is greater than the rectified input or the maximum counter count of 15 is reached. The microprocessor periodically resets the counter and reads its output to determine proper gain numbers for the various path configurations.

### DTMF Encoder/Decoder

The DTMF encode/decode circuitry consists of U16, U9A, and U5A. The microprocessor clock is buffered by U5A and supplied to U16, the DTMF encoder/decoder. The decoder receives its input from switch U15 as described above. When the decoder sees a valid DTMF tone pair, it asserts DV (pin 22). This line is sampled every 5 milliseconds by the microprocessor. When a data valid is seen, the microprocessor takes data enable (DE, pin 5) low causing U16 to output the decoded number on digital lines PB0-PB3. The outputs are then turned off. When a DTMF tone is to be generated, the microprocessor places the digital number on PB0-PB3 and then takes data latch low (LCH pin 17), then back high. To turn the tone off, the microprocessor takes reset (pin 16) high. The generated DTMF tone is buffered by amplifier U9A and sent to the analog switch U15 for routing. When a beep or tick is required, the microprocessor sends a 949 Hz square wave from P22 through C38 to switch U15.

### Phone Line Limiters and Filters

Audio from the phone line is fed through high pass filter U8B to filter out low frequency hum and noise. Audio to the phone line is routed through low pass filter U8A which provides the rolloff characteristics required for FCC registration. Limiters Q6 and Q7 limit the instantaneous voltage that can be applied to the phone line. Surge protectors S1 and S2, in conjunction with chokes L6 and L7, provide a very high degree of surge protection to the phone patch, provided that the frame ground connections are made as described in the installation section.

### Off Hook and Ring Detect Circuitry

In normal telephone systems, one of the telephone lines is grounded at the central office or PBX location and a negative voltage is applied to the other line. The off hook circuitry of U11 detects this voltage and informs the microprocessor via PC5. Large voltage excursions on the phone line are detected by opto-isolator U18 and sent to the microprocessor on digital line PC4. The microprocessor times and counts these pulses to differentiate between dial pulses, ring, etc.

### Microprocessor Bus

Microprocessor U1 puts out multiplexed address and data on AD0-AD7. These signals are demultiplexed by address latch U2 which provides the low order address bits to ROM U3. ROM U3 contains the patch firmware. Peripheral interface adaptor U4 provides 24 input/output lines for operating the various functions in the patch.

### Power Supply

Input voltage is fused, filtered, and sent to 5 V regulator U7 which supplies most of the patch power. Oscillator U5B generates about 100kHz which is buffed by U5C and U5E and fed to VFET's Q1, Q2, and Q3. These FET's provide a push-pull, full B+ swing output. This signal is AC coupled and rectified by high speed diodes D1 and D2. This voltage is filtered and regulated to about -6 V for the various analog devices.

U305 provides regulated 8 V for the repeater logic circuits.

### Power Fail/Restart

When the patch is first powered up, microprocessor reset is held low until B+ reaches about 9 V (D18, R24) which removes the high through D3 to C13. Reset is then allowed to go high after C13 discharges through R23. Once the microprocessor is running, pulses are generated at PA7, keeping C13 discharged through R20 and Q5 and preventing reset. If these pulses are lost due to program malfunction or if power falls below the D18-U5D threshold, reset is again asserted. JU3 is for system emulation use only.

## Internal Diagnostics

The i50R interface/patch has built in test procedures to assist in unusual setup situations and troubleshooting procedures. These tests are invoked through use of the **TEST** and **RESET** buttons on the circuit board. Pressing the **TEST** button once will start test 1 and cause the **MODE** LED to flash once. Pressing it again will start test 2 and cause the **MODE** LED to flash twice and so forth through test 5. Each time a new test is selected, a test timer is set to 15 minutes. If this timer reaches zero, the patch resets itself to idle, ready to process tele-

phone calls. The following paragraphs describe each test and its various indications.

### *Test 1*

Keys the transmit radio, accesses the telephone line, and sends a TouchCode (DTMF) star (*) at a level of about 11 dBm (into a 600 ohm load) to the switched network and about 80 mV (into a 600 ohm load) to the transmit radio. This test can be used to check transmit radio deviation and telephone line access.

While in this test, the **MODE** LED indicates the level of the COR signal from the receive radio source selected by programming switch SWB-4. The LED is on when receiving a system mobile signal. In normal operation, this COR signal is used by the patch to inhibit automatic sending of ring signalling to the field mobiles, to open the patch audio path from the receiver to the phone line, and by the repeater interface to key the repeater.

The **STATUS** LED indicates the level of the patch disable input. The LED is on when the patch is disabled (repeater in knockdown condition) and off when enabled.

### *Test 2*

The transmit radio is keyed and the telephone line is accessed. The patch generates the 12 TouchCode tones at six different levels. These tones are sent to the telephone line and looped back to the DTMF decoder. The **STATUS** LED illuminates on data valid from the DTMF decoder, indicating that it is receiving its own DTMF codes. The tones are on for 100 milliseconds and may be slowed down to 500 milliseconds by pressing the **RESET** button. Pressing the **RESET** button again will freeze the test at the current DTMF tone and level. Pressing the **RESET** button again will allow the test to continue at the fast rate. The highest level is adequate to overdrive the radio transmitter and exceed the maximum input specification on the DTMF decoder. This procedure may be used to test the patch DTMF encoder/decoder and most of the audio paths in the patch.

During this test, the **MODE** LED indicates the "Patch On/Off" button position, illuminating when the button is pushed.

### *Test 3*

The telephone line is accessed and landline signalling is enabled. A system mobile can dial a phone number in DTMF or dial pulse, as programmed. When not landline signalling, receive radio audio is routed to the telephone line with autoleveling. This test allows exercise of the repeater to telephone line path, with autoleveling.

While in this test, the **STATUS** LED is on while receiving a valid DTMF tone pair. The **MODE** LED indicates the level of the COR input, illuminating when a system mobile is being received by the receive radio.

### *Test 4*

The transmit radio is keyed and the telephone line is accessed. Telephone line audio is routed to the transmit radio with autoleveling enabled. This test allows exercise of the telephone line to transmit radio audio path, with autoleveling. The **MODE** LED is on when the audio level on the telephone line is adequate to cause autoleveling. The **STATUS** LED is on when a valid DTMF tone is being sent to the telephone line.

### *Test 5*

This test exercises the nonaccessed functions of the patch. The **MODE** LED illuminates when off hook (phone line voltage below threshold) and extinguishes when on hook (voltage above threshold). The **STATUS** LED flashes on when ringing is received on the telephone line. The **MODE** LED also flashes since ringing will cause the off hook thresholds to be exceeded.

## Jumper Configurations

Table 5-1 lists the jumper settings for GM300 16-channel transmit and receive radios when used with a GR Series repeater and the i50R. Table 5-1 lists the jumper settings for the GM300 8-channel, M120, and M10 transmit and receive radios when used with GR Series repeater and the i50R.

## Adjustments

The following steps should be performed with a service monitor, such as the Motorola R2000 series, connected to the antenna jack of the duplexer (or the transmitter, if applicable). The service monitor must be operating in the duplex mode. Set the service monitor to monitor the frequency of the transmit radio while generating the duplex signal at the frequency of the receive radio. Refer to the operating instructions of your service monitor.

1. Before energizing the the power supply or the radios, ensure that the **Rptr Enable** switch of the i50R is in the released (out) position. Failure to "disable" the repeater will result in keying of the transmit radio.

2. Connect the line cord from the GR Series repeater to a suitable 50/60 Hz ac source.

3. If the repeater is a GR300 or GR400, turn on the power switch on the front panel of the power supply.

*Table 5-1. Radio Jumper Settings (GM300 16-Channel Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | X* |
| JU701 | X* | X* |

* either A or B

*Table 5-2. Radio Jumper Settings (GM300 8-Channel, M120, and M10 Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | X* |
| JU809 | X* | Remove |

* either A or B

4. Turn on the two radios by rotating the volume controls clockwise.

5. Remove the four small Phillips head machine screws that secure the front cover plate to the i50R housing.

6. If the **Set-Up** LED is not illuminated, press the **Rptr Set-Up** momentary pushbutton switch.

7. Press the **Rptr Enable** switch to the engaged (in) position; the **Rptr En** LED should illuminate.

8. Modulate the duplex generator of the service monitor with a 1 kHz tone at 60 percent of full rated system deviation.

9. Adjust the **Rptr Lvl** potentiometer for 60 percent of full rated system deviation of the transmit radio.

10. Check the settings of the dipswitches of SwA and SwB for correctness. (Refer to the GR Series Programming Guide, 6880903Z43).

11. Reattach the front cover plate to the housing of the i50R with the four small Phillips machine screws removed in step 5.

# Section 6
# ZR340 Advanced Interconnect Repeater Controller

## Overview

This section describes the basic operation, system configurations, and theory of operation for the ZR340 Advanced Interconnect Repeater Controller.

## Basic Operation

The Zetron ZR340 is a multi-mode, easy to use telephone interconnect. Simplex VOX, simplex sampling, intelligent sampling, and half duplex modes are supported. Digital voice delay is an available option to enhance simplex operation.

Multi-digit DTMF access codes and toll restrict digits are selectable to eliminate unauthorized use of the phone line. The ZR340 allows mobile DTMF or regenerated pulse dialing. Repeat audio processing and transmitter control are included.

The ZR340 includes factory defaults for all programmable settings so that it will function on any system straight out of the box, or may be customized easily using a Touch-tone telephone or DTMF equipped radio.

### *Phone To Mobile Calls*

When the telephone line rings, the ZR340 will wait the number of programmed rings to answer before ringing out on the channel. This is to allow a parallel phone to be manually answered before the ZR340 begins ringing on the radio channel. If the phone continues to ring, and the channel is not in use, the ZR340 will begin ringing out on the radio channel until the connect code is entered by a mobile. The ZR340 may be installed to ring either once and wait up to 1 minute for an answer, or ring each time the phone rings for up to 1 minute. If a mobile has not answered within this time, the call is terminated. Once a mobile answers, the ZR340 will take the phone off hook and allow the call to progress.

After 10 rings past the number of programmed rings to answer, the phone is answered and the user can enter the program access code to remotely program the ZR340.

Pressing the **Connect** button on the front panel while the ZR340 is on-hook causes it to go off-hook and enter into the conversation mode.

### *Mobile Originated Calls*

To place a call, a mobile user enters the DTMF Access Code (sign-on sequence) and unkeys. Once the Access Code has been started, each additional digit must be transmitted within 1 second of the last without dropping carrier between digits, or the sign-on attempt will be ignored. The ZR340 takes the phone off-hook and sends dial tone (phone audio) to the transmitter. For simplex installations, the transmitter is keyed for 2 seconds, then unkeyed to receive mobile dialing digits. The ZR340 will pass the mobile DTMF to the phone or provide conversion from DTMF to pulse dialing until there is a 5-second gap in the entered digits. The radio timeout and call limit timers are started as soon as the telephone is taken off-hook. During dialing, if the mobile's first digit matches a digit in the first digit toll restricted string, the ZR340 will terminate the call.

The same applies for the second digit toll restrict string.

The user may enter the program access code to gain access to remote programming.

### *Once A Call Is In Progress*

Once a call has been connected, the call may be terminated in one of five ways:

#### Deaccess Code

A mobile may disconnect the call by sending the Deaccess Code. The call is terminated immediately and 5 fast beeps are sent to the mobile indicating that the call is over. Once the Deaccess Code sequence has been started, each additional digit must be transmitted within 1 second of the last without dropping carrier between digits, or the sign-off attempt will be ignored.

#### Busy Disconnect

If a busy tone is detected by the ZR340 during the first 20 seconds of a mobile-originated call, the ZR340 will disconnect and send 3 fast busy tones to the transmitter when it detects a busy signal. The Busy Disconnect feature can be disabled.

#### Mobile Activity

The mobile must transmit at least once during the radio timeout interval. If no transmission occurs during that time, the call is terminated and 5 fast beeps are

sent to the mobile. During the conversation, a single beep is sent to the phone and the mobile every 3 seconds starting 12 seconds before the mobile activity timer expires. This beep serves as a warning to both the telephone user and the mobile user.

### Call Limit

Each call is limited in length. Once the Call Limit timer has expired, the call is terminated and 5 fast beeps are sent to the mobile. Double warning beeps are sent to the telephone and mobile every 3 seconds starting 15 seconds before the call limit timer expires. If programmed to do so, the user may allow the mobile to extend the Call Limit time by pressing the '*' key.

### Connect Button

Pressing the **Connect** Button while the ZR340 is off-hook terminates the call in progress and forces the ZR340 back into the on-hook idle mode.

## *ZR340 Features*

### Access Code

The Access Code may be up to 9 digits in length, and may include any combination of digits 0-9 and '*.' This code is used to gain access to the telephone line.

### Deaccess Code

The mobile Deaccess Code may be to up to 9 digits in length, and may include any combination of digits 0-9 and #. This code is used by a mobile radio to terminate a call in progress.

### Telephone Disconnect Code

The telephone user may terminate a call in progress by dialing the code '#0' from a DTMF telephone.

### Toll Restrict 1

If set for Toll Restrict 1, the ZR340 does not allow a mobile to dial a telephone number whose first digit is in the 1st digit toll restrict table. This table usually contains 0 and 1 so that long distance and operator calls cannot be made. Up to four digits may be restricted as the first dialed digit.

### Toll Restrict 2

This feature operates in the same way as Toll Restrict 1, but acts based on the second digit of a telephone number that a mobile dials.

### Call Limit

The Call Limit is a timer which determines the maximum time that a call may last before being terminated. The Call Limit timer may be reset using a DTMF '*' if programmed to do so. Double warning beeps are sent to the telephone and mobile every 3 seconds, starting 15 seconds before the call is terminated.

### Radio Timeout

The Radio Timeout, or mobile activity time, is the amount of time that may elapse without the ZR340 detecting a mobile transmission before a call is terminated. The timer assures that if a mobile gets out of range (loses control of the interconnect) the conversation will be terminated even though the mobile cannot manually terminate the call. Single warning beeps are sent to the telephone and mobile every 3 seconds, starting twelve seconds before the call is terminated. The Radio Timeout is programmable to 30, 45, or 60 seconds.

### Courtesy Tone

The Courtesy Tone is a short 50 millisecond beep that prompts the phone party to begin speaking. This feature is especially useful since phone callers are not usually aware that they must wait for the mobile to unkey before speaking.

### Carrier Repeat

When enabled, the ZR340 will repeat audio any time the receive radio generates a COR signal. After the receive COR signal ends (the mobile unkeys), the transmitter is held up for the programmable repeater transmit hang time.

### Tx Hang Time

The Tx (transmit) Hang Time is the time that the transmitter will stay keyed after the mobile unkeys during repeat operation. It is programmable to 0, 1, 3, or 5 seconds.

### Privacy Mode

Privacy Mode is intended to discourage casual eavesdropping. During a call with the Privacy Mode disabled, the mobile audio is routed to the transmitter (repeated). With Privacy Mode enabled, a disturbing tone is sent to the transmitter while the mobile speaks. This masks the mobile's half of the conversation to other listening mobiles or scanners.

### Toll Restrict

The Toll Restrict is a code which allows "privileged" users to get around the toll restriction when making calls. This code must be used in place of the Access Code.

### Rings to Answer

The ZR340 may be programmed to ring in two ways: on the channel one time and wait for 1 minute for an answer from a mobile, or continue ringing for up to 1 minute while waiting for an answer. In either case, if

the mobile does not answer within the 1 minute time-out time, the call is terminated.

### Disconnect On Busy

The ZR340 has the ability to automatically disconnect the call when a busy tone is detected. The busy tone detection is only enabled during the first 20 seconds of a mobile-originated telephone call. This feature may be disabled if desired.

> **NOTE**
> Some dial-up services will read back numbers using computer generated voice. These often "sound like" a busy tone to the ZR340.

## *Simplex Operation*

There are five simplex modes:

### Simplex VOX

Simplex VOX is the standard simplex mode that keys the transmitter using phone voice (VOX) detection. When neither party is talking, the ZR340 is watching for either VOX or COR indication. When the ZR340 detects VOX, it will key the transmitter and allow telephone audio to pass to the transmitter. When VOX drops and the VOX hold timer expires, the transmitter is dropped and the ZR340 goes back to waiting. When the ZR340 detects COR, it allows mobile audio to pass to the telephone. When the mobile unkeys and the COR hold timer expires, the ZR340 once again returns to waiting.

The digital voice delay option board may be installed to enhance the Simplex VOX mode (contact Zetron Inc. to order--refer to page iv). Since the ZR340 uses the voice detector to know when to key the transmitter, the first syllable is typically lost while the transmitter (and associated repeater or links) comes up on channel. TPL/DPL decoding will also contribute to the lost syllables. By adding the digital voice delay board, the phone audio is delayed so that the transmitter will have plenty of time to get "on line" before the phone audio is passed to the mobile.

### Simplex VOX with Prekey

Simplex VOX with Prekey mode is identical to the Simplex VOX mode, with one exception: When COR ceases, it is assumed that the telephone user wants to begin talking, so the ZR340 will "prekey" the transmitter. Prekeying the transmitter reduces the chance of lost syllables while the transmitter is coming up to full power. If the phone party does not begin speaking before the VOX hold time expires (typically one second), the transmitter will unkey. The ZR340 then begins watching for either VOX or COR activity.

### Simplex Sampling

When the ZR340 is connected to a radio that switches very quickly between transmit and receive (and is not working through a repeater) the Simplex Sampling mode may be used. Two parameters affect the sampling modes: the sample rate and the sample width times. The Simplex Sampling mode begins with the transmitter keyed up and audio passing from the telco to the mobile. When the sample rate timer expires, the transmitter unkeys and the sample width timer starts. When the sample width timer expires, the ZR340 looks for a COR signal. If COR is not present, the transmitter re-keys and the cycle starts again. If COR is present, telco to mobile audio shuts down and mobile to telco audio opens. Audio is passed from the mobile to the telco until COR drops and the COR hold timer expires; the cycle starts again.

### Simplex Sampling with VOX to Extend Sample Interval

This mode is identical to Simplex Sampling, but the ZR340 looks for VOX indication, as well as for COR detection. When VOX is up, the sample rate is extended to 4 times the normal sampling time. When the ZR340 detects VOX, the telephone user is speaking, and therefore sampling only needs to happen 1/4 as often.

### Intelligent Simplex Mode

When the ZR340 is not working through a repeater (not connected to a control station), the Intelligent Simplex Mode will provide the best possible operation. This mode uses VOX, the sample width timer and the audio delay to provide premium simplex operation. As long as VOX is detected, the transmitter keys and audio passes from the telco to the mobile. When VOX drops for the sample width time (or longer), the ZR340 allows the rest of the audio (still trapped in the delay) to go out the transmitter. Once the audio is out and silence (gap) is detected, the transmitter unkeys. Just before the end of the gap reaches the transmitter, COR is checked. If COR is present, the mobile takes over the call. If COR is not present, the transmitter keys again and the remaining audio in the delay is allowed out the transmitter. Using the delay and timing the gap, the ZR340 is capable of sampling between words without the loss of telephone audio.

> **NOTE**
> This feature is available only when the optional simplex delay has been installed.

## *VOX Hang Time*

VOX Hang Time sets the time that VOX detection must be gone before the telco side of the conversation is assumed to be finished. This time should be set to the minimum required as it slows down the conversation, but a time too short will cause the conversation to flip to the mobile side prematurely. This timer only affects the VOX simplex modes. VOX Hang Time is programmable to 0.5, 0.8, 1.0, 1.3, or 1.5 seconds.

### COR Hang Time

The COR Hang Time can be added to the receive carrier detector in simplex mode to reduce the effects of "picket fencing." When mobiles operate in fringe areas, or through multi-path zones, the carrier can momentarily drop. When it does, the patch assumes that the mobile has unkeyed and keys the transmitter to allow the phone party to begin speaking. The COR Hang Time allows the receive audio to be muted to the phone party, but it won't assume the mobile has unkeyed until the COR Hang Time expires. COR Hang Time is programmable to 0, 100, 300, or 500 msec.

### Sample Rate

The Sample Rate is the rate at which the ZR340 will sample for carrier. This is **not** the amount of time that it looks for carrier, but how often it looks. The sample rate timer is used for Simplex Sampling and Simplex Sampling with VOX. The Sample Rate is programmable to 0.5, 1.0, or 1.5 seconds.

**NOTE**
Simplex Intelligent mode does **not** use this timer.

### Auto Sample Setup

This command allows the simplex sample window duration to be set automatically for any radio. Once the command is executed, the ZR340 will key the radio for 2 seconds allowing time to generate a DTMF digit into the receiver using a DTMF equipped radio. The ZR340 will unkey the transmitter and time how long it takes to decode the DTMF. This is saved as the sample width time. Commands are available to increment and decrement the sample window for fine tuning in 10-millisecond increments.

## Theory of Operation

### Microprocessor

To ensure a proper power-up sequence to the microprocessor, U7, the active low reset signal, is held low until the 12 Vdc supply and crystal Y1 have stabilized. The reset signal is also asserted whenever the supply dips below 8 Vdc. Zener diode CR8, R24, and R53 set the threshold, with R54 and C36 setting the delay until reset is allowed to become active.

VR1 provides a regulated 5 Vdc for the digital circuitry and 5 Vdc (labeled +A) for the analog circuitry. U2D provides a regulated 2 Vdc for an analog bias voltage.

The microprocessor, U7, controls operation of the ZR340 by executing the instructions stored in its internal program memory. The microprocessor also contains data memory for temporary data storage. User programmed values are stored in EEPROMs U4 and U5 which retain their values even when power is lost.

The microprocessor generates DTMF and progress tones which are converted to analog signals by RP1 and U2B. This audio may then be routed by the microprocessor to the transmit radio via U10C and to the telephone interface via U11A.

### Radio Interface

Receiver audio can be scaled by R86 to set the proper level at the output of the buffer U12D. This audio may be routed to three destinations under control of the microprocessor. It may be gated to the transmit radio via U10A, to the DTMF decoder via U11B and to the telephone interface via Q7 and Q8. The transmit audio is amplified by U2A and may be scaled by R87 for a GM300 radio. Unscaled audio is available to the accessory connector.

### Telephone Interface

The ring detect circuit triggers when sufficient voltage is sensed across R20. This causes C29 to be discharged, resulting in a ring signal being sent to the microprocessor.

The telephone line is taken off-hook under microprocessor control by K1. The line is coupled to the circuit by T1. Received telephone audio may be routed to two destinations or gated on and off by U11C. One path is to the DTMF decoder via U11B and the other is to the transmit radio via U10B. If the VOX delay card is installed in J2 the audio is delayed when routed to the transmit radio.

The received telephone audio also passes through the VOX detect circuit. The level at which the VOX triggers may be set with R75. The audio is low-pass filtered by U13D and compared to a threshold by U12C. U8A converts the level to 5 V logic to the microprocessor.

The transmitted telephone audio is generated by U2C which sums the receive radio audio with any internally generated tones. The transmitted audio can be muted by the audio limiter circuit consisting of U13A, U13B, and U13C. The limiter compares the audio with a threshold at U13B which causes C53 to charge. When this level exceeds the threshold at U13C the limiter turns on Q9.

### DTMF Decoding

U9 performs the DTMF decoding of either the receive radio audio or the telephone audio depending upon the state of U11B. When a digit is decoded, the value is sent to an input port of the microprocessor.

### Carrier Squelch Detect

JP7, JP8, and JP9 are used to route the proper inputs for COR and PL/DPL depending upon whether 8 or 16 channel radios are used with the ZR340. JP9 is used to direct the COR input from the transmit radio to U1C. JP8 directs the COR input from the receive radio to U1C which sends an active COR signal to the microprocessor if either transmit or receive is active. JP7 routes the PL/DPL input to the microprocessor for 16 channel radios, and routes the receive radio's COR input for 8 channel radios.

# Jumper Configurations

Table 6-1 lists the jumper settings for the transmit and receive radios when used with a Radius repeater and the ZR340 Advanced Interconnect Repeater Controller. Table 6-2 lists the jumper settings for the ZR340.

# ZR340 Adjustments

The following steps should be performed with a service monitor, such as the Motorola R2000 series, connected to the antenna jack of the duplexer (or the transmitter, if applicable). Except for a simplex radio system, the service monitor must be operating in the duplex mode. Set the service monitor to monitor the frequency of the transmit radio while generating the duplex signal at the frequency of the receive radio. Refer to the operating instructions for your service monitor.

1. Connect the line cord from the repeater to a suitable 50/60 Hz ac source.
2. If the repeater is the GR300, turn on the power switch on the front panel of the power supply.
3. Turn on the two radios by rotating the volume controls clockwise. The front panels of the radios and the green **Power** LED of the ZR340 should illuminate.

## *Transmit Audio Level*

1. Use a DTMF equipped radio to place the ZR340 in the programming mode (default programming access code is '12123').
2. Key in the DTMF command '92#' (Tx test). The ZR340 will generate a 1 kHz tone.
3. Adjust the **TX Setup** potentiometer for 70 percent of full rated system deviation (3.5 kHz for a 5 kHz system or 1.75 kHz for a 2.5 kHz system).
4. Press any DTMF digit to end the test.

## *Repeated Audio Level*

1. Complete the "Transmit Audio Level" adjustment, described above, before continuing.
2. Modulate the duplex generator of the service monitor with a 1 kHz tone at 60 percent of full rated system deviation.
3. Key in the DTMF command '93#' (repeated audio test).
4. Adjust the **RX Setup** potentiometer for 60 percent of full rated system deviation of the transmit radio.
5. Press any DTMF digit to end the test.
6. Key in the DTMF command '99#' to exit the programming mode.

*Table 6-1. Radio Jumper Settings (GM300 16-Channel Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | A |
| JU701 | X* | A |

* either A or B

*Table 6-2. ZR340 Jumper Settings*

| Jumper | Default | Notes |
|---|---|---|
| JP1 | Open | Closed for simplex operation. |
| JP2 | Open | Closed for simplex operation. |
| JP3 | Open | Closed for simplex operation. |
| JP4 | Open | Closed to activate emergency switch. |
| JP5 | Closed | Open to use external speaker for transmit radio (cut trace). |
| JP6 | Closed | Open to use external speaker for receive radio (cut trace). |
| JP7 | B | A = M10, M120, M130 or an 8-channel GM300 receive radio.<br>B = 16-channel GM300 receive radio. |
| JP8 | B | A = M10, M120, M130 or an 8-channel GM300 receive radio.<br>B = 16-channel GM300 receive radio. |
| JP9 | B | A = M10, M120, M130 or an 8-channel GM300 transmit radio.<br>B = 16-channel GM300 transmit radio. |
| JP10 | Closed | Open when VOX delay card installed (cut trace). |

## *Received Audio Level—Simplex Operation*

The received audio level is properly set for a repeater with the two previously described adjustments. For a simplex (one radio) system, the received audio level is adjusted differently.

1. Remove the ZR340 from the GR Series repeater housing (follow the appropriate procedures outlined in this manual).
2. Remove the four 4-40 Phillips head machine screws that secure the top cover to the chassis of the ZR340.
3. Remove the top cover of the ZR340.
4. Connect an ac voltmeter or ocilloscope to pin 14 of U12D.
5. Place the service monitor in the Generate mode.
6. Apply an on channel signal at the frequency of the receiver of the radio.
7. Modulate the signal with a 1 kHz tone at 60 percent of full rated system deviation.
8. Adjust the **RX Setup** potentiometer for 353 mV rms on the ac voltmeter (or 1 V peak-to-peak on the oscilloscope).
9. Disconnect the ac voltmeter or oscilloscope.
10. Replace the top cover of the ZR340 and secure with the four 4-40 Phillips head machine screws that were removed in step 2.
11. Follow the procedures in this manual to remount the ZR340 in the GR Series repeater housing.

# Section 7
# ZR320 Selective Calling Interconnect Controller

## Overview

This section describes the basic operation, system configurations, theory of operation, and jumper configurations for the ZR320 Selective Calling Interconnect.

The ZR320 Selective Calling Interconnect is a plug-in module designed for a GR Series Repeater Station. It is the interface between a telephone line and the radio system. allows mobiles, handhelds, and rural radio telephones to place and receive calls. In phone-to-mobile selective calling, the ZR320 accepts DTMF or rotary dial click overdial for phone-originated calls.

## Physical Description

The ZR320 is housed in self-contained modules, each designed to fit on the top shelf of a GR Series Repeater Station.

Located on the front panel are:

- Setup adjustments
- LED indicators to display the status of the various functions
- **A Programming** jack used for programming with an IBM PC via an RIB programming interface

Interconnection to the transmit and receive radios is made via the 16-pin **Transmit** and **Receive** connectors located on the rear surface of the modules. The **Phone Line** (ZR320) jack used to interconnect a telephone line to the module is also located on the rear surface of the unit.

Components and integrated circuits are mounted on two circuit boards inside the ZR320 unit.

## Standard Features

The following is a list of ZR320 Selective Calling Interconnect features.

- Multi-mode patch: simplex, half- and full-duplex
- Quick Call II selective calling to mobiles, tone+voice, and tone only pagers
- Enable/disable validation for 100 users
- One to eight digit DTMF mobile access
- One to eight digit supervisor override code
- Mobile to phone, mobile to mobile and phone to mobile modes
- Direct channel access mode
- DTMF and rotary pulse dialing
- DTMF and dial click decode for selective calling
- Remote programming via DTMF phone or radio
- First or second digit toll restricts
- Half-privacy mode
- Repeat audio processing for duplex
- Repeater transmit hold timer
- Call limit and timeout timers
- Courtesy tones and Morse station ID

## Access/Deaccess to the ZR320

In order to access/deaccess the ZR320, a specific access/deaccess sequence must be followed.

### *Access Sequence*

The access sequence consists of three entries in the following order:

- **access code**–a code to be used by standard users, which can be up to 8 digits long and can consist of the digits 0-9 and the symbol *.
  **OR**
  **toll restrict code**–a bypass code to be used by a supervisor or administrator which overrides any dialing restrictions
- **user number**–a number 00-99, assigned to a specific user.
- **steering digit**–an entry with which defines one of two modes: telephone interconnect (steering digit 9 or *) or selective calling/revertive paging (steering digit 7).

**IMPORTANT**
No more than 1 second must exist between the digits of the access sequence.

The following instructions explain the use of the access sequence:

**Standard Users**

1. Enter the access code.
2. Enter your user number.
3. Enter the steering digit (9 or * for telephone interconnect; 7 for selective calling/revertive paging).

**Supervisor or Administrator**

1. Enter the toll restrict code (if you wish to override dialing restrictions in interconnect mode.
   **OR**
   Enter the access code (for standard operation).
2. Enter your user number.
3. Enter the steering digit (9 or * for telephone interconnect; 7 for selective calling/revertive paging).

### *Deaccess Sequence–All Users*

The deaccess sequence consists of two entries in the following order:

- **deaccess code**–a code for all users to exit from radio use, which can be up to 8 digits long and can consist of the digits 0-9 and the symbol #.
- **user number**–same as above.

**IMPORTANT**
No more than 1 second must exist between the digits of the deaccess sequence.

The following instructions explain the use of the deaccess sequence for all users:

1. Enter the deaccess code.
2. Enter your user number.

## System Configurations

Through programming, the ZR320 may be configured to support many system requirements from simple dispatch systems to complicated PBX styled systems. The ZR320 supports up to 100 different users which are defined by the equipment type (i.e. non-digital pager, Quik-Call II mobile radio, TPL portable radio, etc). A more detailed discussion of the users and equipment types appears in the GR Series Programming Guide (6880903Z43).

When operating in the telephone link mode, the ZR320, in combination with the ZR330 Radio/Telephone Interface, provides exactly the same type of service as a telephone line.

The main configuration categories described in the following paragraphs are:

- Dispatch
- Interconnect
- Combined Dispatch/Interconnect
- Phone-Link
- Dial-Up Remote

In any of the configurations described in the following paragraphs, TPL/DPL protection may be added by programming the encode/decode on both the receive and transmit radios (refer to GR Series Programming Guide 6880903Z43).

### *Dispatch*

**Carrier Repeat**

Carrier Repeat is the most basic use of the ZR320 and requires a pair of GM300 radios. It is programmed for carrier repeat and no TPL/DPL encode. Each time the ZR320 detects COR activity from the receive radio, it keys the transmit radio and allows the audio to be repeated. If any Transmit Hang Time has been programmed, the ZR320 leaves the transmit radio keyed for the programmed amount of time after loss of the COR activity from the receive radio. The hang time is used to keep the transmit radio from unkeying during brief pauses in the conversation.

**Single User TPL/DPL Repeat**

Single user TPL/DPL repeat is one step away from carrier repeat mode. Like carrier repeat, it also requires a pair of GM300 radios. The receive radio is programmed TPL or DPL "RX Squelch Type" and is required for access to repeat. Either the transmit radio, or the ZR320 may be programmed to provide TPL/DPL encode. In either case, squelch tail elimination is used to mute receive audio.

### *Interconnect*

**Manual Access**

Manual access is the simplest form of telephone interconnect. The ZR320 is connected to either a single GM300 for simplex operation, or to a pair of GM300s for half and full duplex operation. The telephone line into the ZR320 is in parallel with a dispatcher or operator who provides manual telephone service for

mobile radios. The ZR320 is programmed for five rings before putting the call through on the air, so that the operator may answer the call first. When the operator answers the call and is told whom the caller wishes to speak with, the operator gets the user on the air and presses the **Connect** Button to manually connect the telephone party to the mobile party. When the call is over, the **Connect** Button is again pressed to terminate the call.

If the operator does not answer the call, it is processed automatically.

#### Automatic Single User (Industrial Strength Cordless Phone)

In the automatic single user mode, the ZR320 is used like a cordless telephone. While receiving a call, the telephone line rings, and the ZR320 rings over the air to the mobile radio. When the mobile answers, the telephone line is seized and the call takes place. To place a call, the user enters the access code followed by his user number and '9' or '*'. Only one user is making calls so toll restriction is not needed; typically, the person placing the calls owns the telephone line that the ZR320 is connected to. If the ZR320 is programmed to ring 3 or 5 times before putting the call through on the air, it allows an operator or dispatcher to answer the parallel line before ringing out on the channel. Like an answering machine, if nobody answers, the ZR320 will then process the call.

#### Automatic Multi-User

The automatic multi-user mode is one of the most complicated uses for the ZR320 and most closely resembles a PBX. In this mode, outbound calls may be placed selectively to 100 users on mobiles, pagers, talkback pagers and direct channel access. Users sign on using the access code, their user number and then a '9' or '*' for telephone access, or '7' for selective calls. A ZR330 is treated as a mobile when being called by a mobile, portable or another ZR330. Call forwarding can be used for forwarding calls to other devices. An example of call forwarding is a call coming into a ZR330. If the person being called does not answer, the call may be forwarded to his mobile radio. If the user still cannot be reached, the call may be forwarded to his pager. This mode of operation is frequently called 'follow me' where the ZR320 is seeking out a particular user. This mode requires a pair of GM300s for half or full duplex operation, or a single GM300 for simplex operation.

#### Automatic Multi-User/Untrained Callers (Autocall User)

In the automatic multi-user mode for untrained callers, everything functions as described in "Automatic Multi-User", with one exception. The telephone caller must know to enter the user number after the prompt. This works well if every caller has been trained to use the interconnect, but it could be a problem for those who have not been trained. Allowing the autocall user function to take over allows calls to be placed by untrained callers to a designated user (a dispatcher or secretary).

### *Combined Dispatch/Interconnect*

Dispatch operation is useful for in-plant service when the radios have two channels programmed, one for dispatch and one for interconnect. The dispatch and interconnect channels can be the same frequency and only distinguished by the receive TPL/DPL used for decode. On systems where both dispatch and interconnect are on the same RF channel, the dispatch channel in the mobile radio would be programmed for receive TPL/DPL decode and the interconnect channel would be programmed for Quik-Call II squelch with a different receive TPL/DPL ("Scan Stop Tone"). Dispatch operation can be used any time the interconnect is not in the middle of a call, either mobile or telephone. The channel setup for Quik-Call II squelch in the mobile radio must have the 'TPL/DPL required?' question in the RSS set to 'YES' so that scanning will not stop and remain on the interconnect channel when the dispatch channel is in use. The mobile radios continue scanning to keep the user from missing a call. In both cases, the mobile radio must encode the same TPL/DPL on the two channels for proper access to the ZR320. The encoded TPL/DPL is that of the receive radio.

### *Phone Link*

For the ZR320 to be part of a wireless telephone link, it must be connected to a pair of GM300 mobiles for full duplex operation. On the remote end, a ZR330 also needs a pair of GM300 mobiles. The telephone, FAX, etc. is connected to the ZR330. The system is transparent to the user, even the ringing cadence of the PSTN is passed along to the ZR330 for local ringing. It is possible to run up to 100 ZR330s on a single ZR320. In this configuration, the system would operate like a party line. Up to ten ZR320s may be included in the system to allow foreign-exchange type service. When multiple ZR320s or ZR330s are linked, the units must be programmed to operate in multi-unit mode.

### *Dial-Up*

For dial-up remote, the ZR320 is programmed to operate in the single user mode. The "autocall user's equipment type" should be set to direct air access, and the "Rings to Answer" should be set to one. After one ring, the ZR320 answers, beeps, and drops the telephone party on the air. If the ZR320 is set up for simplex operation, the VOX detector is used as the PTT source. The calling party can hail on the channel to call a mobile.

The call is protected using the radio timeout and call limit timers as programmed.

# Basic Operation

The ZR320 has four basic modes of operation:

- Single-User Interconnect
- Multi-User Interconnect
- Single-User Telephone Line Extender
- Multi-User Telephone Line Extender

To program your ZR320 to operate under one of these modes, refer to the GR Series Programming Guide (6880903Z43).

## *Single User Interconnect Mode*

When the ZR320 is operating in single user telephone interconnect mode, outbound (phone to mobile) calls may be placed and inbound (mobile to phone) calls may be received.

### Outbound Calls

An outbound call begins when the telephone line connected to the ZR320 begins to ring. The ZR320 counts the rings and after the set number of 'Rings to Answer' it decides which action must be taken.

#### *Channel Busy*

If the channel is busy, the telephone line will not be answered until the channel has been quiet for 3 seconds. Then the call is processed as usual.

#### *Autocall User*

If the Autocall User is set for TPL mobile, DPL mobile, or QCII mobile, the ZR320 will key the transmit radio, selectively call the mobile, and begin ringing on the channel.

#### *Answer Time*

If the ZR320 is programmed to 'ring once on air, wait for mobile to answer', it will ring one time on the air, unkey the transmit radio and allow the Answer Time for the mobile to answer before the call is terminated.

If the ZR320 Ring on Channel is programmed to 'ring on channel until answer,' it will ring until the mobile answers or the mobile answer timer expires. When the mobile answers the ringing telephone line, the call proceeds. When the mobile does not answer within the Radio Timeout, the call is transferred to the call forward user or terminated if a call forward user has not been programmed.

#### *How a Mobile Answers a Call*

A mobile answers a call by sending the access code followed by the correct user number. Note that the user must enter both digits of the user number in order to answer the call. For example, if the access code is '*' and the user number required to answer the call is 1, '*01' must be sent to answer the call.

#### *How a Call is Terminated*

A call can be terminated in one of the following ways:

- Send the deaccess sequence (the deaccess code followed by the user number of the user who made the call or who answered the call) at any point during the call to terminate the call. For example, when the deaccess code is '#' and the user number is 3, the sequence is '#03.'
- As the party placing a call to a mobile radio, terminate the call by pressing '#' while the mobile radio is ringing. After the mobile radio answers, it must terminate the call.
- If a mobile radio is unable to disconnect a call, the mobile is out of range, the portable's battery has lost power, etc., the Radio Timeout timer terminates the call after some programmed period of loss of the COR indication from the receive radio. The ZR320 indicates that the call will be terminated by sending a single beep every 3 seconds starting 12 seconds before the end of the call. To keep the call alive, the mobile must key up.
- The ZR320 can be programmed to limit the length of calls. When this timer expires, the call is terminated. If the ZR320 is programmed to allow 'call limit reset', the mobile user may send a DTMF '*' to extend the call's duration by the call limit time. The ZR320 indicates that the call will be terminated by sending double warning beeps every three seconds starting 15 seconds before the end of the call.

Once a call is terminated, the ZR320 sends five beeps to both the telephone party and the mobile party.

### Inbound Calls

#### *How a Mobile Initiates a Call*

An inbound call is started when a mobile enters the correct access code followed by the user number and a steering digit indicating the type of call to make, either telephone ('9' or '*') or selective ('7'). While the steering digit is required for access to the interconnect, on single-user systems mobile to mobile selective calling is not used, so the steering digit '7' is ignored.

Once the mobile has signed on and indicated that a mobile to telephone call is to be placed using either a '9' or '*' as a steering digit, the ZR320 "takes the telephone offhook" and allows the telephone audio (dial tone) to be sent to the mobile. When the mobile begins to dial,

the ZR320 monitors the first and second digits dialed. If these two digits match any of the digits programmed for restriction, the call is terminated immediately. There are no restrictions on the length of the number dialed. If the ZR320 is programmed for pulse dialing, the pulse dialer will dial digits until there is a 5-second gap in the received DTMF. This allows calls to be pulse dialed into the telephone line, and DTMF-equipped devices such as answering machines to be used after a connection has been established.

During the call, if the courtesy tone is enabled, it is sent to the telephone party each time the mobile unkeys. If the privacy mode is enabled, each time the mobile keys up a high-pitched tone is transmitted by the ZR320 in place of the mobile's audio. This tone tends to eliminate casual eavesdropping since only one side (telephone side) of the conversation can be monitored.

#### *How the Call is Terminated*

Inbound calls are terminated in the same manner as outbound calls. The deaccess sequence is transmitted by the mobile user.

Additionaly, the ZR320 can be programmed to do **one** of the following if a busy tone is detected:

- terminate the call anytime a busy tone is detected
- terminate the call only when a busy tone is detected during the first 20 seconds
- not to terminate the call (disable busy tone detect).

The Call Limit timers function the same as for outbound calls.

### Half-/Full-Duplex Operation

The following paragraphs describe the features that can be used only if the ZR320 is programmed for half- or full-duplex operation. For equipment types other than mobile or ZR330, the telephone line will be answered and one of the following occurs:

- **Tone-only Pagers** - The Quik-Call II page is sent over the air, the caller will hear five pager beeps and the call is terminated.
- **Tone+voice Pagers** - The Quik-Call II page is sent over the air, the caller hears a talk "beep" and his audio is live on the air until either the Pager Talk Time expires or the ZR320 detects a two second gap in the voice. When the page is finished, the ZR320 sends two beeps to the caller indicating that the talk time is up and the call is terminated.
- **Talkback Pagers** - The TPL/DPL or QCII tone set is encoded and two talk "beeps" are sent to the caller. The caller can then voice hail the talkback pager which has the mobile Answer Time to answer. Once the talkback pager answers, the call proceeds just like a mobile call. When the talkback pager does not answer, the call is terminated.
- **Direct Air** - The caller hears two talk "beeps," is dropped on the air immediately and is allowed to voice hail the mobile for up to the mobile answer time. The mobile must answer within the mobile Answer Time for the call to take place, otherwise it is terminated.

### Simplex Operation

Simplex operation is similar to half- and full-duplex operation. The methods to terminate a call are the same, and the method to make a call is very similar, but the conversation mode (the time the interconnect allows audio to pass from the telephone to mobile and vice versa) is different.

#### *Conversation Mode*

When the call is originated, the ZR320 keys the radio and allows telephone audio to enter the simplex radio for two seconds. Then it unkeys the radio to allow the mobile to begin dialing. The ZR320 allows the user 10 seconds to begin dialing before the call is terminated. After the first digit is dialed, the ZR320 drops into its conversation mode allowing the call to take place as usual.

On half- and full-duplex interconnects, the audio paths are opened in both directions and therefore no decision needs to be made to route the audio. Because a simplex radio cannot receive and transmit simultaneously, it requires a method of determining when the transmitter of the radio is to be keyed and the audio routed from the telephone to the mobile or from the mobile to the telephone.

When the ZR320 is in the conversation mode, it closes all audio paths and waits for COR/TPL/DPL, or VOX to appear. If COR/TPL/DPL appears, the audio from the receiver of the radio is presented to the telephone line allowing the mobile to talk to the telephone party. If the mobile unkeys or fades, the COR hold time is started. During the COR hold time, if COR reappears, the call continues with the mobile talking to the telephone party. If the COR hold timer expires and COR has not reappeared, the ZR320 sends a courtesy beep to the telephone party (if programmed) and goes back to waiting,

If VOX appears, the transmitter is keyed and the audio from the telephone is connected to the transmit audio so the telephone party can talk to the mobile. Like the COR hold timer, the VOX hold timer is used to hold the transmitter up until the ZR320 is absolutely sure the telephone party is no longer talking, at which time the

transmitter is unkeyed and the ZR320 goes back to waiting.

If the ZR320 has been programmed to operate in the simplex VOX with prekey mode, the only difference to the operation described in the above paragraph is that when the COR hold timer expires and the ZR320 is about to go back to waiting for COR or VOX, it keys the transmitter anticipating that the telephone party wants to begin talking immediately. If within the VOX hold time, the VOX indication does not become active, the ZR320 returns to waiting for activity. The problem with VOX operated simplex interconnects is that by the time the VOX becomes active, voice is already present and because it takes time for the transmitter to come up to full power, the first word is usually lost. By "prekeying" the transmitter, the first words of the telephone party are not missed because the transmitter has been keyed before the telephone party begins talking.

## Multi-User Interconnect Mode

There is only one difference between the operation of the ZR320 in the multi-user telephone interconnect mode and the single-user interconnect mode. Once the telephone line rings more than Rings to Answer times, the ZR320 answers the telephone and sends a beep to the caller indicating that it requires a user number to be entered so the call can be placed. When the channel is busy while the telephone line is ringing, the ZR320 ignores the ringing telephone line until there has been no activity on the channel for three seconds. The caller may enter the user number using either a DTMF equipped telephone or a rotary dial telephone. Once the user number has been entered, the call continues as described in Single-User Interconnect Mode.

**NOTE**
To set the ZR320 to the multi-user interconnect mode, use RSS or DTMF command 82# (refer to the GR Series Programming Guide [6880903Z43]).

### Mobile to Mobile

When operating in the Single-User Interconnect Mode, mobile to mobile selective calls are not used and thus were not described above. In multi-user systems, it is often necessary for mobile users to selectively call each other (including pagers). A mobile signs on according to the same protocol described under "Inbound Calls" "How a Mobile Initiates a Call" on page 7-4, except that the steering digit is '7'.

**NOTE**
The steering digit allows a mobile user to choose between two modes:
- telephone interconnect (steering digit 9 or *)
- selective calling/revertive paging (steering digit 7).

The steering digit is entered after the access code (or toll restrict code) and the user number.

When the mobile unkeys, the ZR320 generates a dial tone and waits for a user number to be entered by the mobile. Once the user number has been entered, the ZR320 processes the call depending on the equipment type. ZR330s are called as if they were mobiles.

#### *TPL/DPL/Quik-Call II Mobile*

The selective signalling is sent over the channel and ringing is sent for the mobile Answer Time. When the mobile does not answer within the limits of the mobile Answer Time, the call is either forwarded or terminated. Either the calling party or the called party can disconnect the call by sending the deaccess prefix and the appropriate two-digit user number. On mobile to mobile calls, the mobile Radio Timeout and Call Limit timers, including resetting are applicable. The courtesy tone is not used during mobile to mobile calls.

For specific TPL, DPL, and Quik-Call II codes, refer to the ZR320 section in the GR Series Controllers Programming Guide (6880903Z43).

#### *Tone Only Pager*

The Quik-Call II page is sent over the air and five pager beeps are sent to the originating mobile.

#### *Tone + Voice Pager*

The Quik-Call II page is sent over the air, the originating mobile hears a single talk "beep" and may begin talking. When the Pager Talk Time expires or carrier drops for two seconds, the call is terminated.

#### *Talkback Pagers*

The selective signalling is sent over the air, two talk "beeps" are sent to the originating mobile indicating that he may voice hail the called talkback pager. The called talkback pager must answer the call within the radio timeout time or the call is terminated.

#### *Direct Air*

The ZR320 enters a 'controlled repeat' mode where it repeats everything on the channel for 25 seconds or until the originating mobile terminates the call using the disconnect sequence (the deaccess code and the originating users two digit user number). This is a useful feature when general repeat access is not desired. This type of repeating requires an access code.

### *ZR330*

The ZR320 signals the ZR330 which begins to ring the DTMF telephone connected to the ZR330. Once that telephone is taken "off hook", the call begins. The call can be terminated through the use of the Radio Timeout timer, the Call Limit timer or by either party disconnecting. On the ZR330, disconnecting is accomplished by hanging up the telephone. In all respects, the ZR330 is treated as a mobile.

## *Single-User Telephone Line Extender*

The single-user telephone line extender is also referred to as a telephone 'link' and provides telephone service to a remotely-located telephone. This mode of operation only allows a single telephone to be connected to a single telephone line. Everything is transparent to the users, both on inbound and outbound calls.

> NOTE
> To set the ZR320 to the single user interconnect mode, use DTMF command 81#.

### Outbound Calls

For outbound calls, if the ZR320 is programmed to operate as a link, it ignores the Rings to Answer (commands 06#-08#) command and begins ringing the remote telephone as soon as the telephone line begins to ring. The telephone line is not answered until the remote telephone comes offhook.

### Inbound Calls

For inbound calls, a call is initiated by taking the remote telephone off the hook. When the ZR320 is programmed for pulse dialing, all incoming digits from the ZR330's DTMF telephone are pulse-dialed on the PSTN. Inbound calls are not monitored for toll restriction.

### Conversation Mode

For inbound and outbound calls, the ZR320's call limit timer determines the length of the call. Because the ZR320/ZR330 phone link runs full duplex, the Radio Timeout timer is not used. When at any time the carrier drops for more than 2 seconds, the call is immediately terminated.

## *Multi-User Telephone Line Extender*

This mode is similar to the Multi-User Telephone Interconnect. Inbound and outbound telephone calls can be made as well as ZR330 to mobile or ZR330 to ZR330 calls. From a telephone, calling a ZR330 is identical to calling a mobile. The calling party must know the user number of a particular ZR330 (similar to knowing a telephone "extension" number). Up to 100 ZR330s can be called through the ZR320.

# Equipment Required For Installation

The following equipment is required for installation of the ZR320 or ZR330:

- a communications service analyzer

and **ONE** of the following

- a PC capable of running the Motorola Radio Service Software (RSS)
- a hand-held or mobile radio with DTMF encode capability
- a DTMF telephone

# Theory of Operation

## *ZR320/ZR330 Control Card*

The control card is common to the ZR320 Selective Calling Interconnect and the ZR330 Radio/Telephone Interface.

### Power Supply/Conditioning

The B+ supply (12 VDC) is sourced by the GM300 radio through P1. VR1 provides a low impedance, regulated 5 VDC supply for the digital circuitry. C13, C14, and C15 provide stability for VR1, keeping it from oscillating. The analog supply (+A) is derived from the digital +5 through R11 which isolates the two supplies. C20 provides filtering for the analog supply. The bias voltage used on both circuit boards is provided through R12, R13, C18, C19, C27, C28, R19, R20, R38, Q7 and U4B. These components create a low-impedance, regulated +2 V supply, used for biasing the analog circuitry throughout the product.

### Reset Circuit

The reset circuit consists of R15, RP1B, RP1C, RP5C, Q5, Q6, C24, CR9, and U6E. This circuit is a Schmitt trigger that protects the microprocessor from erratic operation during power brown-outs or low-voltage conditions. When the B+ rail drops to about 9.5 V, CR9 stops conducting, turning off Q6. When Q6 turns off, Q5 latches on, forcing C24 to discharge through it and RP5C. When B+ exceeds 9.5V, CR9 begins conducting again and turns on Q6. When Q6 turns on, Q5 is turned off, causing C24 to charge through RP1B. The reset hold time is approximately 100 milliseconds (ms), which guarantees stability of the oscillator and the voltage rail.

### Microprocessor/EPROM/EEPROM

The microprocessor (U7) is responsible for operating the entire unit, and is controlled by the reset circuit. The microprocessor operates at 11.0592 MHz, using C30, C31, and Y2. C30 and C31 ensure clean startup of the oscillator at power-up. U5 is responsible for demultiplexing the address and data bus coming from the microprocessor. The program code resides partially in U7 and partially in U8, a 64K x 8 EPROM. The microprocessor operates by obtaining and executing instructions from this memory. The EEPROM (U2) stores all system and database programming, and will retain its memory even during power failures.

### Tone Generation

Tone generation is accomplished through the use of port 6 on U7. Data from U7 is clocked into either U9 or U10 to generate tones to the telephone or the radio ports. These tones are translated into an analog waveform by RP2 and RP3 (D/A converters). The two low-pass filters constructed from C35, C36, R24, U11B, R25, C34, C37, and U11C remove the clock noise before presenting the audio to the output ports.

### VOX Circuit

The VOX consists of a band-pass filter (about 300-650 Hz) made up of C39, R40, R39, C42, R32, R33, C44, R34, R35, R36, and U15C. This is a three pole band-pass filter that only allows voice audio through to the rectifier. The rectifier consists of CR10, R31, and C41. The filter discharges C41 through CR10 when the output of U15C goes low (audio is coming through the filter). CR10 blocks U15C from charging C41, allowing it only to discharge. R31 is responsible for charging C41, creating the decay in the VOX circuit (VOX hold time). The comparator cleans up the signal and passes it to the microprocessor through R43 and U3C, which shift the level from 12 V logic to 5 V logic.

### DTMF Decoder Circuit

The DTMF decoder (U1) receives audio from either the telephone or the radio port. The direction of the audio is controlled by the microprocessor and may come from only one source at a time. Audio from the radio port is low-pass filtered by U15B, R46, R47, C45, and C46, to eliminate channel noise before the audio is presented to U1. Telephone audio is not filtered because it contains no high-frequency (discriminator) noise. R29, R30, and U15D buffer the audio coming from either source. U12A is an analog switch that allows the microprocessor to select the audio source presented to U1.

## *ZR320 Trunk Card*

### Audio Limiter

The audio limiter consists of C32, RP2C, RP2D, CR11, RP3D, R35, U5C, R35, C33, RP2A, RP3A, U5B, RP2B, CR9, CR10, R34, C28, RP3C, RP3B, U5A, Q4, and C35. This circuit is used exclusively for FCC Part 68 approval. This circuit consists of a precision comparator that has a rise time of 3 seconds followed by an AC clamp (Q4 and C35) that shorts out all audio being sent to the telephone line. CR10 ensures that the discharge time is short so that recovery of the clamp is fast (i.e. when the level being transmitted into the telephone line drops below -9 dBm, the clamp is released quickly).

### Dial Click Decoder

This circuit is used to detect rotary pulses from distant telephones that are attempting to overdial telephone numbers for users in the system. It consists of:

- An active lowpass filter (C13, RP1A, RP1B, C14, R7, C16, R8, C17, and U3A)
- A variable gain amplifier (C15, R6, R5, and U3B)
- A fullwave rectifier (CR3, RP1C, RP1D, U3C, CR4)
- A filter/buffer amplifier (C30, R27, R28, CR5, CR6, and U3D)
- A microprocessor interface and LED indicator (DS1, R29, and Q3).

The circuit is fed audio directly from the hybrid. The sensitivity of the circuit is controlled by R5. DS1 blinks as dial pulses are decoded.

### Compander

The name of this circuit is a combination of its two functions: It COMpresses and exPANDs the audio on the system. The telephone system has a larger dynamic range than the radio system. To compensate, the compander compresses and expands the audio in both directions, at a ratio of 2 to 1. Audio moving from the telephone to the transmitter is compressed and audio moving from the receiver to the telephone line is expanded to maintain the dynamic range of the original signal. The attack and decay times of the compander are set using R20, C28, C18, and C19. The compander may be switched into and out of the audio paths under microprocessor control through U1B and U1C.

### Ring Detect

The ring detect circuitry consists of R42, R43, C37, U6, R40, R41, C36, R39, R38, U5D, R37 and Q2. When ring voltage is present on the line, enough current flows through optocoupler U6 to cause it to conduct, thereby discharging C36 through R40. The comparator (U5D) cleans up the signal, and Q2 level-shifts the signal and presents it to the microprocessor. When the line stops ringing, C36 is charged through R41, causing the ring signal to drop.

# Jumper Configurations

Table 7-1 lists the jumper settings for the transmit and receive radios when used with a GR Series Repeater and the ZR320 Selective Calling Interconnect Controller. Table 7-2 lists the jumper settings for the ZR320/ZR330 Controller Board. (There are no jumpers on the ZR320 Trunk Card.)

**NOTE**
GM300 8-Channel, M120, and M10 radios are not usable with the ZR320.

# Adjustments

The following steps should be performed with a service monitor, such as the Motorola R2000 series, connected to the antenna jack of the duplexer (or the transmitter, if applicable). The service monitor must be operating in the duplex mode. Set the service monitor to monitor the frequency of the transmit radio while generating the duplex signal at the frequency of the receive radio. Refer to the operating instructions of your service monitor. When you have finished setting the desired levels, press 99# to exit the program mode.

**NOTE**
At any time while programming these settings, if a time period of 60 seconds elapses without a DTMF key press, the ZR320 will exit the program mode automatically.

1. Connect the line cord from the GR Series repeater to a suitable 50/60 Hz ac power source.
2. For a GR300 or GR400, place the power supply power switch to the on position. The power is on when the red portion of the switch is visible.

Turn on both radios by rotating the volume controls clockwise. The front panels of the radios and the green Power LED of the ZR320 should illuminate.

## *Receive Audio Level*

1. Modulate the duplex generator of the service monitor with a 1 kHz tone at 60% of full rated system deviation.
2. Using a DVM or oscilloscope, adjust the **Audio** control until 470 mV rms (1.33V p-p) is present at pin 8 of the ZR320 programming connector J2 on the front of the ZR320 (refer to Figure 7-1), or on either pin of JP5 inside the ZR320.

## *TPL/DPL Encode Level*

1. Enter the program mode of the ZR320 using either a DTMF equipped mobile or portable radio, or a DTMF equipped telephone calling the ZR320. The ZR320 program mode default access code is 12320#.

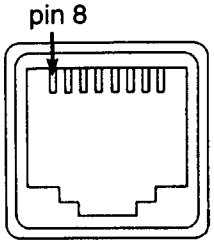



*Figure 7-1. J2 Programming Connector, Front View*

2. Enter command 93# to start TPL generation. The ZR320 will generate 134.4 Hz (the DPL turn-off tone).

*Table 7-1. Radio Jumper Settings (GM300 16-Channel Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | A |
| JU701 | X* | A |

* either A or B

*Table 7-2. Jumper Settings for ZR320 Controller Board*

| Jumper | Default | Notes |
|---|---|---|
| JP1 | No jumper installed/ Cuttable trace shorts jumper | Cut trace to deactivate receive radio's internal speaker. |
| JP2 | No jumper installed | Install to connect transmit radio mic audio to P1, pin 2. |
| JP3 | No jumper installed | Install to connect transmit radio PTT to P1, pin 3. |
| JP4 | No jumper installed | Install to connect transmit audio flat audio to P1, pin 5. |
| JP5 | No jumper installed/ Cuttable trace shorts jumper | Cut trace to disable repeat audio. |

3. Adjust the **PL/DPL** control for 15% of maximum rated system deviation.

4. Press any DTMF digit to end the test.

### *Hybrid Adjustment*

If the ZR320 will be used in the full-duplex mode, the hybrid must be adjusted. Perform the following steps to adjust the hybrid.

1. Enter the program mode of the ZR320 (12320#) using a telephone so that the hybrid may be balanced into the central office to which the ZR320 is connected.

> **NOTE**
> The telephone must have a telephone number (or extension) different from the one for the ZR320.

2. Once in the programming mode, enter command 95#. The ZR320 will generate two tones that are sent to the telephone. Audio coming from the telephone is then presented to the transmit radio so that any hybrid imbalance will appear as transmitted audio.

3. Alternately adjust the **R** and **C** controls for minimum transmitted audio.

4. Repeat Step 3 until no further minimizing of the transmitted audio can be attained. The hybrid is now balanced.

5. Press any DTMF digit to terminate the test.

### *Dial Click Decode Level*

If you are installing a ZR320 and you are planning on using rotary telephones for over-dialing user numbers into the ZR320, perform the following steps.

1. Enter command 96# to enable the dial click decode test.

2. For each rotary digit you enter, the ZR320 will send "beeps" back.

3. Adjust the **CLICK** control until the number of beeps matches the digit dialed.

## Preventive Maintenance

Preventive maintenance of the ZR320 consists of periodic inspection, cleaning, and checks using diagnostic commands entered via the DTMF keyboard.

### *Visual Inspection*

Check that external surfaces of the equipment are clean, that connecting cables are not damaged, and that connections are firm. A detailed inspection of the interior electronic circuitry is not needed or desired.

### *Cleaning*

Periodically clean smudges and grime from the exterior housing. Use a soft, nonabrasive cloth moistened in a mild soap and water solution. Rinse the surface using a second cloth moistened in clean water.

### *Tests*

The following tests are for setup and maintenance of the ZR320.

#### Transmit Level Test

The ZR320 generates a 1kHz tone to modulate the transmit radio, and the transmit radio is keyed. The deviation should measure 40-50% of maximum deviation. For example, the deviation is 1.9-2.3 kHz if the maximum is 4.6 kHz (in a 5 kHz system).

#### TPL/DPL Level Test

The DPL turnoff code, 134.4 Hz is generated, and the transmit radio is keyed. Setup control "PL/DPL," on the front of the ZR320 or ZR330, is adjusted for 15-20% of rated system deviation. For example, the deviation is 375-500 Hz in a 2.5 kHz rated system.

Refer to the Programming Guide's "Programming Over-The-Air," for instructions and examples of how to execute these tests.

# Section 8
# ZR330 Remote Telephone Interface

## Overview

This section describes the basic operation, theory of operation, and the jumper configurations for the ZR330 Radio/Telephone Interface.

The ZR330 Radio/Telephone Interface is a plug-in module designed for a GR Series Repeater Station. It provides an interface between a standard DTMF telephone instrument and the radios, to supply telephone service via radio. The ZR330 is compatible with the ZR320 Selective Calling Interconnect to provide phone to mobile, mobile to phone, and mobile to mobile operation.

## Physical Description

The ZR330 is housed in a self-contained module designed to fit on the top shelf of a GR Series Repeater Station.

Located on the front panel are:

- Setup adjustments
- LED indicators to display the status of the various functions
- **A Programming** jack used for programming with an IBM PC via an RIB programming interface

Interconnection to the transmit and receive radios is made via the 16-pin **Transmit** and **Receive** connectors located on the rear surface of the modules. The **Telephone** jack used to interconnect a telephone line to the module is also located on the rear surface of the unit.

Components and integrated circuits are mounted on two circuit boards inside the ZR330 unit.

## Standard Features

The following is a list of Radio/Telephone Interface features.

- Interface between DTMF telephone and radio
- Multi-mode operation, simplex VOX, half- and full-duplex
- Ideal use for rural radio telephone service
- High-quality companded audio
- Compatible with ZR320 Selective Calling Interconnect
- Selective calling from ZR320 rings phone
- Phone to landline, mobile, pager, or other station calling
- Hookflash
- Call limit timer

## Basic Operation

The ZR330 may be programmed to operate in two ways:

- as a telephone link that is transparent to the end user
- as a multi-function mobile type device

### *ZR330 Telephone Link*

The ZR330, in conjunction with a ZR320 and a DTMF telephone, can be programmed to function like a telephone connected to a standard telephone line. When you lift the handset of the telephone, the dial tone is passed from the telephone line to the earpiece, and you may begin to dial. If a call is coming in at the same instant when the handset is lifted, the telephone line is answered and the call begins.

Hookflashes are passed through the system as long as they are no longer than two seconds. Hookflashes lasting longer than two seconds are considered a hang-up; the ZR320/ZR330 telephone link drops, terminating the call.

If the ZR320 is programmed to pulse dial into the PSTN, it converts the DTMF digits coming from the ZR330's telephone to rotary pulses before entering the PSTN.

To call the ZR330's telephone, you must dial the telephone number of the ZR320. The ZR320 does not answer the ringing line until the ZR330's telephone handset is lifted. Long distance incoming calls are not billed if the telephone is not answered, since the telephone line has not actually been off hook. The ZR330's telephone rings with the same cadence and timing as the telephone line.

The ZR330 can be programmed for more than one ZR320. When you lift the handset, a local dial tone is

generated while the ZR330 waits for a digit from the user, indicating which ZR320 the telephone call will be placed on. When you enter a DTMF digit from 0 to 9, the ZR330 attempts to establish a link with the correct ZR320. If the ZR320 being called does not exist or does not respond, the ZR330 sends error tones until you replace the handset on the cradle. Once the ZR330 links up with the ZR320, the dial tone from the telephone line is passed to the earpiece, and you may begin to dial.

## ZR330 Mobile Type Device

The ZR330 may be programmed as a multi-function, mobile type device. In this mode of operation, the ZR330 may call mobile radios or other ZR330s, or place telephone calls. When the handset is lifted, the ZR330 generates a local dial tone for the DTMF telephone connected to it. The user then enters a 'steering' digit to indicate to the ZR330 which type of call is desired.

> **NOTE**
> The steering digit is 7 for ZR330 to mobile, or ZR330 to ZR330 calls. The steering digit is 9 for telephone calls.

### Mobile Calls (Steering Digit =7)

The ZR330 can be programmed for single- or multiple-ZR320 use. If the ZR330 is programmed for single-ZR320 use, it establishes a link with the ZR320 that has been programmed with a unit ID of 0. If the ZR330 is programmed for multiple-ZR320 use, when you indicate mobile use with the steering digit 7, the ZR330 sends out one beep, prompting you to enter the single digit unit ID of the ZR320 through which to place the call.

Now, the ZR330 is operating in a special mode which causes it to function like a mobile that uses VOX to key the transmitter. This means that when carrier is present, audio on the channel is passed to the earpiece of the handset. When the VOX circuit detects voice on the handset, the transmitter is keyed and audio is passed from the mouthpiece to the transmitter (including DTMF digits). You can place a mobile-to-mobile call through the ZR320 in the same way as a mobile. Enter the two-digit user number to signal the mobile to begin the call. Other ZR330s in the system look like mobiles to the ZR320. In this way, a ZR330 may call any of the other users programmed into the ZR320.

### Telephone Calls (Steering Digit = 9)

If the ZR330 is programmed for single-ZR320 use when you press the steering digit 9, the telephone call proceeds as if the ZR330 were programmed for link-only operation. If the ZR330 is programmed for multiple-ZR320 use, it sends out one beep, prompting you to enter the unit ID of the ZR320 through which to place the call. After you enter the unit ID, the ZR330 attempts to establish a link with the selected ZR320. If this link is successful, the call is processed. If the link fails, the ZR330 sends error tones to the user until the handset is hung up.

## Busy Channel

If the telephone handset is lifted when a carrier is present on the channel, the ZR330 pauses for two seconds before sending a busy tone to the handset. This pause allows the ZR330 to verify that the channel activity is ongoing, and is not an incoming call. The ZR330 generates a busy tone for as long as the channel is busy and the telephone is off hook.

You have two options: to stay on the line, or to press the DTMF "*." If you stay on the line, you may place the call when the carrier drops. If you press the "*," the busy channel ringback feature is enabled. Once the ringback is enabled, you hang up the phone and wait for a triple ring. If you want to disable the busy channel ringback, you can lift the handset and press "*" again. In response, the ZR330 should send out five beeps, confirming that the ringback is terminated.

The ZR330 monitors channel activity until the channel becomes free or the busy channel ringback is disabled. Once the channel is free, the ZR330 selects a random time to wait before attempting to lock down the channel. On systems consisting of multiple ZR330s, there is always a chance that several ZR330s have been placed in the busy channel ringback mode while the channel is busy. Therefore, there must be another way to allow a ZR330 to gain access to the system, besides waiting for the carrier to drop, so that multiple ZR330s do not attempt to make calls at the same time. To alleviate this problem, the ZR330s all select a random period of time after the carrier drops, before checking again for the carrier. If the carrier is not present, the ZR330 attempts to establish a link with the ZR320 whose unit ID is "0." This link locks down the channel while the ZR330 is triple-ringing its user. Other ZR330s in the system recognize that the channel is locked down and wait until the channel is free before trying to place calls.

The ZR330 which has the channel locked down triple-rings the telephone. The user has four rings to answer the phone before the ZR330 removes itself from the call queue (it no longer tries to seize the channel for the user until the user wants to make a call). Operation takes place as usual when the telephone handset is lifted.

# Equipment Required For Installation

The following equipment is required for installation of the ZR330:

- a communications service analyzer

and **ONE** of the following

- a PC capable of running the Motorola Radio Service Software (RSS)
- a hand-held or mobile radio with DTMF encode capability
- a DTMF telephone

# Theory of Operation

## *Circuit Description for ZR320/ZR330 Control Card*

The control card is common to the ZR320 Selective Calling Interconnect and the ZR330 Radio/Telephone Interface. Refer to Section 7, "ZR320 Selective Calling Interconnect Controller" for the theory of operation of the ZR320/ZR330 control card.

## *Circuit Description for ZR330 Trunk Card*

### Compander

The compander COMpresses and X-PANDs the audio on the system. The telephone system has a larger dynamic range than the radio system does, so to compensate for this, the compander compresses and expands the audio in both directions 2 to 1. Audio coming from the telephone going to the transmitter is compressed and audio coming from the receiver going to the telephone line is expanded to maintain the dynamic range of the original signal. The attack and decay times of the compander are set using R11, R13, C13, and C8. The compander may be switched into and out of the audio paths under processor control through U1A and U1B.

### 48 V Supply

The ring voltage and 48-volt supply are generated and regulated by the following components: U3, C19, R19, C20, R18, CX1, R20, R21, Q3, R36, T3, C33, C34, CR4, C35, C36, R39, C37, R38, and C10. U3B, U3C, C18, C19, R17, and R18 form an oscillator used to create a switching supply. U3A, U3D-F, in parallel, drive the gate of Q2. Q2 is turned on and off via the oscillator which causes current to flow through T2. T2 steps up the voltage to roughly 75V which is used for ringing the telephone. The remainder of the circuit is a 48V regulator that is used to power the telephone device. The microprocessor detects loop current (phone on/off hook) by measuring the voltage drop across R43 and sampling the ringer voltage. U4A and U4D form a precision comparator that is used by the microprocessor to determine the hook status of the telephone device. R22 and U1C level shift the signal fed to the microprocessor.

### Ring Generator

The ring generator consists of Q3 and Q4. The microprocessor "wiggles" the gates of Q3 and Q4 one at a time to drive the 75V signal through the telephone ringer. Drain load resistors provide current limiting to protect Q4 and Q5. C39 and C40 DC isolate the ring circuit from the telephone when the ringer is not being used.

# Jumper Configurations

Table 8-1 lists the jumper settings for the transmit and receive radios when used with a GR Series repeater and the ZR320 Selective Calling Interconnect Controller. Table 8-2 lists the jumper settings for the ZR320/ZR330 Controller Board. Table 8-2 lists the jumper settings for the ZR330 Trunk Card.

*Table 8-1. Radio Jumper Settings (GM300 16-Channel Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | X* |
| JU651 | X* | A |
| JU701 | X* | A |

* either A or B

*Table 8-2. Jumper Settings for ZR320/ZR330 Controller Board*

| Jumper | Default | Notes |
|---|---|---|
| JP1 | No jumper installed/ Cuttable trace shorts jumper | Cut trace to deactivate receive radio's internal speaker. |
| JP2 | No jumper installed | Install to connect transmit radio mic audio to P1, pin 2. |
| JP3 | No jumper installed | Install to connect transmit radio PTT to P1, pin 3. |
| JP4 | No jumper installed | Install to connect transmit radio flat audio to P1, pin 5. |
| JP5 | No jumper installed/ Cuttable trace shorts jumper | Cut trace to disable repeat audio. |

*Table 8-3. Jumper Settings for ZR330 Trunk Card*

| Jumper | Default | Notes |
|---|---|---|
| JP1 | Position A | A = Disconnects extra capacitance to hybrid balance.<br>B = Increases hybrid balance capacitance by 0.1 µF |
| JP2 | Position A | A = Disconnects extra capacitance to hybrid balance.<br>B = Increases hybrid balance capacitance by 0.22 µF |

**NOTE**
GM300 8-Channel, M120, and M10 radios are not usable with the ZR330.

# Adjustments

The following steps should be performed with a service monitor, such as the Motorola R2000 series, connected to the antenna jack of the duplexer (or the transmitter, if applicable). The service monitor must be operating in the duplex mode. Set the service monitor to monitor the frequency of the transmit radio while generating the duplex signal at the frequency of the receive radio. Refer to the operating instructions of your service monitor. When you have finished setting the desired levels, press 99# to exit the program mode.

**NOTE**
At any time while programming these settings, if a time period of 60 seconds elapses without a DTMF key press, the ZR330 will exit program mode automatically.

1. Connect the line cord from a GR Series repeater to a suitable 50/60 Hz ac power source.
2. For a GR300 or GR400, place the power supply power switch to the on position. The power is on when the red portion of the switch is visible.
3. Turn on both radios by rotating the volume controls clockwise. The front panels of the radios and the green **Power** LED of the ZR330 should illuminate.

## *Receive Audio Level*

1. Modulate the duplex generator of the service monitor with a 1 kHz tone at 60% of full rated system deviation.
2. Using a DVM or oscilloscope, adjust the **Audio** control until 470 mV rms (1.33V p-p) is present at pin 8 of the ZR330 programming connector J2 on the front of the ZR330 (refer to Figure 8-1), or on either pin of JP5 inside the ZR330.

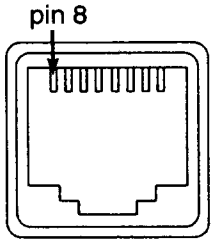



*Figure 8-1. J2 Programming Connector, Front View*

## *TPL/DPL Encode Level*

1. Connect a DTMF telephone to the **Telephone** jack on the rear panel of the ZR330.
2. Press the "*" key and hold it down while lifting the telephone receiver off hook to enter the program mode of the ZR330.
3. Enter command 93# to start TPL generation. The ZR330 will generate 134.4 Hz (the DPL turn-off tone).
4. Adjust the **PL/DPL** control for 15% of full rated system deviation.
5. Press any DTMF digit to end the test.

## *Hybrid Adjustment*

1. In programming mode, enter command 95#. The ZR330 will generate two tones that are sent to the telephone. Any hybrid imbalance will appear as transmitted audio.
2. Alternately adjust the **R** and **C** controls for minimum transmitted audio.

**NOTE**
If insufficient C range is found, you may need to change the positions of the jumper plugs on JP1 and JP2 on the ZR330 trunk card.

3. Repeat Step 2 until no further minimizing of the transmitted audio can be attained. The hybrid is now balanced.
4. Press any DTMF digit to terminate the test.

# Preventive Maintenance

Preventive maintenance of the ZR330 consists of periodic inspection, cleaning, and checks using diagnostic commands entered via the DTMF keyboard.

## *Visual Inspection*

Check that external surfaces of the equipment are clean, that connecting cables are not damaged, and that connections are firm. A detailed inspection of the interior electronic circuitry is not needed or desired.

## *Cleaning*

Periodically clean smudges and grime from the exterior housing. Use a soft, nonabrasive cloth moistened in a mild soap and water solution. Rinse the surface using a second cloth moistened in clean water.

## *Tests*

The following tests are for setup and maintenance of the ZR330.

### Transmit Level Test

The ZR330 generates a 1kHz tone to modulate the transmit radio, and the transmit radio is keyed. The deviation should measure 40-50% of maximum deviation. For example, the deviation is 1.9-2.3 kHz if the maximum is 4.6 kHz (in a 5 kHz system).

### TPL/DPL Level Test

The DPL turnoff code, 134.4 Hz is generated, and the transmit radio is keyed. Setup control "PL/DPL," on the front of the ZR320 or ZR330, is adjusted for 15-20% of rated system deviation. For example, the deviation is 375-500 Hz in a 2.5 kHz rated system.

Refer to the Programming Guide's "Programming Over-The-Air," for instructions and examples of how to execute these tests.



(Page 8-6 is blank)

# Section 9
# TRA100R Tone Remote Adapter Repeater Controller

## Overview

This section describes the basic operation, theory of operation, jumper configurations, and adjustments for the TRA100R Repeater Controller used in a GR Series repeater station.

## Basic Operation

The TRA100R TONE Remote Adapter Repeater Module replaces the R*I*C*K (Repeater Interface Communications Kit) in the GR300 Repeater system. It combines the functions of a 4-frequency tone remote adapter and a Basic Repeater Controller in one unit.

The TRA100R adapter is intended to be used in conjunction with a tone remote controller such as the C100/Command Series Tone Deskset. This will also enable the user to monitor the activity at the repeater.

The adapter also provides routing of audio signals between the wire line and a GR Series repeater. Transmit audio from the wire line is amplified before being input to the station. Receiver audio from the repeater receiver is amplified before being output to the wire line. Automatic line leveling is included which will compensate for telephone line differences on the tone remote adapter's wire line input.

### *Controls and Indicators*

The front panel of the TRA100R contains controls to manually control the operations of the module and contains LED indicators to display the status of the various functions.

#### "Repeater Enable" Button

The **Repeater Enable** button is a momentary type switch that enables the various repeater functions within the module. The LED indicator labeled **Rptr** reflects the selected mode of the switch at a glance.

#### "Line Disable" Button

The momentary push button labeled **Line Disable** is the manual control that alternately enables/disables PTT from the wire line. When the line is disabled the PTT LED flashes.

#### LED Indicators

In order for the repeater to function, the manual **Repeater Enable** button must be enabled as indicated by the **Rptr** LED indicator. The **COR** LED indicator illuminates when the receive radio is receiving a "system mobile" (with appropriate coding, if applicable). This will cause the repeater to activate if it is enabled and set up.

The **Mon** LED indicates the status of the wire line monitor. When active, the receive audio from the transmit or receive radio (depending on the switch settings) will be routed to the wire line.

The **PTT** LED will be on any time a PTT signal is being sent to the radio from line PTT or PTT from the accessory input.

#### Controls

When the front panel cover plate is removed, the two banks of programming switches, the repeater level adjustment and line level adjustments are accessible. The adjustment should be made only by a qualified technician, since satisfactory system operation depends on the settings.

### *General Specifications*

All specifications are for the TRA100R module and apply over the specified operating temperature range, duty cycle, voltage range, and humidity unless otherwise stated.

Additional specifications applicable to a GR Series repeater system and the GM300 mobile radios may be found in their respective manuals.

#### DC input

11 to 16 VDC at less than 300 mA (obtained from the transmit radio connector)

#### Audio frequency response

±3 dB, 300-3000 Hz from 1 kHz reference (line audio input to repeater path; repeater to Tx path)

#### Line audio input

600 Ω impedance; accommodates line losses to 20 dB

#### Line audio output

600 Ω impedance; level adjustable from -10 dBm to +10 dBm with input of 600mV rms from receive radio.

#### Line audio output residual hum and noise

-45 dB relative to rated audio output except guard tone
-60 dB low level guard tone relative to rated audio output

#### Line audio output distortion

Less than 3% total harmonic distortion

#### Tone control input frequencies

F1 select/transmit = 1950 Hz
F2 select/transmit = 1850 Hz
F3 select/transmit = 1750 Hz

F4 select/transmit = 1650 Hz
F5 select/transmit =1350 Hz
F6 select/transmit =1250 Hz
F7 select/transmit =1150 Hz
Monitor = 2050 Hz
Repeater knockdown = 1550 Hz
Repeater setup = 1450 Hz
Guard tone = 2175 Hz
Tone accuracy = ±2%

**Tone amplitudes**

- Guard tone:
  High level = +3 dB relative to maximum audio level (nominally 0 dBm)
  Low level = -30 dB relative to high level guard tone (nominally -30 dBm)
- Function tones:
  10 dB below high level guard tone (nominally -10 dBm)

**Tone timing (durations)**

High level guard tone = 120 milliseconds

Function tone = 40 milliseconds

Low level guard tone = continuous during transmit

**Maximum number of remote control units supported**

10 per tone remote control adapter

**Hum and noise**

-45 dB from 1 kHz ref. using 30 kHz lowpass filter (-30 dBm input, phone line to repeater; 280mV rms input, repeater to phone path)

**Telephone line connections**

Modular jack on unit (supplied with modular phone cable)

**Audio distortion**

3% max., 1 kHz tone (-10 dBm input, phone line to repeater; 280mV rms input, repeater to phone path)

**Input from phone line**

+5dBm maximum; autolevel threshold -35 dBm ±3 dB

# Theory of Operation

## *Power Supply*

DC input applied to connector J3 (or J4) is fused by F1. Common-mode choke L3 assists in suppression of EMI-RFI from the power supply port. Over voltage and reverse polarity protection is provided by D4.

U5, Q4 and associated components form a flyback switchmode supply operating at approximately 50 kHz. U5 furnishes it's own internal 5 volt reference at pin 14. The supply provides both +5 volt regulated and -6 volt analog outputs. Filtering of the high-frequency ripple components is handled by L5, C17, C18, C20, C39, and C40.

## *Microcontroller*

The TRA100R contains a dedicated microcontroller, U15, which contains an internal analog-to-digital converter. U15 controls audio gain, reads the switch positions, and regulates the control signal to the station. Reset to the microcontroller is provided by Q3, U13b and associated components. The clock is provided by Y1 and U14-9 at 3.4758 MHz.

In normal operation, the microcontroller will switch Q3 on and off, through line PA7, to keep C11 charged and U13-4 held high. However, if the signal at PA7 is interrupted due to power-up or software failure, C4 will discharge, forcing U13-4 low and causing the microcontroller to reset.

## *Line RX Audio*

Audio from the station receiver enters via J5-11, and is buffered by U4b. Line audio is either de-emphasized by U1-d (when U23 control pin 10 is low), or passed unaltered (when U23 control pin 10 is high). De-emphasis is determined by SwB-3 and the microcontroller.

Receive to remote line audio passes through active filter U11, suppressing the 2175 Hz component of the receiver audio. The clock for U11 is provided by Y1 and binary counter U14. The notch filter ensures that voice frequency components will not be fed back into the transmitter audio path through T1 and cause a false indication of 2175 Hz guard tone.

The RX audio signal is amplified by U2b with the line drive level set manually by POT-1 (**Line Level**). U26 serves as a line driver while audio is coupled to the line by T1, providing over +12 dBm of audio to the remote line. Lightning and surge protection are provided by L1, L2, S1 and S2, shunting high voltage surges to ground that may enter from the remote line. D15 and D16 serve to clamp high level surges coupled through the transformer in the differential mode.

## *Line TX Audio*

Remote line audio, entering the TRA100R through T1, is coupled by buffer U4d which bridges the secondary of transformer T1. Audio then passes through a jumper at P8 1-2 in the 2-wire mode. If the 4-wire option board is installed, line audio would then be directed through that board, as separate transmitter audio.

The 4-wire option board is detected by the microcontroller as it reads pin 3 of P8 at power up and reset, which inputs to the microcontroller at PB0. A high-pass filter consisting of U2d and associated components helps to reduce hum components that may have been induced into the remote line.

## *Digitally Controlled Gain*

The audio signal from the high-pass filter is routed through U8 and U6b, a digitally controlled gain stage. U6d functions as a full-wave precision rectifier. The resultant DC level, representative of the peak audio

level, is amplified by U6a where it becomes an analog input to the microcontroller at AN0. Analog to digital conversion takes place within the microcontroller. The level of this signal is compared with the required level and an 8-bit word is output on lines PB0-PB7. This results in a gain change through U8 (a digital to analog converter, configured as a stepped attenuator circuit).

### Guard Tone Detection

Autoleveled signal is routed to band-pass filter U9 and peaked at 2175 Hz. The signal leaving U9-19 is amplified by U12a, rectified by U7d, converted to a DC level by D10 and the RC networks consisting of C33, SR16, SR13, and SR12. The high level DC is inverted by U13e to provide an active low indication of guard tone to the microcontroller at PA1.

### Function Tone Detection

Audio entering the TRA100R is preceded by a function tone burst. The frequency of this burst determines the associated command function. This autoleveled tone signal exiting the digital gain block is routed to amplifier U7b, and then to flip-flop U16, where it is sampled at the processor clock frequency. The sampled waveform is used to generate a square wave at half the function tone frequency. This square wave is input to the microcontroller on line PC7.

A 30 dB attenuator, controlled by line PA0 from the processor, allows detection of the low-level guard tone. The attenuator is disabled after detection of the function tone by forcing PA0 low, turning off Q7 and effectively taking R101 out of the circuit. The processor identifies the tone frequency and outputs on the appropriate line. These outputs feed data latch U25, driving the appropriate LED, (**PTT**, **Mon**, **COR**, **Rptr**, or **Pwr**). It is also output to latches U20, U21, U22, or FETs Q9 or Q10 as a control signal (PTT, Mon. etc.) depending on the function tone detected.

### Audio Output

The autoleveled audio signal exiting the digital gain block is routed to the notch function of U9 for preliminary filtering. Final 2175 Hz notch filtering consists of U10 and associated components. The resultant audio signal, suppressed of any 2175 Hz component, is amplified by U12. Control POT2 (**TX Level**) manually sets the final transmit level. This signal is gated to U1b by U23, or to U1c by U33 (as determined by the programming switches). Output is then either on the normal (EIA) or flat input to the repeater transmitter as required by the system.

### Duplex Hybrid

The hybrid, consisting of U17, U2a, U2b and associated components, provides duplex operation in the 2-wire mode. The gain of U17, controlled by the processor through lines D0-D7, addresses the digitally controlled variable attenuator U17. Upon power up, the microcontroller generates a 1700 Hz tone from PC6. This tone is filtered by U7a, and gated to U2-9 summing junction. The microcontroller initiates a routine that decrements the gain of U17 until the input on PC7 reaches a minimum or null point. This point is recorded and the 8-bit word on lines PB0-PB7, which produced the null, is written to U17. A sample of the receiver line audio is taken from the POT1 (**Line Level**) wiper and directed through U17 and U2a. It is summed out of phase, but equal in amplitude, with the receiver audio signal being imposed on the remote line. Canceling of the signal at U2-7 output, takes place as a result of adding these two signals in U2b. The transmit signal is thus suppressed of the receiver audio component.

### Repeat Audio Paths

Receiver audio, entering the TRA100R via J5-11, is buffered by U4b. The repeat level control is manually set by POT3 (**Rptr Level**) to provide a transparent level through the system. Phase reversal of the signal is provided by U1a to ensure that the data retransmitted is of the proper phase for MDC-1200, DPL or other data. The appropriate phase is jumper selectable by JU21. The inverter is bypassed in normal operation.

Repeat audio is then directed to either normal EIA input to the repeater transmitter, or to flat input, as configured by the programming switches. The flat input is used whenever transparent operation of the repeater is desired, particularly in the retransmission of DPL or MDC-1200 data.

Accessory transmit audio, from J4 and buffered by U4a can also be routed to the transmitter via gate U33, to the microphone audio input of the transmitter. Accessory receiver audio is driven by U6c, for conditioned receiver audio, with JU23 in the "1" position, or U4c, for buffered receiver audio, with JU23 in the "2" position. The conditioned receiver audio may be gated (JU22 in the "1" position) or ungated (JU22 in the "2" position).

### Tone Generation and Timing

Transpond and hybrid balance tones are generated by the microcontroller output at PC6 as square-waves. Tone filter U7a rids the signal of odd harmonics, resulting in a sinusoidal waveform. The signal, is gated through U3 by the tone enable control line derived by rectifying the PC6 signal from the processor. The signal is fed to the remote line by summing at U2-9 to provide hybrid balance and the transpond signals.

Repeater drop-out delay timing is supplied by the microcontroller U15, as determined by program switches SwB-1, and 2.

## Internal Diagnostics

The internal diagnostics are initiated by simultaneously pressing the **Repeater Enable/Test** button while pressing the **Line Disable/Reset** button, located on the front panel of the TRA100R. This will place the unit into diagnostic Test 1. The **COR**, **Mon**, and **PTT** LEDs are used to

indicate, in binary format, the selected test number. (The least significant digit is the **PTT** LED). The test number can be incremented by repeatedly pressing the **Test (Repeater Enable)** button until the desired test is obtained. The unit is returned to the normal operating mode by pressing the **Reset** button **(Line Disable)**. However, certain tests use the **Reset** button to select sub-functions. In those cases it will be necessary to advance to the next Test, then press the **Reset** button to return to the normal operating condition for the unit. The **Pwr** LED will flash while in any test mode.

### *Test 1*

Entering the diagnostic test mode will light all LEDs for 1.5 seconds.

The **PTT** LED will then light for 1.5 seconds, indicating test 1, then extinguish. If all SwA switches are ON (down), the **PTT** LED will light; if all switches are OFF (up), the **Mon** LED will light. If all SwB switches are ON (down), the **Rptr** LED will light; if all switches are OFF (up), the **COR** LED will light. Pressing **Reset** will exit this test mode.

### *Test 2*

Entering Test 2 will light the **Mon** LED for 1.5 seconds.

While in Test 2, 2175Hz is generated and routed to the 2175Hz detect circuit. If 2175Hz is detected, the **Rptr** LED will light. Upon entering this test, the attenuator is enabled. Pressing the **Reset** button will toggle the 30dB attenuator.

This test also checks radio input bufferred by writing out to Q9, Q10 and Q6. The **COR** LED will light if the test is successful, and the **PTT** LED will light if this test fails. You must step to test 3 to reset.

### *Test 3*

Entering Test 3 will light the **PTT** and **Mon** LEDs for 1.5 seconds. In this test, TRA100R firmware will test the output latch to the radio, by reading the output back into radio input buffer 1. The **COR** LED will light if the test is successful, and the **PTT** LED will light if the test fails.

### *Test 4*

Entering Test 4 will light the **COR** LED for 1.5 seconds. This test will establish an audio path from the remote line to the transmit microphone. While in this test the audio is autoleveled. Pressing the **Reset** button will toggle the PTT line to the transmit radio. This test can be used for setting remote line to transmit deviation. You must step to Test 5 to reset.

### *Test 5*

Entering Test 5 will light the **COR** and **PTT** LEDs for 1.5 seconds. In this test SwB switch is read and audio paths are enabled based on the read value. Test 5 can be used to set the audio level from receive radio to the remote line. It can also detect the presence of the 4 wire option. If the 4 wire option is detected, the **Rptr** LED will light.

### *Test 6*

Entering Test 6 will light the **COR** and **Mon** LEDs for 1.5 seconds. If a valid function tone, from F1-F4 or 2175 Hz is detected, the binary value of the function tone will be represented by the **COR**, **Mon** and **PTT** LEDs, with the **PTT** LED being the least significant digit. For example, if the tone is 1850 Hz (F2) the **Mon** LED will light. A 2050 Hz tone (monitor) will be indicated by the **COR** and **PTT** LEDs being lit and 2175 Hz is indicated by the **COR** and **Mon** LEDs being lit (when 2175 Hz is detected the **Rptr** LED will light).

Determine the system requirements before attempting to set the programming switches. The down position is ON for all switches. SwA is the leftmost switch bank consisting of 8 switches that control the remote functions. SwB is the switch bank to the right that controls the repeater functions. The switches are numbered from left to right.

## Jumper Configurations

### *Setting the Levels of the Repeater Functions.*

#### Considerations for GM300 Mobile Radio and SwB Switch Bank.

The functions of most of the programming switches are straightforward. However certain factors require some additional discussion.

The "PL/DPL & CSQ Detect" function must be programmed (using the RSS for the GM300 mobile radio) to come from pin 8 of the accessory connector J3 of the receive radio. The OUTPUT direction must be programmed as a LOW active level.

The second consideration concerns whether any of the signalling features contained in the "RapidCall" package are going to be transmitted through the repeater or if PL/DPL is to be retransmitted by the repeater.

**RapidCall, PL, or DPL will be retransmitted.**

If all signalling (PL, DPL, and RapidCall) is to be generated by the field radios, flat audio is required from the receive radio and is sent to the flat transmitter audio input of the transmit radio. To get flat audio from the GM300 radios, JU551 in the receive radio must be in the "A" position. SwB3 should be ON, routing audio to the flat audio input of the transmit radio. Also, the transmit radio must be programmed by the RSS software to transmit "CSQ" (allowing the signalling received to be retransmitted). SwB4 should be OFF to mute the audio sent to the transmit radio when no field mobiles are being received.

A phase select jumper, JU21 (Position 1 or 2) is provided in order to maintain digital signalling phase in certain applications. Access to this jumper requires the removal of the unit cover. Position 1 provides same phase of the flat audio path. Position 2 provides phase reversal of the flat audio path.

**RapidCall, PL, or DPL will not be retransmitted.**

If PL or DPL is to be generated by the transmit radio, the audio from the receive radio should be deemphasized, squelched (normal) audio which will have the coded squelch filtered out. This requires that the JU551 jumper in the receive radio be in the "B" position. SwB3 should be OFF, routing audio to the transmit microphone audio input. SwB4 may be ON to unmute the audio sent to the transmit radio all the time.

Table 9-1 and Table 9-2 list the jumper settings for the transmit and receive radios when used with a GR Series repeater and the TRA100R Tone Remote Adapter Repeater Controller. Table 9-3 lists the jumper settings for the TRA100R.

# Adjustments

The following steps should be performed with a service monitor, such as the Motorola R2000 series, connected to the antenna jack of the duplexer (or the transmit radio, if applicable). The service monitor must be operating in the duplex mode. Set the service monitor to monitor the frequency of the transmit radio while generating the duplex signal at the frequency of the receive radio. Refer to the operating instructions of your service monitor.

To gain access to the controls and programming switches, it is necessary to remove the 4 small Phillips head screws that retain the protective front cover.

1. Connect the line cord from the repeater to a suitable 50/60 Hz ac source.
2. If the repeater is the GR300, turn on the power switch on the front panel of the power supply.
3. Turn on the two radios by rotating the volume controls clockwise. The front panels of the radios and the red **Pwr** LED of the TRA100R should illuminate.

## *Repeated Audio Level*

1. Modulate the duplex generator of the service monitor with a 1 kHz tone at 60 percent of full system rated deviation. Apply the proper TPL/DPL, if required.
2. Adjust the **Rptr** control on the TRA100R for 60 percent of full rated system deviation of the transmit radio by the 1 kHz tone. Take into account any deviation by the TPL/DPL on the transmitted signal.

## *Line Audio Level*

1. Modulate the duplex generator of the service monitor with a 1 kHz tone at 60 percent of full system rated deviation.
2. Enter the diagnostic test mode of the TRA100R.
3. Select test mode #5.
4. Adjust the **Line Level** control on the TRA100R for the desired line audio level (typically 0 dBm).

## *Transmit Level*

1. Disconnect the remote control line from the **Phone Line** modular connector on the back of the TRA100R.
2. Connect an audio generator with a 600 Ω output impedance between pins 2 and 3 of the **Phone Line** connector. Set the frequency to 1 kHz at a level of 0 dBm (775 mV rms at 600 Ω).
3. Enter the diagnostic test mode of the TRA100R.
4. Select test mode #4.
5. Adjust the **TX Level** control on the TRA100R for 60% of full rated system deviation.

## *Control Line Level*

The TRA100R provides automatic level compensation within a range of 20 dB. The unit uses the level of the high level guard tone burst to establish the transmit level. By convention, this high level guard tone is 3 dB above the maximum audio level. The TRA100R will operate outside this 20 dB range, but the output level of the transmitter will vary. The only requirement during installation is to make sure that the level at the TRA100R from each remote desk set is between 0 dBm and -20 dBm.

*Table 9-1. Radio Jumper Settings (GM300 16-Channel Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | B |
| JU651 | X* | A |
| JU701 | X* | A |

*either A or B

*Table 9-2. Radio Jumper Settings (GM300 8-Channel, M120, and M10 Radios)*

| Radio Jumper | Receive Radio | Transmit Radio |
|---|---|---|
| JU551 | B | B |
| JU651 | X* | A |
| JU809 | A | A |

*either A or B

*Table 9-3. TRA100R Jumper Settings*

| Jumper | Default | Notes |
|---|---|---|
| JU8 | 2 | 1=Output to J3-8 for special application<br>2=COR input from J5-8 |
| JU9 | Not installed | Install for channel steer #2 (J3-9 to J5-9) |
| JU11 | Not installed | Connects J3-11 to J5-11 for special application |
| JU14 | Not installed | 1 to 2: Output to J3-9 and J4-9 for special application<br>3 to 4: Monitor function to receive radio (for line monitoring of receive radio audio) |
| JU21 | 1 | 1=Normal phase repeated audio<br>2=Reverse phase repeated audio |
| JU22 | 1 | 1=Gated conditioned accessory audio<br>2=Continuous conditioned accessory audio |
| JU23 | 1 | 1=Conditioned accessory audio (600 mV rms)<br>2=Buffered accessory audio (250 mV rms) |
| P8 | 1-2 | 4-wire audio interface connector<br>Pins 1 and 2 jumpered for 2-wire audio operation |

# Section 10
# Troubleshooting

*Table 10-1. Troubleshooting for Repeaters (General)*

| Symptom | Problem(s) | Possible Solution(s) |
|---|---|---|
| 1. Repeater controller dead (power indicating LED does not light). | 1a. Power supply not turned ON or ac line cord not plugged into ac mains outlet.<br>1b. Receive radio not turned ON.<br>1c. Loose or bad repeater cable from radio to controller.<br>1d. Open fuse in controller (if applicable). | 1a. Turn on power supply and plug power supply cord into ac mains outlet.<br>1b. Turn on receive radio.<br>1c. Check repeater cable connections to radio and controller or replace repeater cable, if necessary.<br>1d. Check fuses in power supply and replace as necessary. |
| 2. No field radios can access system. | 2a. Receive radio programmed with wrong TPL/DPL code.<br>2b. Incorrect I/O programming of accessory connectors of receive radio and transmit radio.<br>2c. Loose or bad repeater cable from receive radio to controller.<br>2d. Incorrect programming of field radios.<br>2e. Repeater controller not enabled or set up (if applicable). | 2a. Check TPL/DPL code of receive radio and reprogram, if necessary.<br>2b. Check accessory connectors and reprogram, if necessary.<br>2c. Check repeater cable connections to radio and controller and replace repeater cable if necessary.<br>2d. Check programming on field radios and reprogram, if necessary.<br>2e. Check repeater enable and setup condition(s). |
| 3. First part of message not repeated. | 3. User speaking too soon after pressing PTT. | 3. Delay conversation to allow for delays in system due to:<br>• TPL/DPL decoding.<br>• Requirements of signalling systems. |
| 4. Loss of receiver sensitivity when transmit radio is keyed (repeater toggles from transmit to receive repeatedly when attempting to communicate through it). | 4a. Leaky coaxial cable(s).<br>4b. Loose antenna connector(s).<br>4c. Faulty antenna connector(s).<br>4d. Duplexer not tuned correctly (if applicable).<br>4e. Inadequate distance between receiver and transmitter antennas (if applicable).<br>4f. Improper or faulty coaxial cable(s) to antenna(s). | 4a. Check coaxial cables and replace if necessary.<br>4b. Check antenna connector(s) and replace, if necessary.<br>4c. Replace antenna connector(s).<br>4d. Re-tune duplexer.<br>4e. Read "Antenna Spacing" on page 1-5 and adjust distance between antennas.<br>4f. Read "Cables" on page 1-5 to determine the types of cables required or replace cable(s), if necessary. |
| 5. Repeater toggles from transmit to receive cyclically without an input signal to the receive radio. | 5. Transmit radio programmed with "COR" signal on same pin of accessory connector as receive radio and is receiving a signal. | 5. Reprogram transmit radio accessory connector pin to "NULL1." |
| 6. "Tinny" repeated audio (lacks low frequencies). | 6. Flat receive audio selected with microphone transmit audio. | 6. Set JU551 in receive radio to position "B." |

*Table 10-1. Troubleshooting for Repeaters (General) (Cont'd.)*

| Symptom | Problem(s) | Possible Solution(s) |
|---|---|---|
| 7. "Bassy" repeated audio (lacks high frequencies). | 7. EIA de-emphasized receive audio selected with flat transmit audio. | 7. Set JU551 in receive radio to position "A." |
| 8. Audio OK using local microphone on a repeater radio, but background audio/noise heard when repeater is operating. | 8. Microphone with "live," ungated audio path (such as a handset) plugged into repeater radio. | 8. Remove microphone. |
| 9. Partial (RapidCall) PTT ID message repeated. | 9a. Pre-time too short.<br>9b. "Pre" PTT ID used. | 9a. Increase pre-time in field radio.<br>9b. Use "Post" PTT ID. |
| 10. Fan in the repeater runs all the time. | 10. Not a problem. | 10. The repeaters are designed with continuous cooling. |

*Table 10-2. Troubleshooting for Repeater Receive Radio*

| Symptom | Problem | Solution |
|---|---|---|
| 1. No speaker audio heard from receive radio. | 1a. Volume of receive radio turned down.<br>1b. Pins 15 and 16 of accessory connector on controller not jumpered together.<br>1c. Loose or bad repeater cable from receive radio to controller.<br>1d. Speaker wires not connected.<br>1e. External speaker (if applicable) not connected between pins 1 and 16 of accessory connector on controller.<br>1f. Defective speaker (internal or external, if applicable). | 1a. Turn up volume.<br>1b. Use jumpered connector provided with the radio to connect pins 15 and 16<br>1c. Check repeater cable connections to radio and controller and replace repeater cable if necessary.<br>1d. Connect speaker wires.<br>1e. Connect external speaker between pins 1 and 16.<br>1f. Check speaker and replace if necessary. |
| 2. Receive radio stays ON with radio power switch OFF. | 2. Voltage entering receive radio from ignition sense (pin 10) of the transmit radio. | 2. Remove fuse F801 in transmit radio. |
| 3. Receive radio constantly keyed. | 3a. Accessory connector of receive and/or transmit radio not programmed correctly or not operating correctly.<br>3b. Receive radio PTT pin pulled LOW by an accessory. | 3a. Check programming of accessory connector and reprogram, if necessary.<br>3b. Remove or correct accessory. |

*Table 10-3. Troubleshooting for Repeater Transmit Radio*

| Symptom | Problem | Solution |
|---|---|---|
| 1. Transmit radio not keying when a properly identified signal is presented to receive radio. | 1a. Controller's repeater function not enabled (if applicable). | 1a. Enable controller repeater function. |
| | 1b. Controller not in Setup state (if applicable). | 1b. Place controller in setup state (locally or remotely). |
| | 1c. Loose or bad repeater cable(s). | 1c. Check repeater cable connection(s) and replace cable, if necessary. |
| | 1d. Receive radio on wrong channel (mode). | 1d. Set receive radio to correct channel (mode). |
| | 1e. No transmit frequency programmed into transmit radio. | 1e. Program transmit frequency for transmit radio. |
| | 1f. Incorrect frequency or TPL/DPL programmed into receive radio. | 1f. Check receive radio frequency and TPL/DPL and reprogram, if necessary. |
| | 1g. Accessory connector of receive radio not programmed correctly or not operating correctly. | 1g. Check programming of accessory connector and reprogram, if necessary. |
| | 1h. "Busy Channel Lockout" or "Transmit Inhibit on Busy" programmed into transmit radio and channel is active. | 1h. Remove the function with RSS or wait until channel is inactive. |
| 2. Transmit radio keying continuously or keying without a properly identified signal presented to receive radio. | 2a. Receive radio on wrong channel (mode). | 2a. Set receive radio to correct channel (mode). |
| | 2b. Wrong TPL/DPL programmed into receive radio. | 2b. Check TPL/DPL and reprogram, if necessary. |
| | 2c. Pin 3 of accessory connector on controller pulled LOW by an accessory. | 2c. Remove accessory and correct LOW condition |
| | 2d. Accessory connector of receive radio not programmed correctly or not operating correctly. | 2d. Check programming of accessory connector and reprogram, if necessary. |
| 3. Low or erratic output power level, or no output power level from transmit radio. | 3a. Loose RF cable connector(s). | 3a. Tighten RF cable connectors to<br>• radios<br>• duplexer<br>• antenna |
| | 3b. Faulty antenna or feedline. | 3b. Replace faulty component. |
| | 3c. Faulty duplexer (if applicable). | 3c. Check:<br>• Tuning of duplexer<br>• Tightness of locking nuts on tuning screws.<br>Replace duplexer if duplexer is correctly tuned and nuts are properly tightened. |
| | 3d. Output voltage from power supply drops during transmit. | 3d. Check:<br>• Correct position of "115/230" switch on power supply.<br>• Output power of transmit radio; do not set greater than 10% over rated RF output power (measured at radio, NOT at duplexer antenna connector). |
| | 3e. Excessive power supply current drain. | 3e. Disconnect components, one at a time, to locate faulty piece. Replace faulty piece. |

*Table 10-3. Troubleshooting for Repeater Transmit Radio (Cont'd.)*

| Symptom | Problem | Solution |
|---|---|---|
| 4. Transmit radio keys but no or low audio is transmitted. | 4a. Loose or bad repeater cable(s). | 4a. Check repeater cable connection(s) and replace cable, if necessary. |
| | 4b. JU551 missing on logic board of receive radio. | 4b. Replace JU551 in proper position. |
| | 4c. JU651 missing on logic board of transmit radio. | 4c. Replace JU651 in proper position. |
| | 4d. Transmit radio audio loaded down due to connections to accessory connector of controller. | 4d. Remove accessory and correct. |
| | 4e. Receive radio audio loaded down due to connections to accessory connector of controller. | 4e. Remove accessory and correct. |
| | 4f. Audio loaded by microphone plugged into transmit radio. (DTMF microphone may cause this problem.) | 4f. Remove DTMF microphone during repeater operation. |
| 5. No speaker audio heard from transmit radio in bi-directional repeater configuration. | 5a. J3-15 and J3-16 of transmit radio not jumpered together. | 5a. Remove repeater cable wires from P3-15 and P3-16 of transmit radio. Jumper locations 15 and 16 of cable connector. |
| | 5b. Loose or bad repeater cable from transmit radio to repeater controller. | 5b. Check repeater cable connection(s) and replace cable, if necessary. |
| | 5c. Volume control of transmit radio turned down. | 5c. Turn volume up. |
| | 5d. Speaker wires broken or not connected. | 5d. Check speaker wires and connections; replace speaker wires, if necessary. |
| | 5e. External speaker (if applicable) not connected between J3-1 and J3-16 of transmit radio. | 5e. Remove repeater cable wires from J3-1 and J3-16 of transmit radio. Plug in external speaker wires. |
| | 5f. Defective speaker (internal or external, if applicable). | 5f. Replace speaker. |

*Table 10-4. Troubleshooting for Basic Repeater Controller*

| Symptom | Problem | Solution |
|---|---|---|
| 1. Basic repeater controller dead, green LED does not light when "Enable" pushbutton is pressed. | 1a. Power supply not turned ON or ac line cord not plugged into ac mains outlet.<br>1b. Receive radio not turned ON.<br>1c. Loose or bad cable from receive radio.<br>1d. Open fuse, F1.<br>1e. External supply not turned ON (if applicable). | 1a. Turn power supply ON, and check that ac line cord is plugged in.<br>1b. Turn on receive radio.<br>1c. Check cable from receive radio and replace if necessary.<br>1d. Replace fuse F1.<br>1e. Turn on external supply (if applicable). |
| 2. Transmit radio not keying when a properly identified signal is presented to receive radio. | If COR LED does not light:<br>2a. Controller not enabled.<br>2b. Loose or bad repeater cable(s).<br>2c. Accessory connector of receive radio not programmed correctly or not operating correctly.<br>2d. S2 not configured correctly.<br>2e. Incorrect frequency or TPL/DPL programmed into receive radio.<br>2f. Receive radio on wrong channel (mode).<br>If COR LED lights:<br>2g. Controller not in Setup state.<br>2h. No transmit frequency programmed into transmit radio.<br>2i. Loose or bad repeater cable(s). | 2a. Push S1, Enable, in (on position).<br>2b. Check repeater cable connection(s) and replace cable, if necessary.<br>2c. Check programming of accessory connector and reprogram, if necessary.<br>2d. Check S2 and reconfigure, if necessary.<br>2e. Check frequency and TPL/DPL code and reprogram, if necessary.<br>2f. Change receive radio channel (mode).<br>2g. Set up controller locally or remotely.<br>2h. Program transmit frequency.<br>2i. Check repeater cable connection(s) and replace cable, if necessary. |
| 3. Transmit radio keying continuously or keying without a properly identified signal presented to receive radio. | 3a. Pin 3 of "J4-ACC" pulled LOW by an accessory.<br>3b. If using VOX, JU551 in receive radio in "flat/unmuted" ("A") position. | 3a. Remove accessory and correct LOW condition.<br>3b. Move JU551 to "B" position. |
| 4. First part of message not repeated. | 4a. User speaking too soon after pressing PTT.<br>4b. If using VOX:<br>• User speaking too softly.<br>• Inadequate handset audio level from receive radio. | 4a. Delay conversation to allow for delays in repeater and field radios from:<br>• TPL/DPL decoding.<br>• Requirements of signalling systems.<br>4b. Educate users to hold microphone closer to mouth, or speak more loudly into it.<br>When using an older radio, modify the handset audio output of the receive radio. |
| 5. Transmit radio keys but low or no audio is transmitted. | 5a. S2-5 or S2-6 of controller not turned ON.<br>5b. R23 of controller not adjusted correctly. | 5a. Turn S2-5 ON for flat transmit audio; turn S2-6 ON for EIA microphone audio.<br>5b. Adjust R23. |
| 6. "Tinny" repeated audio (lacks low frequencies). | 6. Flat receive audio selected with microphone transmit audio. | 6. Check positions of:<br>• S2-5 (ON)<br>• S2-6 (OFF) |
| 7. "Bassy" repeated audio (lacks high frequencies). | 7. EIA de-emphasized receive audio selected with flat transmit audio. | 7. Check positions of:<br>• S2-5 (OFF)<br>• S2-6 (ON) |

*Table 10-4. Troubleshooting for Basic Repeater Controller (Cont'd.)*

| Symptom | Problem | Solution |
|---|---|---|
| 8. TPL/DPL signalling "passing through" controller. | 8. Flat receive audio selected. | 8. Refer to "Symptom 6. 'Tinny' repeated audio" above. |
| 9. TPL/DPL signalling not "passing through" controller. | 9. EIA de-emphasized receive audio selected. | 9. Refer to "7. 'Bassy' repeated audio" above. |
| 10. DPL sense inverted in "pass through" mode (flat audios). | 10. Inversion caused by processing of signal in receive radio circuits. | 10. Add unity gain inverting amplifier in audio path (either receive radio audio output or transmit radio audio input). This amplifier is **not** available from Radius Products.<br>**or** Reprogram field radios for "INV DPL" Receiver SQUELCH Mode. |
| 11. Undesirable squelch tails and noise transmitted during drop-out delay. | 11. Audio gate enabled with flat receive audio selected, S2-7 ON. | 11. Set S2-7 OFF. |
| 12. Audio OK in repeater operation (between field radios) but noisy when using local microphone on a repeater radio. | 12. Flat audio has been selected. | 12. Select EIA de-emphasized/muted audio on repeater radios (set JU551 on logic board of each radio to "B").<br>If flat audio is required, set S2-7to OFF. |
| 13. Long delay in audio from microphone plugged into transmit radio. | 13. S2-5 and S2-6 simultaneously ON. | 13. Set S2-5 (flat audio) ON and S2-6 (EIA audio) OFF, or set S2-6 ON and S2-5 OFF. |

*Table 10-5. Troubleshooting for Basic Repeater Controller Bi-Directional Repeater*

| Symptom | Problem | Solution |
|---|---|---|
| 1. Part or all of the reverse conversation not repeated. | 1a. 0-second drop-out delay not selected.<br>1b. User speaking too soon after pressing PTT.<br>1c. Receive radio is operating in another repeater system and is keeping transmit radio keyed during drop-out delay. | 1a. Set S2-11 ON.<br>1b. Delay conversation to allow for delays in repeater and field radios from:<br>• TPL/DPL decoding.<br>• Requirements of signalling systems.<br>1c. Consult Radius Product Services at 1-800-356-1520 for possible remedy. |
| 2. Transmitter of receive radio not keying. | 2a. Loose or bad repeater cable(s).<br>2b. S2-1 not ON.<br>2c. Accessory connector of transmit radio not programmed correctly or not operating correctly.<br>2d. No transmit frequency programmed into receive radio. | 2a. Check repeater cable connection(s) and replace cable(s), if necessary.<br>2b. Set S2-1 ON.<br>2c. Check programming of accessory connector and reprogram, if necessary.<br>2d. Program transmit frequency. |
| 3. No or low transmitter audio from receive radio. | 3a. Loose or bad repeater cable(s).<br>3b. S2 not configured correctly.<br>3c. JU551 missing on logic board of transmit radio.<br>3d. JU651 missing on logic board of receive radio.<br>3e. R24 not adjusted correctly.<br>3f. Audio loaded by an accessory connected to "J4-ACC."<br>3g. Audio loaded by microphone plugged into receive radio. DTMF microphone may cause this problem. | 3a. Check repeater cable connection(s) and replace cable, if necessary.<br>3b. Reconfigure S2.<br>3c. Replace JU551 (in "B" position).<br>3d. Replace JU651 (in "A" position).<br>3e. Adjust R24.<br>3f. Remove accessory and correct condition.<br>3g. Remove microphone. Substitute regular mobile or desk microphone. |
| 4. Receive radio constantly keyed. | 4a. S2 not configured correctly.<br>4b. Accessory connectors of receive and transmit radios not programmed correctly.<br>4c. Pin 8 of the "J4-ACC" connector pulled LOW by an accessory.<br>4d. Transmit radio turned OFF. | 4a. Reconfigure S2.<br>4b. Check programming of accessory connectors and reprogram, if necessary.<br>4c. Remove accessory and correct LOW condition.<br>4d. Turn transmit radio ON. |
| 5. "Tinny" repeated audio (lacks low frequencies). | 6. Flat receive audio selected with microphone transmit audio. | 6. Check positions of:<br>• S2-8 (OFF)<br>• S2-9 (ON) |
| 7. "Bassy" repeated audio (lacks high frequencies). | 7. EIA de-emphasized receive audio selected with flat transmit audio. | 7. Check positions of:<br>• S2-8 (ON)<br>• S2-9 (OFF) |

*Table 10-6. Troubleshooting for Basic Repeater Controller Setup/Knockdown*

| Symptom | Problem | Solution |
|---|---|---|
| 1. Repeater not in "Setup" mode at power-up, yellow LED not lighted and/or transmit radio front panel not ON. | 1a. JU1 in wrong position or missing.<br>1b. Loose or bad repeater cable to transmit radio.<br>1c. Transmit radio turned OFF.<br>1d. Power cable not connected to transmit radio. | 1a. Replace JU1, if necessary, and place in position 1-2.<br>1b. Check repeater cable connection(s) and replace cable, if necessary.<br>1c. Turn transmit radio ON.<br>1d. Connect power cable to transmit radio. |
| 2. Repeater not in "Knockdown" state at power-up, yellow LED lighted and/or transmit radio front panel ON. | 2a. JU1 in wrong position.<br>2b. Ignition sense fuse (F801) not removed from logic board of transmit radio. | 2a. Place JU1 in position 2-3.<br>2b. Remove F801 from logic board of transmit radio. |
| 3. Transition from "Setup" to "Knockdown" state not occurring when front panel switch (S3) is pressed and released. | 3a. JU1 missing.<br>3b. Loose or bad repeater cable to transmit radio.<br>3c. Transmit radio turned OFF.<br>3d. Power cable not connected to transmit radio.<br>3e. Ignition sense fuse (F801) not removed from logic board of transmit radio. | 3a. Replace JU1.<br>3b. Check repeater cable connection(s) and replace cable, if necessary.<br>3c. Turn transmit radio ON.<br>3d. Connect power cable to transmit radio.<br>3e. Remove F801 from logic board of transmit radio. |
| 4. Remote Setup/Knockdown function not working. | 4a. S2-4 turned OFF.<br>4b. Ignition sense fuse (F801) not removed from logic board of transmit radio.<br>4c. Transmit radio turned OFF.<br>4d. Power cable not connected to transmit radio.<br>4e. JU1 in wrong position or missing.<br>4f. Loose or bad repeater cable(s).<br>4g. Incorrect MDC-1200 programming of receive radio or console radio. | 4a. Turn S2-4 ON.<br>4b. Remove F801 from logic board of transmit radio.<br>4c. Turn transmit radio ON.<br>4d. Connect power cable to transmit radio.<br>4e. Check position of JU1 or replace, if necessary.<br>4f. Check repeater cable connection(s) and replace cable(s), if necessary.<br>4g. Check signalling mode and Call Lists in both radios |

*Table 10-7. Troubleshooting for i50R Controller*

| Symptom | Problem | Solution |
|---|---|---|
| 1. "Tinny" repeated audio (lacks low frequencies). | 1. Flat receive audio selected with microphone transmit audio. | 1. Check SwB-3 ON for flat transmit audio. |
| 2. "Bassy" repeated audio (lacks high frequencies). | 2. EIA de-emphasized receive audio selected with flat transmit audio. | 2. Check SwB-3 OFF for EIA audio. |
| 3. Low repeated audio. | 3a. "Rptr Lvl" control not adjusted correctly.<br>3b. Audio loaded by microphone plugged into transmit radio. DTMF or LED microphone may cause this problem. | 3a. Adjust "Rptr Lvl" control on i50R.<br>3b. Remove microphone. Substitute a non-DTMF and non-LED microphone. |
| 4. Undesirable squelch tails and noise transmitted during drop-out delay. | 4. Audio gate enabled with flat receive audio selected; SwB-4 OFF. | 4. Set SwB-4 ON. |
| 5. Repeater not in "Setup" mode at power-up, yellow LED not lighted and/or transmit radio front panel not ON. | 5a. SwB-8 in wrong position.<br>5b. Loose or bad repeater cable to transmit radio.<br>5c. Transmit radio turned OFF.<br>5d. Power cable not connected to transmit radio. | 5a. Set SwB-8 ON.<br>5b. Check repeater cable connection(s) and replace cable, if necessary.<br>5c. Turn transmit radio ON.<br>5d. Connect power cable to transmit radio. |
| 6. Repeater not in "Knockdown" state at power-up, yellow LED lighted. | 6. SwB-8 in wrong position. | 6. Set SwB-8 OFF. |
| 7. Remote Setup/Knockdown function not working. | 7a. SwB-5 OFF.<br>7b. Loose or bad repeater cable(s).<br>7c. Incorrect MDC-1200 programming of receive radio or console radio. | 7a. Set SwB-5 ON.<br>7b. Check repeater cable connection(s) and replace cable(s), if necessary.<br>7c. Check signalling mode and Call Lists in both radios |
| 8. Intermittently disconnects from call. | 8. Single "#" character deaccess code may voice false. | 8. Use "##" deaccess code. |
| 9. Patch rings out over busy radio channel. | 9a. JU4 or JU5 not installed.<br>9b. Improper transmit radio programming. | 9a. Install either JU4 or JU5, as required.<br>9b. Use RSS to verify and correct:<br>• Pin 8 ("CSQ Detect," active "Low")<br>• Receive frequency equal to transmit frequency. |
| 10. i50R returns "busy" when attempting to access. | 10a. Telephone in parallel with i50R "off-hook."<br>10b. Telephone modular connectors not fully inserted.<br>10c. Low talk voltage with JU1 "In."<br>10d. Low talk voltage from Telco (< 10 V dc)<br>10e. JU2 left "In." | 10a. Hang-up or remove telephone **or** wait until telephone is "on-hook."<br>10b. Reinsert connectors firmly into i50R and any phone jacks.<br>10c. Place JU1 "Out" for low talk voltage.<br>10d. Contact local telephone company.<br>10e. Place JU2 in "park" position. |

*Table 10-7. Troubleshooting for i50R Controller (Cont'd.)*

| Symptom | Problem | Solution |
|---|---|---|
| 11. i50R will not ring out when called from landline. | 11a. Low ring voltage (JU6 not installed).<br>11b. Very low ring voltage (<30 V).<br>11c. Ring frequency too low (<17 Hz).<br>11d. "Busy" radio channel.<br>11e. Improper transmit radio programming.<br>11f. SwA-1 ON. | 11a. Install JU6 for low ring voltage.<br>11b. Contact local telephone company.<br>11c. Contact local telephone company.<br>11d. Wait until radio channel is clear.<br>11e. Use RSS to verify and correct:<br>• Pin 8 (CSQ Detect, active "Low")<br>11f. SwA-1 should be OFF. |
| 12. Cannot access i50R from a field radio. | 12a. Wrong access code sent by field radio.<br>12b. i50R not "Set up" and "Enabled."<br>12c. Too high or too low DTMF deviation of field radio.<br>12d. Receive radio not programmed for proper TPL tone or DPL code.<br>12e. Improper programming of accessory connector of receive radio.<br>12f. SwB-7 OFF. | 12a. Access code must match position of SwA-8.<br>• "#*" (SwA-8 OFF)<br>• "*" (SwA-8 ON)<br>12b. "Setup" and "Enable" i50R.<br>12c. Readjust DTMF deviation of field radio for 60% to 70% rated system.<br>12d. Use RSS to verify and correct "Rx Squelch Code."<br>12e. Use RSS to verify and correct:<br>• Pin 8 ("TPL/DPL & CSQ Detect" active "Low").<br>• Pin 14 ("NULL1").<br>12f. Set SwB-7 ON. |

*Table 10-8. Troubleshooting for ZR340 Controller*

| Symptom | Problem(s) | Possible Solution(s) |
|---|---|---|
| 1. No "Rx" LED indication when signal is received. | 1a. Improper programming of accessory connector of receive radio. | 1a. Use RSS to verify and correct:<br>• Pin 4 ("CSQ Detect," active "High")<br>• Pin 12 ("TPL/DPL & CSQ Detect," active "Low"). |
| | 1b. Loose or bad repeater cable to receive radio. | 1b. Check cable connections and replace cable, if necessary. |
| | 1c. JP7 and/or JP8 in ZR340 in wrong position(s). | 1c. Check position(s) and correct. |
| 2. No "Tx" LED indication in repeater mode when properly identified signal is received. Transmit radio does not key. | 2a. Receive radio not programmed for proper TPL/DPL code. | 2a. Use RSS to verify and correct "Rx Squelch Code." |
| | 2b. Improper programming of accessory connector of receive radio. | 2b. Use RSS to verify and correct:<br>• Pin 4 ("CSQ Detect," active "High")<br>• Pin 12 ("TPL/DPL & CSQ Detect," active "Low"). |
| | 2c. Incorrect programming of ZR340. | 2c. Use DTMF to select half-duplex and repeater enabled (40# then 18#). |
| | 2d. Improper programming of accessory connector of transmit radio. | 2d. Use RSS to verify and correct:<br>• Pin 4 ("CSQ Detect," active "High")<br>• Pin 12 ("NULL1," active Low"). |
| | 2e. Transmit frequency "busy." | 2e. Wait for channel to clear. Program receiver of transmit radio for "Local" mode. |
| 3. Some field radios can not access telephone. | 3a. Incorrect setup of ZR340. | 3a. Check "Rx" (receive) control setting of ZR340. |
| | 3b. Incorrect programming of field radios. | 3b. Reprogram field radios. |
| | 3c. Incorrect access codes being sent by field radios. | 3c. Reprogram field radios or reeducate radio users. |
| | 3d. Low DTMF deviation in field radios. | 3d. Readjust DTMF deviation for 60% to 70% rated system. |
| 4. No speaker audio heard from receive radio. | 4. JP6 (or P3-15 and P3-16) of ZR340 not jumpered. | 4. Jumper JP6 (inside ZR340) or place radio jumpered accessory plug on ZR340 "Accessory" connector. |
| 5. Transmit radio keys but no or low audio is transmitted. | 5. "Rx" and/or "Tx" control(s) of ZR340 not adjusted correctly. | 5. Adjust "Rx" and/or "Tx" control(s) on ZR340. |
| 6. No "Phone" LED indication when attempting to access telephone line (PSTN). | 6a. Improper programming of field radios or ZR340. | 6a. Reprogram field radios or ZR340. |
| | 6b. Wrong access code transmitted by field radios. | 6b. Reprogram field radios or reeducate radio users. |
| 7. ZR340 will not pulse dial PSTN from field unit DTMF. | 7a. Not programmed for pulse dial. | 7a. Reprogram the ZR340. |
| | 7b. Too much time has elapsed between digits. | 7b. Do not allow more than 5 seconds between digits. |
| 8. Unreliable dialing or misdialed numbers. | 8a. Low DTMF deviation of field radios. | 8a. Readjust DTMF deviation for 60% to 70% of rated system deviation. |
| | 8b. Incorrect setting of "Rx" control on ZR340. | 8b. Reset "Rx" control on ZR340. |

*Table 10-8. Troubleshooting for ZR340 Controller (Cont'd.)*

| Symptom | Problem(s) | Possible Solution(s) |
|---|---|---|
| 9. Unable to access dial tone or answer a call. | 9. Incorrect positions for JP6, JP7, JP8, and JP9 in ZR340. | 9. Check positions of JP6 to JP9 and correct, if necessary. Type of radio will determine correct positions. |
| 10. Intermittently disconnects from call. | 10a. Noisy phone line may false "busy" tone detector.<br>10b. Single character deaccess code may voice false. | 10a. Disable the "busy" tone detector (cmd 86#).<br>10b. Use more than one character in the deaccess code. |

*Table 10-9. Troubleshooting for ZR320 Controller*

| Symptom | Problem(s) | Possible Solution(s) |
|---|---|---|
| 1. No "Rx" LED indication when signal is received. | 1a. Improper programming of accessory connector of receive radio. | 1a. Use RSS Radio Mode to verify and correct:<br>• Pin 4 ("CSQ Detect," active "High")<br>• Pin 12 ("TPL/DPL & CSQ Detect," active "Low"). |
| | 1b. Loose or bad repeater cable to receive radio. | 1b. Check cable connections and replace cable, if necessary. |
| 2. No "Tx" LED indication in repeater mode when properly identified signal is received. Transmit radio does not key. | 2a. Receive radio not programmed for proper TPL/DPL code. | 2a. Use RSS to verify and correct "Rx Squelch Code." |
| | 2b. Improper programming of accessory connector of receive radio. | 2b. Use RSS radio mode to verify and correct:<br>• Pin 4 ("CSQ Detect," active "High")<br>• Pin 12 ("TPL/DPL & CSQ Detect," active "Low"). |
| | 2c. Incorrect programming of ZR320. | 2c. Use RSS to verify and correct:<br>• CSQ, PL tone or DPL code in "Carrier Repeat" highlight (must NOT indicate "Off").<br>• Half Duplex for "Interconnect Mode."<br>**or** Use DTMF to select half-duplex and repeater enabled (40# then 18#). |
| | 2d. Improper programming of accessory connector of transmit radio. | 2d. Use RSS radio mode to verify and correct:<br>• Pin 4 ("CSQ Detect," active "High")<br>• Pin 12 ("NULL1," active "Low"). |
| | 2e. Transmit frequency "busy." | 2e. Wait for channel to clear. Program receiver of transmit radio for "Local" mode. |

*Table 10-9. Troubleshooting for ZR320 Controller (Cont'd.)*

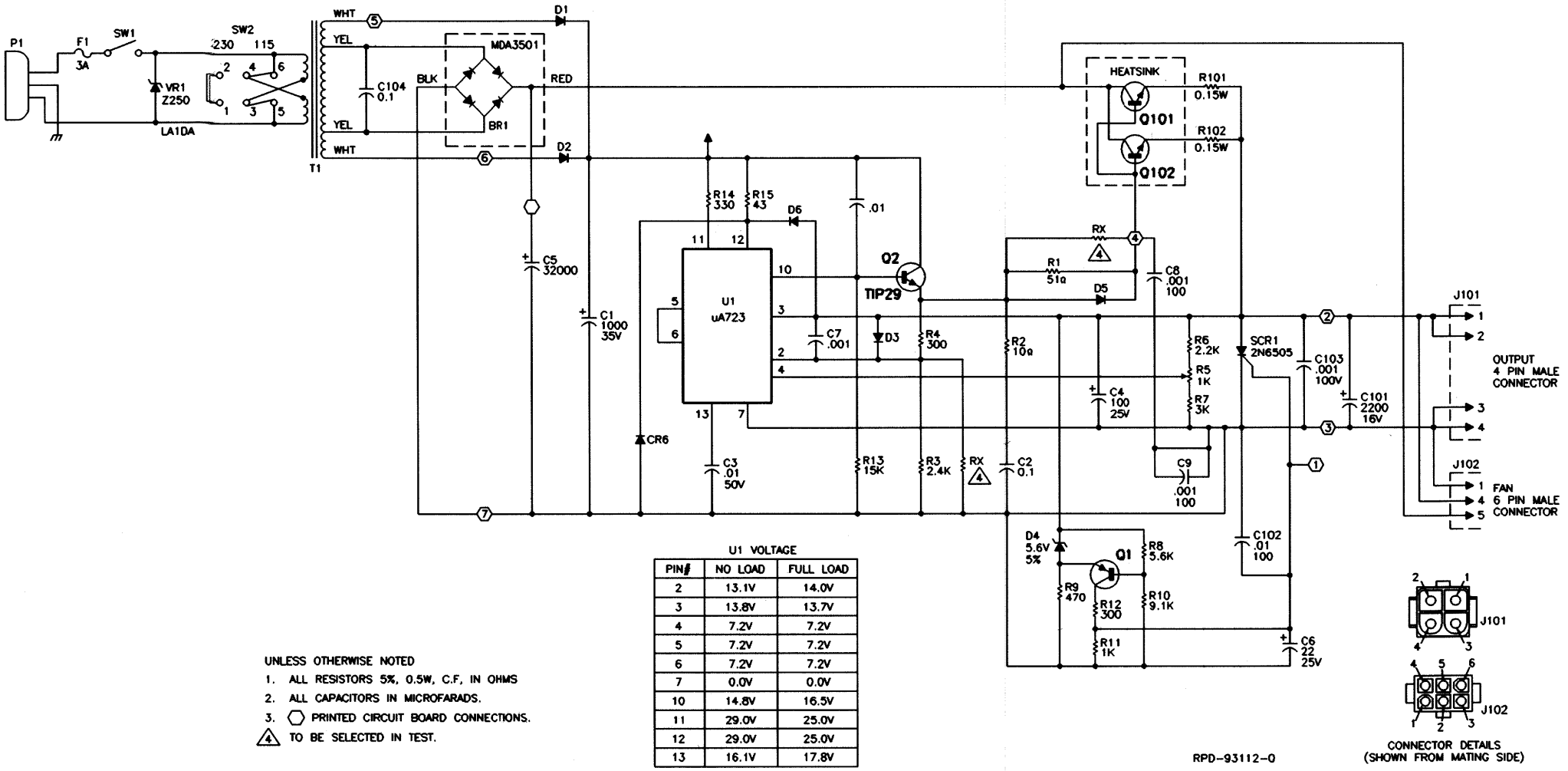
| Symptom | Problem(s) | Possible Solution(s) |
|---|---|---|
| 3. Some field radios can not access system telephone or paging capabilities. | 3a. User ID not valid in ZR320 database.<br>3b. Incorrect setup of ZR320.<br>3c. Incorrect programming of field radios.<br>3d. Incorrect access codes being sent by field radios.<br>3e. Radio users sending access sequence too slowly. | 3a. Add user to database.<br>3b. Use RSS to check and correct database.<br>3c. Reprogram field radios.<br>3d. Reprogram field radios or reeducate radio users.<br>3e. Educate radio users to send sequence with no more than 1 second between characters. |
| 4. No or intermittent decode of proper TPL/DPL/QC-II codes by field radios. | 4a. Improper signalling level to transmit radio.<br>4b. Transmit radio programmed for TPL/DPL (interferes with ZR320 TPL/DPL).<br>4c. JU701 missing in transmit radio (if applicable).<br>4d. Loose or bad repeater cable to transmit radio. | 4a. Adjust "TPL/DPL" control on ZR320.<br>4b. Change transmit radio to CSQ. Use "Carrier Repeat" of ZR320 to generate TPL/DPL for general repeater use.<br>4c. Replace in position "A" and adjust "TPL/DPL" level on ZR320.<br>4d. Check cable connections and replace cable, if necessary. |
| 5. No speaker audio heard from receive radio. | 5. JP1 (or P3-15 and P3-16) of ZR320 not jumpered. | 5. Jumper JP1 (inside ZR320) or place radio jumpered accessory plug on ZR320 "Accessory" connector. |
| 6. Transmit radio keys but no or low audio is transmitted. | 6a. "Audio" control of ZR320 not adjusted correctly.<br>6b. Audio loaded by microphone plugged into transmit radio. DTMF or LED microphone may cause this problem. | 6a. Adjust "Audio" control.<br>6b. Remove microphone. Substitute a non-DTMF and non-LED microphone. |
| 7. Repeated audio has less deviation than incoming received signal. | 7. None | 7. Normal operation; repeated audio is transmitted at 50% system deviation for 60% system deviation input signal. |
| 8. No "Phone" LED indication when attempting to access telephone line (PSTN). | 8a. Improper programming of field radios or ZR320.<br>8b. Wrong access code transmitted by field radios. | 8a. Reprogram field radios or ZR320.<br>8b. Reprogram field radios or educate radio users. |
| 9. Tone and Voice pager talk time too short. | 9a. Incorrect talk time programmed in ZR320.<br>9b. VOX "sensitivity" control not set correctly. | 9a. Reprogram talk time.<br>9b. Readjust R39 (on ZR320 controller board). |
| 10. "Direct Air" mode does not have PL or DPL. | 10. Early version program for ZR320. | 10. Upgrade EPROM available; contact Radius Product Services at 1-800-356-1520 for details. |
| 11. Cannot access ZR320 from a telephone to run Setup/ Testing commands. | 11. ZR320 in single-user mode. | 11. Use RSS or DTMF radio to change to multi-user mode and add a user.<br>OR Wait for 10 rings then dial programming access code. |
| 12. ZR320 will not pulse dial PSTN from field unit DTMF. | 12a. Not programmed for pulse dial.<br>12b. Too much time has elapsed between digits. | 12a. Reprogram the ZR320.<br>12b. Do not allow more than 5 seconds between digits. |

*Table 10-9. Troubleshooting for ZR320 Controller (Cont'd.)*

| Symptom | Problem(s) | Possible Solution(s) |
|---|---|---|
| 13. Low audio to telephone line. | 13a. "Audio" control not set correctly.<br>13b. Early versions of ZR320. | 13a. Adjust "Audio" control on ZR320.<br>13b. Contact Radius Product Services at 1-800-356-1520 for new component values. |
| 14. Poor VOX sensitivity. | 14a. VOX sensitivity control not set correctly.<br>14b. Early versions of ZR320. | 14a. Adjust VOX sensitivity control (inside ZR320).<br>14b. Contact Radius Product Services at 1-800-356-1520 for new component values. |

*Table 10-10. Troubleshooting for ZR330 Controller*

| Symptom | Problem | Solution |
|---|---|---|
| 1. No audio to/from telephone but link with ZR320 repeater is established. | 1a. Accessory connector of receive radio not programmed correctly.<br><br>1b. Loose or bad repeater cable. | 1a. Use RSS Radio Mode to verify and correct:<br>• Pin 4 ("CSQ Detect," active "High")<br>• Pin 12 ("TPL/DPL & CSQ Detect," active "Low")<br>1b. Check cable connection(s) and replace cable, if necessary. |
| 2. ZR330 operates in VOX mode instead of full duplex. | 2a. Companion ZR320 repeater not enabled in full duplex mode.<br><br>2b. Companion ZR320 repeater defined as multi-user. | 2a. Use RSS to change "Interconnect Mode" to "Full Duplex"<br>**or** use DTMF command 41#.<br>2b. VOX operation of ZR330 is **required**. |
| 3. Cannot establish "link" to ZR320 for line extender operation. | 3a. Different TPL/DPL in radios in ZR320 and/or ZR330 setups.<br>3b. ZR320 "Unit ID" incorrect or ZR330 not in database.<br>3c. ZR330 not programmed correctly. | 3a. Check radios and reprogram, if necessary.<br>3b. Reprogram ZR320 for "Unit ID" of "0." Add ZR330 to ZR320 database.<br>3c. Use RSS to check:<br>• Unit ID–must be 0 (zero).<br>• "Phone Only Mode" should be "Y." |




U1 VOLTAGE

| PIN# | NO LOAD | FULL LOAD |
|---|---|---|
| 2 | 13.1V | 14.0V |
| 3 | 13.8V | 13.7V |
| 4 | 7.2V | 7.2V |
| 5 | 7.2V | 7.2V |
| 6 | 7.2V | 7.2V |
| 7 | 0.0V | 0.0V |
| 10 | 14.8V | 16.5V |
| 11 | 29.0V | 25.0V |
| 12 | 29.0V | 25.0V |
| 13 | 16.1V | 17.8V |

UNLESS OTHERWISE NOTED
1. ALL RESISTORS 5%, 0.5W, C.F, IN OHMS
2. ALL CAPACITORS IN MICROFARADS.
3. ⬡ PRINTED CIRCUIT BOARD CONNECTIONS.
4. △ TO BE SELECTED IN TEST.

NOTE: THIS IS AN ASTRON SL-14M POWER SUPPLY (IN THIS CASE, THE "M" STANDS FOR MOTOROLA- THERE ARE NO METERS ON THIS UNIT)

*Schematic Diagram for GR300 Power Supply*

# Parts List

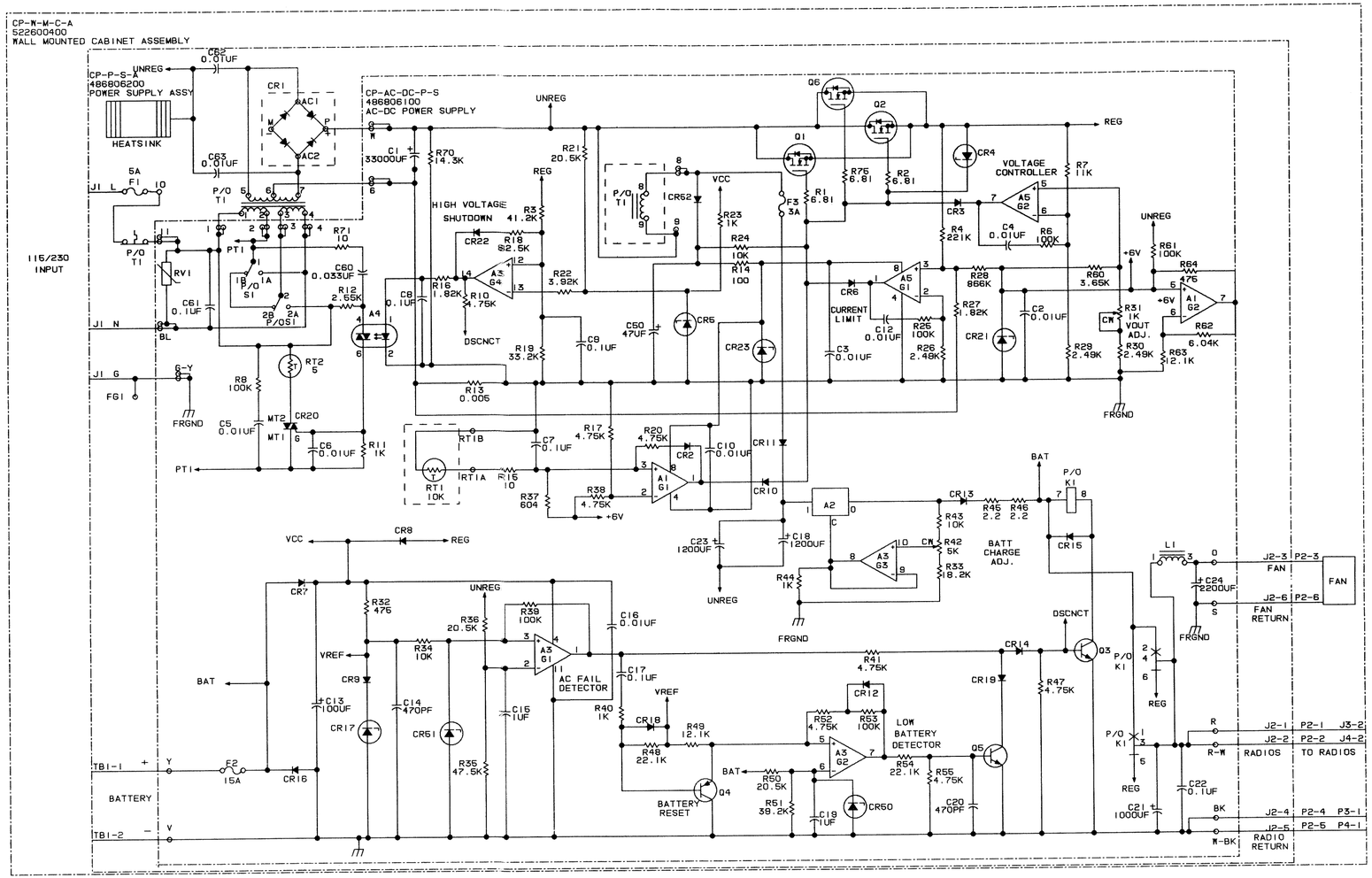
GR500 Power Supply — PL-941033

| REFERENCE SYMBOL | RELIANCE/COMM-TEC PART NO. | DESCRIPTION |
|---|---|---|
| | | **terminal, plug:** unless otherwise stated |
| 1 thru 4 | 245775100 | |
| 6 | 355310400 | |
| 8, 9 | 245775100 | |
| 11 | 245775100 | |
| BL | 245775100 | |
| BK | 245380900 | |
| G-Y | 245775100 | |
| O | 245380800 | |
| R | 245380900 | |
| R-W | 245380900 | |
| RT1A | 245380600 | |
| RT1B | 245380600 | |
| S | 245380800 | |
| V | 245380900 | |
| W | 355310400 | |
| W-BK | 245380900 | |
| Y | 245380900 | |
| | | **integrated circuit: (see note)** |
| A1 | 287114400 | LM258N |
| A2 | 287133200 | MC7805BT |
| A3 | 287112400 | LM224J |
| A4 | 285713200 | M0C3023T |
| A5 | 287114400 | LM258N |
| | | **capacitor, fixed: uF +/-1%; 50 V:** unless otherwise stated |
| C1 | 273138810 | 33,000; 40 V; electrolytic |
| C2 thru 6 | 272458000 | 0.01 |
| C7 thru 9 | 272450900 | 0.1 |
| C10 | 272458000 | 0.01 |
| C12 | 272458000 | 0.01 |
| C13 | 273113200 | 100; 25 V; electrolytic |
| C14 | 272465000 | 470 pF |
| C15 | 272450700 | 1 |
| C16 | 272458000 | 0.01 |
| C17 | 272450900 | 0.1 |
| C18 | 273125100 | 1200; 16 V; electrolytic |
| C19 | 272450700 | 1 |
| C20 | 272465000 | 470 pF |
| C21 | 273121300 | 1000; 35 V; electrolytic |
| C22 | 272450900 | 0.1 |
| C23 | 273125100 | 1200; 16 V; electrolytic |
| C24 | 273125800 | 2200; 16 V |
| C50 | 273112500 | 47; 50 V; electrolytic |
| C60 | 272468200 | 0.033; 200 V |
| C61 | 271451700 | 0.1; 250 V |
| | | **diode: (see note)** |
| CR2, 3 | 281110100 | 1N4148 |
| CR4 | 283623500 | 1N4744A |
| CR5 | 283532500 | 1N823; 6.2 V; zener |
| CR6 | 281110100 | 1N4148 |
| CR7, 8 | 281222200 | 1N4003 |
| CR9, 10 | 281110100 | 1N4148 |
| CR11 | 281242000 | BYV27-200 |
| CR12 | 281110100 | 1N4148 |
| CR13 | 281242000 | BYV27-200 |
| CR14 | 281110100 | 1N4148 |
| CR15 | 281222200 | 1N4003 |
| CR16 | 281303500 | MR756 |
| CR17 | 283541100 | 1N4736A; 6.8 V; zener |
| CR18, 19 | 281110100 | 1N4148 |
| CR20 | 286503800 | MAC223A8 |
| CR21 | 283532500 | 1N823; 6.2 V; zener |
| CR22 | 281110100 | 1N4148 |
| CR23 | 283651500 | 1N4751A; 30 V; zener |
| CR50 | 283627300 | 1N4745ARL; 16 V; zener |
| CR51 | 283651500 | 1N4751A; 30 V; zener |
| CR52 | 281242000 | BYV27-200 |
| | | **fuse:** |
| F2 | 248326500 | 15 A |
| F3 | 248319200 | 3 A |
| | | **relay:** |
| K1 | 254331600 | DPDT, 12 V |

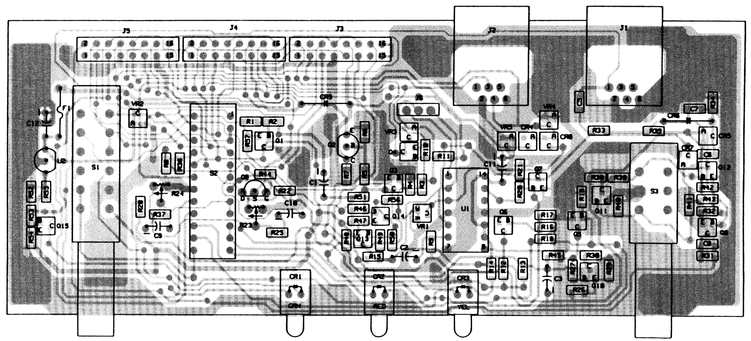
GR500 Power Supply — PL-941033

| REFERENCE SYMBOL | RELIANCE/COMM-TEC PART NO. | DESCRIPTION |
|---|---|---|
| | | **choke, filter:** |
| L1 | 441165000 | |
| | | **transistor: (see note)** |
| Q1, 2 | 285226900 | MTH40N10 |
| Q3 | 284106100 | 2N3904 |
| Q4 | 284305600 | 2N3906 |
| Q5 | 284106100 | 2N3904 |
| Q6 | 285226900 | MTH40N10 |
| | | **resistor, fixed: +/-1%; 1/4 W:** unless otherwise stated |
| R1, 2 | 263452100 | 6.81 Ω |
| R3 | 263467800 | 41.2 k |
| R4 | 263471400 | 221 k |
| R6 | 263469600 | 100 k |
| R7 | 263465100 | 11 k |
| R8 | 263469600 | 100 k |
| R10 | 263463200 | 4.75 k |
| R11 | 263459700 | 1 k |
| R12 | 263564400 | 2.55 k; 1 W |
| R13 | 266310000 | 0.005 Ω; 3 W |
| R14 | 263455700 | 100 Ω |
| R15 | 263452400 | 10 Ω |
| R16 | 263460900 | 1.82 k |
| R17 | 263463200 | 4.75 k |
| R18 | 263469300 | 82.5 k |
| R19 | 263467300 | 33.2 k |
| R20 | 263463200 | 4.75 k |
| R21 | 263466400 | 20.5 k |
| R22 | 263462700 | 3.92 k |
| R23 | 263459700 | 1 k |
| R24 | 263464800 | 10 k |
| R25 | 263469600 | 100 k |
| R26 | 263461600 | 2.49 k |
| R27 | 263460900 | 1.82 k |
| R28 | 263474300 | 866 k |
| R29, 30 | 263461600 | 2.49 k |
| R31 | 267511200 | 1 k; 1/2 W; variable |
| R32 | 263458200 | 475 Ω |
| R33 | 263466200 | 18.2 k |
| R34 | 263464800 | 10 k |
| R35 | 263468100 | 47.5 k |
| R36 | 263466400 | 20.5 k |
| R37 | 263458800 | 604 Ω |
| R38 | 263463200 | 4.75 k |
| R39 | 263469600 | 100 k |
| R40 | 263459700 | 1 k |
| R41 | 263463200 | 4.75 k |
| R42 | 267511700 | 5 k; 1/2 W; variable |
| R43 | 263464800 | 10 k |
| R44 | 263459700 | 1 k |
| R45, 46 | 263760300 | 2.2 Ω |
| R47 | 263463200 | 4.75 k |
| R48 | 263466500 | 22.1 k |
| R49 | 263465200 | 12.1 k |
| R50 | 263466400 | 20.5 k |
| R51 | 263467600 | 39.2 k |
| R52 | 263463200 | 4.75 k |
| R53 | 263469600 | 100 k |
| R54 | 263466500 | 22.1 k |
| R55 | 263463200 | 4.75 k |
| R60 | 263462600 | 3.65 k |
| R61 | 263469600 | 100 k |
| R62 | 263463100 | 6.04 k |
| R63 | 263465200 | 12.1 k |
| R64 | 263458200 | 475 Ω |
| R70 | 263465500 | 14.3 k |
| R71 | 263452400 | 10 Ω |
| R75 | 263452100 | 6.81 Ω |
| | | **thermistor:** |
| RT2 | 267619800 | 5 Ω; 1/4 W |
| | | **varistor:** |
| RV1 | 267635500 | 275 V; V275LA40A |
| | | **switch:** |
| S1 | 251370500 | 115/230 V |

**note1:** For optimum performance, diodes, transistors, and integrated circuits must be ordered by Reliance/Comm-Tec part numbers from Reliance/Comm-Tec.




*Schematic Diagram and Parts List for GR500 Power Supply*



**Component Side Plating (Gray)** RCB-94119-O

**Solder Side Plating (Pink)** RCB-94120-O

**Component Side Overlay** RCB-94121-O

# Parts List

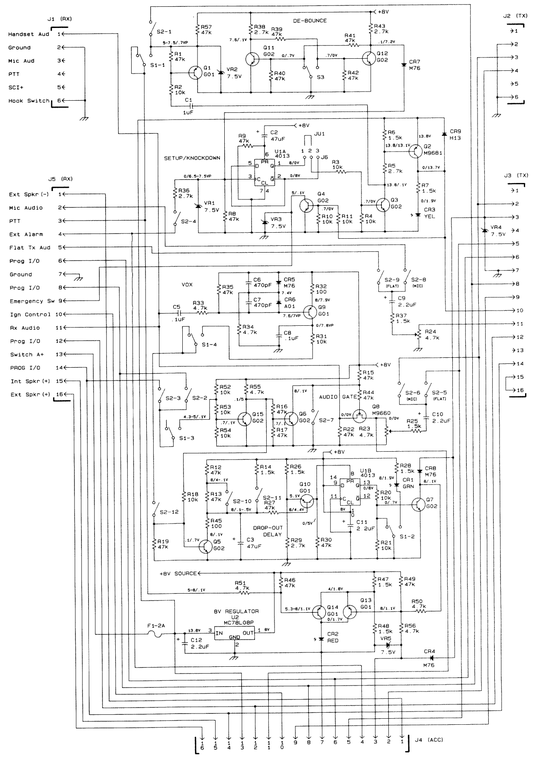
Basic Repeater Controller — PL-911001-C

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| | | **capacitor, chip: uF +/-5%; 50 V; unless otherwise stated** |
| C1 | 0811051A19 | 1; 63 V; polyester |
| C2, 3 | 2311048B19 | 47; ±20%; 16 V; electrolytic |
| C5 | 2113741B69 | 0.1 |
| C6, 7 | 2113740B65 | 470 pF |
| C8 | 2113741B69 | 0.1 |
| C9 thru 12 | 2311048B06 | 2.2; ±20%; electrolytic |
| | | **diode: (see note)** |
| CR1 | 4888245C22 | LED, green |
| CR2 | 4888245C24 | LED, red |
| CR3 | 4888245C23 | LED, yellow |
| CR4, 5 | 4805129M76 | silicon, MMBD914 |
| CR6 | 4884616A01 | hot carrier |
| CR7, 8 | 4805129M76 | silicon, MMDB914 |
| CR9 | 4880008E01 | silicon, 1N4005 |
| | | **fuse:** |
| F1 | 6505214E04 | 2 A |
| | | **jumper:** |
| JU1 | 0984181L01 | push-on, 2-pin |
| | | **connector, receptacle:** |
| J1, 2 | 0983112N01 | 6-pin TELCO |
| J3 thru 5 | 2880923V01 | male, 16-pin |
| J6 | 2880002P03 | 3-pin header |
| | | **transistor: (see note)** |
| Q1 | 4880214G01 | PNP; MMBT3906 |
| Q2 | 4800869681 | PNP; M9681 |
| Q3 thru 7 | 4880214G02 | NPN; MMBT3904 |
| Q8 | 4800869660 | P-channel; J-FET; 2N5461 |
| Q9, 10 | 4880214G01 | PNP; MMBT3906 |
| Q11, 12 | 4880214G02 | NPN; MMBT3904 |
| Q13, 14 | 4880214G01 | PNP; MMBT3906 |
| Q15 | 4880214G02 | NPN; MMBT3904 |
| | | **resistor, fixed: +/-5%; 1/8 W: unless otherwise stated** |
| R1 | 0611077B15 | 47 k |
| R2 thru 4 | 0611077A98 | 10 k |
| R5 | 0611077A84 | 2.7 k |
| R6, 7 | 0611077A78 | 1.5 k |
| R8, 9 | 0611077B15 | 47 k |
| R10, 11 | 0611077A98 | 10 k |
| R12, 13 | 0611077B15 | 47 k |
| R14 | 0611077A78 | 1.5 k |
| R15 thru 17 | 0611077B15 | 47 k |
| R18 | 0611077A98 | 10 k |
| R19 | 0611077B15 | 47 k |
| R20, 21 | 0611077A98 | 10 k |
| R22 | 0611077B15 | 47 k |
| R23, 24 | 1805500L05 | 4.7 k, variable |
| R25, 26 | 0611077A78 | 1.5 k |
| R27 | 0611077B15 | 47 k |
| R28 | 0611077A78 | 1.5 k |
| R29 | 0611077A84 | 2.7 k |
| R30 | 0611077B15 | 47 k |
| R31 | 0611077A98 | 10 k |
| R32 | 0611077A50 | 100 Ω |
| R33, 34 | 0611077A90 | 4.7 k |
| R35 | 0611077B15 | 47 k |
| R36 | 0611077A84 | 2.7 k |
| R37 | 0611077A78 | 1.5 k |
| R38 | 0611077A84 | 2.7 k |
| R39 thru 42 | 0611077B15 | 47 k |
| R43 | 0611077A84 | 2.7 k |
| R44 | 0611077B15 | 47 k |
| R45 | 0611077A50 | 100 Ω |
| R46 | 0611077B15 | 47 k |
| R47, 48 | 0611077A78 | 1.5 k |
| R49 | 0611077B15 | 47 k |
| R50, 51 | 0611077A90 | 4.7 k |
| R52 thru 54 | 0611077A98 | 10 k |
| R55, 56 | 0611077A90 | 4.7 k |
| R57 | 0611077B15 | 47 k |

Basic Repeater Controller — PL-911001-C

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| | | **switch:** |
| S1 | 4084324C10 | 4 PDT |
| S2 | 4083022M04 | SPDT, 12-pos |
| S3 | 4080065E02 | DPDT |
| | | **integrated circuit: (see note)** |
| U1 | 5184887K13 | MC14013 - CMOS dual D- flip-flop |
| U2 | 5184621K73 | MC78L08P - 3-terminal LP pos reg |
| | | **voltage regulator: (see note)** |
| VR1 thru 5 | 4880140L11 | Zener, 7.5 V 5% 250 mW SOT |
| | | **non-referenced items** |
| | 1484360C01 | INSULATOR, S1, 2 used; S3, 1 used |

**note:** For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.




NOTES:
1. Pin assignments for J1 and J2 are identical.
2. Pin assignments for J3, J4 and J5 are identical.
3. JU1-A1 power up 1-2 for rptr on/2-3 for rptr off.
4. All voltages are dc and measured with hi-Z DMM.
5. S1 and all sections of S2 are shown "OFF".
6. Voltages shown are Inactive/Active state. "P" after a voltage means pulsed (not continuous).
7. Measure voltages with Switch in normal operation with radios attached to J3-TX AND J5-RX. S1, "Repeater Enable", S2-4 and either S2-2 or S2-3 must be "ON" S2-12 must be "ON" to check VOX.

*Schematic Diagram, Circuit Board Details, and Parts Lists For Basic Repeater Controller*

# Parts List

i50R Circuit Board — PL-941008-O

| REFERENCE SYMBOL | I.A.I. PART NO. | DESCRIPTION |
|---|---|---|
| | | **capacitor, fixed: uF, +/-10%, 50 V: unless otherwise stated** |
| C1 | 3306-00220-00 | 22 pF |
| C2 | 4606-00470-00 | 47 pF |
| C3 | 3306-01003-00 | 0.1 |
| C4 | 3306-44704-00 | 4.7, 20 V |
| C5 | 3306-41004-00 | 1 |
| C6 | 3306-01001-00 | 0.001 |
| C7 thru 9 | 3306-41004-00 | 1 |
| C10 | 3306-01003-00 | 0.1 |
| C11 | 3306-41004-00 | 1 |
| C12, 13 | 3306-01003-00 | 0.1 |
| C14 | 3306-01001-00 | 0.001 |
| C15 | 3306-41004-00 | 1 |
| C16 | 4606-10010-00 | 100 |
| C17 thru 20 | 3306-26110-00 | 4700 pF |
| C21 | 3306-01000-00 | 100 pF |
| C22 | 3306-01001-00 | 0.001 |
| C23 | 3306-01003-00 | 0.1 |
| C24 thru 26 | 3306-01000-00 | 100 pF |
| C27 | 4606-01002-20 | 0.01 |
| C28 | 3306-01000-00 | 100 pF |
| C30 | 4606-06104-00 | 0.1, 630 V |
| C31 | 3306-01003-00 | 0.1 |
| C32 | 4606-01002-20 | 0.01 |
| C33 | 3306-01001-00 | 0.001 |
| C35, 36 | 3306-01003-00 | 0.1 |
| C37 | 3306-41004-00 | 1 |
| C38 thru 44 | 3306-01003-00 | 0.1 |
| C45 | 3306-01001-00 | 0.001 |
| C46 | 3306-02700-00 | 270 pF |
| C47 | 3306-01000-00 | 100 pF |
| C48,49 | 3306-01003-00 | 0.1 |
| C50 | 3306-01000-00 | 100 pF |
| C52 thru 54 | 3306-01000-00 | 100 pF |
| C55 | 3306-01001-00 | 0.001 |
| C56, 57 | 4606-01002-20 | 0.01 |
| C300 thru 302 | 3306-00220-00 | 22 pF |
| C303 | 4606-41204-00 | 2.2 |
| C304 | 4604-10500-00 | 1 Tant. |
| C305 thru 307 | 3306-00220-00 | 22 pF |
| C308 | 3306-44704-00 | 4.7, 20 V |
| C309 | 4606-41204-00 | 2.2 |
| C310 | 3306-00220-00 | 22 pF |
| C311 | 4606-41204-00 | 2.2 |
| C312 | 3306-01003-00 | 0.1 |
| C313 | 3306-41004-00 | 1 |
| C314 | 4606-01103-00 | 0.01 |
| C316 | 3306-41004-00 | 1 |
| C317 | 3306-01003-00 | 0.1 |
| | | **coil, rf:** |
| L1 | 3307-00099-40 | Choke |
| L2 | 4607-60000-00 | Choke |
| L5 | 4607-60000-00 | Choke |
| L6, 7 | 3307-00010-30 | 1.2 mH Choke |
| | | **connector, receptacle:** |
| J2 | 4611-52025-00 | Mod Tel Jack |
| J3 thru 5 | 4611-80923-01 | 16 Pin |
| | | **crystal: (see note)** |
| X1 | 3312-00100-00 | 3.57 mHz |
| | | **diode: (see note)** |
| D1, 2 | 3302-20002-00 | Switching |
| D3 thru 15 | 3302-20008-00 | Silicon, Signal |
| D16, 17 | 3302-20012-00 | Zener, 8.2 V |
| D18,19 | 3302-20010-00 | Zener, 6.8 V |
| D20 | 3302-20005-00 | Zener, 18 V |
| D301 thru 305 | 3302-20008-00 | Silicon, Signal |
| | | **fuse:** |
| F1 | 4612-10500-20 | |

i50R Circuit Board — PL-941008-O

| REFERENCE SYMBOL | I.A.I. PART NO. | DESCRIPTION |
|---|---|---|
| | | **integrated circuit: (see note)** |
| U1 | 4601-10147-00 | Microprocessor |
| U2 | 4601-10241-00 | Octal D-Type Latch |
| U3 | 4601-10190-00 | EPROM |
| U4 | 4601-41485-00 | PIA |
| U5 | 4601-10112-00 | Hex Schmitt Inverter |
| U6 | 4601-10165-00 | Quad NAND Gate |
| U7 | 4601-10154-00 | Regulator |
| U8, 9 | 4601-10225-00 | Dual Op Amp |
| U10 | 4601-10214-00 | Quad Op Amp |
| U11 | 3301-10006-00 | Quad Op Amp |
| U12 | 3301-10021-00 | Analog Multiplexer |
| U13 | 3301-10022-00 | Quad NAND Gate |
| U14 | 3301-10001-00 | D/A Converter |
| U15 | 4601-10166-00 | Dual Analog Gate |
| U16 | 4601-10167-00 | DTMF Transceiver |
| U17 | 3301-10025-00 | Binary Counter |
| U18 | 4601-10219-00 | Opto-Isolator |
| U29 | 4601-10225-00 | Dual Op Amp |
| U301 | 3301-10017-00 | Hex Inverter |
| U302 | 3301-10022-00 | Quad Schmitt NAND |
| U303 | 3301-10012-00 | D-Type Flip Flop |
| U304 | 3301-10016-00 | Triple NOR Gate |
| U305 | 4601-10271-00 | 8 V Regulator |
| U306 | 3301-10059-00 | Timer |
| U307 | 3301-10010-00 | Quad NOR Gate |
| | | **jumper:** |
| JU1 thru 3 | 4611-91024-00 | 2 Pin |
| JU4, 5 | 4611-10004-00 | 4 Pin Header |
| JU6 | 4611-91024-00 | 2 Pin |
| JU21 | 4611-10003-10 | 3 Pin Plug |
| | | **light emitting diode: (see note)** |
| LED1, 2 | 3306-00750-00 | Red |
| LED3 | 4602-01503-00 | Green |
| LED4 | 4602-01400-00 | Yellow |
| LED5 thru 7 | 3306-00750-00 | Red |
| | | **miscellaneous** |
| POT1 | 3305-05001-10 | 5 k |
| S1, 2 | 4612-20026-00 | Surge Suppressor |
| SR1 | 5604-01002-05 | SIP-Y, 10 k, Resistor Array |
| SR4 | 5604-01003-05 | SIP-X, 100 k, Resistor Array |
| SR5, 6 | 5604-01002-05 | SIP-Y, 10 k, Resistor Array |
| SR7 thru 9 | 5604-11003-05 | SIP-X, 100 k, Resistor Array |
| SR10, 11 | 5604-01002-05 | SIP-Y, 10 k, Resistor Array |
| | | **relay:** |
| K1 | 3310-01193-00 | |
| | | **resistor, fixed: Ohms, +/-5%; 1/4 W: unless otherwise stated** |
| R1, 2 | 3303-01001-10 | 1 k |
| R17 | 3303-04701-10 | 4.7 k |
| R18 | 3303-02201-10 | 2.2 k |
| R19 | 3303-01002-10 | 10 k |
| R20 | 3303-01000-10 | 100 |
| R21 | 3303-01003-10 | 100 k |
| R22 | 3303-04702-10 | 47 k |
| R23 | 3303-04702-10 | 470 k |
| R24 | 3303-04701-10 | 4.7 k |
| R25 | 3303-06800-10 | 680 |
| R26, 27 | 3304-01003-10 | 100 k, ±1% |
| R28 | 3304-01002-10 | 10 k, ±1% |
| R29 | 4604-09091-10 | 9.09 k, ±1% |
| R30 | 3304-04992-10 | 49.9 k, ±1% |
| R31 | 3304-03322-10 | 33.2 k, ±1% |
| R32 | 3303-04702-10 | 12 k |
| R33 | 3303-05601-10 | 5.6 k |
| R35 | 3303-04702-10 | 47 k |
| R36 | 3303-03902-10 | 39 k |
| R37 | 4604-01402-10 | 14 k, ±1% |
| R38, 39 | 3304-02943-10 | 294 k, ±1% |

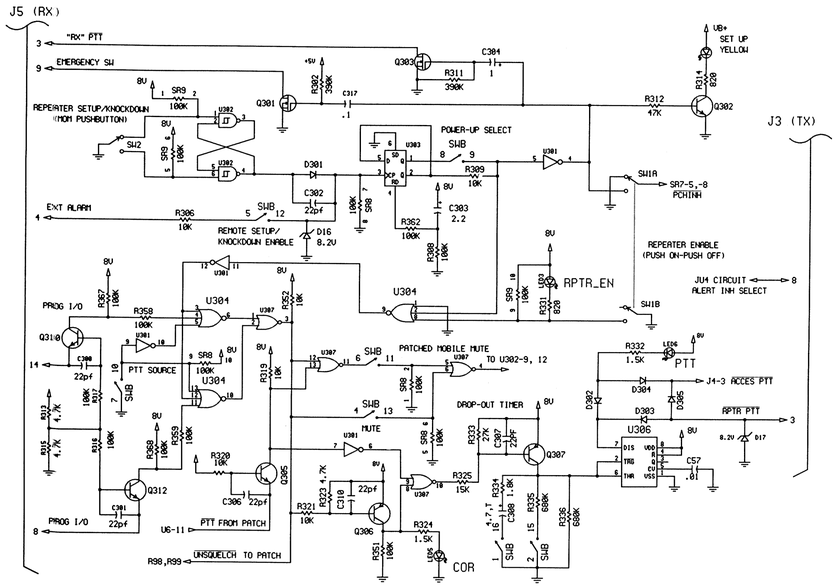
i50R Circuit Board — PL-941008-O

| REFERENCE SYMBOL | I.A.I. PART NO. | DESCRIPTION |
|---|---|---|
| R40 thru 43 | 4604-02944-10 | 2.94 M, ±1% |
| R44, 45 | 3303-02002-10 | 39 k |
| R46 | 3303-01002-10 | 10 k |
| R51 | 3304-02212-10 | 22.1 k, ±1% |
| R52 | 3304-01002-10 | 10 k, ±1% |
| R53 | 3304-04991-10 | 4.99 k, ±1% |
| R54, 55 | 3304-01002-10 | 10 k, ±1% |
| R56 | 3304-02943-10 | 294 k, ±1% |
| R57 | 3304-02942-10 | 29.4 k, ±1% |
| R60 | 3303-03902-10 | 39 k |
| R61 | 3303-04702-10 | 47 k |
| R62 | 3303-02702-10 | 27 k |
| R63, 64 | 3304-01003-10 | 100 k, ±1% |
| R65 | 3304-04992-10 | 49.9 k, ±1% |
| R66 | 3304-01003-10 | 100 k, ±1% |
| R67 | 3304-04992-10 | 49.9 k, ±1% |
| R68 | 3304-01003-10 | 100 k, ±1% |
| R69 | 3304-04992-10 | 49.9 k, ±1% |
| R70 | 3304-01003-10 | 100 k, ±1% |
| R71 | 3304-04992-10 | 49.9 k, ±1% |
| R72 | 3304-01003-10 | 100 k, ±1% |
| R73 | 3303-01801-10 | 1.8 k |
| R76 | 3303-01801-10 | 1.8 k |
| R80 | 3303-01203-10 | 120 k |
| R81 | 3303-01803-10 | 180 k |
| R90 | 3303-02702-10 | 27 k |
| R92, 93 | 3303-05602-10 | 56 k |
| R94 | 3303-02701-10 | 2.7 k |
| R95 | 3303-01502-10 | 15 k |
| R96 | 3303-01501-10 | 1.5 k |
| R97 | 3303-01502-10 | 15 k |
| R98, 99 | 3303-01003-10 | 100 k |
| R100 | 3303-01000-10 | 100 |
| R104 | 3303-01002-10 | 10 k |
| R106, 107 | 4604-04753-10 | 475 k, ±1% |
| R108 | 3303-02702-10 | 27 k |
| R109 | 3304-02212-10 | 22.1 k, ±1% |
| R110 | 3304-04991-10 | 4.99 k, ±1% |
| R111 | 3303-00100-10 | 10 |
| R112 | 3303-04702-10 | 47 k |
| R113 | 3304-02943-10 | 294 k, ±1% |
| R114 | 3303-06200-10 | 620 |
| R118 | 3303-02701-10 | 2.7 k |
| R119 | 3303-01003-10 | 100 k |
| R121 | 3304-02002-10 | 20 k, ±1% |
| R122 | 3304-01002-10 | 10 k, ±1% |
| R123 | 3304-02002-10 | 20 k, ±1% |
| R125 | 4604-09090-10 | 909, ±1% |
| R126, 127 | 4604-01402-10 | 14 k, ±1% |
| R129, 130 | 3303-04703-10 | 470 k |
| R185 | 3303-04702-10 | 47 k |
| R191 | 3303-01001-10 | 1 k |
| R302 | 3303-03903-10 | 390 k |
| R303, 304 | 3303-04702-10 | 47 k |
| R305 | 3303-00100-10 | 10 |
| R306 | 3303-01002-10 | 10 k |
| R308 | 3303-01003-10 | 100 k |
| R309 | 3303-01002-10 | 10 k |
| R311 | 3303-03903-10 | 390 k |
| R312 | 3303-04702-10 | 47 k |
| R313 | 3303-04701-10 | 4.7 k |
| R314 | 3303-08200-10 | 820 |
| R315 | 3303-04701-10 | 4.7 k |
| R316 thru 318 | 3303-01003-10 | 100 k |
| R319 thru 321 | 3303-01002-10 | 10 k |
| R323 | 3303-04701-10 | 4.7 k |
| R324 | 3303-01501-10 | 1.5 k |
| R325 | 3303-01502-10 | 15 k |
| R326 | 3303-01002-10 | 10 k |
| R331 | 3303-08200-10 | 820 |
| R332 | 3303-01501-10 | 1.5 k |
| R333 | 3303-01503-10 | 27 k |
| R334 | 3303-01801-10 | 1.8 k |
| R335, 336 | 3303-06803-10 | 680 k |
| R337 | 3303-01501-10 | 1.5 k |

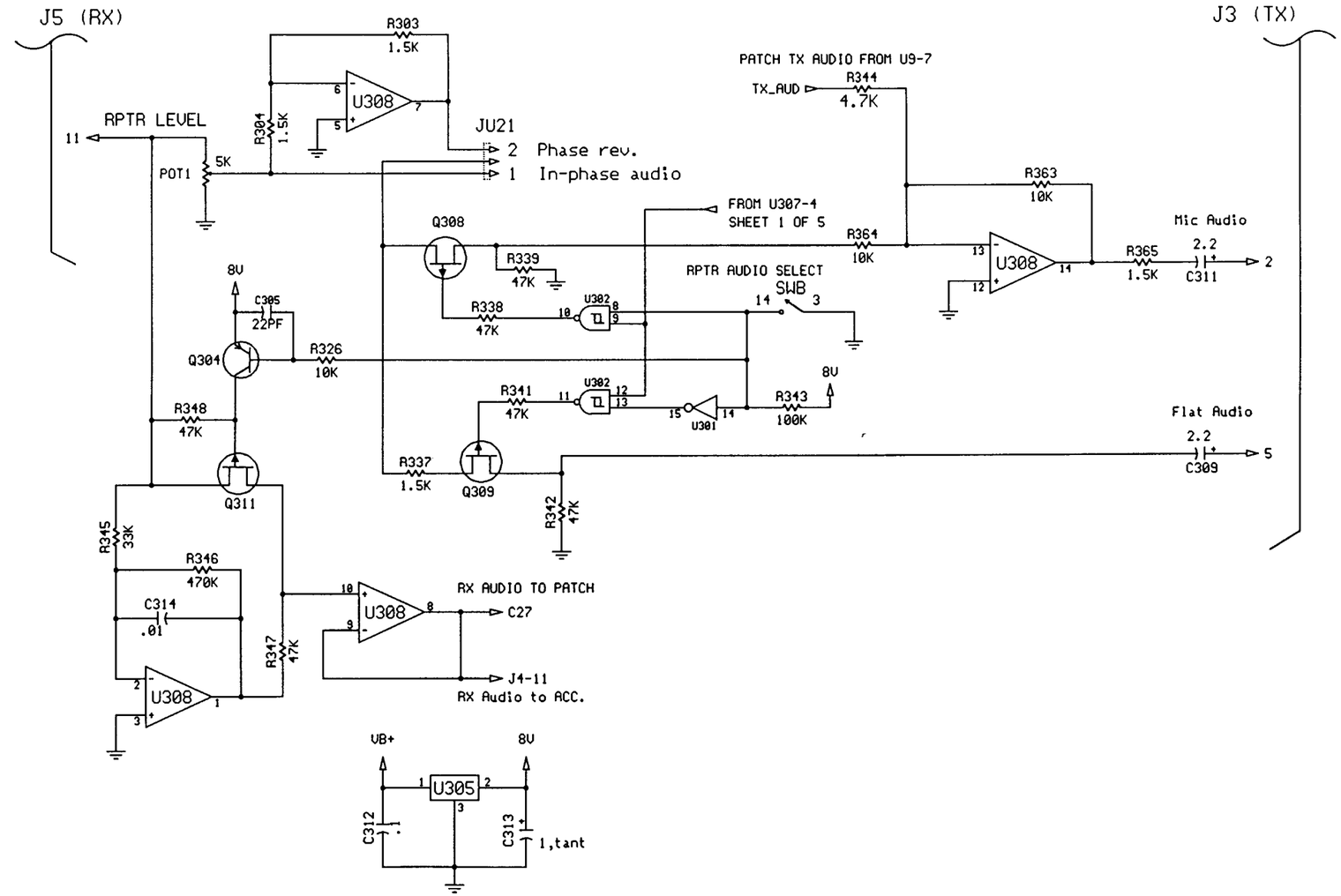
i50R Circuit Board — PL-941008-O

| REFERENCE SYMBOL | I.A.I. PART NO. | DESCRIPTION |
|---|---|---|
| R338, 339 | 3303-04702-10 | 47 k |
| R341, 342 | 3303-04702-10 | 47 k |
| R344 | 3303-04701-10 | 4.7 k |
| R345 | 3303-03902-10 | 33 k |
| R346 | 3303-04703-10 | 470 k |
| R347, 348 | 3303-04702-10 | 47 k |
| R352 | 3303-01002-10 | 10 k |
| R358, 359 | 3303-01003-10 | 100 k |
| R362 | 3303-01003-10 | 100 k |
| R363 | 3303-01002-10 | 10 k |
| R364 | 3303-01002-10 | 10 k |
| R365 | 3303-01501-10 | 1.5 k |
| R366 | 3303-01801-10 | 1.8 k |
| R367, 368 | 3303-01003-10 | 100 k |
| | | **switch:** |
| PB1, 2 | 4612-00211-00 | Push button |
| SW1 | 4612-76000-00 | Push on/Push off |
| SW2 | 4612-77000-00 | Momentary |
| SW3 | 4612-78000-00 | Momentary w/red cap |
| SWA, B | 4612-01008-10 | 8 P PDS |
| | | **transformer:** |
| T1 | 3308-03873-00 | Test |
| | | **translator: (see note)** |
| Q1 thru 3 | 4609-07000-00 | P-Channel FET |
| Q4 | 3309-44030-00 | PNP |
| Q5 | 3309-44010-00 | NPN |
| Q6 | 3309-44030-00 | PNP |
| Q7 | 3309-44010-00 | NPN |
| Q8 | 4609-07000-00 | P-Channel FET |
| Q301 | 4609-07000-00 | P-Channel FET |
| Q302 | 3309-44030-00 | PNP |
| Q303 | 4609-07000-00 | P-Channel FET |
| Q304 | 3309-44030-00 | PNP |
| Q305 | 3309-44010-00 | NPN |
| Q306, 307 | 3309-44030-00 | PNP |
| Q308, 309 | 4609-00175-00 | P-Channel JFET |
| Q310 | 3309-44010-00 | NPN |
| Q311 | 4609-00175-00 | P-Channel JFET |
| Q312 | 3309-44010-00 | NPN |
| | | **non-referenced items** |
| | 6616-30001-06 | M3x6mm Screw, 4 used |
| | 6616-20002-06 | M2x6mm Screw, 4 used |
| | 6616-30000-05 | M3x5mm Screw, 7 used |
| | 3311-30028-00 | 28 Pin Socket |
| | 4611-00032-00 | 0.05 Spacer-breakaway |
| | 4616-20000-00 | #4 Starwasher, 4 used |
| | 4616-44013-16 | 4-40x3/16 Screw, 7 used |
| | 4616-10325-08 | 10-32x5/8 Screw, 2 used |
| | 4616-10320-00 | 10-32 Nut, 2 used |
| | 4616-00000-00 | #10 Flat Washer, 4 used |
| | 4616-10320-01 | 10-32 Hex Nut, 2 used |
| | 4616-00010-00 | #10 Starwasher, 2 used |
| | 4612-11150-10 | Fuse Clip, 2 used |
| | 4616-83462-00 | Screw Terminal |
| | 4616-90720-00 | LED Spacer, 5 used |

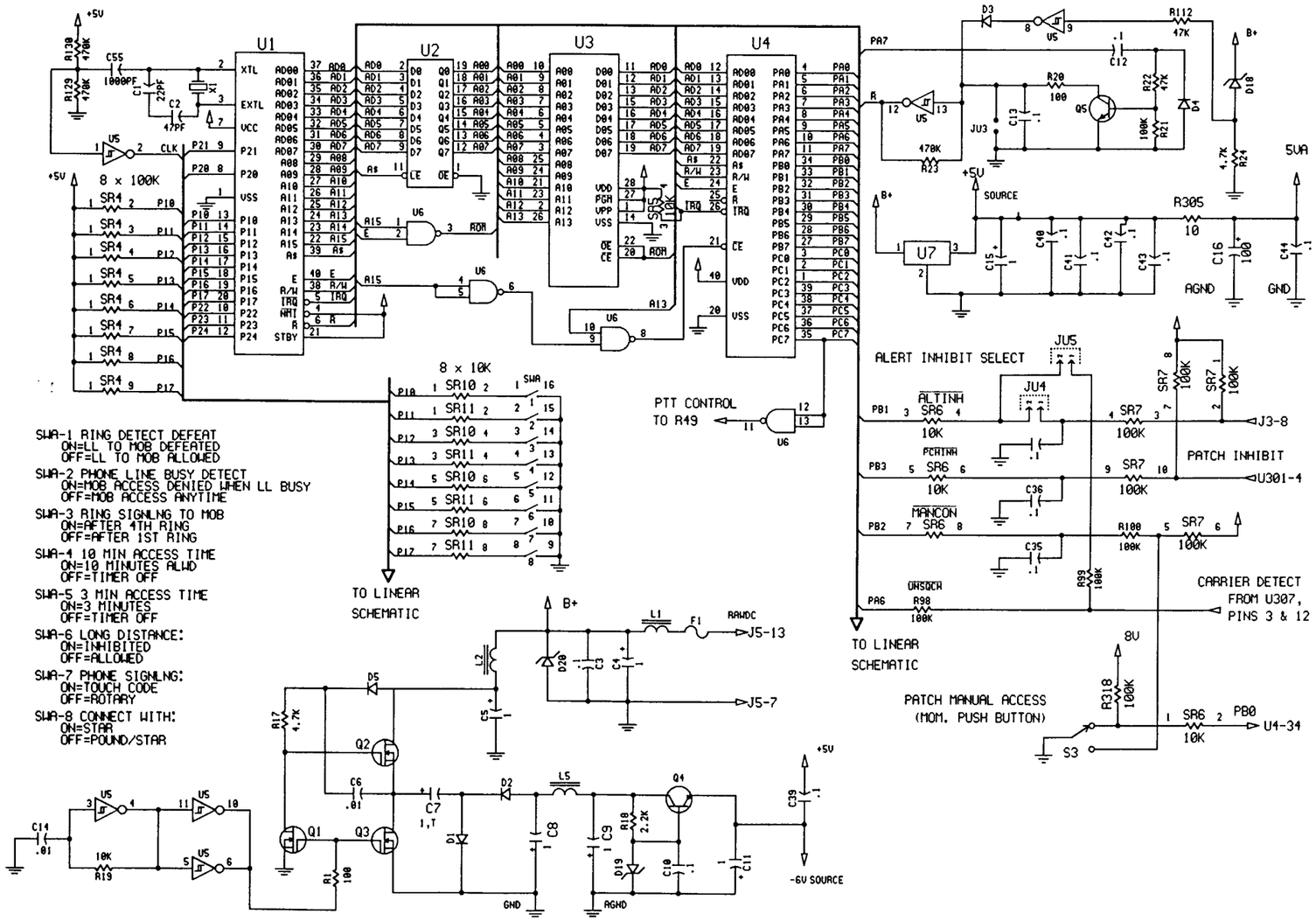
**note:** For optimum performance, diodes, transistors, and integrated circuits must be ordered by Instrument Associates, Inc. (I.A.I.) part numbers from Instrument Associates.



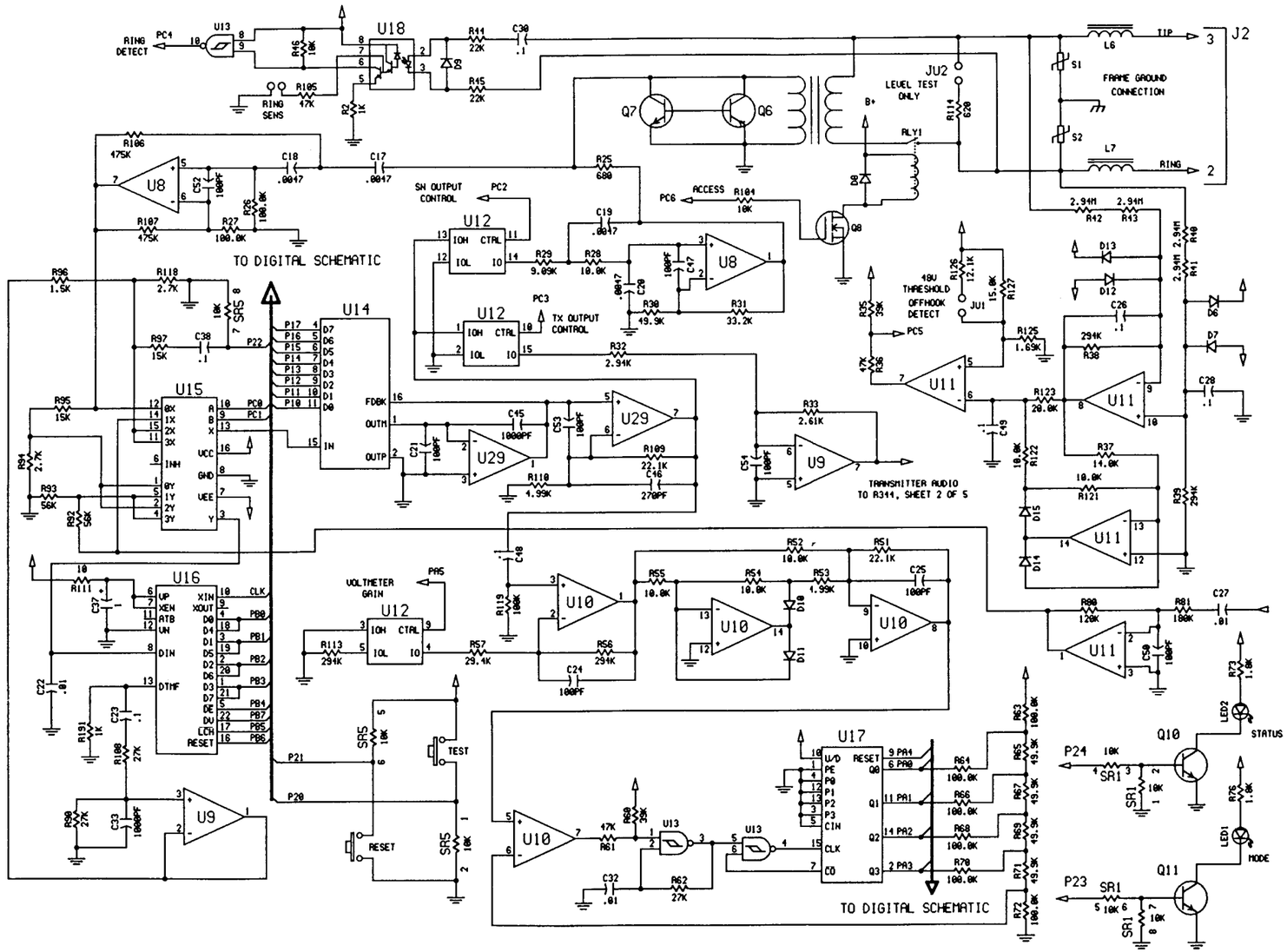

*Schematic Diagram and Parts List for i50R Basic Interconnect Controller, Repeater Interface Circuit (Sheet 1 of 5)*



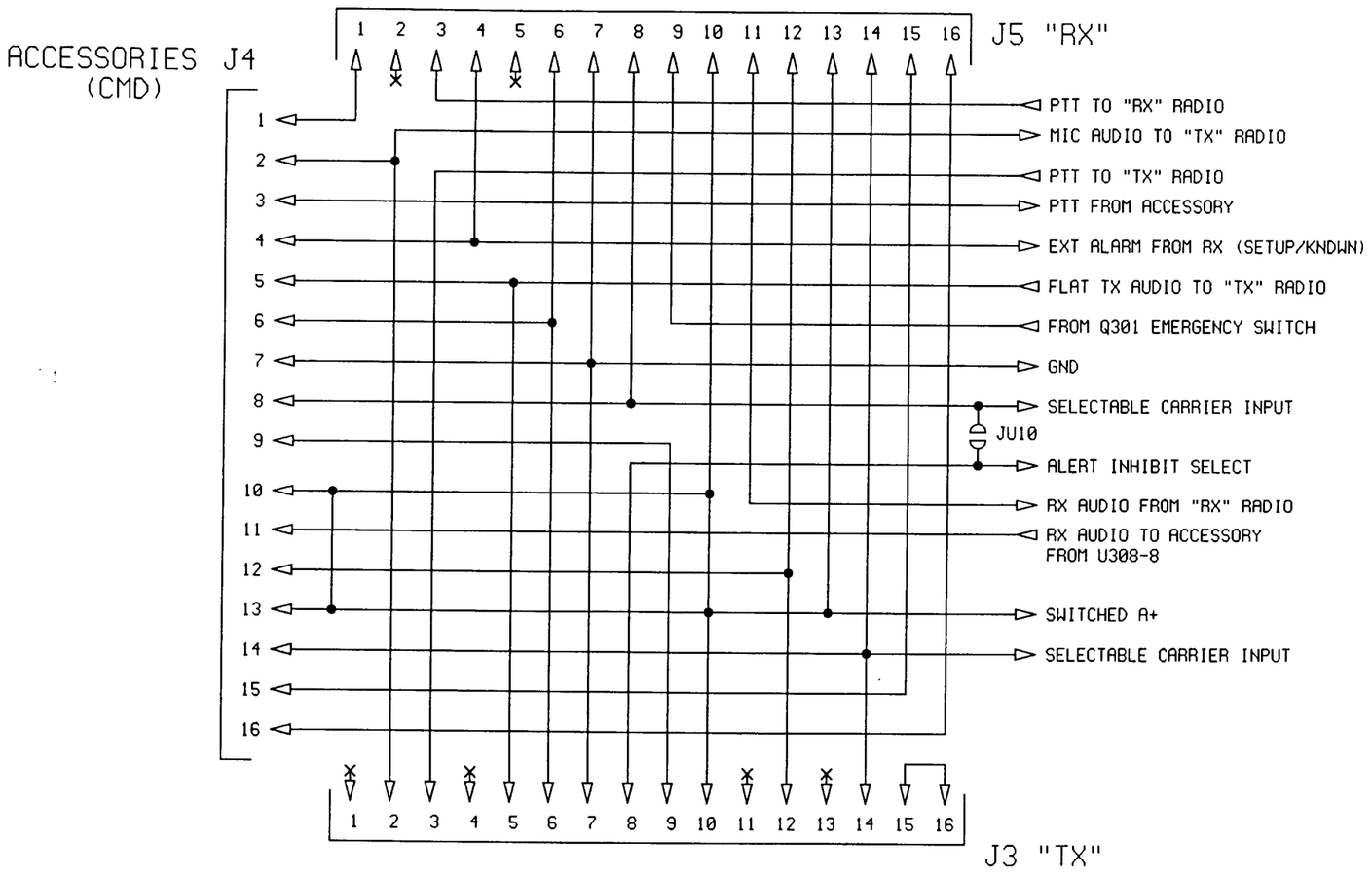

*Schematic Diagrams for i50R Basic Interconnect Controller, Repeater Audio Paths (Sheet 2 of 5)*



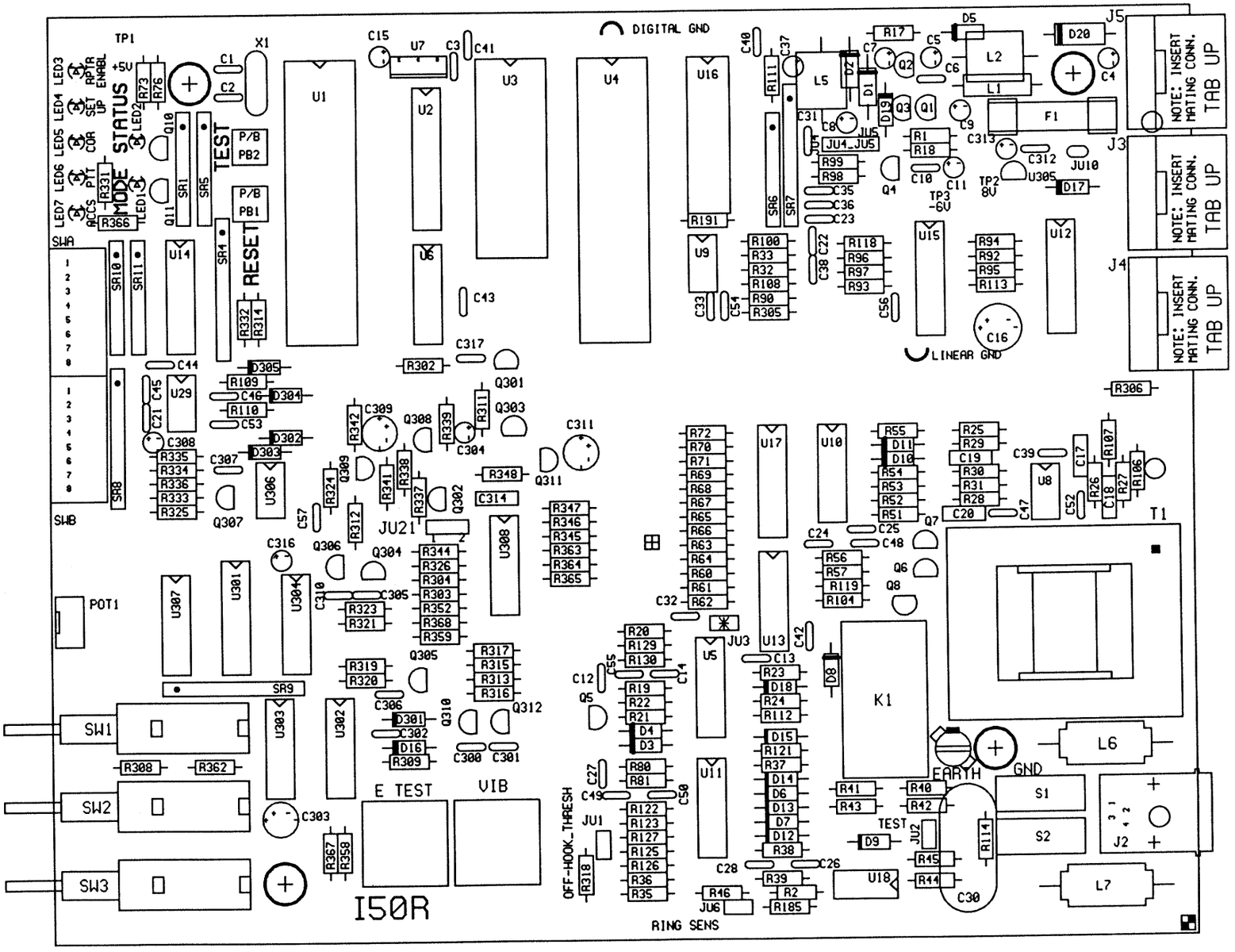

*Schematic Diagrams for i50R Basic Interconnect Controller, Power Supply and Digital Section (Sheet 3 of 5)*




*Schematic Diagrams for i50R Basic Interconnect Controller, Patch Audio Circuits (Sheet 4 of 5)*




*Schematic Diagrams for i50R Basic*
*Interconnect Controller, Interface Schematic Diagram*
*(Sheet 5 of 5)*




*Component Layout Diagram for i50R Basic Interconnect Controller*

# Parts List

ZR340 Advanced Interconnect Controller Board — PL-941017-O

| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| | | **capacitor:ceramic,ftixed:uF+/-10%,50V:** unless otherwise stated |
| C1 | 151-0180 | 0.1; ±20% |
| C2 | 154-0100 | 10; 16 V; tantalum |
| C3 | 151-0180 | 0.1; ±20% |
| C4 thru 11 | 150-0096 | 1000 pF; ±20%; 1 kV |
| C12 | 154-0100 | 10; 16 V; tantalum |
| C13 | 151-0180 | 0.1; ±20% |
| C14 | 155-0083 | 470; 10 V; electrolytic |
| C15 | 154-0100 | 10; 16 V; tantalum |
| C16 | 151-0180 | 0.1; ±20% |
| C17 | 152-0021 | 0.47; 250 V; polyester |
| C18 | 152-0012 | 0.1; ±5%; polyester |
| C19 | 154-0035 | 2.2; (16 V – 25 V) |
| C20, 21 | 154-0100 | 10; 16 V; tantalum |
| C22 thru 24 | 151-0180 | 0.1; ±20% |
| C25 | 151-0047 | 470 pF; ±10%/5%; 100 V/200 V |
| C26 | 151-0020 | 0.001 |
| C27 | 152-0080 | 0.22; ±5% |
| C28 | 155-0077 | 100; ±20%; 25 V; electrolytic |
| C29 | 154-0035 | 2.2; (16 V – 25 V) |
| C30 | 151-0180 | 0.1; ±20% |
| C31, 32 | 151-0022 | 22 pF; ±10%/5%; 100 V/200 V |
| C33, 34 | 152-0012 | 0.1; ±5%; polyester |
| C35, 36 | 154-0100 | 10; 16 V; tantalum |
| C37 | 151-0180 | 0.1; ±20% |
| C38 thru 40 | 152-0012 | 0.1; ±5%; polyester |
| C41 | 152-0080 | 0.22; ±5% |
| C42 | 151-0027 | 270 pF; 100 V/200 V |
| C43 | 151-0180 | 0.1; ±20% |
| C44 | 151-0020 | 0.001 |
| C45 | 152-0012 | 0.1; ±5%; polyester |
| C46 | 151-0020 | 0.001 |
| C47 | 151-0120 | 0.01 |
| C48 | 151-0100 | 0.033; 50 V/100 V |
| C49 | 152-0012 | 0.1; ±5%; polyester |
| C50 | 151-0100 | 0.033; 50 V/100 V |
| C51 | 154-0025 | 4.7; 35 V; tantalum |
| C52 | 151-0180 | 0.1; ±20% |
| C53, 54 | 154-0100 | 10; 16 V; tantalum |
| C55 | 152-0080 | 0.22; ±5% |
| | | **diode: (see note 1)** |
| CR1 | 342-0001 | silicon; 100 V; 1 A |
| CR2 | 343-3110 | 20 V; ±5%; 1 W |
| CR3 | 342-0001 | silicon; 100 V; 1 A |
| CR4 thru 5 | 343-3110 | 20 V; ±5%; 1 W |
| CR6 | | not used |
| CR7 | 343-3035 | 12 V; ±5%; 1 W |
| CR8 | 343-3017 | 6.2 V; ±5%; 1/2 W |
| CR9 | 342-0103 | Schottkey; 0.37 V; 1MA |
| CR10 | 342-0009 | silicon |
| CR11 | 342-0103 | Schottkey; 0.37 V; 1MA |
| | | **light emitting diode: (see note 1)** |
| DS1 | 311-0012 | green |
| DS2 thru 4 | 311-0011 | red |
| | | **ferrite beads:** |
| E1 thru 8 | 305-0001 | w/leads |
| | | **connector, receptacle:** |
| J1 | 401-0080 | 6-pin TELCO |
| J2 | 401-6006 | 6-pos male |
| | | **jumper:** |
| JP1 thru 6 | 403-0002 | not installed |
| JP7 thru 9 | 403-0003 | 2-pin header with plating jumper |
| JP10 | 403-0002 | 2-pin header with plating jumper |
| XJP7 thru 9 (pos A) | 402-3040 | mini jumper |
| | | **relay:** |
| K1 | 380-0030 | DPDT 12 V;±5% 3600 HM |
| | | **connector, plug:** |
| P1 thru 3 | 401-0254 | double row header, 16 pin |
| P4 | 403-0004 | 4-pin connector |

ZR340 Advanced Interconnect Controller Board — PL-941017-O

| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| | | **transistor: (see note 1)** |
| Q1 | 340-7000 | HEX fet |
| Q2 | 340-3904 | NPN 40 V; 200 MA |
| Q3 | | not used |
| Q4 | 340-0014 | NPN Darlington |
| Q5, 6 | 340-3904 | NPN 40 V; 200 MA |
| Q7 thru 9 | 340-7000 | HEX fet |
| | | **resistor,carbonfilm,ftixed:w/-5%;1/4W:** unless otherwise stated |
| R1 | 101-0078 | 1.8 k |
| R2 | 101-0121 | 100 k |
| R3, 4 | 101-0097 | 10 k |
| R5 | 101-0121 | 100 k |
| R6 | 101-0097 | 10 k |
| R7 thru 9 | 101-0121 | 100 k |
| R10 | 101-0097 | 10 k |
| R11 | 101-0068 | 620 Ω |
| R12 | 101-0025 | 10 Ω |
| R13 | 101-0109 | 33 k |
| R14 | 101-0105 | 22 k |
| R15 | 101-0033 | 22 Ω |
| R16, 17 | 101-0073 | 1 k |
| R18, 19 | 106-0047 | 4.7 Ω, fusible, 1/2 W |
| R20 | 101-0081 | 2.2 k |
| R21 | 101-0105 | 22 k |
| R22, 23 | 101-0117 | 68 k |
| R24 | 101-0083 | 2.7 k |
| R25 | 101-0115 | 56 k |
| R26 | 101-0073 | 1 k |
| R27 | 101-0117 | 68 k |
| R28 | 101-0073 | 1 k |
| R29 | 101-0121 | 100 k |
| R30 | 101-0097 | 10 k |
| R31 | 101-0049 | 100 Ω |
| R32 | 101-0160 | 10 M |
| R33 | 101-0145 | 1 M |
| R34 thru 36 | 101-0121 | 100 k |
| R37 | 101-0097 | 10 k |
| R38 | 101-0090 | 5.1 k |
| R39 thru 41 | 101-0121 | 100 k |
| R42 | 101-0066 | 510 Ω |
| R43 | 101-0121 | 100 k |
| R44 | 101-0073 | 1 k |
| R45 | 101-0065 | 470 Ω |
| R46 | 101-0057 | 220 Ω |
| R47 | 101-0145 | 1 M |
| R48 | 101-0113 | 47 k |
| R49 | 101-0121 | 100 k |
| R50 | 101-0091 | 5.6 k |
| R51 | 101-0121 | 100 k |
| R52 | 101-0097 | 10 k |
| R53 | 101-0073 | 1 k |
| R54 | 101-0097 | 10 k |
| R55 | 101-0085 | 8.2 k |
| R56 | 101-0117 | 68 k |
| R57 | 101-0096 | 9.1 k |
| R58 | 101-0121 | 100 k |
| R59, 60 | 101-0097 | 10 k |
| R61 | 101-0114 | 51 k |
| R62 | 101-0113 | 47 k |
| R63 | 101-0065 | 470 Ω |
| R64 | 101-0062 | 360 Ω |
| R65 | 101-0099 | 12 k |
| R66 | 101-0090 | 5.1 k |
| R67 | 101-0073 | 1 k |
| R68 | 101-0108 | 30 k |
| R69 | 101-0109 | 33 k |
| R70 | 101-0121 | 100 k |
| R71 | 101-0101 | 15 k |
| R72 | 101-0073 | 1 k |
| R73 | 101-0025 | 10 Ω |
| R74 | 101-0065 | 470 Ω |
| R75 | 107-0202 | 2 k POT 1 turn |
| R76 | 101-0131 | 270 k |

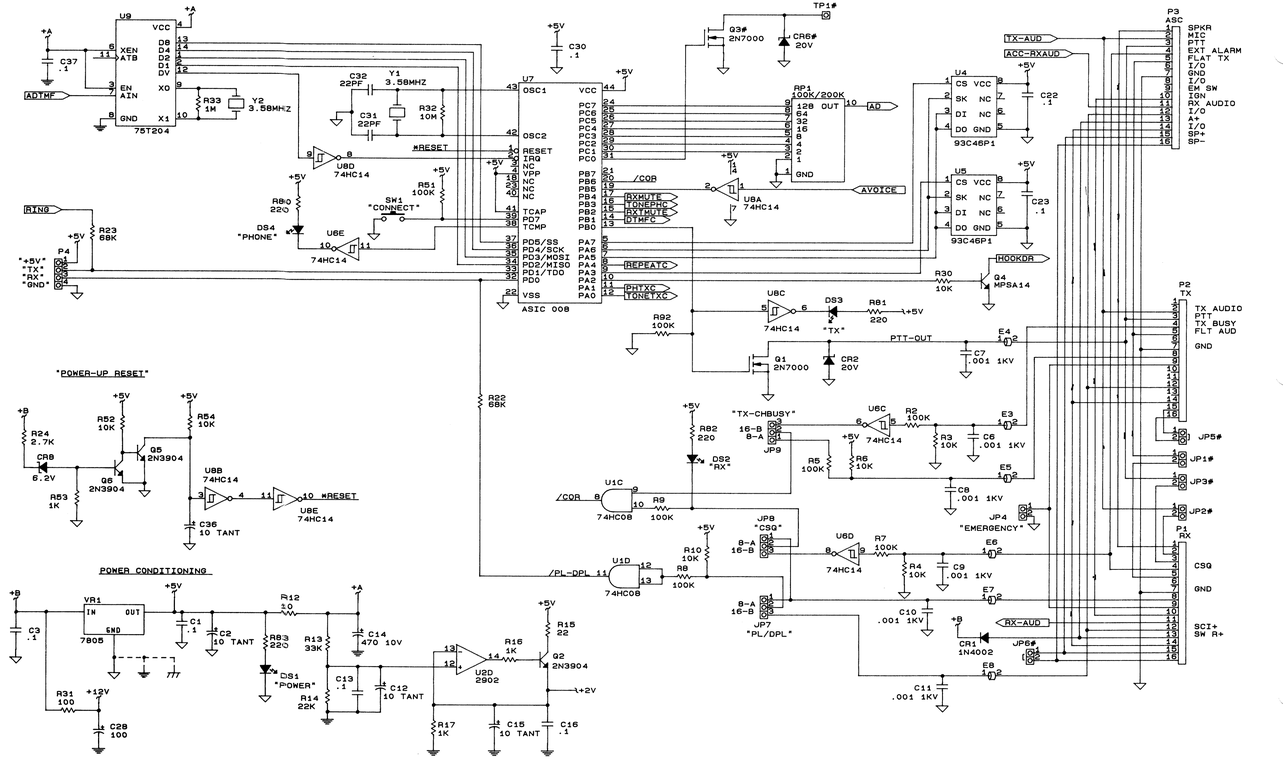
ZR340 Advanced Interconnect Controller Board — PL-941017-O

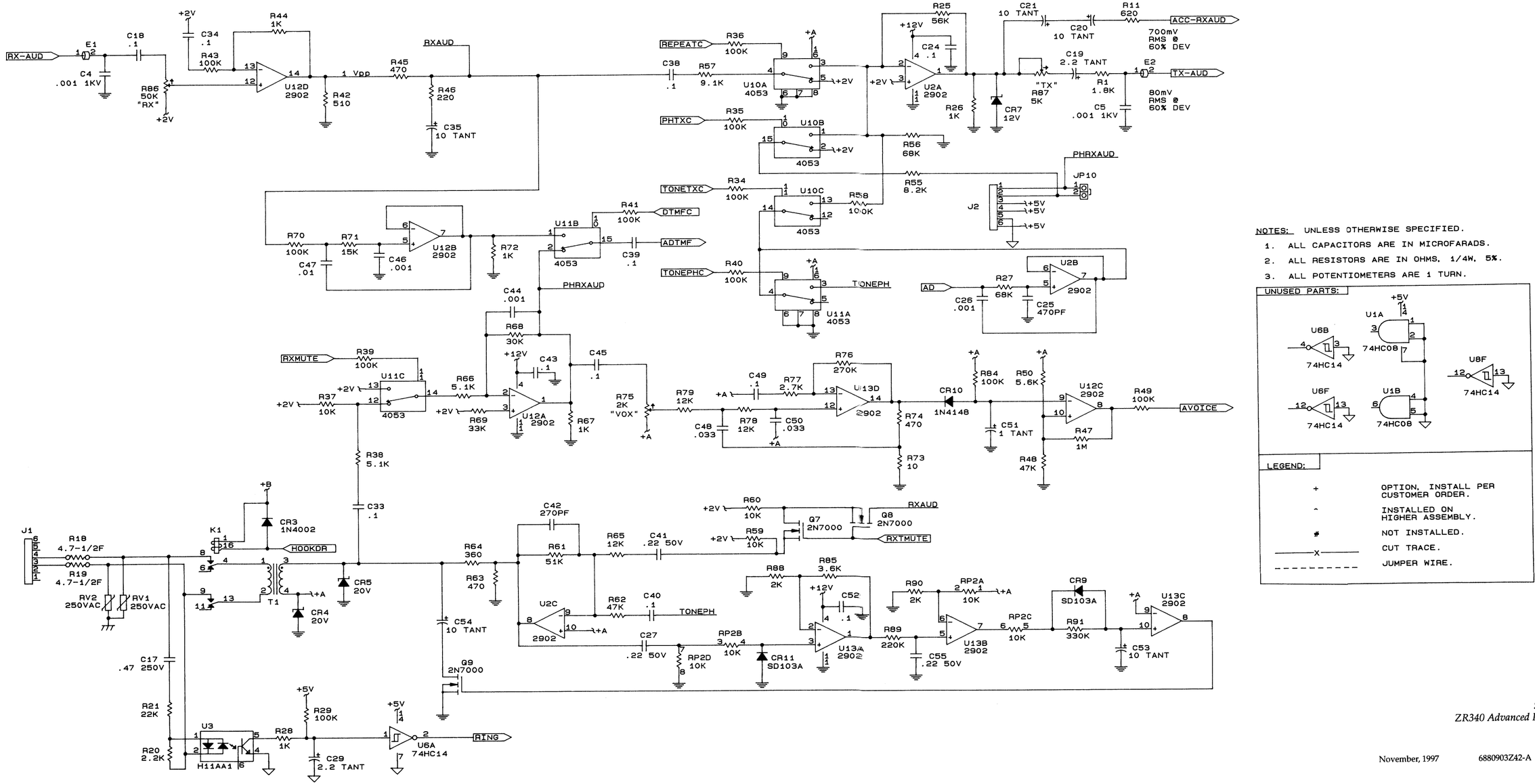
| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| R77 | 101-0083 | 2.7 k |
| R78, 79 | 101-0099 | 12 k |
| R80 thru 83 | 101-0057 | 220 Ω |
| R84 | 101-0121 | 100 k |
| R85 | 101-0086 | 3.6 k |
| R86 | 107-0015 | 50k POT 1 turn |
| R87 | 107-0005 | 5 k POT 1 turn |
| R88 | 101-0080 | 2 k |
| R89 | 101-0129 | 220 k |
| R90 | 101-0080 | 2 k |
| R91 | 101-0133 | 330 k |
| R92 | 101-0121 | 100 k |
| | | **resistor, network:** |
| RP1 | 119-0021 | R2R 100 k/200 k 10 pin SIP |
| RP2 | 119-0025 | 10 k x 4 R-SIP |
| | | **varistor:** |
| RV1, 2 | 105-0001 | 250 V ac |
| | | **switch:** |
| SW1 | 371-0024 | SPST, momentary push-button |
| | | **transformer:** |
| T1 | 305-2105 | line coupling |
| | | **integrated circuit: (see note 1)** |
| U1 | 324-7408 | quad 2 in and |
| U2 | 316-2902 | quad 324 op-amp, -40 to +85 C |
| U3 (see note 3) | 311-1001 | opto isolator, bi-polar |
| U4, 5 | 322-9345 | 1024 bit serial EEPROM, -40 to +85 C |
| U6 | 324-7414 | hex Schmidt |
| U7 | 321-6805 | ASIC 008, preprogrammed |
| U8 | 324-7414 | hex Schmidt |
| U9 | 321-0204 | DTMF receiver |
| U10, 11 | 323-4053 | 3 PDT switch |
| U12, 13 | 316-2902 | quad 324 op-amp, -40 to +85 C |
| | | **voltage regulator: (see note)** |
| VR1 | 316-4780 | ±5%, 1 A, ext. temp. |
| | | **crystal: (see note 1)** |
| Y1, 2 (see note 2) | 376-0358 | 3.58 MHz; HC 18 case |
| | | **non-referenced items** |
| | 407-0014 | SKT, 14-pin DIP |
| | 407-0006 | SKT, 6-pin DIP |
| | 407-0008 | SKT, 8-pin DIP |
| | 407-0014 | SKT, 14-pin DIP |
| | 407-0044 | SKT, 44-pin PLCC |
| | 407-0014 | SKT, 14-pin DIP |
| | 407-0016 | SKT, 16-pin DIP |
| | 407-0014 | SKT, 14-pin DIP |

**note 1:** For optimum performance, diodes, transistors, and integrated circuits must be ordered by Zetron part numbers from Zetron, Inc.
**note 2:** Secure component to board using 22 gauge bare wire or equivalent.
**note 3:** Part is opposite direction from other integrated circuits, due to layout restrictions.

*Schematic Diagram and Parts List for ZR340 Advanced Interconnect Controller (Sheet 1 of 2)*








NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL CAPACITORS ARE IN MICROFARADS.
2. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.
3. ALL POTENTIOMETERS ARE 1 TURN.




*Schematic Diagram for ZR340 Advanced Interconnect Controller (Sheet 2 of 2)*

# Parts List

ZR320 Trunk Card — PL-931010-A

| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| | | **capacitor,ceramic,fixed:uF+/-10%;50V:** unless otherwise stated |
| C1 thru 4 | 151-0180 | 0.1 |
| C5 | 155-0077 | 100 ±20%; 25 V; electrolytic |
| C6 | 155-0082 | 470 +5%-10%; 16 V; electrolytic |
| C7 thru 10 | 151-0199 | 0.47; polyester |
| C11 | 151-0180 | 0.1 |
| C12 | 154-0035 | 2.2 (16 V-25 V); ±20%; tantalum |
| C13, 14 | 152-0012 | 0.1; polyester |
| C15 | 152-0050 | 10; 100 V, non-polar electrolytic |
| C16 | 152-0085 | .01; polyester |
| C17 | 152-0090 | .001 ±2.5%; 33 V, polyester |
| C18 | 154-0025 | 1; 35 V; ±20%; tantalum |
| C19 | 151-0199 | 0.47; polyester |
| C20 | 154-0035 | 2.2 (16 V-25 V); ±20%; tantalum |
| C21 | 151-0180 | 0.1 |
| C22 | 151-0199 | 0.47; polyester |
| C23 thru 25 | 151-0180 | 0.1 |
| C26 | 152-0012 | 0.1; polyester |
| C27 | 151-0180 | 0.1 |
| C28 | 154-0100 | 10; 16 V; ±20%; tantalum |
| C29 | 151-0180 | 0.1 |
| C30 | 154-0025 | 1; 35 V; ± 20%; tantalum |
| C32, 33 | 152-0080 | 0.22 |
| C34 | 151-0180 | 0.1 |
| C35, 36 | 154-0100 | 10; 16 V; ±20%; tantalum |
| C37 | 152-0021 | 0.47; 250 V, polyester |
| C38, 39 | 154-0050 | 4.7; 16 V; ±20%; tantalum |
| C40 | 152-0012 | 0.1; polyester |
| | | **diode, silicon: (see note)** |
| CR1 | 343-3035 | Zener; 12 V; ±5%; 1W |
| CR2 | 342-0001 | 1 Amp; 100 V; 1N4002 |
| CR3 thru 5 | 342-3009 | 1N4148 |
| CR6 | 342-0103 | hot carrier; SD103A |
| CR8 | 343-3035 | Zener; 12 V; ±5%; 1W |
| CR9 | 342-3009 | 1N4148 |
| CR10, 11 | 342-0103 | hot carrier; SD103A |
| | | **light emitting diode: (see note)** |
| DS1 | 311-0010 | red |
| | | **connector, receptacle:** |
| J1 | 401-0080 | 6-pin; Telco |
| | | **relay:** |
| K1 | 380-0030 | DPDT 12V ±5% 0.50 sp |
| | | **connector, plug:** |
| P1 | 401-0253 | 25-pin |
| | | **transistor: (see note)** |
| Q1, 2 | 340-3904 | NPN; 2N3904 |
| Q3, 4 | 340-7000 | TMOS fet; 2N7000 |
| | | **resistor,fixed,carbonfilm: +/-5%;1/4W:** unless otherwise stated |
| R1, 2 | 107-0010 | 10 k; pot 1 turn |
| R3 | 107-0005 | 5 k; pot 1 turn |
| R4 | 107-0010 | 10 k; pot 1 turn |
| R5 | 107-0203 | 200 k; 1 turn |
| R6 | 101-0081 | 2.2 k |
| R7, 8 | 101-0123 | 120 k |
| R9 thru 12 | 101-0121 | 100 k |
| R13 | 101-0097 | 10 k |
| R14 | 101-0049 | 100 Ω |
| R15 | 101-0089 | 4.7 k |
| R16, 17 | 101-0108 | 30 k |
| R18 | 101-0098 | 11 k |
| R19 | 104-0094 | 7.5 k; ±1% |
| R20, 21 | 101-0104 | 20 k |
| R22 | 101-0091 | 5.6 k |
| R23 | 101-0090 | 5.1 k |
| R24 | 101-0061 | 330 Ω |
| R25 | 101-0052 | 150 Ω |

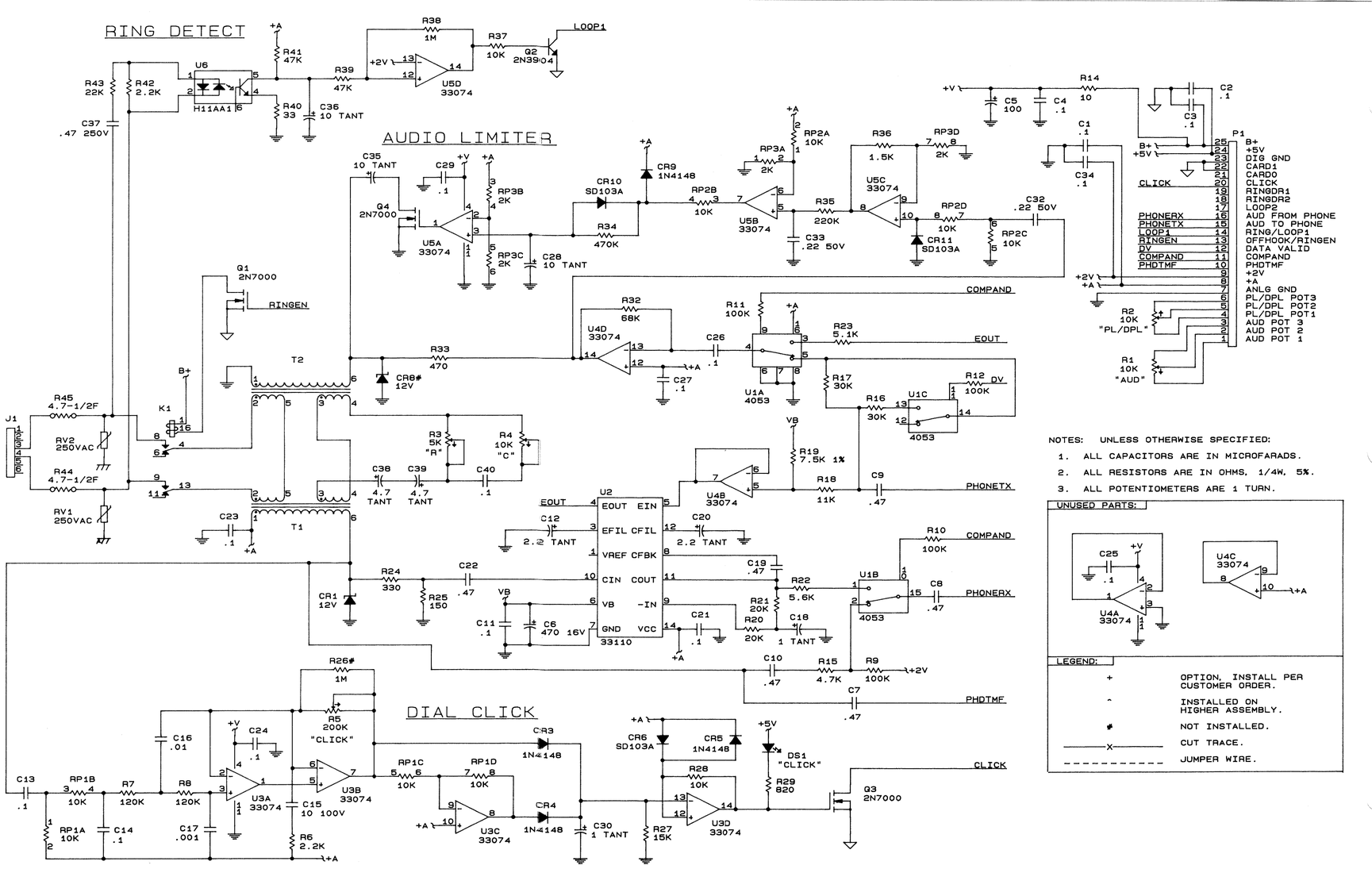
ZR320 Trunk Card — PL-931010-A

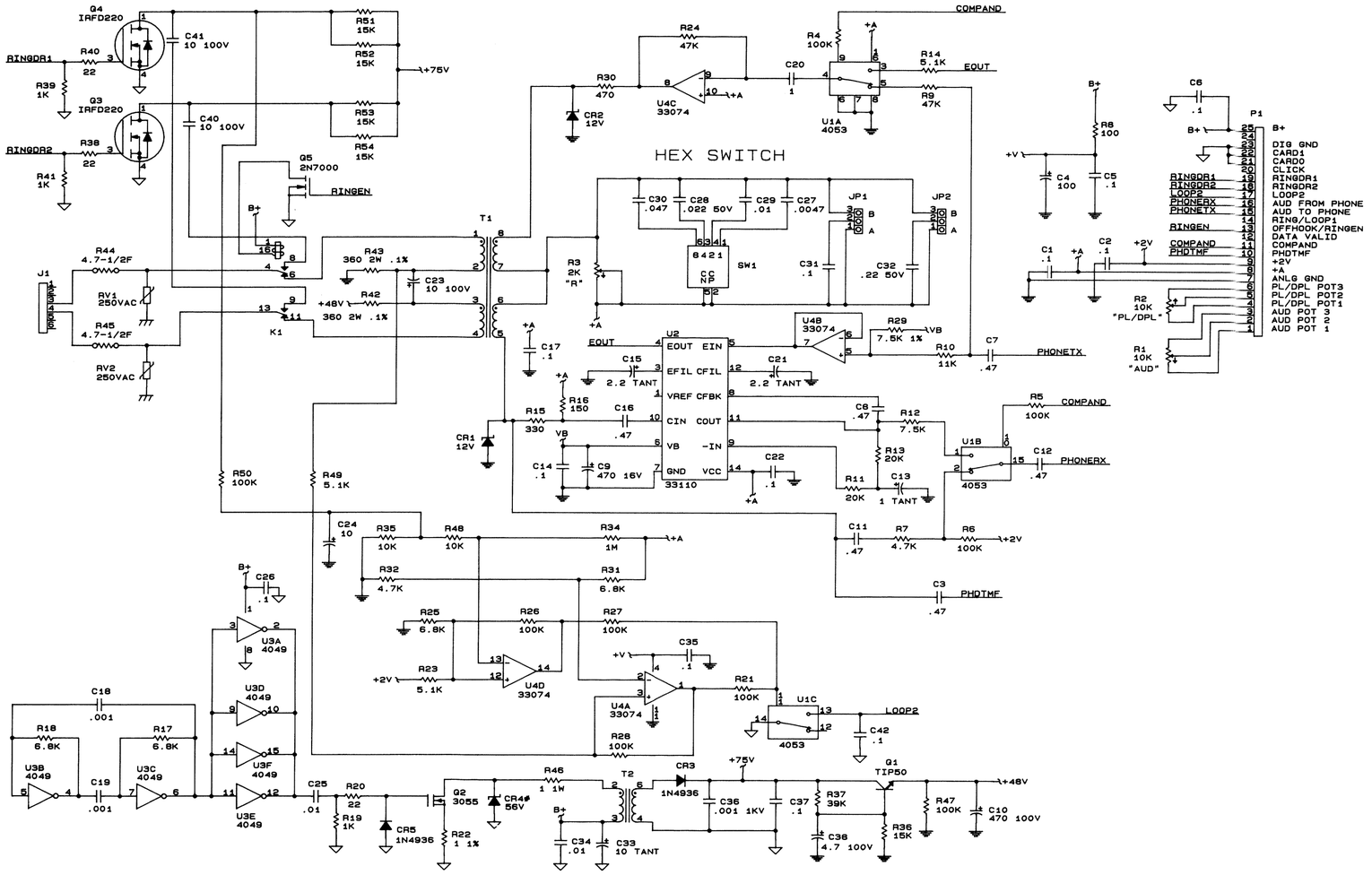
| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| R27 | 101-0101 | 15 k |
| R28 | 101-0097 | 10 k |
| R29 | 101-0071 | 820 Ω |
| R32 | 101-0117 | 68 k |
| R33 | 101-0065 | 470 Ω |
| R34 | 101-0131 | 470 k |
| R35 | 101-0129 | 220 k |
| R36 | 101-0075 | 1.5 k |
| R37 | 101-0097 | 10 k |
| R38 | 101-0145 | 1 M |
| R39 | 101-0097 | 10 k |
| R40 | 101-0036 | 33 Ω |
| R41 | 101-0105 | 22 k |
| R42 | 101-0081 | 2.2 k |
| R43 | 101-0105 | 22 k |
| R44, 45 | 106-0115 | 15 Ω; 1/2 W; fusing resistor |
| | | **resistor, network:** |
| RP1, 2 | 119-0025 | 10k x 4 SIP |
| RP3 | 119-0026 | 2k x 4 SIP |
| | | **varistor:** |
| RV1, 2 | 105-0001 | 250V AC |
| | | **transformer:** |
| T1, 2 | 305-0211 | phone hybrid; low profile |
| | | **integrated circuit: (see note)** |
| U1 | 323-4053 | 3PDT Switchl 4053 |
| U2 | 316-3311 | compander; 33110 |
| U3 thru 5 | 316-3074 | quad HF op-amp, 33074 |
| U6 | 311-1001 | opto isolator, bi-polar; H11AA1 |
| | | **non-referenced items** |
| | 407-0006 | 06-pin DIP socket (1 used) |
| | 407-0014 | 14-pin DIP socket (4 used) |
| | 407-0016 | 16-pin DIP socket (1 used) |

**note:** For optimum performance, diodes, transistors, and integrated circuits must be ordered by Zetron part numbers from Zetron, Inc.

*Schematic Diagram and Parts List for Trunk Card for ZR320 Selective Calling Interconnect Controller*








# Parts List

ZR330 Trunk Card PL-931015-O

| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| | | **capacitor,ceramic,fixed:uF+/-10%;50V: unless otherwise stated** |
| C1, 2 | 151-0180 | 0.1 |
| C3 | 151-0199 | 0.47; polyester |
| C4 | 155-0077 | 100; 25 V; ±20%; electrolytic |
| C5, 6 | 151-0180 | 0.1 |
| C7, 8 | 151-0199 | 0.47; polyester |
| C9 | 155-0082 | 470; 16 V; +50% -10% axial; electrolytic |
| C10 | 155-0085 | 470; 100 V; ±20% axial; electrolytic |
| C11, 12 | 151-0199 | 0.47; polyester |
| C13 | 154-0025 | 1; 35 V; ±20%; tantalum |
| C14 | 151-0180 | 0.1 |
| C15 | 154-0035 | 2.2 (16 V-25 V); ±20%; tantalum |
| C16 | 151-0199 | 0.47; polyester |
| C17 | 151-0180 | 0.1 |
| C18, 19 | 152-0089 | 0.001; ±5%; polyester |
| C20 | 152-0012 | 0.1; polyester |
| C21 | 154-0035 | 2.2 (16 V-25 V); ±20%; tantalum |
| C22 | 151-0180 | 0.1 |
| C23 | 155-0051 | 10; 100 V; +50% -10% axial; electrolytic |
| C24 | 154-0100 | 10; 16 V; ±20%; tantalum |
| C25 | 152-0085 | 0.01; ±5%; polyester |
| C26 | 151-0180 | 0.1 |
| C27 | 152-0088 | 0.0047; ±5%; polyester |
| C28 | 152-0122 | 0.022; ±5%; polyester |
| C29 | 152-0085 | 0.01; ±5%; polyester |
| C30 | 152-0250 | 0.047; ±5%; polyester |
| C31 | 152-0012 | 0.1; polyester |
| C32 | 152-0080 | 0.22; ±5% |
| C33 | 154-0100 | 10; 16 V; ±20%; tantalum |
| C34 | 151-0120 | 0.01 |
| C35 | 151-0180 | 0.1 |
| C36 | 150-0096 | 1000 pF; 1 kV; ±20% |
| C37 | 152-0010 | 0.1; 250 V; polyester |
| C38 | 155-0013 | 4.7; 100 V; electrolytic |
| C40, 41 | 152-0050 | 10; 100 V; ±20% non-polar; electrolytic |
| C42 | 152-0012 | 0.1; polyester |
| | | **diode, silicon: (see note)** |
| CR1, 2 | 343-3035 | Zener; 12 V; ±5%; 1W |
| CR3 | 342-4936 | Zener; 400 V; 1A |
| CR4 | 343-3115 | Zener; 56 V; ±10%; 1W |
| CR5 | 342-4936 | Zener; 400 V; 1A |
| | | **connector, receptacle:** |
| J1 | 401-0080 | 6-pin; Telco |
| | | **relay:** |
| K1 | 380-0030 | DPDT 12V ±5% 0.50 sp |
| | | **connector, plug:** |
| P1 | 401-0253 | 25-pin |
| | | **transistor: (see note)** |
| Q1 | 340-0050 | NPN; 400 V; 1A |
| Q2 | 340-3055 | N fet; 60 V; 12A |
| Q3, 4 | 340-9200 | TMOS fet; 200 V |
| Q5 | 340-7000 | HEX fet; 2N7000 |
| | | **resistor,fixed,carbon film: +/-5%;1/4W: unless otherwise stated** |
| R1, 2 | 107-0010 | 10k; pot 1 turn |
| R3 | 107-0003 | 2k; pot 1 turn |
| R4 thru 6 | 101-0121 | 100k |
| R7 | 101-0089 | 4.7k |
| R8 | 101-0049 | 100 |
| R9 | 101-0113 | 47k |
| R10 | 101-0098 | 11k |
| R11 | 101-0104 | 20k |
| R12 | 104-0094 | 7.5k |
| R13 | 101-0104 | 20k |
| R14 | 101-0090 | 5.1k |
| R15 | 101-0061 | 330 |
| R16 | 101-0052 | 150 |
| R17, 18 | 101-0093 | 6.8k |

ZR330 Trunk Card PL-931015-O

| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| R19 | 101-0073 | 1k |
| R20 | 101-0033 | 22 |
| R21 | 101-0121 | 100k |
| R22 | 104-0001 | 1; ±1% |
| R23 | 101-0090 | 5.1k |
| R24 | 101-0113 | 47k |
| R25 | 101-0093 | 6.8k |
| R26 thru 28 | 101-0121 | 100k |
| R29 | 104-0094 | 7.5k; ±1% |
| R30 | 101-0065 | 470 |
| R31 | 101-0093 | 6.8k |
| R32 | 101-0089 | 4.7k |
| R34 | 101-0145 | 1M |
| R35 | 101-0097 | 10k |
| R36 | 101-0101 | 15k |
| R37 | 101-0111 | 39k |
| R38 | 101-0033 | 22 |
| R39 | 101-0073 | 1k |
| R40 | 101-0033 | 22 |
| R41 | 101-0079 | 1k |
| R42, 43 | 104-0360 | 360; ±0.1%; 2W |
| R44, 45 | 106-0047 | 4.7; 1/2W |
| R46 | 103-0001 | 1; 1W |
| R47 | 101-0121 | 100k |
| R48 | 101-0097 | 10k |
| R49 | 101-0090 | 5.1k |
| R50 | 101-0121 | 100k |
| R51 thru 54 | 101-0101 | 15k |
| | | **varistor:** |
| RV1, 2 | 105-0001 | 250V AC |
| | | **switch:** |
| SW1 | 371-0042 | HEX rotary ra |
| | | **transformer:** |
| T1 | 305-0018 | phone hybrid; XFMR |
| T2 | 305-0030 | ZR300 switching |
| | | **integrated circuit: (see note)** |
| U1 | 323-4053 | 3PDT Switchl 4053 |
| U2 | 316-3311 | compander; 33110 |
| U3 | 323-4049 | HEX buffer inv |
| U4 | 316-3074 | quad HF op-amp, 33074 |
| | | **non-referenced items** |
| | 402-3040 | mini jumper (2 used) |
| | 403-0003 | (3 used) |
| | 407-0014 | 14-pin DIP socket (2 used) |
| | 407-0016 | 16-pin DIP socket (2 used) |

**note:** For optimum performance, diodes, transistors, and integrated circuits must be ordered by Zetron part numbers from Zetron, Inc.

*Schematic Diagram and Parts List for Trunk Card for ZR330 Remote Telephone Interface Controller*

# Parts List

ZR320/ZR330 Controller Board — PL-931009-A

| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| | | **capacitor,ceramic,fixed:uF;+/-10%;50V:** unless otherwise stated |
| C1 | 152-0080 | 0.22; ±5% |
| C3 thru 9 | 151-0020 | 0.001 |
| C10 | 151-0095 | 0.0047 |
| C11 | 151-0095 | 0.001 |
| C12 | 154-0035 | 2.2; (16 V - 25 V) |
| C13, 14 | 151-0180 | 0.1 |
| C15, 16 | 154-0100 | 10; 16 V; tantalum |
| C17 | 151-0095 | 0.0047 |
| C18 | 154-0100 | 10; 16 V; tantalum |
| C19 | 151-0180 | 0.1 |
| C20 | 155-0083 | 470; 10 V; electrolytic |
| C21, 22 | 151-0180 | 0.1 |
| C23, 24 | 154-0100 | 10; 16 V; tantalum |
| C25 thru 27 | 151-0180 | 0.1 |
| C28 | 154-0100 | 10; 16 V; tantalum |
| C29 | 151-0180 | 0.1 |
| C30, 31 | 151-0022 | 22 pF |
| C32, 33 | 151-0180 | 0.1 |
| C34, 35 | 151-0091 | 0.0033; ±5% |
| C36, 37 | 152-0089 | 0.001; ±5%; polyester |
| C38 | 151-0180 | 0.1 |
| C39, 40 | 152-0012 | 0.1; ±5%; polyester |
| C41 | 154-0025 | 1; 35 V; tantalum |
| C42 | 152-0130 | 0.015; ±5%; polyester |
| C43 | 151-0180 | 0.1 |
| C44 | 152-0130 | 0.033; ±5%; polyester |
| C45 | 152-0012 | 0.1; ±5%; polyester |
| C46 | 152-0085 | 0.01; ±5%; polyester |
| C47 | 151-0180 | 0.1 |
| C48 | 155-0077 | 100; ±5%; 25 V; electrolytic |
| C49 | 151-0180 | 0.1 |
| CX1 | 152-0012 | 0.1; ±5%; polyester |
| | | **diode: 0.50 SP (see note 1)** unless otherwise stated |
| CR3 | 343-3029 | zener; 5.1 V; ±5%; 1W |
| CR4 | 343-3035 | zener; 12 V; ±5%; 1W |
| CR6 | 343-3035 | zener; 12 V; ±5%; 1W |
| CR7, 8 | 342-3009 | silicon, 1N4148 |
| CR9 | 343-3100 | zener; 8.2 V; ±5%; 1W |
| CR10 | 342-3009 | silicon; 1N4148 |
| | | **light emitting diode: (see note 1)** |
| DS1 | 311-0012 | green |
| DS2 thru 4 | 311-0011 | red |
| | | **ferrite beads:** |
| E1 thru 10 | 305-0001 | with leads |
| | | **connector, receptacle:** |
| J1 | 401-6006 | 6-pos male |
| J2 (see note 3) | 401-0194 | 8-pin TELCO |
| | | **jumper:** |
| JP1 thru 4 | | plating pattern on PC board |
| JP5 | 403-0002 | 2-pin header with plating jumper |
| | | **connector, plug:** |
| P1 thru 3 | 401-0254 | double row header |
| P4 | 401-0252 | 25-pos |
| | | **transistor: (see note 1)** |
| Q1 thru 4 | 340-7000 | TMOS fet; 2N7000 |
| Q5 thru 7 | 340-3904 | NPN; 2N3904 |
| Q8, 9 | 340-3906 | PNP; 2N3906 |
| | | **resistor,fixed,carbon film: +/-5%; 1/4W:** unless otherwise stated |
| R1 | 101-0010 | 1 Ω |
| R2 | 101-0097 | 10 k |
| R3 | 101-0145 | 1 M |
| R4 | 101-0097 | 10 k |
| R5 | 101-0121 | 100 k |
| R6 | 101-0078 | 1.8 k |
| R7 | 101-0067 | 560 Ω |
| R8 | 101-0121 | 100 k |
| R9 | 101-0081 | 2.2 k |
| R10 | 101-0073 | 1 k |
| R11 | 101-0025 | 10 Ω |

ZR320/ZR330 Controller Board — PL-931009-A

| REFERENCE SYMBOL | ZETRON PART NO. | DESCRIPTION |
|---|---|---|
| R12 | 101-0109 | 33 k |
| R13 | 101-0105 | 22 k |
| R14 | 101-0047 | 47 Ω |
| R15 | 101-0097 | 10 k |
| R16, 17 | 101-0109 | 100 k |
| R18 | 101-0010 | 1 Ω |
| R19 | 101-0073 | 1 k |
| R20 | 101-0033 | 22 Ω |
| R21, 22 | 101-0111 | 39 k |
| R23 | 101-0123 | 120 k |
| R24, 25 | 101-0117 | 68 k |
| R26, 27 | 101-0097 | 10 k |
| R28 | 101-0121 | 100 k |
| R29, 30 | 101-0097 | 10 k |
| R31 | 101-0121 | 13 k |
| R32 | 101-0073 | 1 k |
| R33 | 101-0097 | 10 k |
| R34 | 101-0121 | 200 k |
| R35 | 101-0073 | 2 k |
| R36 | 101-0033 | 22 Ω |
| R37 | 101-0097 | 10 k |
| R38 | 101-0073 | 1 k |
| R39 | 107-0202 | 2 k POT 1 turn |
| R40 | 101-0089 | 1 Ω or short circuit |
| R41 | 101-0073 | 1 k |
| R43 | 101-0121 | 100 k |
| R44 | 101-0145 | 1 M |
| R45 | 101-0097 | 10 k |
| R46 | 101-0094 | 7.5 k |
| R47 | 101-0073 | 1 k |
| R48 | 101-0121 | 100 k |
| R49 | 101-0097 | 10 k |
| R50 | 101-0049 | 100 Ω |
| | | **resistor, network:** |
| RP1 | 119-0006 | 10 k x 9 SIP |
| RP2, 3 | 119-0021 | 100 k/200 k SIP |
| RP4 | 119-0008 | 10 k x 7 SIP |
| RP5 | 119-0017 | 220 x 8 SIP |
| | | **switch:** |
| SW1 | 371-0024 | SPST; momentary, pushbutton |
| | | **integrated circuit: (see note 1)** |
| U1 | 321-0204 | DTMF receiver; 75T204 |
| U2 | 322-9366 | 4k; EEPROM; 93C66 |
| U3 | 324-7414 | hex Schmidt trigger; 74HC14 |
| U4 | 316-3074 | quad hf op-amp; 33074 |
| U5 | 324-4373 | Octal latch; 74HC373 |
| U6 | 324-7414 | hex Schmidt trigger; 74HC14 |
| U7 | 321-0451 | ASIC |
| U8 | 322-1256 | 62k x 8 CMOS EPROM; 27C512 |
| U9, 10 | 324-4374 | Octal type-D flip flop; 74HC374 |
| U11 | 316-3074 | quad hf op-amp; 33074 |
| U12 | 323-4053 | 3 PDT switch, 4053 |
| U14 | 323-4066 | quad analog switch, 4066 |
| U15 | 316-3074 | quad hf op-amp; 33074 |
| | | **voltage regulator: (see note 1)** |
| VR1 | 316-4780 | +5 V; 1 A; 7805 |
| | | **crystal: (see note 1)** |
| Y1 (see note 2) | 376-0358 | 3.58 MHz; HC 18 case |
| Y2 (see note 2) | 376-1106 | 11.06 MHz; HC 18 case |

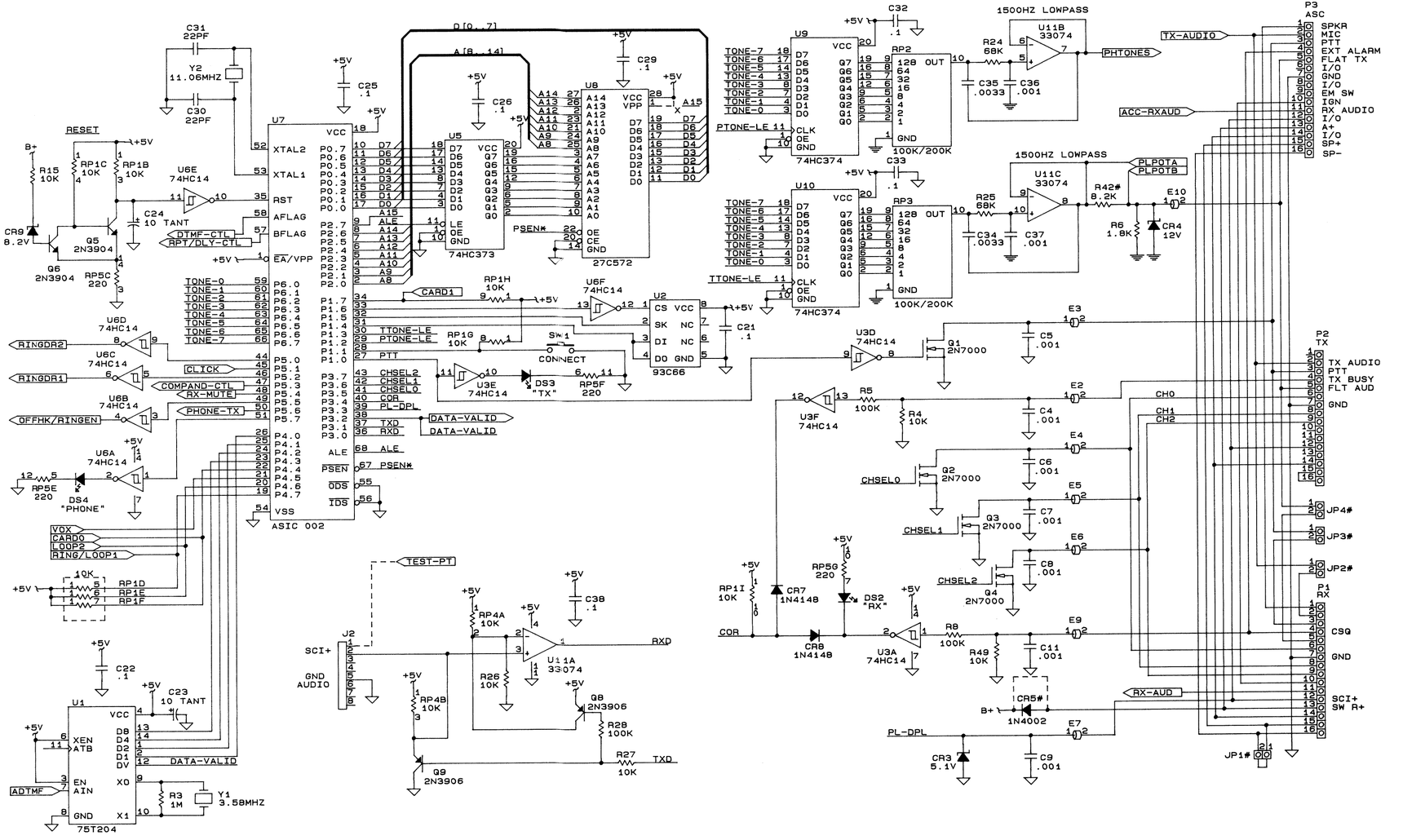
**non-referenced items**

| | |
|---|---|
| 210-0001 | 440 KEPT nut plated |
| 220-0102 | 440 x 3/8 pan Phillips |
| 407-0008 | 08-pin DIP socket (1 used) |
| 407-0014 | 14-pin DIP socket (5 used) |
| 407-0016 | 16-pin DIP socket (1 used) |
| 407-0020 | 20-pin DIP socket (2 used) |
| 407-0028 | 28-pin DIP socket (1 used) |
| 407-0068 | 68-pin PLCC socket (1 used) |
| 417-0010 | LED Mount (4 used) |

**note 1:** For optimum performance, diodes, transistors, and integrated circuits must be ordered by Zetron part numbers.

**note 2:** Secure component to board using 22-gauge bare wire or equivalent.

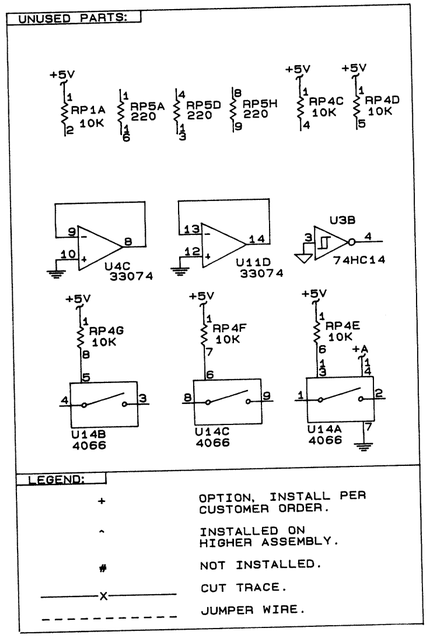
**note 3:** On solder side jumper wire from J2.8 to JP5.1 (pad closest to center of PCB).

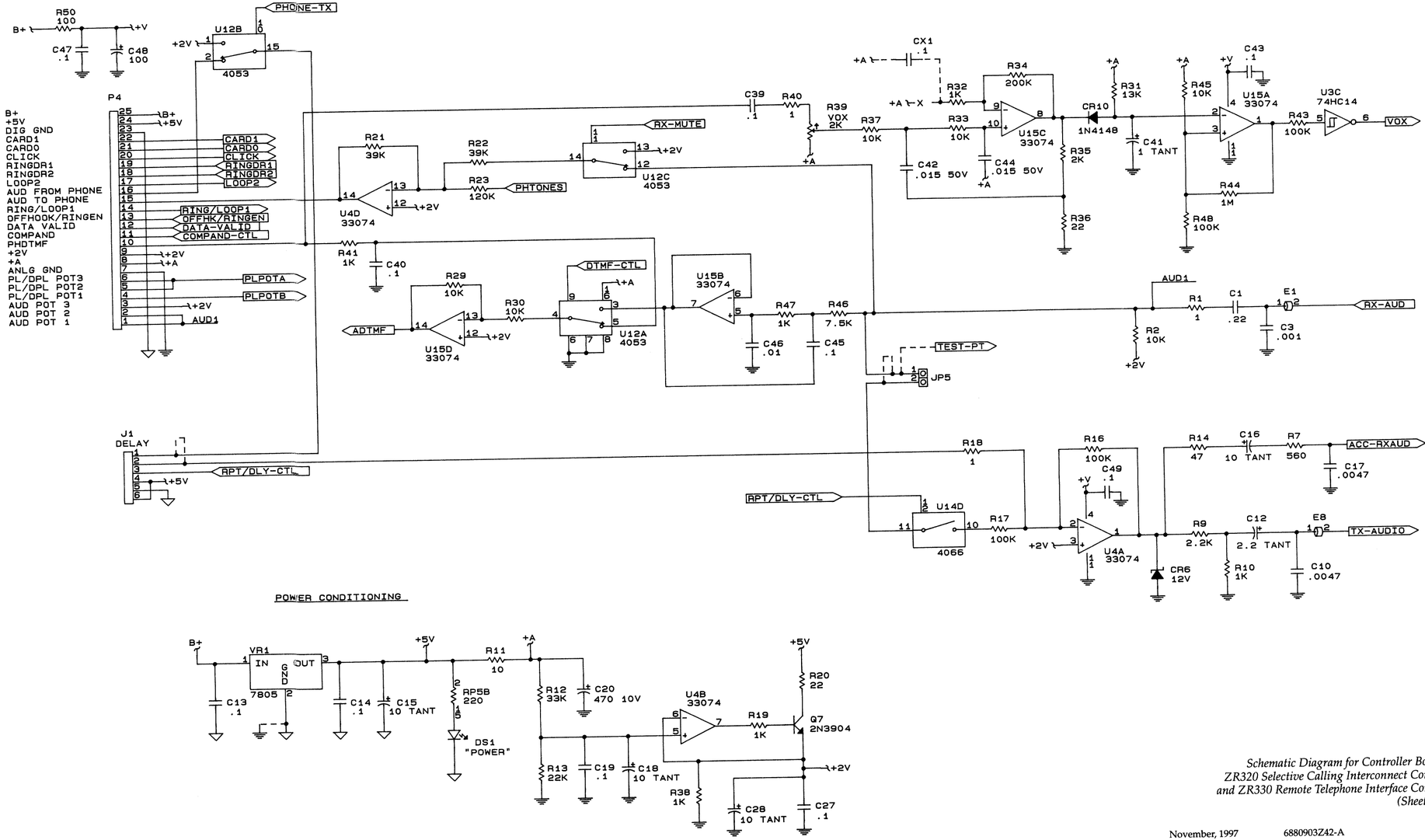



*Schematic Diagram and Parts List for Controller Board for ZR320 Selective Calling Interconnect Controller and ZR330 Remote Telephone Interface Controller (Sheet 1 of 2)*

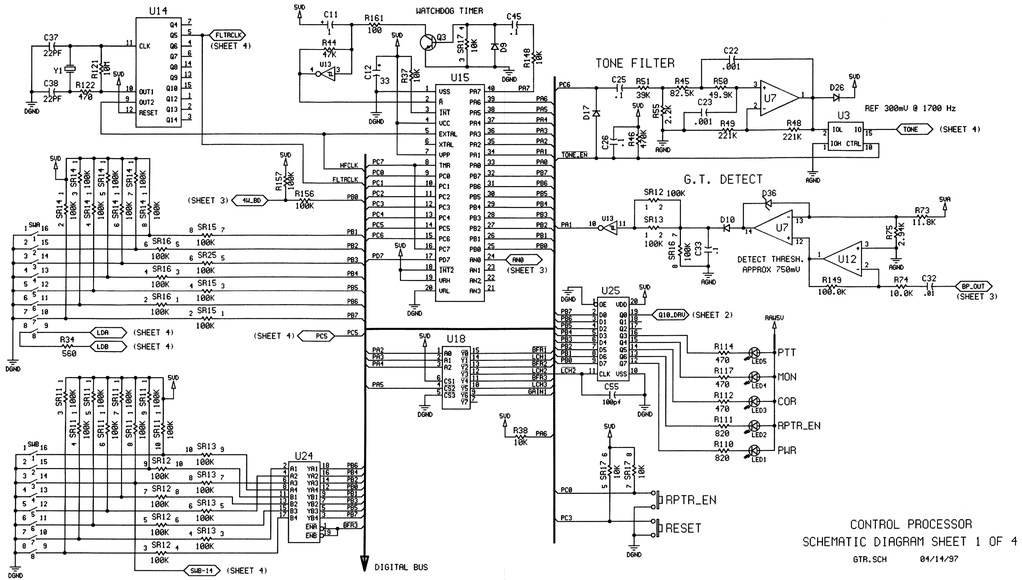
NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL CAPACITORS ARE IN MICROFARADS.
2. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.
3. ALL POTENTIOMETERS ARE 1 TURN.




*Schematic Diagram for Controller Board for ZR320 Selective Calling Interconnect Controller and ZR330 Remote Telephone Interface Controller (Sheet 2 of 2)*




*Schematic Diagram and Parts List for*
*TRA100R Tone Remote Adapter Repeater Controller,*
*Controller Processor Section*
*(Sheet 1 of 4)*

# parts list

GTR Circuit Board

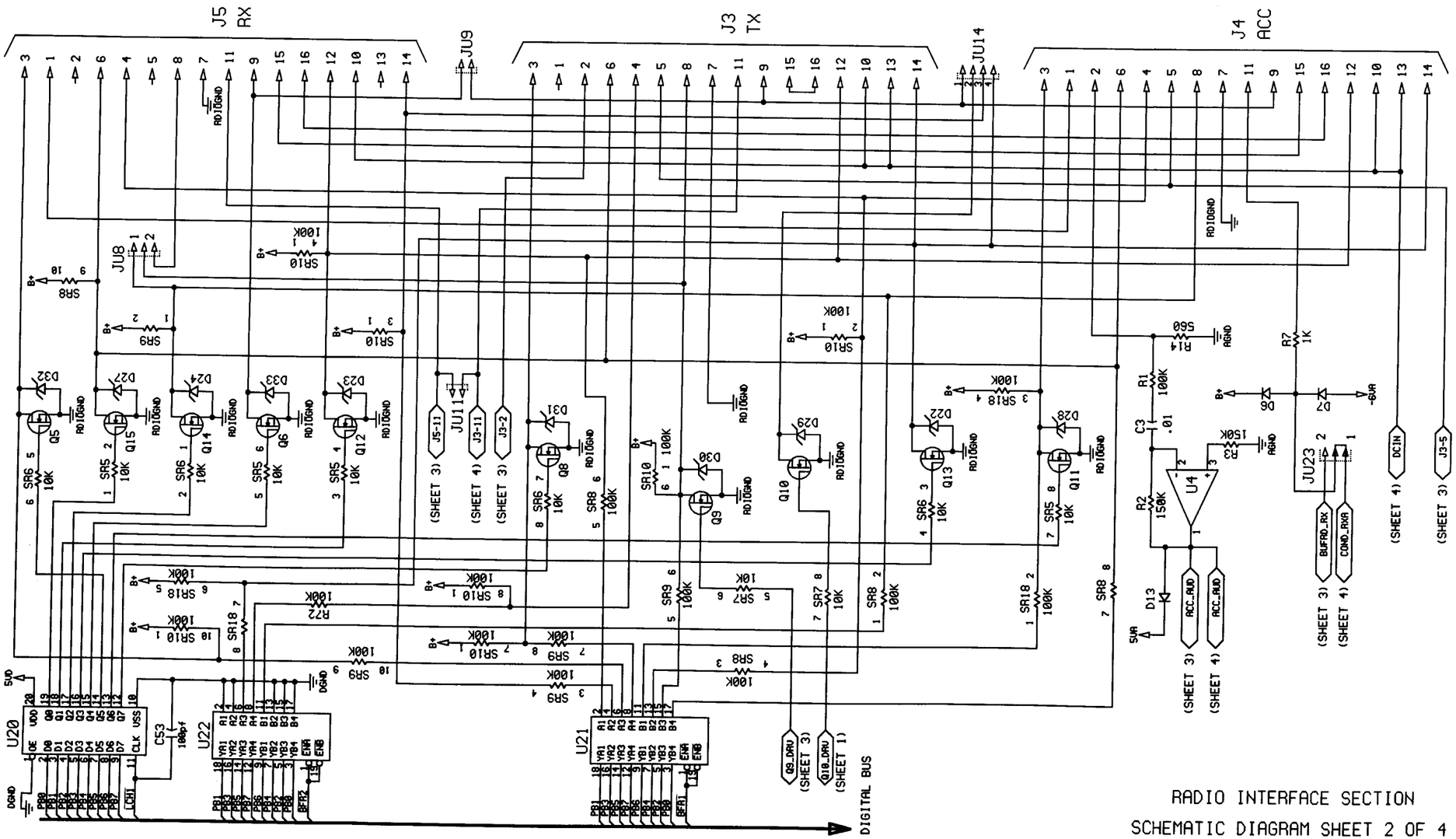
| Reference Number | Part Number | Description |
|---|---|---|
| | | **integrated circuits** |
| U1, U2 | 4601-10214-00 | MC3403 |
| U3, U23, | 3301-10021-00 | IC4053 |
| U4, U6 | 4601-10214-00 | MC3403 |
| U5 | 4601-10217-00 | TL494 |
| U7 | 4601-10214-00 | MC3403 |
| U8, U17 | 4601-10183-00 | AD7584 |
| U9 | 4601-10227-00 | MF10BN |
| U10, U11 | 4601-10221-00 | MF10CCN |
| U12 | 4601-10225-00 | MC3458 |
| U13 | 4601-10112-00 | 74HC14 |
| U14 | 4601-10224-00 | 74HC4060 |
| U15 | 4601-10223-00 | MC68705 |
| U16 | 4601-10174-00 | 74HC74 |
| U18 | 4601-10151-00 | 74HC138 |
| U19, U20 | 4601-10254-00 | 74HC574 |
| U21, U22 | 4601-10155-00 | 74HC244 |
| U24 | 4601-10155-00 | 74HC244 |
| U25 | 4601-10254-00 | 74HC574 |
| U26 | 4601-10243-00 | MC34119 |
| U33 | 3301-10021-00 | IC4053 |
| | | **diodes** |
| D4 | 3302-20005-00 | 1N5355 |
| D1, D2 | 3302-20008-00 | 1N4148 |
| D3, D5 | 3302-20008-00 | 1N4148 |
| D6, D7 | 3302-20008-00 | 1N4148 |
| D9, D10 | 3302-20008-00 | 1N4148 |
| D11, D12 | 3302-20008-00 | 1N4148 |
| D13, D14 | 3302-20008-00 | 1N4148 |
| D17, D19 | 3302-20008-00 | 1N4148 |
| D21, D26 | 3302-20008-00 | 1N4148 |
| D35 | 3302-20008-00 | 1N4148 |
| D15, D16 | 3302-20010-00 | 1N754 |
| D34 | 3302-20010-00 | 1N754 |
| D20 | 3302-20015-00 | 1N5819 |
| D25, D36 | 4602-05231-00 | 1N5231 |
| D18, D22 | 4602-20027-00 | 1N965 |
| D23, D24 | 4602-20027-00 | 1N965 |
| D27, D28 | 4602-20027-00 | 1N965 |
| D29, D30 | 4602-20027-00 | 1N965 |
| D31, D32 | 4602-20027-00 | 1N965 |
| D33 | 4602-20027-00 | 1N965 |

| Reference Number | Part Number | Description |
|---|---|---|
| | | **resistors, fixed: ±5%, 1/4w** |
| R60, R63 | 3303-00100-10 | 10 |
| R64 | 3303-00100-10 | 10 |
| R161 | 3303-01000-10 | 100 |
| R7 | 3303-01001-10 | 1K |
| R8, R33 | 3303-01002-10 | 10K |
| R36, R37 | 3303-01002-10 | 10K |
| R38, R59 | 3303-01002-10 | 10K |
| R71, R128 | 3303-01002-10 | 10K |
| R148, R158 | 3303-01002-10 | 10K |
| R1, R17 | 3303-01003-10 | 100K |
| R70, R72 | 3303-01003-10 | 100K |
| R113, R116 | 3303-01003-10 | 100K |
| R156, R157 | 3303-01003-10 | 100K |
| R53 | 3303-01004-10 | 1.0M |
| R121 | 3303-01005-10 | 10M |
| R25 | 3303-01202-10 | 12K |
| R9, R18 | 3303-01501-10 | 1.5K |
| R11, R24 | 3303-01502-10 | 15K |
| R2, R3 | 3303-01503-10 | 150K |
| R43, R55 | 3303-02201-10 | 2.2K |
| R10 | 3303-02202-10 | 22K |
| R40, R41 | 3303-03300-10 | 330 |
| R4, R5 | 3303-03303-10 | 330K |
| R51 | 3303-03902-10 | 39K |
| R30 | 3303-04470-10 | 47 |
| R47, R112 | 3303-04700-10 | 470 |
| R114, R117 | 3303-04700-10 | 470 |
| R122 | 3303-04700-10 | 470 |
| R12, R21 | 3303-04702-10 | 47K |
| R27, R44 | 3303-04702-10 | 47K |
| R54, R69 | 3303-04702-10 | 47K |
| R100 | 3303-04702-10 | 47K |
| R6, R32 | 3303-04703-10 | 470K |
| R46 | 3303-04703-10 | 470K |
| R14, R34 | 3303-05600-10 | 560 |
| R52 | 3303-06801-10 | 6.8K |
| R110, R111 | 3303-08200-10 | 820 |
| R62 | 4303-00056-20 | 0.56, 1/2w |

| Reference Number | Part Number | Description |
|---|---|---|
| | | **resistors, fixed: ±1%, 1/4w** |
| R22, R29 | 4606-01001-10 | 1.0K |
| R31, R42 | 4604-01001-10 | 1.0K |
| R61, R84 | 4604-01001-10 | 1.0K |
| R101, R151 | 4604-01001-10 | 1.0K |
| R160, R161 | 4604-01001-10 | 1.0K |
| R15, R74 | 3304-01002-10 | 10K |
| R76, R86 | 3304-01002-10 | 10K |
| R87, R88 | 3304-01002-10 | 10K |
| R89, R90 | 3304-01002-10 | 10K |
| R98, R136 | 3304-01002-10 | 10K |
| R139, R140 | 3304-01002-10 | 10K |
| R39, R57 | 3304-01003-10 | 100K |
| R58, R79 | 3304-01003-10 | 100K |
| R91, R138 | 3304-01003-10 | 100K |
| R149 | 3304-01003-10 | 100K |
| R19 | 4604-01103-10 | 110K |
| R73, R92 | 4604-01182-10 | 11.8K |
| R137 | 4604-01182-10 | 11.8K |
| R93 | 3304-01212-10 | 12.1K |
| R96 | 3304-01503-10 | 150K |
| R107 | 3304-01692-10 | 16.9K |
| R104 | 3304-01823-10 | 182K |
| R28, R81 | 3304-02002-10 | 20K |
| R82, R103 | 3304-02002-10 | 20K |
| R16, R35 | 3304-02212-10 | 22.2K |
| R94 | 3304-02212-10 | 22.2K |
| R48, R49 | 3304-02213-10 | 221K |
| R56 | 3304-02213-10 | 221K |
| R135 | 4604-02492-10 | 24.9K |
| R75 | 4604-02941-10 | 2.94K |
| R102 | 3304-02942-10 | 29.4K |
| R85 | 3304-03322-10 | 33.2K |
| R95, R99 | 4604-04753-10 | 475K |
| R50, R80 | 3304-04992-10 | 49.9K |
| R97 | 3304-04992-10 | 49.9K |
| R23 | 3304-05622-10 | 56.2K |
| R45 | 3304-08252-10 | 82.2K |
| R78 | 4604-08451-10 | 8.45K |
| R77 | 4604-09092-10 | 90.0K |
| | | **capacitors** |
| C37, C38 | 3306-00220-00 | 22pF |
| C46 | 3306-00220-00 | 22pF |
| C10, C29 | 3306-01000-00 | 100pF |
| C30, C34 | 3306-01000-00 | 100pF |
| C42, C53 | 3306-01000-00 | 100pF |
| C54, C55 | 3306-01000-00 | 100pF |
| C14, C15 | 3303-01001-00 | 1000pF |
| C22, C23 | 3306-01001-00 | 1000pF |
| C35, C48 | 3306-01001-00 | 1000pF |
| C49 | 3306-01001-00 | 1000pF |

| Reference Number | Part Number | Description |
|---|---|---|
| | | **capacitors** |
| C1, C3 | 3306-01002-00 | .01uF |
| C32 | 3306-01002-00 | .01uF |
| C6, C19 | 3306-01003-00 | 0.1uF |
| C21, C25 | 3306-01003-00 | 0.1uF |
| C26, C28 | 3306-01003-00 | 0.1uF |
| C33, C41 | 3306-01003-00 | 0.1uF |
| C45, C50 | 3306-01003-00 | 0.1uF |
| C56, C57 | 3306-01003-00 | 0.1uF |
| C58, C59 | 3306-01003-00 | 0.1uF |
| C24, C31 | 3306-02700-00 | 270pF |
| C12, C13 | 4606-00330-50 | 33uF |
| C16, C17 | 4606-00330-50 | 33uF |
| C39, C40 | 4606-00330-50 | 33uF |
| C47 | 4606-00470-00 | 47pF |
| C2, C44 | 4606-01103-00 | .01uF |
| C44 | 4606-01103-00 | .01uF |
| C27 | 4606-02720-00 | 2700pF |
| C7, C11 | 4606-09025-00 | 1.0uF |
| C9, C18 | 4606-10010-00 | 100uF |
| C20 | 4606-10010-00 | 100uF |
| C4, C5 | 4606-41204-00 | 2.2uF |
| C8, C51 | 4606-41204-00 | 2.2uF |
| | | **miscellaneous** |
| F1 | 4612-23500-01 | Fuse |
| J3, J4 | 4621-80923-01 | 16 pos. conn. |
| J5 | 4621-80923-01 | 16 pos. conn. |
| J6 | 4611-52025-00 | 4 pos. conn. |
| JU9, JU11 | 4611-10002-10 | 2 pos. conn. |
| JU8, JU21 | 4611-10003-10 | 3 pos. conn. |
| JU14 | 4611-10004-00 | 4 pos. conn. |
| JU22, JU23 | 4616-08022-00 | 24awg wire |
| L1, L2 | 3307-00010-40 | 680MHz Choke |
| L3 | 4607-27587-00 | Choke |
| L4, L5 | 4607-00487-00 | choke |
| P7, P8 | 4611-36094-20 | Header |
| PB1, PB2 | 4612-01210-00 | KXLOV211 |
| POT1, 2, 3 | 3305-05001-10 | 5K Pot |
| Q2, Q3 | 3309-44010-00 | 2N4401 |
| Q7 | 3309-44010-00 | 2N4401 |
| Q4 | 4609-03055-00 | MTP3055 |
| Q5, Q6 | 4609-07000-00 | 2N7000 |
| Q8, Q9 | 4609-07000-00 | 2N7000 |
| Q10, Q11 | 4609-07000-00 | 2N7000 |
| Q12, Q13 | 4609-07000-00 | 2N7000 |
| Q14, Q15 | 4609-07000-00 | 2N7000 |
| SWA, SWB | 4612-01008-10 | 8 pos. switch |
| S1, S2 | 4612-30000-10 | Srg. suppresser |
| T1 | 3308-08238-00 | transformer |
| Y1 | 4612-34758-00 | 3.4758MHz crystal |

| Reference Number | Part Number | Description |
|---|---|---|
| | | **miscellaneous** |
| SR2, SR4 | 5604-01002-05 | 10K |
| SR5, SR6 | 5604-01002-05 | 10K |
| SR7, SR17 | 5604-01002-05 | 10K |
| SR10, SR11 | 5604-01003-05 | 100K |
| SR14 | 5604-01003-05 | 100K |
| SR1, SR8 | 5604-11003-05 | 100K |
| SR9, SR12 | 5604-11003-05 | 100K |
| SR13, SR15 | 5604-11003-05 | 100K |
| SR16, SR18 | 5604-11003-05 | 100K |
| SR19 | 5604-11003-05 | 100K |
| | | **non-referenced** |
| 5 each | 4616-35961-00 | LED spacer |
| 1 each | 4616-20000-00 | #4 star washer |
| 1 each | 4616-00611-00 | lock washer |
| 2 each | 4612-11150-10 | Fuse clip |
| 2 each | 4612-00750-49 | Switch cap |
| 6 each | 4611-91024-00 | 2 pos. jumper |
| 1 each | 6616-30000-00 | M3 Hex Nut |
| 1 each | 6616-30001-05 | M3x5mm screw |
| 1 each | 3308-04872-00 | transformer |
| 2 each | 4606-00028-00 | Red LED |
| 1 each | 4606-00038-00 | Green LED |
| 2 each | 4606-00048-00 | Yellow LED |

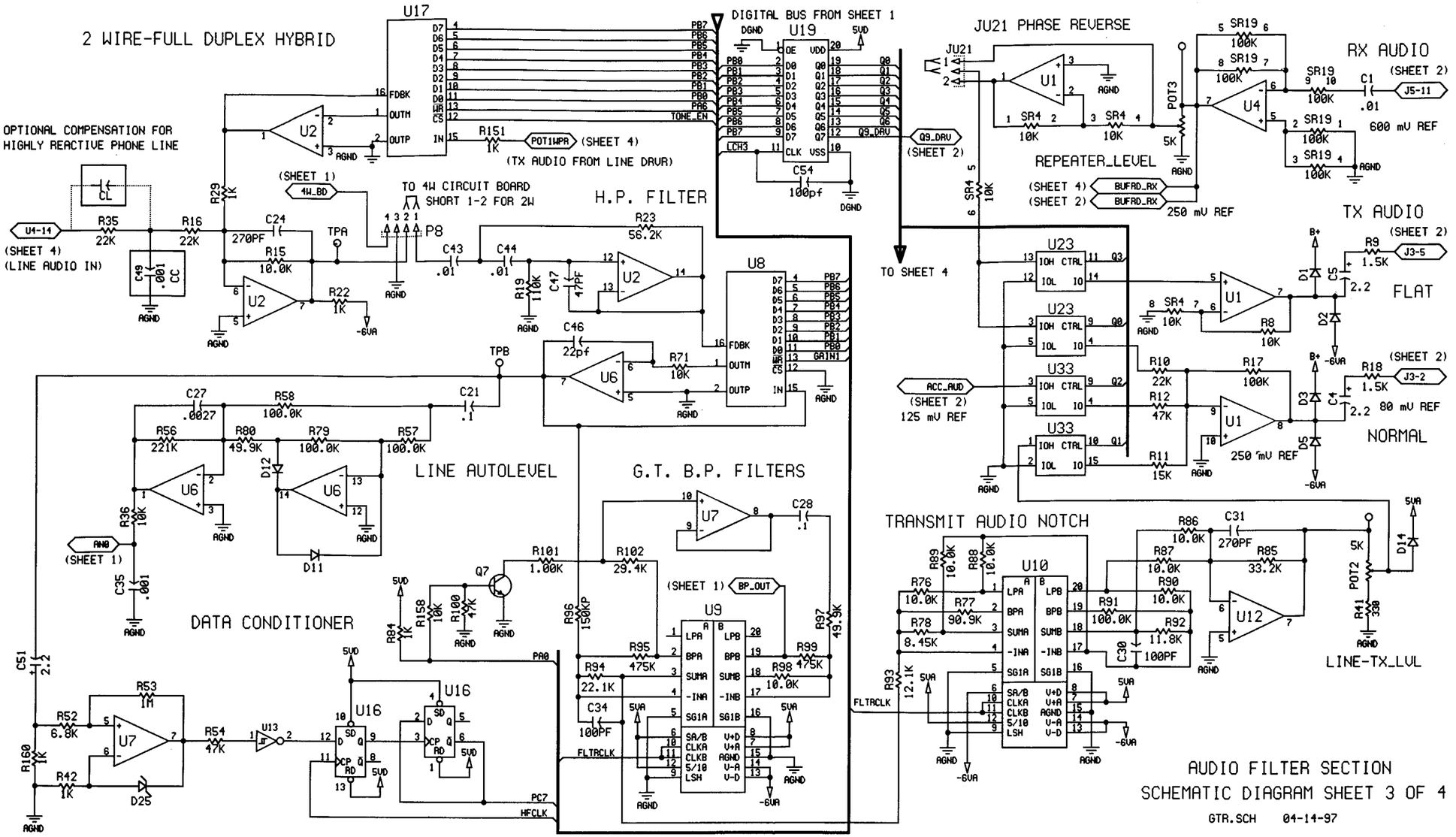



RADIO INTERFACE SECTION

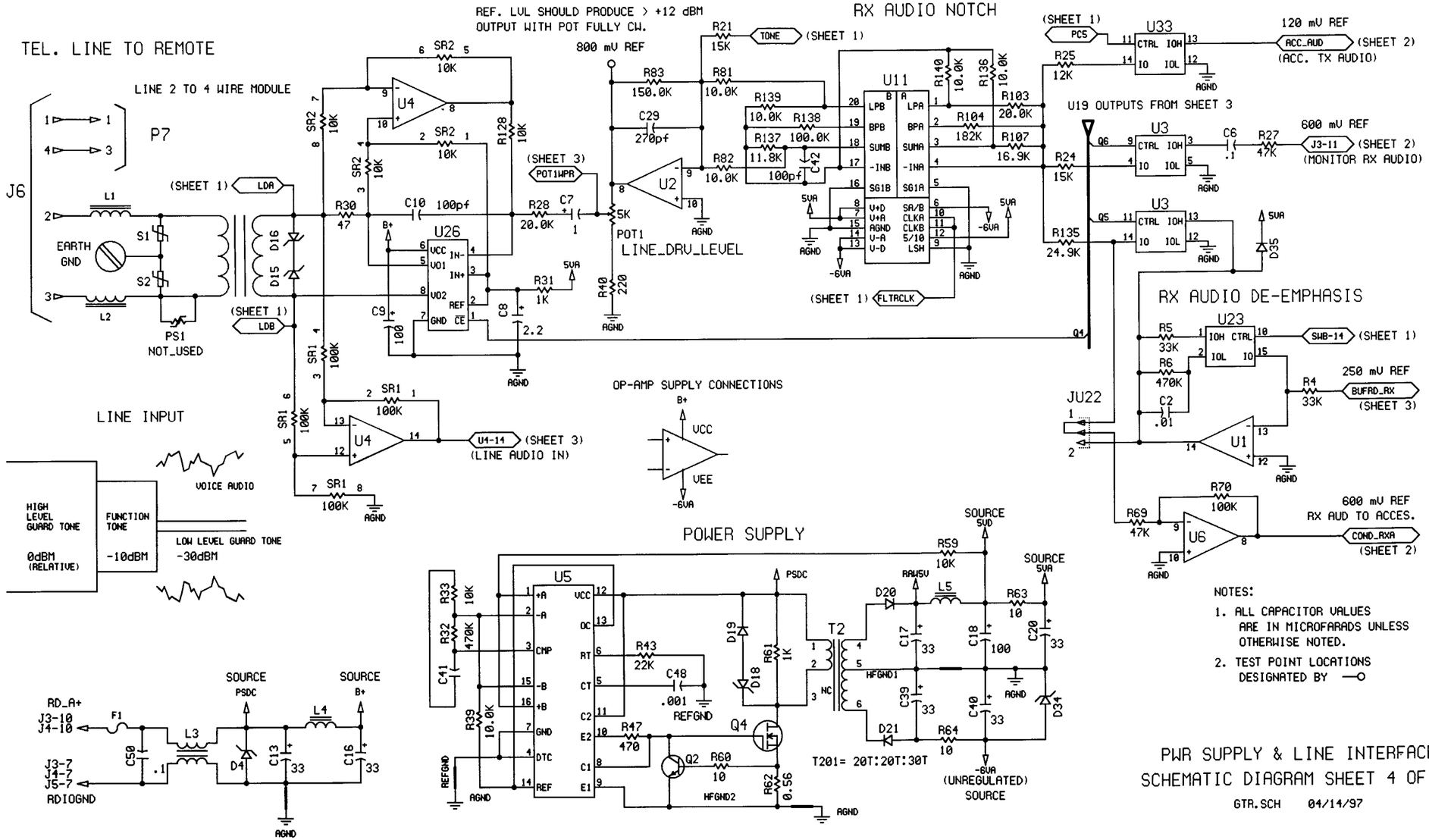
SCHEMATIC DIAGRAM SHEET 2 OF 4

GTR.SCH 04/14/97

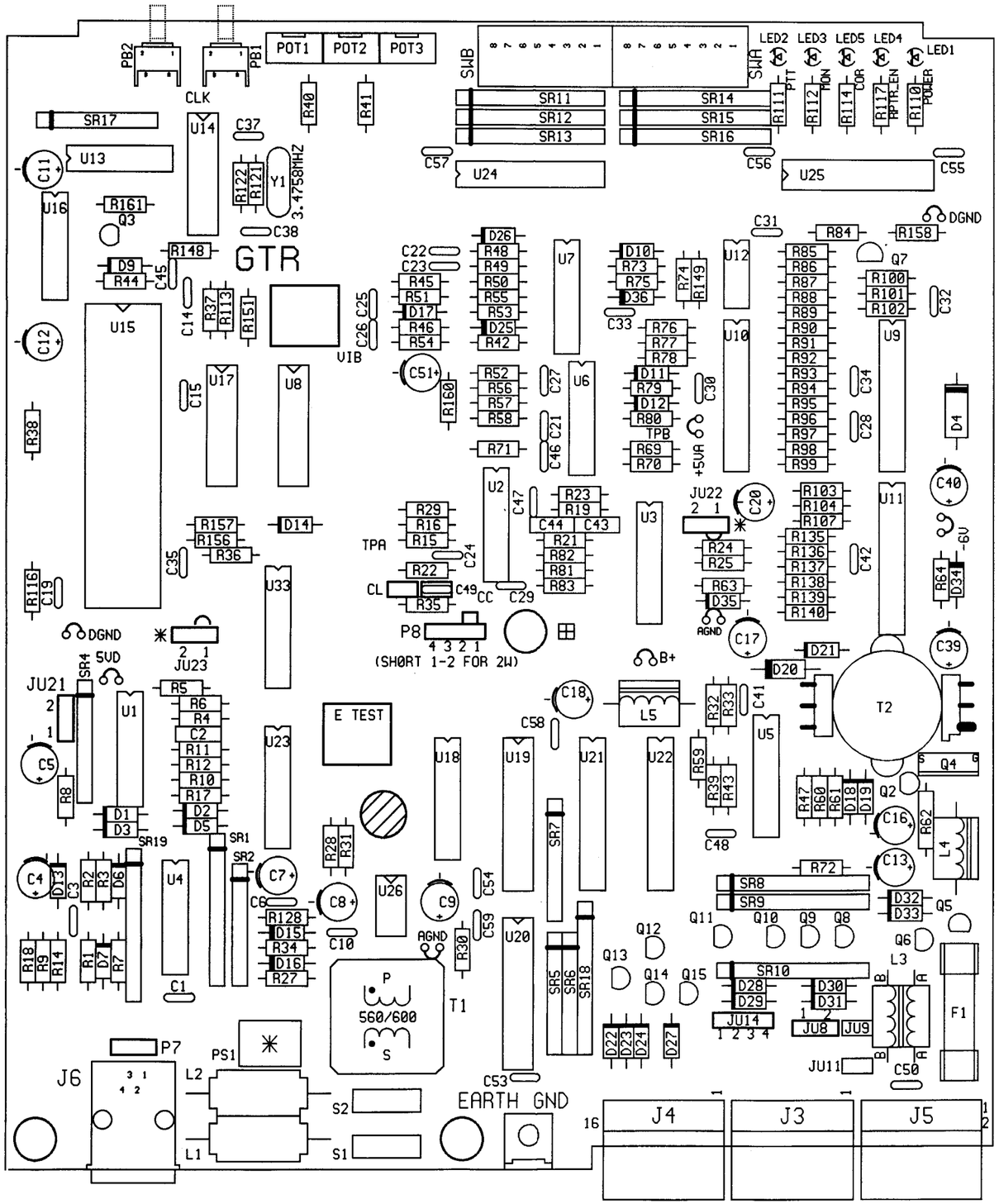
*Schematic Diagram for*
*TRA100R Tone Remote Adapter Repeater Controller,*
*Radio Interface Section*
*(Sheet 2 of 4)*




*Schematic Diagram for*
*TRA100R Tone Remote Adapter Repeater Controller,*
*Audio Filter Section*
*(Sheet 3 of 4)*




*Schematic Diagram forr*
*TRA100R Tone Remote Adapter Repeater Controller,*
*Power Supply & Line Interface Section*
*(Sheet 4 of 4)*




*Component Layout Diagram for*
*TRA100R Tone Remote Adapter Repeater Controller*

# Glossary

**Basic Repeater Controller:**
a repeater interface component that connects between two Radius mobile radios to construct an intermittent duty radio repeater (identical to the R*I*C*K).

**Bi-directional repeater:**
a repeater configuration in which the receive and transmit radios perform both receive and transmit functions. The audio and COR signals from the receiver of the receive radio are routed to the transmitter of the transmit radio. Unlike the unidirectional case, though, the audio and COR signals of the receiver of the transmit radio are also routed to the transmitter of the receive radio. Example: the receive radio receives a signal on 456.550 MHz which is re-transmitted by the transmit radio on 451.650 MHz. The transmit radio then receives a signal on 451.550 MHz which is re-transmitted by the receive radio on 456.550 MHz.

**Console radio:**
a fixed (base station) or a mobile radio installation that has been designated as the controlling radio for the repeater or as the "hub" for communications. The console radio is not part of the repeater hardware.

**COR ("Carrier Operated Relay"):**
a carry-over term from the early days of repeater operation. COR is used in its generic sense and does not necessarily mean only Carrier Squelch operation. For the GR300/GR500 repeater station, the COR signal is found on pin 4, pin 8, pin 12, or pin 14 of the 16-pin accessory jack (J3) of the radio. Whenever a "properly" identified signal is received, a dc level change occurs on pin 4, pin 8, pin 12, or pin 14.

**Courtesy "Over" Beep:**
An alert tone transmitted by the repeater to denote reset of the Time-Out Timer of the repeater. Used to indicate when the next field radio can transmit.

**Cross band repeater:**
a repeater in which the receive radio operates in a different frequency band than the transmit radio. Example: the receive radio operates on 159.420 MHz in the highband VHF and the transmit radio operates on 451.650 MHz in the 450-470 MHz UHF band. Cross-band repeaters may be either unidirectional or bi-directional.

**CSQ:**
Carrier **SQ**uelch.

**CWID:**
Morse code station identification.

**Drop out delay:**
the time, in seconds, that the transmit radio remains keyed, or on the air, after the input signal to the receive radio ceases. Also known as "transmit (tx) hang time."

**EIA de-emphasized audio:**
the audio frequency response of the receiver that is measured at the speaker and at pin 11 of the radio accessory connector with JU551 in the "B" position.

**EIA pre-emphasized audio:**
the audio frequency response of the transmitter for an audio input to the microphone or pin 2 of the radio accessory connector.

**Field radio:**
a mobile or portable radio that is neither a part of the repeater hardware nor a console radio. Field radios may intercommunicate via the repeater or directly.

**Flat audio:**
receiver or transmitter audio that does not change appreciably in amplitude as the frequency of that audio is varied from 1 Hz to 3 kHz. The receiver audio response from pin 11 of the radio accessory conector with JU551 in the "A" position and the transmitter audio response for input to pin 5 of the radio accessory connector are "flat."

**i20R:**
a repeater controller that provides service for up to 10 different user groups (TPL/DPL).

**i50R:**
a basic telephone interconnect with single user repeater operation.

**i750R:**
a repeater controller that provides telephone interconnect and revertive, selective calling. TPL, DPL, Quik-Call II and MDC-1200 signalling formats are supported.

**Linked Repeater:**
A uni-directional repeater that sends receiver audio and COR signals to an external "link" radio (or another repeater such as a GR300/GR500 repeater) for the purpose of relaying repeated information to another location. Receiver audio and COR signals from the "link" radio are applied to the GR300/GR500 repeater transmit radio as transmit audio and PTT signals. For example, VHF coverage can be extended between two cities with a UHF link between the two VHF, uni-directional repeaters.

**Normal receiver audio:**
see EIA de-emphasized audio.

**Normal transmitter audio:**
see EIA pre-emphasized audio.

**"On Battery" Alert Tone:**
An alert tone ("beep") transmitted periodically to indicate to field radio operators that the repeater is operating on a battery backup power source and they should limit their transmissions (number and duration). Requires external switching source such as battery revert module.

**PAC*RT:**
Portable Area Communications RepeaTer; a specialized cross band, bi-directional repeater configuration. Example: paramedics at an accident scene may use 450-470 MHz UHF portable radios to communicate with a highband VHF dispatcher.

**Page PTT:**
A PTT signal that is a programmable function on an input or input/output pin of the accessory connector. May be used to gate either EIA transmit audio (microphone on pin 2) or flat transmit audio (on pin 5) of the accessory connector. "Debounce" of page PTT may be eliminated to reduce transmitter turn on/turn off times.

**Power-up:**
the initial application of operating potential (voltage) to the radios and the repeater controller.

**"Properly" identified signal:**
all signals being received on a CSQ receiver or those signals with the correct TPL tone or DPL code being received on a coded squelch receiver.

**Receive radio:**
the radio that performs the receiving functions in the GR300/GR500 repeater station.

**Repeater controller:**
a module or option card that fits into the GR300/GR500 repeater station and provides the control of the repeater radios.

**Repeater knockdown:**
to deactivate a repeater or to remove it from service.

**Repeater setup:**
to activate a repeater or to place it into service.

**Revertive signalling (paging):**
accessing a repeater with one signalling format (e.g., DTMF) and selective signalling with a different format (e.g., MDC-1200).

**R*I*C*K:**
a repeater interface component that connects between two Radius mobile radios to construct an intermittent duty radio repeater (identical to the Basic Repeater Controller).

**Selective signalling (calling):**
a method of signalling with TPL, DPL, multiple tones or digital words to alert an individual radio user in a group.

**Single band repeater:**
a repeater in which both the receive radio and the transmit radio operate in the same frequency band. *Example:* receive at 456.650 MHz and transmit at 451.650 MHz in the 450-470 MHz UHF band.

**ST-853M SmarTrunk II:**
A repeater controller that allows trunking operation. Up to 4096 subscriber units (field radios) with individual identification can be serviced. Telephone interconnect, individual and group selective calling are supported.

**TRA100R:**
a repeater controller that provides tone remote control capability to the repeater.

**Transmit radio:**
the radio that performs the transmitting functions in the GR300/GR500 repeater station.

**Unidirectional repeater:**
a repeater configuration in which the receive radio receives signals only from the field radios and the transmit radio transmits signals only to the field radios.

**VOX:**
voice controlled transmission; the transmit radio is keyed by a circuit that detects the presence of voice output from the receive radio or from a telephone line.

**ZR310:**
a repeater controller that provides individualized repeater service for up to 70 different customer groups (TPL/DPL).

**ZR320:**
a repeater controller that acts as an interface to the telephone line, providing selective calling telephone interconnect features and repeater operation. TPL, DPL, and Quik-Call II signalling formats are supported.

**ZR330:**
an interface between a standard DTMF telephone and the GR300/GR500 repeater, providing full duplex telephone extension to another GR300/GR500 repeater that has a ZR320.

**ZR340:**
a repeater controller that provides telephone interconnect with expanded sign-on/sign-off code features and CWID for the single user repeater.