ZETRON

Model 49 Trunking Repeater Manager (Main Board Revision S and Higher) Operation and Installation Manual

Part No. 025-9313D

Please check for change information at the end of this manual.

Technician's Note:

Zetron makes improvements to its products on a regular basis. Each circuit card in the product is marked with a hardware revision letter and if it has software, a version number. When you call Zetron engineers for installation or service assistance, they may ask you for the revision and version of your equipment.

The main circuit card is marked 702-9202x, where "x" is the hardware revision letter, such as R. These boards are labeled near the middle of the card, at the right end of the Model 49 (as viewed from front). The main operating software is stored in chips U29 and U31, marked with a version number v.vv, such as 4.92. The tone generator software is stored in chip U20 with a version number such as 1.3. The LTR protocol software is in ASIC chip U32 with a version number such as 3.7. Other option cards such as telephone interfaces, audio compandor, etc. are similarly marked.

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WARRANTY STATEMENT

Zetron's warranty is published in the current Zetron *United States Price Book*.

LIMITATION OF LIABILITY

Zetron makes no representation with respect to the contents of this document and/or the contents, performance, and function of any accompanying software and specifically disclaims any warranties, expressed or implied, as to merchantability, fitness for purpose sold, description, or quality.

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TRADEMARKS

FEDERAL COMMUNICATIONS COMMISSION (FCC) REGULATIONS

1. This Trunking Repeater Manager, before its connection to a Telephone Central Office must be reported to the "CENTRALIZED OPERATIONS GROUP" of the local area Telephone Company, not the business office, by the user, installer or Installation Supervisor to insure a smooth installation. Three C.O. telephone connection methods are possible:

   a. In the End-to-End configuration:
   The FCC registration number of this system (EYBUSA-20362-OT-E), ringer equivalence number (0.4B), and connection jack (RJ11) must be reported.

   b. In the Two-Wire DID configuration:
   The FCC registration number of this system (EYBUSA-20362-OT-E), ringer equivalence number (0.0B), service order code (9.0Y & AS.3), facility interface code (02RV2-T) and connection jack (RJ11) must be reported.

   c. In the Four-Wire E & M configuration:
   The FCC registration number of this system (EYBUSA-20362-OT-E), ringer equivalence number (0.0B), service order code (9.0Y & AS.3), facility interface code (TL11M telco end,TL11E Zetron end), and connection jack (RJ2GX) must be reported.

2. This Trunking Repeater Manager, before its connection to a Telephone Private Branch Exchange (PBX) must be reported to the "MAINTENANCE GROUP" of the local area Telephone Supplier by the user, installer or Installation Supervisor to insure a smooth installation. Four telephone connection methods are possible:

   a. In the End-to-End Loop Start configuration:
   The FCC registration number of this system (EYBUSA-20362-OT-E), ringer equivalence number (0.4B), service order code (9.0Y), facility interface code (02LS2) and connection jack (RJ11) must be reported.

   b. In the End-to-End Ground Start configuration:
   The FCC registration number of this system (EYBUSA-20362-OT-E), service order code (9.0Y), facility interface code (02GS2), ringer equivalence number (0.0B), and connection jack (RJ11) must be reported.

   c. In the Four-Wire E & M trunk configuration:
   The FCC registration number of this system (EYBUSA-20362-OT-E), ringer equivalence number (0.0B), service order code (9.0Y & AS.3), facility interface code (TL11M telco end and TL11E Zetron end) and connection jack (RJ2GX) must be reported.

   d. In the Two-Wire DID (tie-trunk) configuration:
   The FCC registration number of this system (EYBUSA-20362-OT-E), ringer equivalence number (0.0B), service order code (9.0Y & AS.3), facility interface code (02RV2-T) and connection jack (RJ11) must be reported.

3. The total of all ringer equivalence numbers on any one line should not exceed 5.0 for best performance.

4. This device complies with Part 15 of FCC Rules for a Class A digital device. Operation of this device is subject to the following two conditions:

   a. this device may not cause harmful interference, and

   b. this device must accept any interference, including interference that may cause undesired operation.

5. This device must not be installed on coin-operated or multi-party telephone lines.

6. DID answer supervision: Allowing this equipment to be operated in such a manner as to not provide for proper answer supervision on DID calls is a violation of Part 68 of FCC rules.

7. E&M answer supervision: Allowing this equipment to be operated in such a manner as to not provide for proper answer supervision on E&M calls is a violation of Part 68 of FCC rules.

8. Answer supervision will be returned within 500 ms after the incoming call is:

   a. answered by the called station
      or
   b. routed to a dial prompt
      or
   c. routed to a recorded announcement that can be administered by the CPE (Customer Premise Equipment) user.

9. If this unit malfunctions, the telephone company may disconnect service temporarily. If disconnection is necessary, the telephone company must attempt to notify the user in advance, if possible. If not, they must notify the user as soon as they are able.

10. Repair work on this device must be done by Zetron, Inc. or an authorized Zetron repair station.

INDUSTRY CANADA REGISTRATION

The Industry Canada label identifies certified equipment. This certification means that the equipment meets telecommunications network protective, operational and safety requirements as prescribed in the appropriate Terminal Equipment Technical Requirements document(s). The Department does not guarantee the equipment will operate to a user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be coordinated by a representative designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.
Users should ensure for their own protection 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.

CAUTION: Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

The Ringer Equivalence Number (REN) assigned to each terminal device provides an indication of the maximum number of terminals allowed to be connected to a telephone interface. The termination on an interface may consist of any combination of devices subject only to the requirement that the sum of the Ringer Equivalence Numbers of all the devices does not exceed 5.

The model number and Ringer Equivalence Number may be found on the label attached to the device.

CANADIAN 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 Industry Canada.

AVIS CANADIEN

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe A prescrites dans le Règlement sur le brouillage radioélectrique édicté par l'Industrie Canada.

INSTALLATION WARNING

This equipment generates, uses, and can radiate radio frequency energy; and if not installed and used in accordance with the instruction manual, may cause interference to radio communications.

Installation of this equipment should be accomplished by personnel with experience in radio trunking systems. Specialized knowledge in telephone systems is also important to ensure a smooth interface when connecting with the Telco network.

1. SYSTEM OVERVIEW

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NEW GENERATION

The Zetron Model 49 Trunking Repeater Manager is an LTR radio channel controller. The design of this unit advances the state of LTR equipment and eliminates many of the quirks of traditional control.

Interconnect capabilities were designed in from the start, not added on. Great importance was placed upon compatibility with *every* brand of mobile and portable radio and with the existing trunking system infrastructure pioneered by E.F. Johnson and Uniden. You do not have to replace all of your fixed equipment to use Zetron units; simply add on as your system expands and as your interconnect requirements grow.

This manual relates to the Model 49 Trunking Repeater Managers of Revision S and above only. These new hardware revisions have incorporated service adjustment refinements and eliminated the separate LTR Protocol Boards of earlier revisions for improved reliability. Optional circuitry has been added to provide a heater system for improved temperature stability in very cold environments.

Here are a few of the major benefits of Model 49 control:

* Simple programming and billing access of multiple sites from a central computer
* Easier to get an interconnect when one is free
* High priority users get preferential interconnect access
* Reduced system congestion with load sensitive call limiting
* Better audio quality of telephone calls
* Individual mobile calling privileges
* DID option is built-in, fast, and low cost
* Air time billing is cost effective even on 3-channel systems
* No extra phone lines are needed for billing access
* Expandability into networking
* Programming access to the system, even while trunking
* Improved reliability with modularity and fewer parts
* E&M 4-wire Type I capability
* Encode and decode capability
* Network Capability

CAPACITIES

The Model 49 complies with the standard E.F. Johnson LTR trunking protocol that supports:

- 1 to 20 RF channels per system
- 250 user IDs per channel (5000 per system)

Air time accumulation for Model 49 home-channel users:

- 500 accumulators (prime and non-prime time per User ID) to count 0 to 16,777,216 (194 days)
- 500 hit counters (prime and non-prime time per User ID) to count 0 to 65,536

Hourly repeater loading statistical data:

- Previous 24-hour period
- Today's data from midnight to current time
- Occurrences when all repeaters are busy simultaneously (i.e. system full).

Call detail (SMDR) buffer:

- 6000 call records in <u>each</u> Model 49 (Revision H and above) - more 49s means more storage
- Calls which are shorter than the "Minimum Call Time to Store" setting of the Multibase configuration program are not stored.

MULTIPLE CAPABILITIES

The Model 49 installs in a radio repeater rack and fully manages the operation of one channel of a trunked radio system. A Model 49 can turn any DPL capable repeater into a fully functional LTR channel. One Model 49 controls one repeater channel.

A Model 49 controller performs the functions of many equipment units: Logic Unit, Validator, Interconnect, Air time Accumulator, Call Detail Buffer, Access Modem, and Site Monitor, as shown in Figure 1-1.

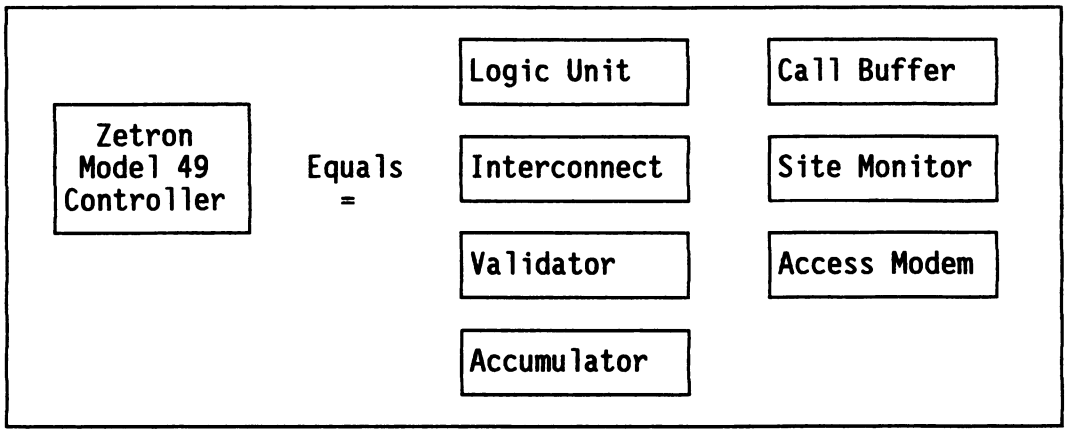

Figure 1-1. Model 49 Capabilities

Logic Unit

As a logic unit, the Model 49 decodes and encodes the trunking data from and to mobiles or portables, routes RX to TX repeat audio, limits mobile conversation lengths, and allocates radio channel access on a multi-channel trunking system.

In a multi-channel LTR trunked radio system, Model 49s can be mixed with traditional E.F. Johnson Logic units. The Model 49 is compatible with the trunking repeater buses from E.F. Johnson and Uniden.

Validator

The built-in validator permits or prevents access from mobile users with designated dispatch and interconnect IDs. User IDs can be validated or invalidated without site visits, using a PC compatible office computer. The Model 49 can even serve as an EFJ or Uniden compatible validator for Johnson Logic or Uniden Logic on the same repeater bus.

A Zetron proprietary feature provides automatic validation based upon the time of the day. Two time-of-day periods can be specified as prime time. Individual user IDs can be marked as Deferred and have access to the system only during non-prime time. This allows you to provide after hours service which increases system loading without sacrificing system availability during peak periods. Note: The Model 49 considers Saturday and Sunday as non-prime time.

Interconnect
An interconnect option, built into the Model 49, provides telephone line or microwave radio connection to the radio channel for conversations between land line parties and mobile subscribers. A choice of telephone interface (end-to-end, DID, or E&M) adapts the Model 49 to your preferred interconnect arrangement.

The Model 49's special interconnect features give you a high capability mobile telephone system at an economical price. If a land side caller, through a Model 49, tries to reach a mobile that is already making an interconnect call on any channel, the Model 49 gives the land side caller a busy signal.

With DID access, your mobile clients can have private direct dial 7-digit telephone numbers. Mobile users can be reached by callers from any location, from any telephone (rotary or tone). Telephone numbers are easy to assign to any mobile user ID, in any order you choose. When you retrofit one of your dispatch channels with a DID equipped Model 49, you don't even have to reprogram your mobiles!

High quality telephone hybrid circuitry allows your full duplex mobiles to operate effectively. When E&M microwave circuits are available, you can eliminate hybrids at the site and further improve audio fidelity.

Dynamic interconnect call limits control the length of each telephone call based upon actual measured system load. Dispatch throughput no longer has to suffer at the expense of interconnect calls. You select call length, and number of active interconnect calls for five loading levels of two classes of customers; high and low priority. Software versions 6.10 and higher provide four customer priority classes; low, medium, high and very high.

Intelligent free channel allocation improves system access at sites with a mixture of dispatch-only and interconnect channels. When a dispatch Model 49 becomes busy, it designates another dispatch channel as the next free one, not just any adjacent channel. This keeps interconnect channels free until all of your dispatch channels are full. Mobiles have a better chance of making a call on the first attempt, saving them frustration, and saving you air time.

Two mobile answer time limits also save air time. You can program long horn honk times, and short times for normal mobile customers.

An interconnect Compandor audio processing board is available which improves the audio quality of interconnect calls. Noise introduced by the mobile to land line RF path is reduced to the point that mobile radio calls sound as good as regular land-to-land telephone calls. If your full duplex mobile is equipped with an audio compandor, you will be able to improve the quality of the land-to-mobile audio as well.

Air Time Accumulator
Totals of air time used on a per user ID basis are accumulated within each Model 49 for its home channel users. This standard feature tracks usage in seconds per ID for two time-of-day periods; prime time and non-prime time. It even keeps track of all attempts at system access by invalid user IDs for that home channel.

With a prime time premium billing rate in your invoicing system, you can encourage off hours business and smooth out peak usage. The air time accumulator is equipped with a huge memory that keeps track of 194 days of air time used per ID.

Regardless of which channel is used by a particular mobile user ID, its home channel Model 49 accumulates its air time usage total. You retrieve the air time totals from the site with your PC office computer via telephone modem.

The air time for dispatch IDs is kept accurate to the nearest second since LTR dispatches are short fragments of conversations. Interconnect calls, however are message trunked, using the channel for the duration of the conversation. If desired, the air time of each interconnect call will be rounded up to the next minute whenever a mobile uses .1 (6 seconds) of the next minute (same method used by telephone companies).

Call Detail Buffer
The SMDR (station message detail record) buffer is used in conjunction with the interconnect option to record each telephone call placed through the Model 49. The buffer can hold 6000 call records. Each record contains the mobile ID, date and time of call, number dialed, and call length.

You retrieve the call detail records from the site with your PC office computer via telephone modem. The records are transmitted in a compact binary format to save telephone transmission time, and converted to universal ASCII codes within the PC computer. Since the Model 49 keeps accurate call length totals, you can bill to the nearest second of actual usage. If you allow "free calls under so many minutes", you can tell the Model 49 not to store these calls and save SMDR buffer space.

Access Modem
A built-in 1200 bps modem is part of the interconnect option. With interconnect, you do not need a separate telephone line for modem access; any Model 49 interconnected channel doubles as a modem.

If you want to keep all of your telephone lines available for interconnect, or if you are operating only dispatch (no interconnect), or if 1200 bps is not fast enough, you can attach an external modem with its own end-to-end telephone line to the Model 49 front panel RS-232 port. Configuration switches on the Model 49 select the preferred modem data rate of 300, 1200, 2400, or 4800 bps.

SYSTEM MANAGEMENT BY COMPUTER

Programming of the Model 49's mobile user database is performed with a PC compatible office computer running Zetron's Multibase software system. This software keeps track of Model 49s on multiple channels at multiple sites. The settings are programmed "off-line" on computer disk and loaded into the Model 49s with a telephone call via the computer's modem.

In like manner, billing data and repeater loading information are retrieved from the channel controllers for processing in the office computer. Since the modem links are used only during actual data transfers, not during clerical "thinking" time, telephone charges are kept to a minimum.

Repeater loading histograms and a real-time site monitor display are also standard features of the Model 49. You can even use Zetron's ZEBRA billing software to process the usage data from your Model 49s to print customer invoices. ZEBRA is a full accounts receivable program and integrates with ACCPAC Plus accounting modules from Computer Associates.

Special Note: Only one telephone call to the site is required to retrieve data from all of your Model 49s. Zetron's proprietary subscriber bus allows one Model 49 to access all the others at the radio site.

USING THIS MANUAL

Two different manuals describe the Zetron Model 49 system. Both manuals can stand alone but cannot cover all the information needed to install, configure, and maintain an efficient system. Depending on the system, you will have either a Multibase or Ebase manual in addition to this manual (shaded in the table). In addition, if a Zetron FASTNet Switch is part of the system, its manuals are also needed references.

Manual Title	Zetron Part Number	Description
Model 49 Revision S+ Operation & Installation	025-9313	Presents an overview of the Model 49 Trunking Repeater Manager hardware and theory of operation. Describes procedures for installing, adjusting, and maintaining the unit. (Newer main boards revisions S+)
Model 49 Multibase Version 6.1+ Operation	025-9297	Presents installation, setup, and management of the user database program, Multibase. Also describes billing file storage and management and some standard and optional features of the Model 49. (Newer software versions 6.x)
Model 49 Ebase Operation	025-9402	Presents installation, setup, and management of the user database program, Ebase, for the ESAS™ protocol. Also describes billing file storage and management and some standard and optional features of the Model 49.
Model 2540 FASTNet Switch Operation & Programming	025-9270	Presents an overview of the features of the Model 2540 and explains how to program the Model 2540 using Fastbase, the PC-based database manager for the Model 2540. Information regarding the Trunk Card Editor is also provided in order to properly configure the input and output trunk ports of the Model 2540.
Model 2540 FASTNet Switch Installation & Maintenance	025-9260	Presents step-by-step installation instructions with adjustment and troubleshooting procedures. Also included are the product specifications and theory of operation.
Model 2540 FASTNet Switch Schematics	025-9266	Presents the parts lists, schematic drawings, and silkscreens for the Model 2540.

Zetron recommends storing the manuals in a convenient location. For instance, the operation and installation manual should be located with the equipment at the site, and the database manual should be near the office computer. In addition, when contacting Zetron for technical support, it is helpful to have the manuals handy for quick reference.

> **Note:**
>
> When reading this manual, please bear in mind that references to Multibase also apply to Ebase. Also please note that the current phone number for Zetron is on the front cover of this manual. Disregard references to the old area code in this manual.

MODEL 49 SPECIFICATIONS

Physical

Height	3.5 inches
Width	19 inches
Depth	6.95 inches
Weight	4.5 pounds (U.S.)
Mounting	Two style of mounting are prestamped into the front panel: 1. The front panel is configured for standard 19-inch rack mounting, with holes vertically separated by 3 inches (two "rack spaces"). 2. The front panel has two holes for the locking screws and side-mounting captive nuts to fit slide mounts of E.F. Johnson repeater cabinets.

Power Supply

DC Input	+10 to +16 Vdc
DC Power	10.7 WDC @ 16 VDC input if all options are installed

Environmental

Temperature Range	+32 to +140 degrees Fahrenheit (0 to +70 degrees Celsius) Optional heater for operation to -22 degrees Fahrenheit (-30 degrees Celsius)
Humidity	5% to 90% relative humidity, non-condensing

Telephone Interface

Line Type	Three options available: 1. End-To-End: Loop Start or Ground Start 2. Type I E&M 4-Wire: Two-way DID/DOD interface Wink Start or Immediate Start 2 to 4 feed digits DTMF, MF, or Dial Pulse Feed Digit Decoding 3. DID: Direct Inward (ONLY) Dial Wink Start or Immediate Start 2 to 4 feed digits DTMF, MF, or Dial Pulse Feed Digit Decoding
Connector	RJ11

Radio Interface

Connector	15-pin Weidmueller card-edge connector
Connections	AC/DC Power Input, PTT Output (Relay NO/COM/NC or Transistor open collector), Control Line Output, Sense Input, COR (Carrier Operated Relay) Output, Tx Audio, SubOut (Tx Data), Disc In (Rx Audio).
Rx Audio Input	100 mVpp - 10 Vpp in two selectable ranges
Rx Audio Impedance	Zin = 50 kΩ minimum
Tx Audio Output	0 to 8 Vpp in two selectable ranges
Tx Audio Impedance	Zout = 1.2 kΩ maximum
SubOut Level	0 to 1.2 Vpp, continuously variable

SubOut Impedance	Zout = 1 kΩ AC or DC coupled, jumper selectable
PTT Outputs	Selectable outputs: Relay Type: Normally Open (NO) Closes for PTT Common (COM) Strapped in Cable Normally Closed (NC) Opens for PTT Transistor Type : Open Collector Output

Control-Sense Interface

Connector	12-pin Weidmueller card-edge connector
Connections	Control Lines 2, 3, and 4. Sense Lines 2, 3, and 4. GND
Control Lines	Software-controlled selectable relay outputs: Normally Open (NO) Closes for output Common (COM) Strapped in cable Normally Closed (NC) Opens for output
Sense Lines	Software controlled (A to D) inputs, 0 to 6 Vdc. Used by alarm software; detection windows selectable.
GND	Reference ground connections for each sense line.

2. SYSTEM OPERATION

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DISPATCH OPERATION (Mobile to Mobile Calling)

The basic dispatch version of the Model 49 is more than just a traditional trunking logic unit. It performs the following major functions:

a. Controls 2 to 20 channel repeater trunking, or 1 channel stand-alone sites
b. Accumulates air time for two time-of-day periods (prime and non-prime time) for its home users
c. Validates mobile access to prohibit invalid mobile users
d. Monitors mobile activity in real time on each repeater
e. Stores repeater loading data for current and previous day's system usage as well as "busy" data for all repeaters.

When a mobile user wants to call a group of users, he/she presses the microphone push-to-talk button on his/her mobile radio. The radio tunes to a free channel and transponds data packets with the repeater logic unit that then becomes busy with the calling mobile.

Using the repeater data bus, the repeater tells all other repeaters which user group (home channel + ID) is being called. If the calling mobile is not on its home channel, then the members of the called group are still tuned to their home channel repeater. To get the group together on the calling repeater, the home repeater sends "Go To" data packets to cause the called radios to tune to the calling repeater frequency.

As long as the calling mobile remains keyed, the logic unit sends data packets to keep the group together, and the calling mobile can talk to the group. As soon as the calling mobile releases his/her microphone button, the logic unit sends the group "home" with a "turn-off" code and releases the repeater for another one-way "conversation".

This so-called "transmission trunking" is very efficient in the use of air time. Less than 300 milliseconds is required to get a dispatch message going, and less than 200 milliseconds to release the channel each time.

DISPATCH AIR TIME

Each Model 49 is equipped to total the air time used and number of accesses for two time-of-day periods by each of the 250 IDs on that repeater home channel. By monitoring the repeater bus, the Model 49 records usage by its home channel users, even when the users are trunked to other channels.

This capability makes it easy for you to add air time billing to your system by replacing one of your existing logic units with a Zetron one, and keeping your users "homed" to the Model 49. You can then move your old logic to new channels that have no home users, but can be used for trunking.

Air time accumulation is kept to the nearest second, so customers are accurately billed for their short dispatch conversations. When you import

the air time values into your billing system, you can convert these totals into minutes if necessary. Multibase retrieves the air time totals into your office computer for import into your billing system.

LAND LINE TO MOBILE CALLING

A land line party calls an LTR mobile party by dialing the telephone number of an interconnected LTR channel. With End-to-End telco interface equipped Model 49s, this 7-digit number accesses the Model 49 controller by "ringing the line." The Model 49 "answers" and mimics the beep tones of an EFJ or Uniden system or plays voice prompts to the phone caller. The caller then uses his/her Touch-Tone telephone to key in the mobile User ID as a five-digit number (HHIII, where HH is the mobile's two-digit home channel and III is the mobile's three-digit ID). Instead of the five-digit ID code, a Model 49 site can be programmed to accept a four-digit access code.

With a DID telco interface, all interconnected mobile users can have their own 7-digit telephone number. This eliminates the need for phone callers to "over dial" the 5-digit number, and callers can use old-style rotary telephones to reach mobile users.

When a Model 49 is equipped with an E&M interface, access to the site is direct via RF or microwave links. The 4-wire audio system into the Model 49 eliminates any hybrid circuitry at the site. The E&M signals supervise interconnect calls and can carry "DID or overdial" type calls. Interface equipment at the base end of the system (such as a PBX or Tellabs/Wescom module) determine whether the E&M link will act like a DID or overdial type of circuit. Programming settings in the Model 49 tailor its software to handle the circuit.

If the LTR channel is busy with a dispatch call when the phone "rings", the Model 49 waits for the mobile user to release PTT and end their short transmission. At that time, the mobile user will trunk to a free channel so the telephone party's call can be processed.

The Model 49 checks the database to make sure that the User ID is an interconnect ID and has been validated for service. If so, subaudible LTR data packets are generated to the designated mobile along with audible ringing tones. The mobile has one of two "Answer Times" as programmed in the Site Config Interconnect database to press PTT and answer the call. Some users can be programmed for long times so they can answer their "horn honk".

Once the call is answered by the mobile party, telephone audio is opened to the mobile and the call timer and billing timer begin. The mobile and phone parties can then converse (see "Conversing" later in this section).

Second Overdial

If the ID is not interconnect or is not valid, and the incoming call is not a DID call, the caller will hear a "retry" tone. At this time the caller will be given another opportunity to enter a valid ID. After the second try, if the ID entered is still invalid, the phone party will hear "error" tones and the call will be disconnected. If the incoming call is DID, no retries are allowed.

MOBILE TO LAND LINE CALLING

The mobile party selects an interconnect ID on the mobile radio system & group switches. Then the user presses the PTT or SEND key to access an interconnected LTR channel. If there is no free channel at all, the radio will not transmit and will immediately return a busy indication to the mobile user. If there is no free interconnected channel, the mobile may end up on a dispatch channel and will get "turn off" packets from the controller. If a mobile ends up on an interconnected channel that does not allow outgoing calls the Model 49 will play busy before sending "turn-off" packets.

If the mobile accesses a channel equipped with an interconnected Model 49, the mobile's ID is validated for outgoing interconnect service from the User ID database settings. The Model 49 waits for the mobile to un-key, then accesses the telco line, waits for dial tone from the telephone system, and cuts the audio through to the mobile.

The mobile then has to enter the phone number to dial, using the DTMF keypad on the mobile radio. As programmed in the Site Config Interconnect database, the mobile user has specific time limits within which he/she must enter the first and subsequent digits of the telephone number into the Model 49. Phone number dialing is regenerated by the Model 49s built-in DTMF generator, providing accurate dialing in the presence of weak radio reception. A minimum and maximum number of dialed digits (programmed in the Site Config Interconnect database) speeds phone call placement. If the mobile user unkeys after entering the minimum regenerated digits, the Model 49 will assume dialing is completed, and any subsequent digits will not be regenerated; they will pass through directly. These digits will however be stored in the Call Detail Record, up to the maximum regenerated digits, or until the interdigit timeout occurs.

Note: The Model 49 is compatible with the special automatic dialing sequences of E.F. Johnson's 8865 and Uniden's SMS-300 full-duplex mobile radios.

INTERCONNECT AIR TIME

Each Model 49 is equipped to total the air time used and number of accesses for two time-of-day periods by each interconnect ID on that repeater home channel. By monitoring the repeater bus, the Model 49 records usage by its home channel users, even when the users are trunked to other channels.

This capability makes it easy for you to add air time billing to your system by replacing one of your existing interconnect and logic units with a Zetron one, and keeping your users "homed" to the Model 49. You can then move your old equipment to new channels that have no home users, but can be used for trunking.

Air time is accumulated for each interconnect call to the nearest second. You can specify that the Model 49 round calls up to the next minute before adding them into the air time totals (see Site Config Interconnect database). In addition, you can ignore short calls and not add them into the air time totals, such as for giving people "free" 3-minute calls (see Site Config Interconnect database).

Multibase retrieves the air time totals from your Model 49s and puts the data onto your office computer hard disk in ASCII file format. You can use these files with Zetron's billing system or your own.

CALL DETAIL (SMDR)

For each telephone call (land line to mobile and mobile to land line) that is processed by the Model 49, a call detail record is generated and stored in its internal SMDR memory. These records keep track of length of call, number dialed (mobile to land line), time of day, date, user ID, and status of call. The memory is automatically protected from power failures for more than 5 years of continuous power-off. This option does *not* record dispatch communications records.

Calls that are determined to be "incomplete" can be omitted from the call detail memory to save space and retrieval time. In the Site Config Interconnect database, you specify that local calls shorter than a specific time be discarded. With this feature, you can 1) sell "free" 3-minute local calls, 2) eliminate calls that are not answered by the mobile, or 3) not charge for calls that don't go through in so many rings. Toll calls shorter than the minimum of the programmable "minimum call time to store" and 30-seconds are not stored. This gives you more room in your call detail buffer and reduces the telephone time to retrieve billing records from the site.

The time accumulation for land line to mobile calls begins when the mobile radio users keys up to answer the ringing tones from the Model 49. On mobile to land line calls, there is not so positive an indication of "called party answer". The Model 49 begins the call timer on these calls when dialing is complete.

Your office staff uses the Multibase system to retrieve call detail records from the Model 49s by telephone modem. Individual named and dated computer files are generated in ASCII data format each time you perform a retrieval. At the end of a billing period, these files are collated and sorted by your billing system to produce invoices for each customer account. If you use Zetron's ZEBRA Billing Software, this operation becomes quite straightforward.

SMDR call records are stored in compact binary images inside the Model 49 to save space and reduce transmission time. Each record requires only 16 bytes of storage in the Model 49. Transfer of this data to the office computer by 1200 bps modem occurs at approximately 400 records per minute. On large systems, you can further reduce communications time by using a high speed modem connected to the front panel RS-232 port on the Model 49.

CONVERSING

Half-Duplex Conversing

The mobile party presses the PTT microphone button whenever he/she wishes to speak to the land line party, and releases the button to listen. If the "Turn-Around" beep is programmed "Y" in the User ID database, then the phone party will hear a "go-ahead" beep each time the mobile releases the PTT button.

There is a "Turn-Around" time programmed in the Site Config Interconnect database. This timer (typically 30 seconds by F.C.C. rules) requires that the mobile periodically presses PTT to keep the interconnect conversation active, otherwise a short warning beep is issued to the mobile. If the mobile presses PTT within 5 seconds of the warning, the conversation stays alive, otherwise the Model 49 terminates the call.

An interconnect call can be terminated by either the land line or mobile party by pressing the "#" key on their DTMF keypad. The person on the phone side must hold the # key for a long 1/2 second before the Model 49 will terminate the call. A short 80 millisecond # key from the mobile radio party will terminate the call almost instantly. For firmware version 6.10 and higher units, # key termination may be programmed to be active for durations from 60 to 500 milliseconds received from the mobile.

If the land line party just hangs up the telephone, the Model 49 can detect this and terminate the call automatically if the telco circuit is equipped for one of the following:

1. a "ground start" end-end line
2. a loop start end-end line with reverse battery supervision
3. DID or E&M trunk idle supervision
4. dial tone detection (only detected when mobile carrier and/or packets are not present)

   Note: for further details on telco services, call Zetron Mobile Systems Division's Applications Engineers at (206) 820-6363.

If the call is ended without a "#" key or telco disconnect detection, the Model 49 will terminate the call when the mobile turn-around timer expires (set in Site Config Interconnect database). Billing timing stops when the call is actually terminated. Obviously, to avoid being billed for wasted air time, your clients are encouraged to use their "#" key to end calls. Some microphones can automatically generate "#" when placed back in their hanger to make call termination quick and easy.

The Model 49 runs a timer during the conversation and checks its value against the Call Limit as determined by the Dynamic Call Limit Table (see subsection below). For 30 seconds prior to call limit termination, the Model 49 plays a "tick" once per second to the mobile party as a countdown warning. Obviously, if the mobile party is transmitting during this warning period, he/she will not hear the ticks.

In addition, a warning tone time can be set in the Site Config Interconnect database. When the programmed time has elapsed a "warning" tone will be played three times at fifteen second intervals. This tone can be used to

let callers know that they have exceeded some billing threshold, and are now being billed at a premium.

Full-Duplex Conversing
The audio path is open continuously between the phone and mobile parties for the entire conversation. Either party can speak to the other whenever they wish, interrupting freely. There are no turn-around beeps or turn-around time requirements to concern the mobile party. In most ways, LTR full-duplex interconnect rivals mobile telephone systems with simplicity of use.

In full-duplex mode the call can be terminated by the mobile party at any time by pressing the # key on the DTMF keypad. The landline party can only disconnect with a # if the mobile carrier and/or data packets are not present. The person on the phone side must hold the # key for a long ½ second before the Model 49 will terminate the call. A short 80 millisecond # key from the mobile radio party will terminate the call almost instantly. For firmware version 6.10 and higher units, # key termination may be programmed to be active for durations from 60 to 500 milliseconds received from the mobile.

If the land line party just hangs up the telephone, the Model 49 can detect this and terminate the call automatically if the telco circuit is equipped for one of the following:

1. a "ground start" end-end line
2. a loop start end-end line with reverse battery supervision
3. DID or E&M trunk idle supervision
4. dial tone detection (only detected when mobile carrier and/or packets are not present)

   Note: for further details on telco services, call Zetron Mobile Systems Division's Applications Engineers at (206) 820-6363.

Most full-duplex LTR mobile units automatically send a "#" key when the handset is returned to its hanger, thereby terminating the call. If the handset is misplaced and the mobile radio continues transmission, the call can still be terminated by telco circuit conditions (see above). However, the "stuck transmit" condition of the mobile will cause a succession of interconnect attempts and prevent other mobiles from accessing the system. In this case, you must rely on the mobile's built-in transmit time-out timer (TOT) to shut it off. If the mobile signal fades completely, the call is terminated when the turn-around timer expires (programmed in Multibase Site Config Interconnect database).

The Model 49 runs a timer during the conversation and checks its value against the Call Limit as determined by the Dynamic Call Limit Table (see section below). For 30 seconds prior to call limit termination, the Model 49 plays a "tick" once per second to the mobile party as a countdown warning.

Note: You can use Multibase's Traffic Monitor feature to call your Model 49 at the site and determine exactly which mobile User ID is holding any channel busy. The Model 49 monitors traffic from <u>all</u> channels at the site, whether they have Johnson, Uniden, or Zetron logic controllers.

MOBILE TO LAND DIALING CONTROL

Dialed Number Restriction

As the phone number to be dialed is being regenerated by the Model 49, the number is checked for authorization in the User ID database. Specific User IDs can be given privileges for no outgoing, autodial numbers only, local, credit card, operator, long distance or international dialing. Specific calling prefixes can be designated as allowed or restricted in the Site Config Interconnect Prefixes database screen. A '?' can be used to designate a digit as a wild card.

Restricted prefixes are useful for screening out telephone numbers that you wish to prohibit, since they might cost money or are sources of phone abuse. If the prefix is restricted from use by the User ID, the call is terminated before the phone number is completely regenerated, thereby preventing any billing.

Allowed prefixes are useful if you want to limit certain users to dialing a few selected prefixes.

To further prevent "smart" users from cheating the system, the Model 49 can be programmed to prevent dialing extra DTMF digits after a specific time period once the call is placed. The 2nd Dialtone/DTMF Thru and Overdialing Time Limit values in the Site Config Interconnect database screen let you set appropriate call screening conditions.

Autodialing

Up to 100 numbers can be programmed into a Model 49 system as Autodial numbers. The mobile party can use these preprogrammed numbers by entering *nn, instead of a phone number after accessing the system and hearing dial tone. The "*" tells the Model 49 that the digits to follow are for an autodial number and the "nn" is the two-digit number that indicates which entry in the autodial table to use. After *nn is received the Model 49 out-dials the phone number and the call continues as a normal mobile to landline call.

Note: Depending on how an autodial number is programmed, a call can have toll restriction (toll restriction includes prefix restrict and toll privileges) applied to the autodial phone number.

Auto Overdial Users
Any user programmed as Interconnect can also be programmed as Auto Overdial. These users are treated in a special way when they access an autodial table entry, or are homed on a channel with a direct link to another LTR site.

When an Auto Overdial User enters *nn to select an autodial table entry, the number selected will be dialed by the Model 49. If the number being called is marked in the autodial table to be another LTR site the Model 49 will automatically overdial the ID or access code associated with the user initiating the call.

If an Auto Overdial User is homed on a channel with a direct link to another LTR site, when the mobile keys up the Model 49 will take the phone offhook and overdial the ID or access code of the initiating mobile.

If a user who is programmed as Auto Overdial receives an incoming call and the Model 49 has been programmed for Answer Mode: "A" (Autonet DTMF), a prompt tone will be sent to the caller once the ID code has been sent out and the caller can begin talking. No ringing tones are sent.

Push to Connect (PTC) Users
Interconnect users may be designated as Push to Connect users. Each PTC user has an autodial table entry associated with it, plus if another LTR site is being called, an ID or ACCESS code to overdial on the answering system. When a PTC user keys up, the Model 49 automatically out-dials the autodial number designated for that user, and automatically overdials the programmed ID code if necessary. To make a PTC call, all the user needs to do is key up, no DTMF is required.

A time delay can be programmed as part of the PTC user configuration, which is injected before the Model 49 does the autodialing. This allows a user programmed as PTC to use the same ID code to make regular phone calls, if equipped with a DTMF keypad.

VOICE MESSAGING ACCESS USING THE # KEY

A user can turn off the pound (#) disconnect feature during a call. This is sometimes necessary for customers that use voice messaging systems. To disable the DTMF #:

1. Press the DTMF '*' key twice, "* *". The Model 49 prompts you with four low tones to indicate that the '#' hangup has been disabled.

2. Press the DTMF '*' key twice again and the Model 49 prompts you with four high tones to indicate that the '#' hangup has been re-enabled again.

Since some voice messaging services also respond to the DTMF '*' key, it is recommended that you dial the voice mail number and disable the DTMF '#' during the ringing to keep the voice mail system from being confused.

DYNAMIC CALL LIMITING

The time limit of each interconnect call and number of active calls can be regulated automatically by the Model 49, based upon measured system activity. During busy system periods, you can 1) maintain a specific grade of service for your interconnect users by cutting back on call lengths and 2) give preferred system availability to dispatch users by cutting back on the number of allowed interconnect calls. In this way, you can maintain loading requirements and still provide excellent interconnect availability during non-peak periods.

The system loading (0 to 100%) is determined based upon the number of channels and total air time used during a 5-minute period. Every 30 seconds a new loading value is calculated and the 'maximum call length' and 'simultaneous calls allowed' values are updated. Active interconnect users are continuously being checked to make sure the maximum call length has not been exceeded. If an interconnect user has been on too long, then that user is given a warning and 30 seconds to complete his/her phone call. The maximum simultaneous calls are checked only when a call is initiated.

Multibase gives you the facility to program interconnect call limits and number of concurrent calls for each loading point in 20% steps, for two classes of users; high and low priority. In firmware versions 6.10 and higher, four classes of users are available; low, medium, high, and very high.

You can also give individual User IDs premium service. Those high priority IDs can obtain more interconnect channels during peak periods when you program the maximum simultaneous calls in the Dynamic Call Limit Table. During the busiest time periods, you can even deny interconnect access to low priority users by setting their number of calls to 0.

Note: If you prefer fixed (non-dynamic) time limits, put the same value in each entry of the Dynamic Call tables.

INTELLIGENT FREE REPEATER ALLOCATION

Most LTR systems have rigid repeater system setups in which you must install interconnects in consecutively numbered repeaters for best results. You usually assign interconnects to the lowest numbered repeaters, but other configurations work well as long as all RICs are installed consecutively.

On systems with two or three interconnected channels, all interconnect users are usually "home channeled" on the lowest numbered repeater. This lets users be trunked up to the other interconnected repeaters if their home channel is busy. The problem with most LTR systems is that interconnect users homed on upper channels have difficulty obtaining a free repeater for mobile to land line calls.

The Model 49's Intelligent Repeater Channel allocation designates the next free repeater based on trunking information programmed for each repeater. Channels can be set up so that the next free repeater is based upon whether the home channel is dispatch-only or interconnect capable. Mobiles homed on interconnect channels will be trunked to interconnected channels first, before ending up on a dispatch channel. Similarly, mobiles homed on dispatch channels will be trunked to other dispatch channels first, keeping the interconnected ones free as long as possible. Your mobile users will be able to make interconnect calls more easily, improving your system's grade of service.

The default values in the "Trunking: From___ To___" fields in the Repeater Config screen can be altered from "T" & "T" to accommodate specific trunking schemes that are unique. These values will affect overall system performance and should be left at default unless your system has particular trunking needs.

OPTIONS

DID Option

The Model 49 can be equipped with a DID (direct inward dial/selector-level) interface card (in place of an end-end station card) so that phone callers can access mobile users without overdialing the user ID. Any mobile user can be given his/her own personal telephone number, just as in cellular radio service.

Due to the way DID trunks work, they cannot be used to place outgoing calls from mobiles. Fortunately, since you have a trunking system, you can equip some repeater channels with DID for fast incoming calls and other channels with end-end interfaces for outgoing calls. If you make at least 20% of your revenue from dispatch users, then you can effectively place a DID Model 49 in place of any dispatch-only channel. If you have to provide out-calling service on all of your channels, then a separate DID converter unit will be the most beneficial to you.

You order DID service from your local telephone company in blocks of 100 telephone numbers. For example 555-34xx covers the 100 numbers from 555-3400 through 555-3499. When you order more than 100 numbers, the phone company may provide you with disjoint blocks of numbers, such as 555-34xx and 555-36xx for 200 numbers.

When you setup the Model 49, you program the DID Access # in the USER ID database for each mobile getting DID service.The DID access number is the last 2, 3, or 4 digits of the phone number, depending upon whether the phone company is gives you "2, 3, or 4-digit feed".

When a phone caller dials one of the phone numbers in the bank, the phone equipment 'feeds' the last digits of the phone number down the wire pair as either pulses or DTMF, drawing current from the -48V power supply built into the Model 49. These feed digits are then used to look up the particular mobile ID from the DID access table database.

No beep tones are issued to the caller on DID since the digits are automatically sent by the phone company. The Model 49 supplies the necessary ringing and busy tones so that phone callers know what's happening. If a caller accesses a number that you have not programmed into the database, or if a user ID is invalid, then the Model 49 plays "reorder tones" to the caller for a few seconds and hangs up.

Note: You can give any mobile User ID any DID access number you choose. No matter which channel the user is homed on, a call through a DID trunk will generate a message on the repeater bus to move the mobile over and receive the call.

Audio Compandor Option
This optional plug-in circuit card improves telephone interconnect audio fidelity by reducing the noise introduced by radio signal propagation. The 2:1 compandor circuitry is similar to that used in cellular mobile telephone systems. The Model 49 Compandor is the ideal companion to full-duplex mobiles that are equipped with compandors.

For those mobiles without built-in compandors, the Model 49's card can be operated just in mobile to phone Expansion mode (without phone to mobile Compression). This reduces "data rumble" and reduces the hisses and pops, so common to line of sight radio reception. By improving the received signal to noise ratio, even telephone hybrid adjustment becomes less critical. When using the Model 49 in conjunction with a Zetron Model 810 Digital Hybrid, it is recommended *not* to exercise this "Expand Only" option due to frequency response operations of the Model 810 unit.

Individual User IDs are programmed using Multibase to utilize or bypass the compandor audio processor. In this way, you have full flexibility and control over audio processing. As you add new compandored mobiles to the system, you can obtain the full benefit of your Compandor card.

Voice Prompt Option
This optional plug-in circuit card provides recordable voice prompts for each Model 49 in which it has been installed.

If a voice prompt has not been recorded the progress tones will be played. As the voice prompts are recorded they will be played instead of the progress tones. The following are some of the voice prompts available:

1. Welcome
2. Call cannot be completed
3. Thank you
4. Please wait, your call is being processed
5. The number you dialed is invalid
6. The number is not valid, please retry
7. Please proceed
8. Alarm on repeater

For Model 49 units equipped with version 6.10 firmware, the prompt set has been completely reconfigured and is detailed in the *Model 49 Multibase Version 6.1 or Above Operation Manual* (Part No. 025-9297).

Alarm Monitoring
The alarm feature provides the capability in each Model 49 to monitor up to 3 analog sense inputs for out-of-range conditions, as well as loss of Sync and SMDR storage nearly full. Each of the five possible alarms can be individually enabled by repeater.

Once one of the alarm conditions has been met a tone or voice prompt will be transmitted to the ID code entered in Multibase as the alarm ID. The alarm can be programmed to be retransmitted up to 999 times with a selectable time interval between each transmission.

Three control outputs are also available to correspond to each sense input. If desired, the Model 49 will automatically set the appropriate control when an alarm occurs on the sense input. The control outputs are form-relay closures that are jumper selectable for N.O. or N.C.

Station ID Operation
The built-in tone generator plus software on the main board provides station identification using International Morse Code CW ID. When enabled through Multibase programming in the Repeater Configuration database, transmissions occur automatically at programmable intervals. If you already have a channel transmitting station IDs, you simply disable the Model 49 through programming.

During station identification, the Model 49 sends sub-audible LTR data packets with an ID=253, thereby marking the channel busy so that mobiles will trunk off to a free channel (unlike some systems where mobiles end up camping on until identification finishes). Also, if the ID timer comes due while the channel is busy, the Model 49 waits for the channel to go idle before commencing station identification.

TRAFFIC MONITOR

The traffic monitor feature of the Model 49 displays, on your computer screen, the activity for each repeater channel at the selected site. Activity is shown for <u>all</u> repeater logic units connected to the repeater bus (Johnson, Uniden, and Zetron). You use Multibase to connect to your Model 49 to the remote site through the interconnect line. For further explanation, refer to *Model 49 Multibase Operation Manual* (Part No. 025-9173) or to *Model 49 Multibase, Version 6.1 or Above Operation Manual* (Part No. 025-9297).

SYSTEM CONNECTIONS

Equipment Connections

Figure 2-1 shows the architecture of a typical trunked radio system. Note that the radio controllers (Model 49s) communicate with each other via a repeater bus (which can be shared with E.F. Johnson or Uniden logic units) to allocate repeater channel use.

A second bus, the subscriber bus, is used by the Model 49s for database and billing information transmission. With this bus, one phone call to any Model 49 can update the database and retrieve billing data for all Zetron-controlled channels.

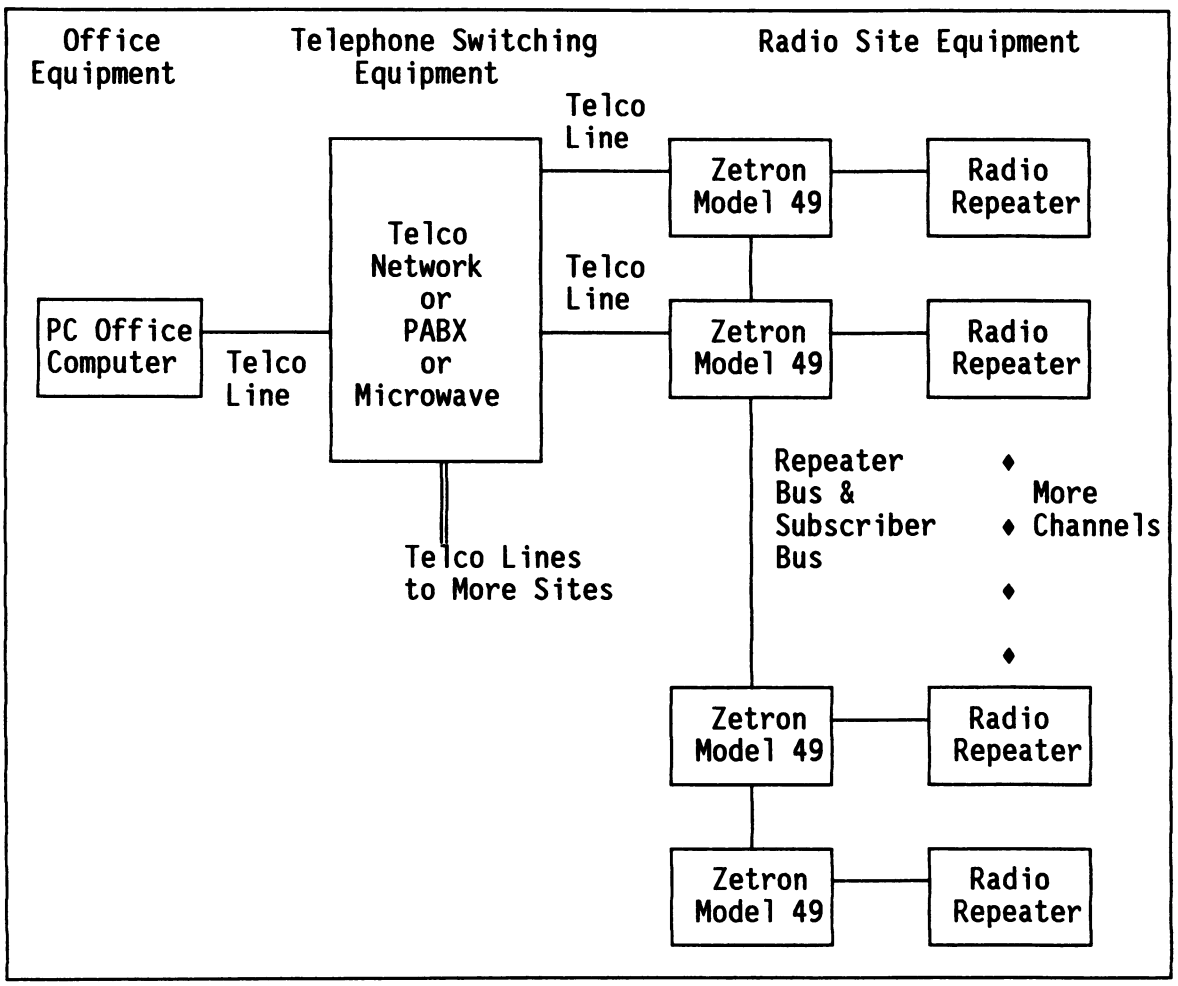


Figure 2-1. System Block Diagram

Repeater Connections
As shown in Figure 2-2, each radio channel consists of a channel controller and a radio repeater. Typical connections between the controller and the repeater consist of discriminator audio, transmit audio/data, PTT, and power/ground.

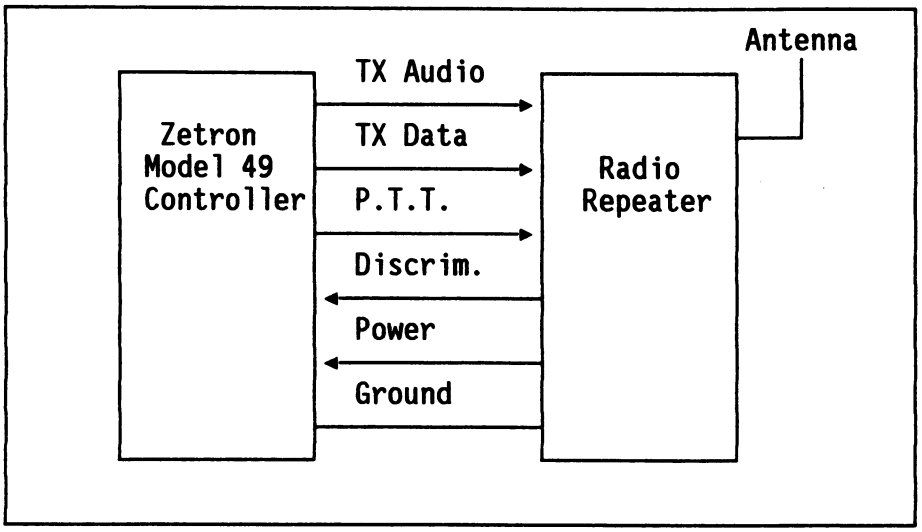


Figure 2-2. Model 49/Repeater Connections

REMOTE PROGRAMMING

Many operational settings for the mobile users are programmable on a per user basis. These settings are stored in the Model 49's non-volatile memory, which is kept intact even during power failures. Programming of these settings is performed with Zetron's Multibase software on an IBM compatible personal computer and loaded into the Model 49. If the Model 49 is at the site, the programming is loaded by telephone modem. If the Model 49 is in the shop, the programming is loaded locally via an RS-232 port and a Zetron serial cable (for a 9-pin AT comm port, use Zetron cable Part No. 709-7144; for a 25-pin PC comm port, use Zetron cable Part No. 709-9030).

The general configurations for remote programming is illustrated in Figure 2-3.

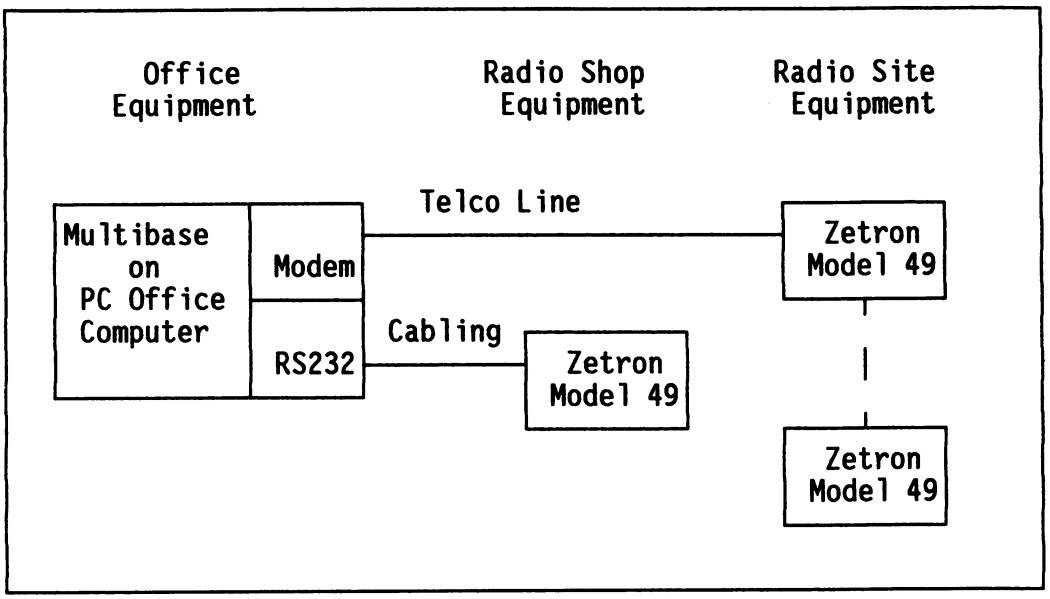


Figure 2.3 - Model 49 Local/Remote Programming

You can handle multiple Model 49s at multiple sites with one Multibase software system. Programming settings and retrieving billing data is performed right from your office. With Zetron's automatic cloning, one telephone call to any Model 49 at the site automatically loads all of the Zetron units without extra telephone calls.

Multibase is easy for clerical personnel to learn and use. Arrow keys permit navigation on the screen to select menu items and to fill in forms. Help screens give specific instructions, examples, and hints for each operation. Refer to *Model 49 Multibase Operation Manual* (Part No. 025-9173) or to *Model 49 Multibase, Version 6.1 or Above Operation Manual* (Part No. 025-9297) for more information.

3. LTR TRUNKING

3. LTR TRUNKING

LTR PROTOCOL

The LTR protocol gives the Model 49 its LTR personality. In revision "S" and higher main boards, this circuitry has been incorporated onto the main board. This circuitry decodes and encodes the LTR subaudible data streams through the radio repeater from the mobile radios. Analog filtering and data processing are utilized to extract data packets from noisy radio channels.

Simple TX and RX data level adjustments on the main board set the RF channel deviation levels (950 Hz for 800 MHz, 800 Hz for 900 MHz) recommended for the subaudible data. Indicator lamps show transmitted and received data packets as well as receive signal quality. Quick communication between the protocol card and the main Model 49 processor keeps LTR data packets flowing smoothly from/to the mobile radios to maintain channel efficiency.

TRUNKING BUSES

Multi-channel repeater channel allocation is performed using the high-speed repeater bus. The Model 49 is configured with jumpers for compatibility with the E.F. Johnson high-speed data bus (HDB) or the Uniden repeater network data link (RNDL) bus. Each repeater controller (numbered 1 through 20) has a designated time slot on the bus, during which it indicates the currently active user on its repeater. The other control units use this information to determine available free channels and to send "go to" commands to gather groups of mobiles. Since Zetron is compatible with both standard buses, you can add Zetron Model 49s to your existing LTR trunking systems. Figures 3-1 and 3-2 illustrate E.F. Johnson and Uniden bus configurations for LTR systems.

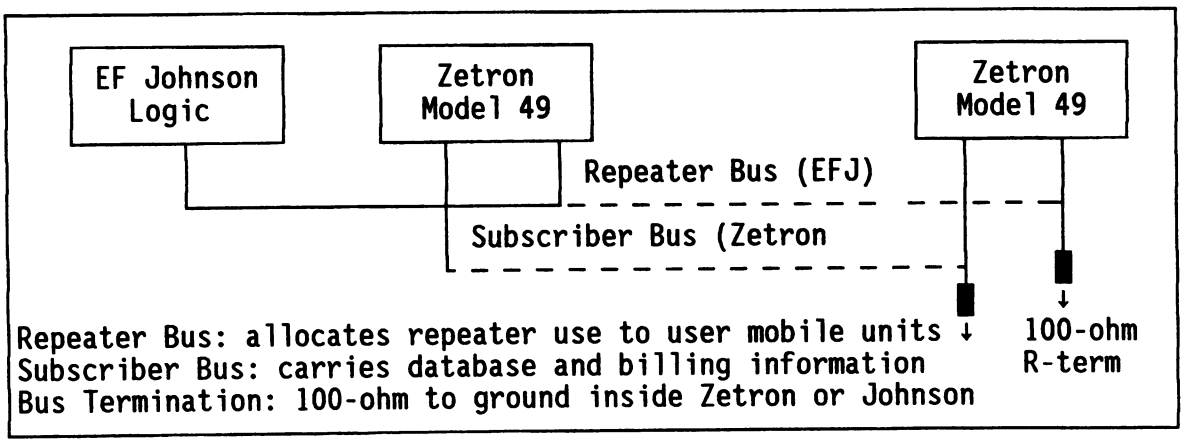


Figure 3-1. Model 49 Trunking Buses (Johnson Compatible)

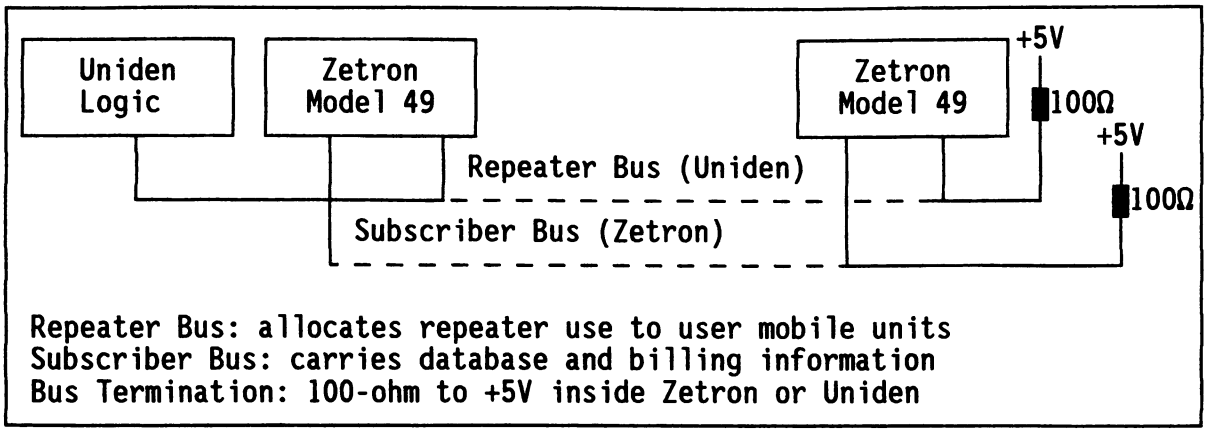


Figure 3-2. Model 49 Trunking Buses (Uniden Compatible)

The subscriber bus is used for communicating database and billing information from one Model 49 to another. When the office computer connects into one Model 49 by modem, it can obtain data from any Model 49 via the subscriber bus.

There is a pair of BNC connectors for each bus on the rear panel of the Model 49, making it easy to daisy-chain the cables. These party-line buses connect logic units together with 50-ohm coaxial shielded cable. On EFJ systems, termination resistors at the ends pull the open-emitter drivers to ground through 100-ohm. On Uniden systems, a 100 ohm resistor (installed inside one of the logic units) on each bus pulls the open-collector drivers to +5 volts.

* * * * * * * * * * * * * * * * N O T E * * * * * * * * * * * * * * * * * *

For proper operation, <u>each</u> bus must have <u>one</u> terminating resistor, rated at 100 Ω.

* *

REPEATER BUS OPERATION

This bus is called the high-speed data bus (HDB) on E.F. Johnson systems and the repeater network data link (RNDL) on Uniden systems. The bus is a coaxial cable system and has a time slot for each active repeater on the system to identify which user (home channel + ID) is using that repeater.

If the repeater is available (free), then the home channel number (01 to 20) and ID of 255 appears on the bus. One logic unit is designated the bus master and provides the sync pulse necessary for bus operation. Either a Zetron Model 49 or other brand of logic unit can operate as the sync master. If the sync master fails to generate sync pulses at the appropriate time (at least every 35 milliseconds), then the repeater controllers do not trunk, but revert to single channel LTR radio repeaters. As soon as sync reappears, trunking resumes automatically.

The repeater bus timing is shown in Figure 3-3, beginning with the sync pulse. The sync pulse on the repeater bus notifies all of the logic units when time slot #1 begins. Only one logic unit, designated the "sync master" generates the sync pulse for each bus cycle. A switch setting in each Johnson/Uniden Logic Unit and in each Zetron Model 49 designates whether it generates or looks for sync pulses. Only one unit on each repeater bus should be configured as the sync master to generate sync.

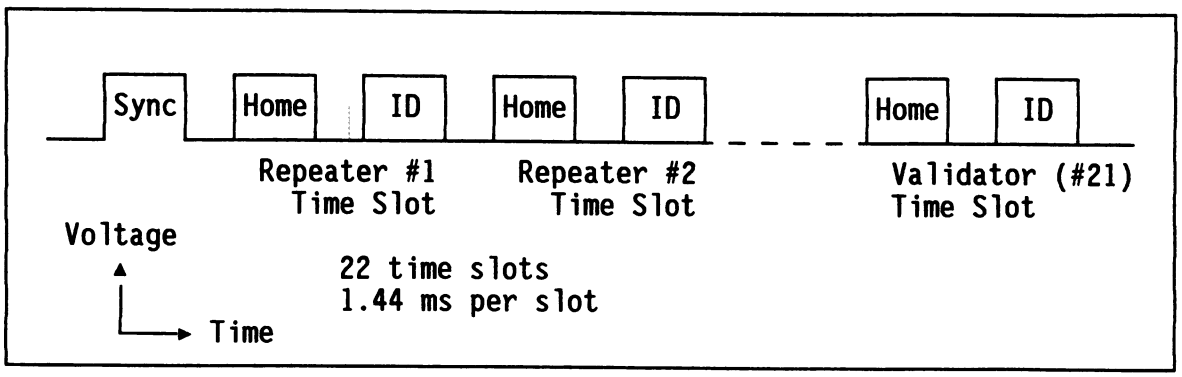


Figure 3-3. Repeater Bus Timing

Slot #21 is used to convey user ID validation information on systems with a separate validator box. Slot #22 is not used. If a user ID has been set as invalid, then the active repeater sets a home channel of 21 along with the ID being invalidated in its repeater bus time slot.

The SYNC light on the front of the Model 49 indicates when it is generating/receiving sync depending upon whether it is set as a repeater bus master/slave. Similar SYNC light on Johnson and RCD light on Uniden logic confirm proper repeater bus operation.

SUBSCRIBER BUS OPERATION

This bus carries messages among Zetron Model 49s at the site. The bus provides access to database and billing data of all Model 49s from any one Model 49. The messages carry database information for automatic cloning, air time and detail records for billing data retrieval, and repeater loading data for system use analysis.

The bus is a coaxial cable party-line system where one Model 49 is a "subscriber master" and the others slaves. When the master talks to the slaves, its front panel POLL light is lit steadily and the slave POLL lights flicker quickly. During database cloning, the POLL light flashes every second or so until cloning is complete.

> **Note:**
>
> **As jumpered in the Model 49, this bus is electrically identical to the repeater bus so that cross connecting the buses will cause no damage. However, just like the repeater bus, the subscriber bus requires its own termination resistor of 100Ω.**

USER ID VALIDATION

Many LTR systems operate with no validation system, i.e. any LTR radio that is programmed to the correct frequencies can access the system. With validation, a standard feature of the Zetron Model 49, only those designated user IDs are permitted system access. If an invalidated user ID attempts access, the logic unit for that channel sends a "turn-off" message to the mobile, causing the mobile radio to squelch. If the mobile is half-duplex, it won't hear the "turnoff" packet until it stops transmitting.

The validation system in the Model 49 is very flexible. Depending upon the settings of the Validate and Sync switches, the Model 49 can validate its own users (internal validation), look for validation information from a system validator on the repeater bus (external validation), or generate validation information for other logic units (validator function). For setting up the validation system, refer to the dip switch settings in Figure 4-32 on page 4-86 of Section 4.

When the Model 49 is performing validation on other logic units, it will only tell the other logic units whether or not an ID is valid. Therefore, the ID's capability is determined by the channel that the call is being made on. This is true for a trunked or homed call. When using Uniden or EFJ logic the IDs are programmed on a block approach. The preceding facts make it necessary that all channels must be programmed in identical increments. This is true even in the Zetron channel.

Example:

IDs	Model 49 Channel 1
1 – 100	Dispatch capable
101 – 150	Interconnect with only local capability
151 – 250	Interconnect with long distance capability

IDs	EFJ Channel 2
1 – 100	Dispatch capable
101 – 150	Interconnect with only local capability
151 – 250	Interconnect with long distance capability

TRUNKING DATA PACKETS

A mobile radio is normally tuned to its "home" channel, listening for data packets from its home repeater. These data packets tell the radios which repeater is available for use and whether any mobile or telephone party is calling them. The serial format of these data packets is illustrated in Figure 3-4.

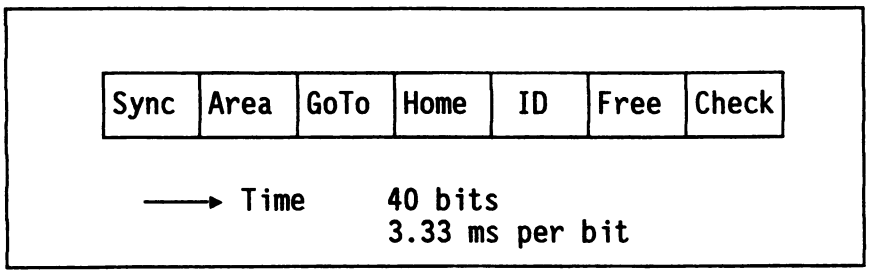


Figure 3-4. LTR Data Packet Format

If all channels are busy, then a "Free" repeater number of 0 is sent by the logic unit. If the home repeater is free, the logic unit sets "Go To=Home" and sends idle packets at regular intervals to keep mobiles updated, typically every 10 seconds.

The "Check" field guarantees accurate communication of data between the logic units and the mobiles. Packets in error are discarded.

4. MODEL 49 SETUP

4. MODEL 49 SETUP

OVERVIEW

The Model 49 is designed with a heavy-duty face plate that has holes to accommodate standard 19" rack mounting. Additional holes in the front and side panels provide compatibility with E.F. Johnson racking systems. The #8-32 side holes attach directly to the slide rails from an EFJ modular mounting frame.

Power consumption of the Model 49 is approximately 400 mA on a Dispatch Unit, 500 mA on an End-End Interconnect Unit, and 600 mA on a DID Interconnect Unit. Generally, sufficient spare +12V DC power is available from the radio repeater to power the Model 49. Note: DC input power must be at least +10.5V DC for proper Model 49 operation.

The following equipment is recommended to make installation and programming easy:

Equipment	Purpose
Tool kit with screwdrivers	Mechanical assembly
Comm. monitor with deviation meter	Adjusting RX and TX levels
Voltmeter	Adjusting RX and TX audio levels
1000-Hz audio oscillator	Adjusting modulation limiter
Trunking radio, with DTMF keypad*	Adjusting RX and TX data levels
LTR encoder, decoder	Adjusting RX and TX data levels
Model 49 Trunking Repeater Manager	System component
Radio repeater	System component
Cable from repeater to Model 49	System component
BNC cables between all logic units	System component
IBM compatible PC (w/ Hayes modem)	Program site, repeater, user IDs
RS-232 cable from computer to Model 49	Programming connection
Telephone line or telco simulator*	Adj. telco levels and balance
Modular telephone cord*	Telephone connection

* This item required only for telephone interconnect installations

We recommend that you allot sufficient time in your radio shop to become familiar with the Model 49 and to set up and operate your first Zetron controlled repeater there, before traveling to the repeater site. Although the Model 49 is a small unit, its comprehensive capabilities will require time to adjust it, to program its database, and to become familiar with its operation. Zetron Mobile Systems Division applications engineers are available by telephone (at (206) 820-6363) to assist you in your installation.

> NOTICE
> This equipment generates, uses, and can radiate radio frequency energy; and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. Installation should be accomplished by personnel with experience in radio trunking systems. Specialized knowledge in telephone systems is also important when interconnecting with telco or microwave networks.

Note that some jumpers on the Model 49 are underneath option cards, inside the unit: JP1 is under the TELCO card; JP4, JP5, JP6 are under the Voice Prompt Card. There are no jumpers under the Compandor card.

All adjustment pots and DIP switches are behind a removable front panel cover and are accessible without removing the top cover from the unit.

Most of the status display LEDs are immediately visible from the front panel. The exceptions are the LTR Protocol ASIC status outputs:

DS1	("RX")	Indicates LTR data [packet] received.
DS2	("TX")	Indicates LTR data packet transmitted.
DS3	("Qual")	Indicates a received data packet has been qualified as valid (this does *not* indicate a valid USER ID).

These three indicators are located beneath the Voice Prompt Card and are only of interest during level setting and troubleshooting procedures. It may be necessary to temporarily remove the Voice Prompt Card during these service operations. The voice messages will not be disturbed if the card is handled carefully.

INSTALLATION CHECKLIST

Start with the unit in your shop and complete the following steps, which are described in detail in the remainder of this section:

[] Step 1: Set jumpers for data bus and alarm jumpers (see page 4-4). Unique repeater jumper configurations are listed in Step 4.

[] Step 2: Clear memory (see page 4-10).

[] Step 3: Set dip switches (see page 4-12).

[] Step 4: Modify and install repeater. A list of repeaters is given on the first page of this step (see page 4-13).

[] Step 5: Set repeater levels (see page 4-61).

[] Step 6: Make trunking connections (see page 4-66).

[] Step 7: Test dispatch calls (see page 4-67).

[] Step 8: Test trunking (see page 4-68).

[] Step 9: Test interconnect (see page 4-69).

[] Step 10: Make telco adjustments (see page 4-70).

[] Step 11: Program users and time (see page 4-75).

Once your system is operating well in your shop, record the equipment settings and any pertinent notes on the worksheets provided at the end of this section. Keep these worksheets for future reference; they will ease future installation of additional Zetron units.

WARNING

To protect this equipment against high voltage surges induced by lightning, care must be taken to observe proper grounding practices for both the radio and telephone transmission systems. Installation should be accomplished by personnel with experience in radio-telephone equipment. Consequent damage due to failure to provide adequate protection is not covered under Zetron's warranty.

Zetron recommends use of *additional lightning protection equipment* such as Zetron's DeadBolt Lightning Arrestor to increase security against unwanted downtime and improve system reliability in harsh environments.

Step 1: Setting the Jumpers

[]1. Remove the Model 49 top cover.

[]2. Set repeater bus compatibility jumpers. See Figure 4-1 for the location of the main board jumpers.

The subscriber bus is used for the programming, SMDR, and call accumulation of Zetron units *only*. The Repeater bus is used for trunking and loading information that all logic units need. These buses must be connected and terminated properly for correct operation.

While the Model 49 can work properly with any equipment, Uniden and EFJ logic units cannot coexist in any one system. If the Model 49 is in a system with Uniden logic, pick Uniden logic from below. If the Model 49 is in a system with EFJ logic, pick EFJ logic from below. If the Model 49s are the only logic in the system either Uniden or EFJ logic will work properly.

Uniden logic:

JP11	B=Uniden RNDL Repeater Bus Timing
JP17,19	B=Uniden Subscriber Bus hardware
JP18,20	B=Uniden Repeater Bus hardware
*JP21	B=Uniden 100 ohm pull-up Subscriber Bus termination
*JP22	B=Uniden 100 ohm pull-up Repeater Bus termination

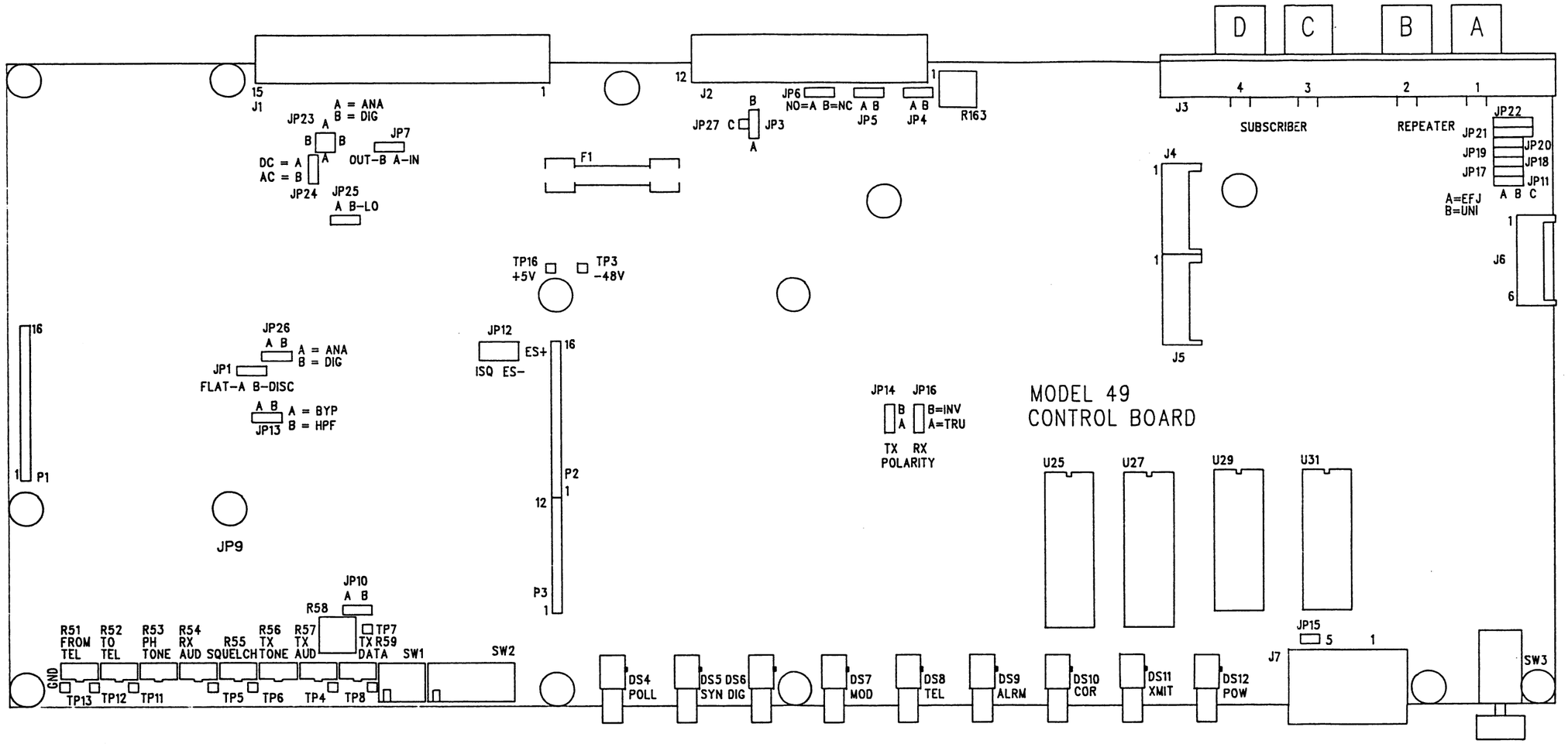
EFJ logic:

JP11	A=EFJ HDB Repeater Bus timing
JP17,19	A=EFJ Subscriber Bus hardware
JP18,20	A=EFJ Repeater Bus hardware
*JP21	A=EFJ 100 ohm pull-down Subscriber Bus termination
*JP22	A=EFJ 100 ohm pull-down Repeater Bus termination

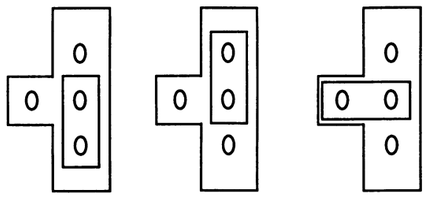
* For either type of logic there should only be 1 pull up or down resistor on the Subscriber or Repeater bus. Because of this, it is necessary on all other logic units to remove any termination. This is done on the Model 49 by placing JP21 (Subsc Bus) and JP22 (Rptr Bus) in the C position.

We recommend placing the termination-resistor jumper for each data bus into the "Master" logic unit for that bus. This will ease service since the exact location of the termination for each bus will be known. Set all bus "Slave" unit terminations to "C".

See "Trunking Connections in Detail" later in this section for a detailed explanation of trunking operations and connections.

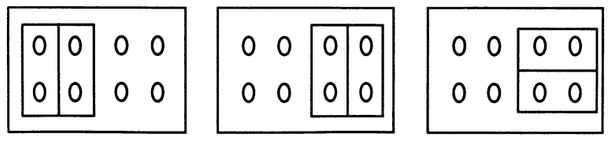


JP3 and JP27
(viewed from front)



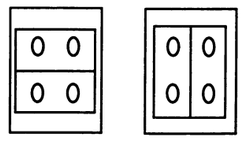
Set to JP3 A and JP27 Out | Set to JP3 B and JP27 Out | Set to JP3 Out and JP27 In

JP12
(viewed from front)



Set to ISQ | Set to ES- | Set to ES+

JP23
(viewed from front)



Set to AA | Set to BB

024–0127B

Figure 4-1. Main Board Jumpers

[]3. Set repeater configuration jumpers.

Refer to the repeater instructions in Step 4 for the specific repeater that will be interfaced with the Model 49, or refer to the following jumper table.

Note: Jumper 1 is located under the TELCO card, if installed.

[]4. Set site alarm and cross-busy jumpers.

The site alarm interface and cross-busy features have relay outputs that can be normally open (N.O.) or normally closed (N.C.). The corresponding jumpers are as follows:

Cross-busy (CTL-1)
JP3 A = N.O.
B = N.C.

Alarms (CTL2-4)
JP4-6 A = N.O.
B = N.C.

[]5. Fill in the blank Model 49 (Rev S and Higher) Jumper Table (Literature No. 005-0902), which was included with your order. Record the jumper settings for your specific installation site and repeaters and display the filled-in jumper table at your site for service personnel.

A sample jumper table showing each of the repeater configurations follows.

M49 (Revision "S" and Higher) Jumper Table

Repeater Model	Main Board Jumper Number																										Comp	Voice Prompt				E-E Telco			E&M 4W Telco				Rev B+	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1	1	2	3	4	Main 1	Bal. Bd. 1	Bal. Bd. 2	1	2	3	4	5	6
Daniels Electronics	B	--					A	--	B	A	*	A	B	A	--	B	*	*	*	*	* C	* C	A	B	A	A	Out	--			B	B	AB	--	A	A						
E.F. Johnson 8600	B	--					A	--	A	A	*	A	B	A	--	A	*	*	*	*	* C	* C	A	B	A	A	Out	--			B	B	AB	--	A	A						
Kenwood TKR-900	B	--					A	--	A	A	*	A	B	A	--	A	*	*	*	*	* C	* C	A	A	A	A	Out	--						--								
Midland LMR	B	--					A	--	A	A	*	A	B	B	--	A	*	*	*	*	* C	* C	A	B	B	A	Out	--			B	B	AB	--	A	A						
Motorola Micor	B	--					A	--	A	A	*	A	B	B	--	A	*	*	*	*	* C	* C	A	B	A	A	Out	--			B	B	AB	--	A	A						
Relm 800 MHz	B	--					A	--	A	A	*	A	B	A	--	B	*	*	*	*	* C	* C	A	B	A	A	Out	--			B	B	AB	--	A	A						
SEA	A	--	C				A	--	B	B	*	B	A	B	--	A	*	*	*	*	* C	* C	B	A	A	B	In	--			B	B	AB	--	A	A						
Standard RP70K	B	--					A	--	A	B	*	A	B	B	--	B	*	*	*	*	* C	* C	A	A	A	A	Out	--			B	B	AB	--	A	A						
Standard RPT-38	B	--					A	--	A	A	*	A	B	A	--	A	*	*	*	*	* C	* C	A	B	A	A	Out	--			B	B	AB	--	A	A						
Tait	B	--					A	--	A	A	*	A	B	A	--	A	*	*	*	*	* C	* C	A	B	A	A	Out	--			B	B	AB	--	A	A						
Uniden MRS 804	B	--					A	--	A	A	*	A	B	B	--	A	*	*	*	*	* C	* C	A	B	A	A	Out	--			B	B	AB	--	A	A						
Uniden MRS 802	B	--					A	--	A	A	*	A	B	B	--	A	*	*	*	*	* C	* C	A	B	A	A	Out	--			B	B	AB	--	A	A						
E&M Config. for M810																																					A	A	B	B	A	A
*Uniden Logic (100Ω +5V)											B						B	B	B	B	B C	B C																				
*EFJ Logic (100Ω -Gnd)											A						A	A	A	A	A C	A C																				
Functional Descriptions Notes: N.O. = Normally Open N.C. = Normally Closed H.P.F. = High Pass Filter	Tx Audio to Radio: A=Flat, B = Disc	Reset (Active = IN) Normally Out	Alarm 1 (X-BSY) : A = N.O.; B = N.C.	Alarm 2 : A = N.O.; B = N.C.	Alarm 3 : A = N.O.; B = N.C.	Alarm 4 : A = N.O.; B = N.C.	COR Directions: A = Input; B = Output	PTT Drive : OUT = Relay; IN = Trans.	Radio Rx Amp: A = High ; B = Low	Radio Tx Amp : A = High; B = Low	EFJ /Uniden Bus : A = EFJ; B = UNI	COR Drive: A=ISQ; B=EXT-; C = EXT+	Radio Rx Filter: A = Thru; B = HPF	Tx Data Polarity : A = Normal; B= Invert	+12 Voc to J9 : OUT = OFF; IN = ON	Rx Data Polarity: A = Normal; B = Invert	EFJ/Uniden : A = EFJ; B = Uniden	EFJ/Uniden : A = EFJ; B = Uniden	EFJ/Uniden : A = EFJ; B = Uniden	EFJ/Uniden : A = EFJ; B = Uniden	Subsc. Bus Termination: Master (Poll Lamp) Slaves	Rptr. Bus Termination: Master (Sync. Lamp) Slaves	Sub-in Format: A = Analog; B = Digital	Sub-out Coupling: A = DC; B = AC	Sub-out Level : A = High; B = Low	Sub-out Format: A = Analog; B = Digital	Telco Enable (SEA): Jump to JP3-2	-48V Drive: Not Installed	Rx Disc Audio Filter : A = Flat B = HPF	RAM Voltage	Read Control	Audio Input	Write Control	Not Installed	Z-Match Telco to Hybrid A = Normal Line; B = Long Line	Z-Match Telco to Hybrid A = Short Line; B = Normal Line	Supervision: A=M control; B=E control	Output Control Relay Contacts A = N.O. ; B = N.C.	Sense Detection Off-Hook Voltage A = -48V ; B = Ground	Control Lead Output Off-Hook Voltage A = Ground ; B = -48V	From Tel Level: A = Std; B = µwave	To Tel Level: A = Std; B = µwave

The following tables summarize the Model 49 jumper settings.

Jumper Name	Label	A Setting	B Setting	C Setting
Radio TX Audio (under TELCO interface card)	JP1	__ Flat	__ Discriminator	
Reset	JP2	__ Out = Run	__ In = Reset	
Control 1	JP3	__ N.O.	__ N.C.	
Control 2	JP4	__ N.O.	__ N.C.	
Control 3	JP5	__ N.O.	__ N.C.	
Control 4	JP6	__ N.O.	__ N.C.	
COR Direction	JP7	__ In (to M49)	__ Out (from M49)	
PTT	JP8	__ Out = Relay	__ In = Transistor	
Radio RX amp	JP9	__ x20 dB	__ x0 dB	
Radio TX amp	JP10	__ High	__ Low	
EFJ/Uniden bus	JP11	__ E F Johnson	__ Uniden	
COR Input Select	JP12	__ Internal	__ External -	__ External +
Radio RX filter	JP13	__ Direct	__ High Pass Filter	
Tx Data polarity	JP14	__ Normal	__ Inverted	
+12V to J7	JP15	__ Out=Off	__ In=On	
Rx Data Polarity	JP16	__ Normal	__ Inverted	
EFJ/Uniden bus	JP17-20	__ Johnson	__ Uniden	
Subs bus Resistor	JP21	__ EFJ 100Ω	__ Uniden 100Ω	__ No resisto
Rptr bus Resistor	JP22	__ EFJ 100Ω	__ Uniden 100Ω	__ No resistor

Jumper Settings on End-End Telephone Interface Card (702-9227)

Jumper Name	Label	A Setting	B Setting
Supervision	JP1	__ Loop Start	__ Gnd Start

Jumper Settings on End-End Telephone Interface Card (702-9283)

Jumper Name	Label	A Setting	B Setting	C Setting
Balance	JP1	__ DC Bias	__ Large Bal C	__Med Bal C
Balance	JP2	__ DC Bias	__ Bal Cap In	n/a

Jumper Settings on E&M Interface Card (702-9445), Revision A:

Jumper Name	Label	A Setting	B Setting
Supervision	JP1	__ M control	__ E control
Control Relay	JP2	__ Norm Open	__ Norm Closed
Off-Hook Sense	JP3	__ -48 Volts	__ Ground
Off-Hook Control	JP4	__ Ground	__ -48 Volts

Installation Notes for microwave systems:
Replace R10 (1.0 KΩ) with 1.5 KΩ to accommodate -16 dBm output
Replace R13 (1.0 Ω) with 75 KΩ to accommodate +7 dBm input

Jumper Settings on E&M Interface Card (702-9445), Revision B:

Jumper Name	Label	A Setting	B Setting	C Setting
Supervision	JP1	__ M control	__ E control	n/a
Control Relay	JP2	__ Norm Open	__ Norm Closed	n/a
Off-Hook Sense	JP3	__ -48 Volts	__ Ground	__COR (5 VDC)
Off-Hook Control	JP4	__ Ground	__ -48 Volts	n/a
From Tel Level	JP5	__ Standard	__ Microwave	n/a
To Tel Level	JP6	__ Standard	__ Microwave	n/a

Step 2: Clearing Memory

HARD RESET
When you install the Model 49 for the first time, move the unit from one channel to another, or put a spare unit into service, it is important to guarantee that all database and billing information is cleared. To do this, perform the following steps:

> CAUTION
> A hard reset will result in the loss of both the Air Time Accumulator and the Call Detail Record data from the Model 49 memory. Retrieve this data before doing a hard reset.

[]1. Power on the Model 49 and wait about 5 seconds for the front panel lights to stabilize.

[]2. Set all the front panel DIP switches to the DOWN position.

[]3. Press and release the front panel the Connect/Disconnect button four times. The rate at which you press the button is important. To get an idea as to how quickly, read the following out loud:

Press...Release...Press...Release...Press...Release...Press...Release

After you release the button for the second time, the five LEDs: POLL, SYNC, DIGIT, MODEM, and ALARM lights flash briefly. On the third press and release, these LEDs will stay on. On the fourth press and release, the LEDs will go out. This is your indication that the Model 49 has successfully cleared all of its memory to factory settings.

[]4. Set all the front panel DIP switches back to their operating positions.

[]5. Press the Connect/Disconnect button twice. You will see the POLL, SYNC, DIGIT, MODEM, and ALARM lights come on and then go off. Press the Connect/Disconnect button twice again. The five lights will flash briefly. The Model 49 has read the front panel switches.

SOFT RESET
Unlike the full database hard reset, the soft reset will not alter the Air Time Accumulators or the Call Detail Buffer. The main purpose of the soft reset is to "read" the front panel DIP switches. We also recommend that you do a soft reset after removing or installing either the repeater or subscriber bus cables.

Every time you change a switch setting, you must make the Model 49 read the new settings. You can cycle the power off then on, or you can do the following:

[]1. Wait until no radio traffic is busy on the repeater.

[]2. Press and release the CONNECT/DISCONNECT button twice.

- OR -

Press and hold the CONNECT/DISCONNECT button (approximately two seconds) until...

The five LEDs: POLL, SYNC, DIGIT, MODEM, and ALARM lights flash briefly. If you don't see the lights flash, try pressing the button again.

Step 3: Setting DIP Switches

The DIP switches (behind the front panel cover) make it easy for you to set the Model 49 for multi-channel trunking without programming PROMS! There are two switches; the 4-position one on the left is called A, and the 8-position one is called B. Refer to "Hardware Layout" later in this section for diagrams of these switches.

Switch A:1 should be in the Down position for normal operation. The Up position is used for activating test modes for alignment.

Switch A:2 selects repeater data bus validation. The Down position causes the Model 49 to validate from its internal database *and* from the Repeater Bus time slot 21. The Up position validates to or from slot 21 of the Repeater Bus, dependent upon whether the Model 49 is master or slave.

Switches A:3 and A:4 set the communications speed between the Model 49 front panel RS-232 connector and a computer. When the Model 49 uses its internal modem (through the interconnect port), the data rate is 300 bits/second if 300 Baud is selected, or 1200 bits/second if 1200 Baud, 2400 Baud, or 4800 Baud are selected.

Switch B:1 sets up the Model 49 for communication on the Subscriber Bus used for database cloning and billing data retrieval. The subscriber bus is only used between Zetron units, and only one Zetron unit should be set with this switch Up (bus master unit). Other units (slaves) should have this switch set Down. Standalone units should be configured as "master" for proper operation.

Switch B:2 sets up the Model 49 for communication on the Repeater Bus used for trunking with other channels. The repeater bus is used by all the logic units. Only one logic unit should be set as Bus Master (this switch Up on the Model 49). Other units have to be set as slaves (this switch Down on the Model 49). Standalone units should be configured as "master" for proper operation.

Switch B:3 selects the LTR Area being controlled by your trunking system. The setting of this switch must agree with your other logic units and with the programming of all of your mobiles. Set this switch Up for Area 1, and Down for Area 0.

Five switches, B:4 through B:8, select the Repeater channel number being controlled by your Model 49. Your mobiles are programmed with FCC RF channels that correspond to certain repeater numbers. These assigned repeater numbers determine the switch settings of each Model 49. Most repeater numbering systems evenly space the repeater numbers (although this is not critical). A 5-channel system usually has repeaters 1, 5, 9, 13, 17; a 10-channel system has repeaters 1, 3, 5, 7, 9, 11, 13, 15, 17, 19. These switches are coded in binary with the least significant bit on the right (B:8). Refer to "Hardware Layout" later in this section for the coding of these switches.

Note: Changing the switch settings requires a soft reset before the switches are read.

Step 4: Installing and Modifying the Repeater

Select the appropriate repeater from the list below and follow the corresponding modification and installation procedure.

If you are using a repeater not listed, contact a Zetron Mobile Systems Division Applications Engineer at (206) 820-6363.

A. DANIELS ELECTRONICS LOW POWER MT-3 REPEATER

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR Input
JP9	B=RX amp 0 dB gain
JP10	A=TX amp high range
JP12	A=COR from INTernal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	A=True Tx LTR Data polarity
JP16	B=Invert Rx LTR Data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	A or B:Cross-Busy Output (JP7 may change if using cross-busy)
JP4	A or B:Control 2 Output
JP5	A or B:Control 3 Output
JP6	A or B:Control 4 Output

NOTE 1: These jumper positions have been found to operate properly with slight modifications of the repeater, as performed by the repeater manufacturer.

NOTE 2: The Model 49 may be modified for reduced power consumption if desired. Details are provided in Section 9.

[]4. Connect the Model 49 to the Daniels MT-3 Repeater using the Daniels Auxiliary Control interface cable and Figure 4-2. Be careful to reference the correct rackframe slots (A or B) for the transmitter module and receiver module applicable for your installation.

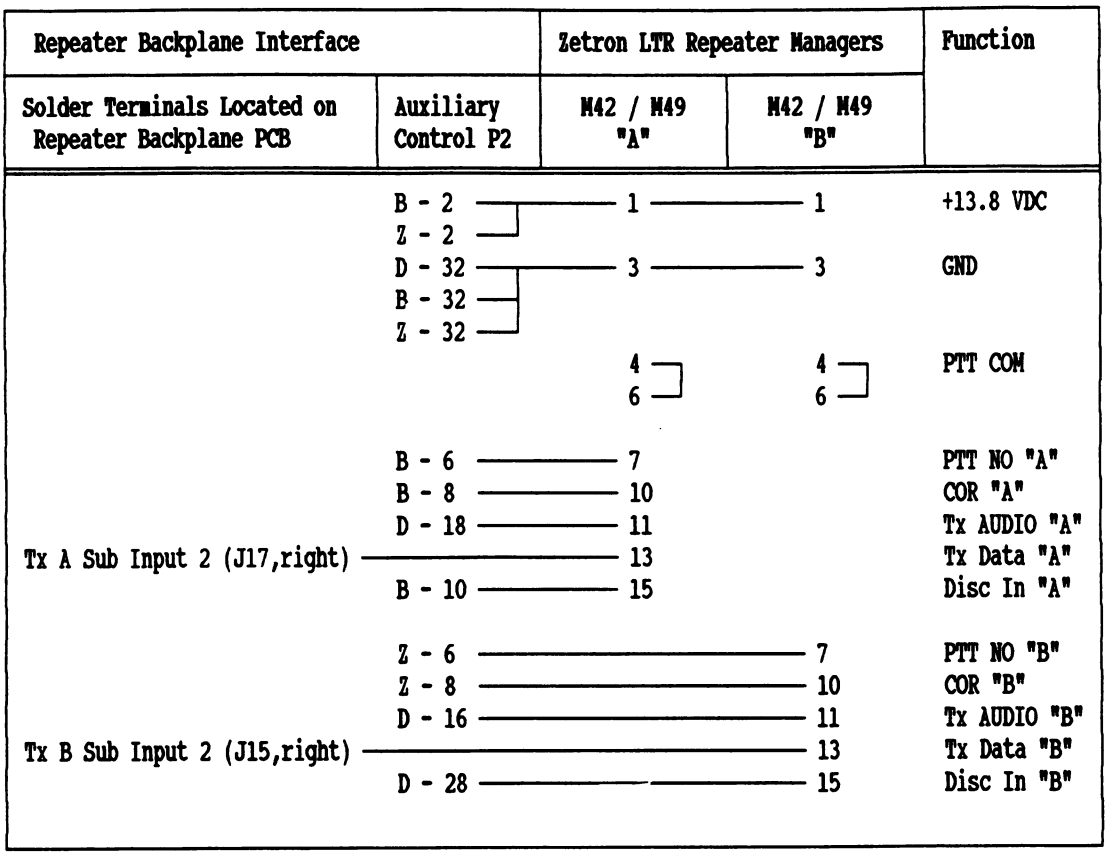


Figure 4-2. Model 49 Interface Cabling to Daniels MT-3 Repeater

[]5. Verify the Daniels MT-3 hardware configuration as listed below:

Receiver

Replace C48 (1 μF Nonpolar) with 10 μF Tantalum Electrolytic capacitor (16V), oriented with negative (-) lead toward TP9. Nonpolar would be best.

JU5 Installed (solder bridged)

Transmitter

Replace the following transmitter module components:

MT-3 Audio Processing Board:

C40 (330 nF) changed to 10 μF, (-) toward R44. (J16 out)

MT-3 800 MHz Synthesizer:

Install Solder bead for JU2.
R11 (2.80 KΩ) changed to 10 KΩ
R12 (2.37 KΩ) changed to 33.2 KΩ
C10 (470 nF) changed to 33 nF
C11 (2.2 μF) changed to 220 nF
C14 (33 nF) changed to 2.2 nF

MT-3 800 MHz Tx Module Main Board:

Connect JA4-2 (Subtone #2 Output) to JS1-18 (Spare Synth I/O), using shielded coaxial cable
J6 Installed (solder bridged)

[]6. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

B. E.F. JOHNSON REPEATER

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	A=True TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

Perform the following modifications to your EFJ repeater:

[]4. Remove the E.F. Johnson Logic Unit, RIC, and cabling harness from the repeater cabinet.

[]5. Remove the slide brackets from the EFJ Logic Unit and attach them to the Model 49.

[]6. Mount the Model 49 into the EFJ repeater cabinet.

[]7. Attach the Zetron Cable Harness (P/N 709-7117) to the Model 49, EFJ Exciter, EFJ Receiver, and EFJ power supply. Note that each connector is marked. Refer to Figure 4-3 for the wiring diagram.

[]8. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

Note: You can record your settings on the worksheets at the end of this section.

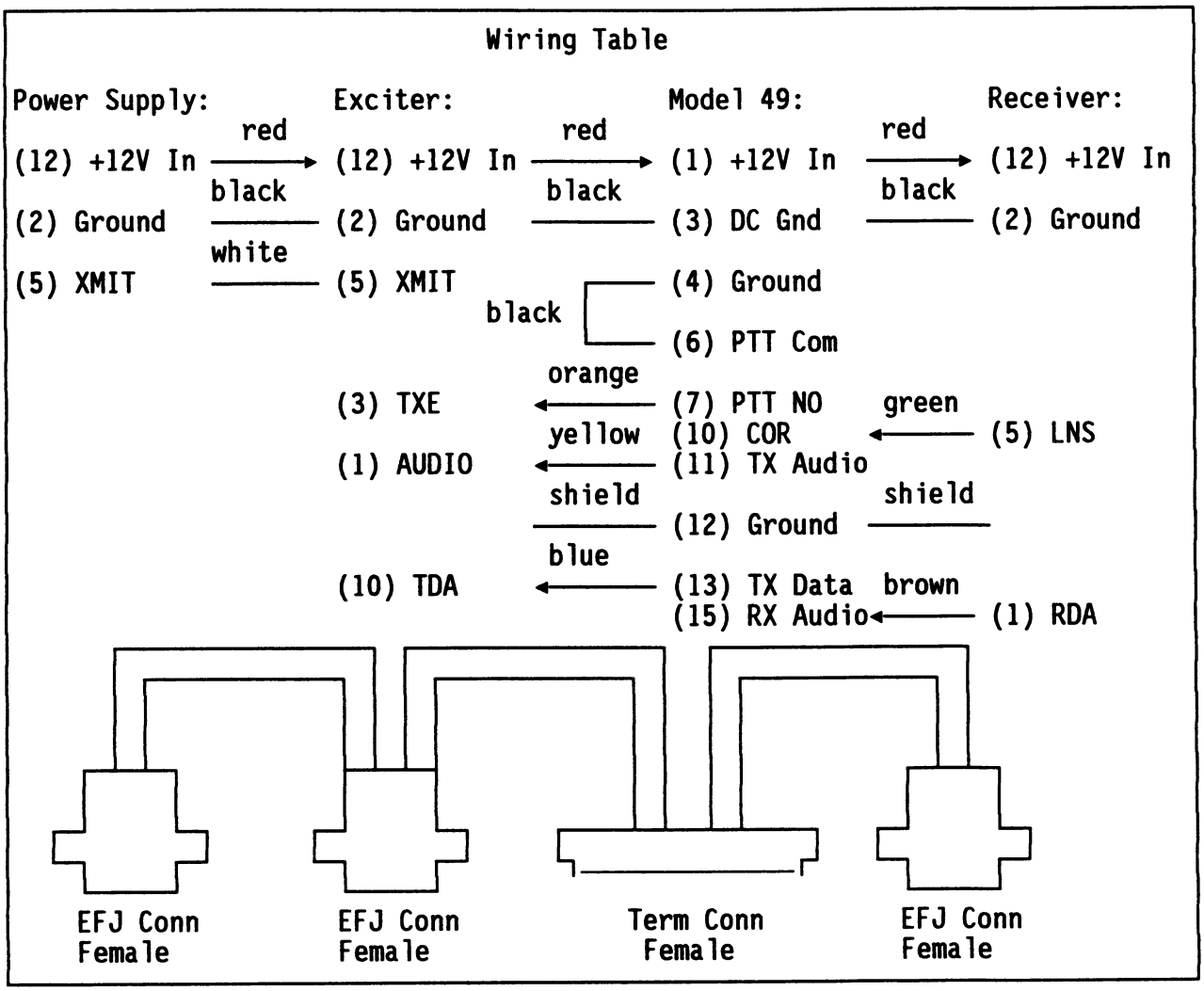


Figure 4-3. Model 49 to E.F. Johnson 800 MHz Repeater Cable (P/N 709-7117)

C. KENWOOD TKR-900 REPEATER

[]1. Remove the six (6) screws which secure the top cover of the repeater, then remove the cover.

[]2. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]3. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	A=True TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	A=DC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

Note: If noise peaks greater than 2 Vpp above 4KHz are not present at J1-15 (Disc In) of the Model 49, then the internal squelch circuitry may not function properly. In that case, JP12 may need to be configured for external COR control ("ES-": 5-6, 7-8).

[]4. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

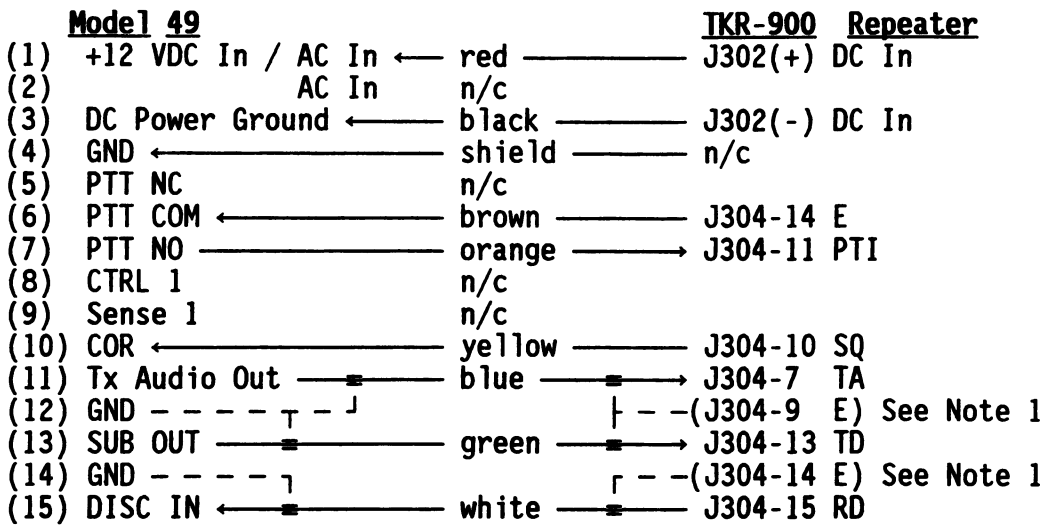
JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

[]5. Set the front panel controls as follow:

VOLUME:	Any position (receiver level to Zetron Model 49 is independent)

[]6. Connect the Model 49 to the TKR-900 Logic Interface connector (J304) with the Generic repeater cable (709-7116) as shown in Figure 4-4.

TKR-900 Repeater Wiring Diagram



Notes:
1. Improved audio noise reduction may be attained by using shielded audio cable as noted if strong RF fields are present and causing interference. (cable not provided)

Figure 4-4. Model 49 Generic Cable (709-7116) to Kenwood Repeater

[]7. Remove the six (6) screws holding the cover onto the receiver module (X55-3020-10) of the repeater. Remove the cover.

[]8. Locate VR2 (Rx Detector Signal Level) and turn fully clockwise to open the squelch for proper Model 49 operation.

[]9. Replace the cover onto the receive module, firmly securing all screws.

[]10. Replace the repeater cover, firmly securing all screws.

[]11. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

D. MIDLAND LMR REPEATER

This interface configuration pertains to Rev S or higher Model 49 controller hardware interfaced with Midland LMR series 800 MHz repeaters. Zetron provides OEM models of the Model 49 to Midland directly. The OEM Model 49s have gray faceplates and are identified as Midland Model 71-949B.

Configuration information regarding Model 49 hardware revisions prior to Rev S are covered in a Technical Information bulletin provided by Zetron Mobile Systems Division, which is intended to be used in conjunction with the *Model 49 Trunking Repeater Manager Operation and Installation Manual* (Part No. 025-9108 Rev Q or later). Please contact Zetron Mobile Systems Applications personnel to obtain this data if needed.

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	B=Invert TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	B=SUBOUT Tx Low level
JP26	A=Analog SUBOUT

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]4 Connect the Model 49 to the LMR repeater using the Generic interface cable (Zetron p/n 709-7116) and Figure 4-5.

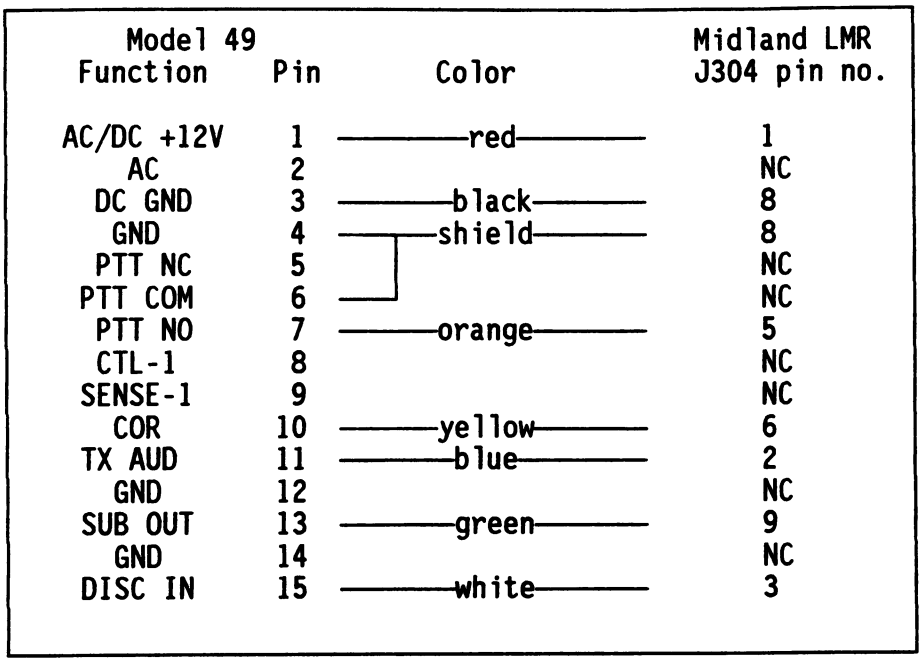


Figure 4-5. Model 49 to Motorola Micor Repeater Cable (P/N 709-7116)

[]5. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

E. MOTOROLA MICOR REPEATER

Motorola MICOR Repeaters are optionally equipped with one of three backplane boards:

Unified Remote Control Chassis (TCN1148A, TCN1187A, TCN1190A)
TCN1107A Remote Control Chassis
TCN1125A Remote Control Chassis

This interface configuration pertains to the Unified Remote Control Chassis only, use of the other two types are possible, but not described herein. Please contact Zetron Mobile Systems Division, Applications Department for notes concerning either of the latter types of chassis listed above.

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	B=Invert TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]4 Remove all modules except the Station Control and Squelch Gate modules.

[]5. Connect the Model 49 to the Motorola Repeater using the Zetron Generic Repeater Interface Cable (part #709-7116). Refer to Figure 4-6 for cable wiring.

Model 49 Function	Pin	Color	Micor Connection*
AC/DC +12V	1	red	J1 Pin-1
AC	2		NC
DC GND	3	black	J1 Pin-4
GND	4	shield	NC
PTT NC	5		NC
PTT COM	6		NC
PTT NO	7	orange	TB3 Pin-14
CTL-1	8		NC
SENSE-1	9		NC
COR	10	yellow	NC
TX AUD	11	blue	TB3 Pin-20
GND	12		NC
SUB OUT	13	green	J2 Pin-16
GND	14		NC
DISC IN	15	white	Pin-22 of Station Control Module

* All of these connections are on the Unified Control Chassis.

Figure 4-6. Model 49 to Motorola Micor Repeater Cable (P/N 709-7116)

[]6. Remove CR12 in the Station Control module.

[]7. Install JU1 on the Unified Chassis to bypass F1 PL Module processing of the Tx Audio signal.

[]8. Remove J12 in the Squelch Gate module to disable the RPTR PTT output from the Squelch Gate Module.

[]9. Set up the squelch gate module jumpers for a base station.

[]10. Connect a jumper wire at the Model 49 end of the cable between pins 4 and 6.

[]11. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

F.1 RELM 800-MHZ REPEATER, NEW VERSION

This newest revision of the Relm WS20RD repeaters has been marketed since November of 1993.

These instructions pertain to the WS20RD 800 MHz Repeaters shipped from Relm equipped with WHZ38A wiring kits (also called "Whiz Kits"), commencing from November 1993.

These units may be identified when the top cover is removed by the absence of the piggy-back comparator board, which resided in the transmitter cavity of earlier version repeaters.

[]1. Remove the top cover of the Relm Repeater.

[]2. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]3. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	A=True TX data polarity
JP16	B=Invert RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]4. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]5. Set the front panel controls as follow:

VOLUME:	Any position (receiver level to Zetron Model 49 is independent)
SQUELCH:	Any position (Model 49 squelching is independent)
REPEAT/LOCAL:	Put switch into IN (repeat) position

[]6. Connect the Model 49 to the Relm bulkhead connector with the NEW RELM repeater cable (709-7279) as shown in Figures 4-7 and 4-8.

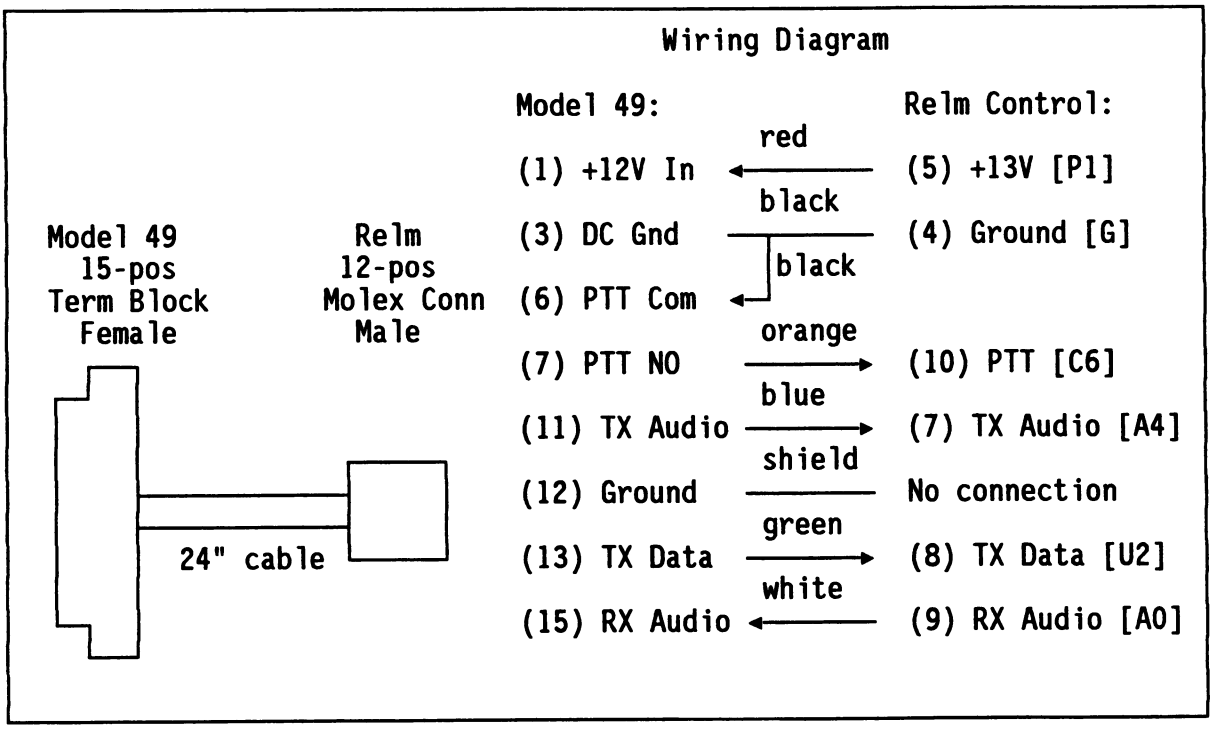


Figure 4-7. Model 49 to New Relm Repeater Cable (P/N 709-7279)

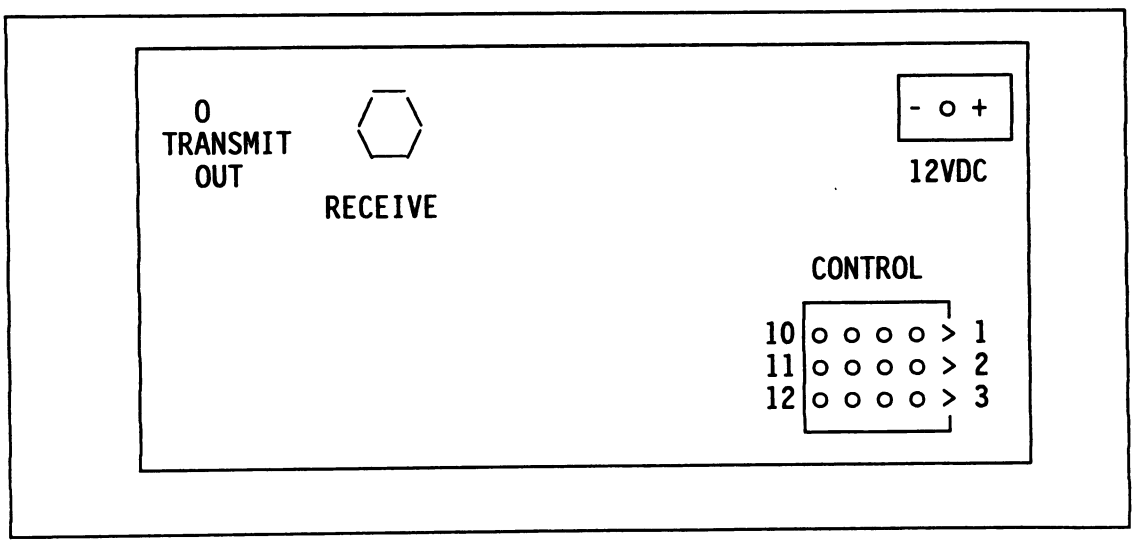


Figure 4-8. Relm Rear Panel

[]7. Repeater Adjustments:

Transmit Level Adjustments

[]a. Put Model 49 into Test mode: put SW1-1 up, press and hold the connect/disconnect button about 2 seconds, or until the front panel lights flash and go off. Then release the button. The Model 49 should boot up transmitting data and ring bursts.

During the following steps, verify that the Model 49 "Compat. Mode" is set to "J" (use the following screens: Multibase / Edit / Site Config / Compat. Mode [located near the middle of the screen]). If you need to change the setting, make note of the original setting.

[]b. Disconnect the blue and green wires (pins 11 & 13) from the radio connector on the Model 49.

[]c. Connect a 1000-Hz audio oscillator between the green wire (disconnected above) and the base station ground lead (pin 3 - radio connector on Model 49).

[]d. While monitoring transmitter deviation with a service monitor, adjust the audio oscillator until the modulation level doesn't increase with any further increase in the output of the audio oscillator.

[]e. Double the output level of the audio oscillator (to insure that you are well into the transmitters limiter).

[]f. Adjust the transmitter modulation pot (R337D) for 4.0 kHz (assuming 5.0 kHz total channel deviation). Disconnect the audio oscillator after this adjustment is complete.

[]g. Reconnect the green lead to pin 13 of the Model 49 radio connector.

[]h. Adjust the Model 49 TX DATA for 0.95-kHz deviation.

[]i. Reconnect the blue lead to pin 11 of the Model 49 radio connector.

[]j. Adjust the Model 49 TX AUD for 4.5-kHz deviation during ring bursts.

[]k. Turn off Test mode: set SW1-1 down and reset. To reset, press and hold the connect/disconnect button about 2 seconds, or until the front panel lights flash and go off. Then release the button.

Squelch Adjustments

[]l. With NO Receive carrier applied to the repeater, adjust the Model 49 SQUELCH fully CW. The "CARRIER" LED should light. Adjust slowly CCW until the LED goes off steady.

Receive Level Adjustments

[]m. Inject 1 mV Receive carrier directly into the Repeater RX Antenna port.

[]n. With 1-kHz tone modulating at 4-kHz deviation, adjust the Model 49 RX AUD potentiometer until 1 V p-p (354 mVrms) is measured at Model 49 TP5.

[]o. Remove the service monitor, and reconnect the antenna. Test the repeater using radios having VALID ID numbers.

[]9. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

F.2 RELM 800-MHZ REPEATER, OLD VERSION

[]1. Remove the top cover of the Relm repeater.

* * * * * * * * * * * * * * * * NOTE * * * * * * * * * * * * * * * *

If a second feed-thru exists between the Relm Rx and Tx cavities *and* is wired, contact RELM personnel about upgrading the repeater before using.

* *

[]2. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]3. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	A=True TX data polarity
JP16	B=Invert RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]4. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]5. Locate the Zetron jumper cable (Part No. 709-7152) in the cable kit (Part No. 815-9071). See Figure 4-9.

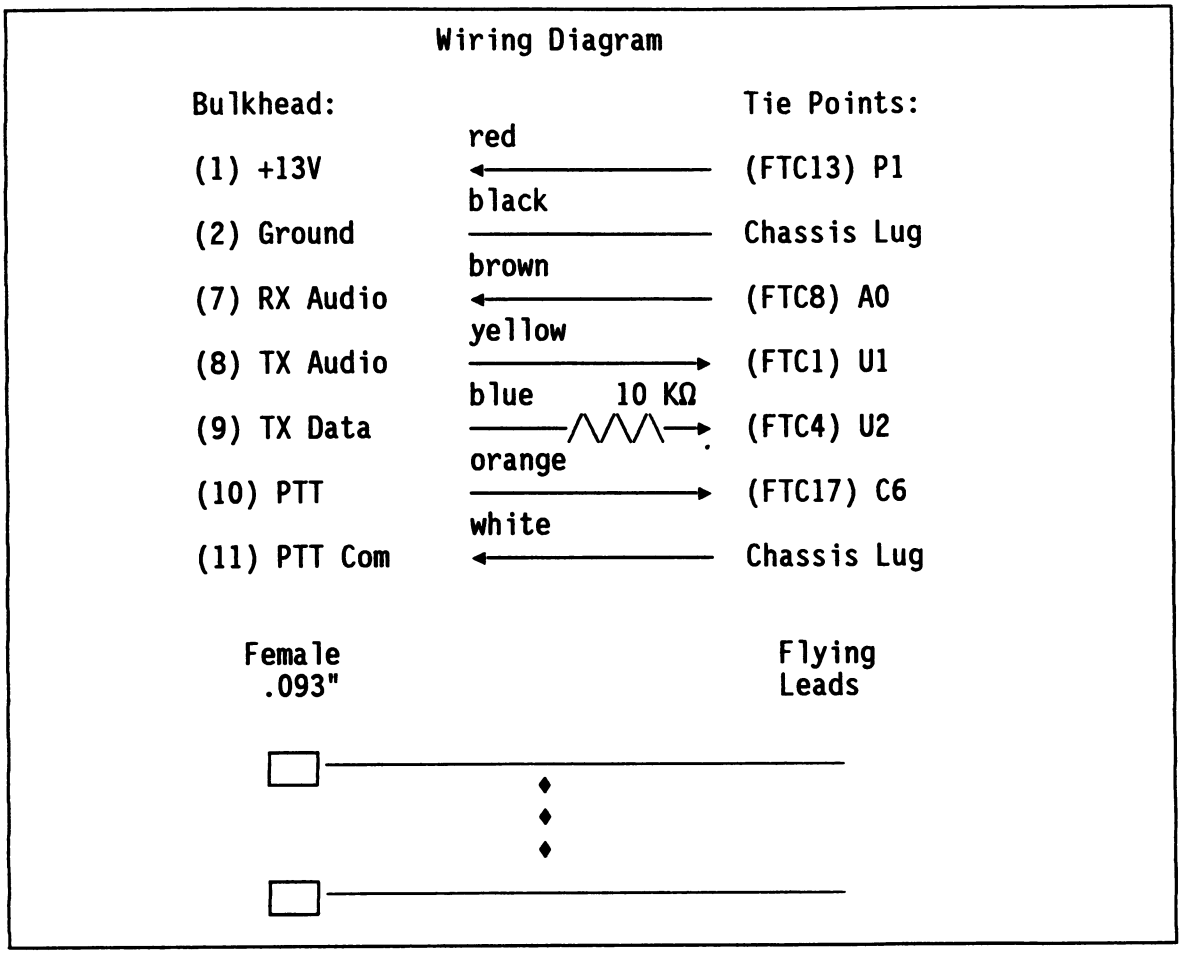


Figure 4-9. Relm Repeater Jumper Cable (P/N 709-7152)

[]6. Solder the bare wire ends to the feed-thru capacitors in the walls of the RF cabinet as shown in Figure 4-10.

Note that the blue wire has a resistor lead exposed (10 KΩ). If this wiring is being created in the field (i.e. not using the Zetron kit), the [10 KΩ] resistor may be eliminated and JP25 set to B for Rev R+ Model 49 units.

[]7. Solder the 100-ohm, ¼-watt resistor from the cable kit (Part No. 815-9071) across C305 of the repeater. C305 is located behind and to the right of R337D, the Transmit Limit Adjust potentiometer in the repeater transmit cavity. Refer to Figure 4-11.

[]8. Solder the black wire, white wire, and bare shield wire to a convenient chassis lug.

[]9. Insert the female 0.093-inch sockets from the jumper cable into the 12-position plastic bulkhead connector per the pin numbers shown in Figure 4-12.

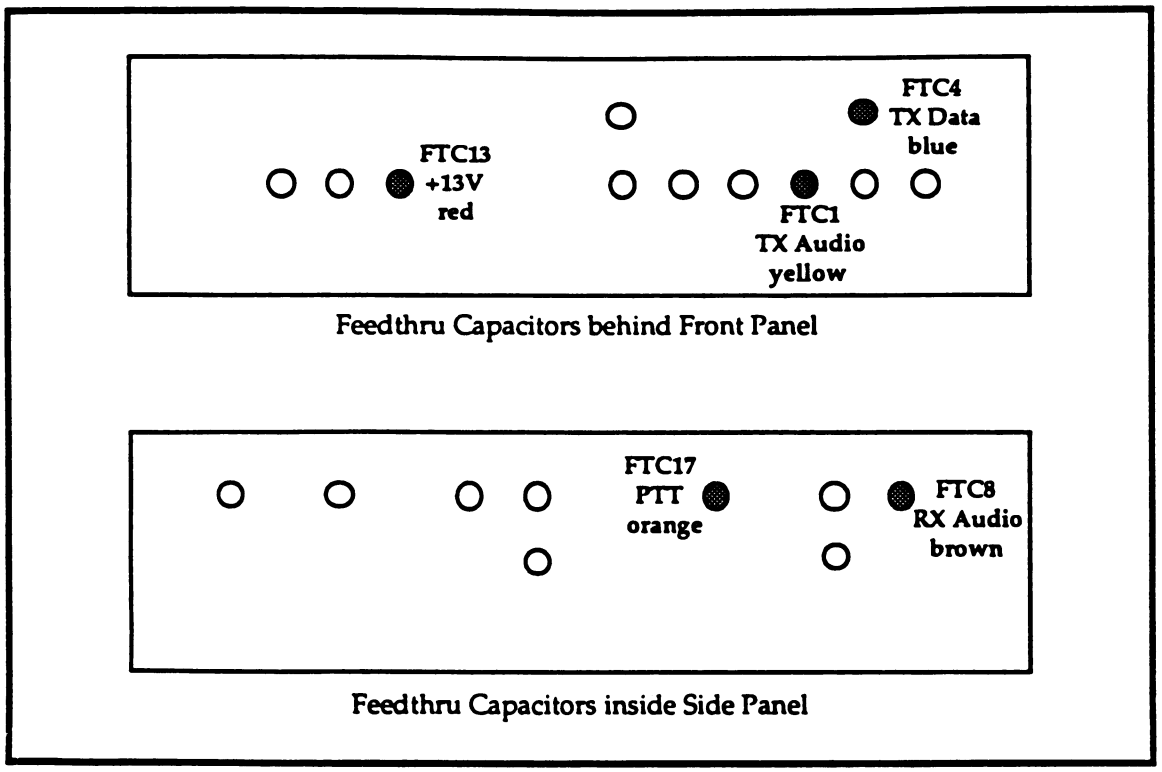


Figure 4-10. Relm Repeater Tie Points

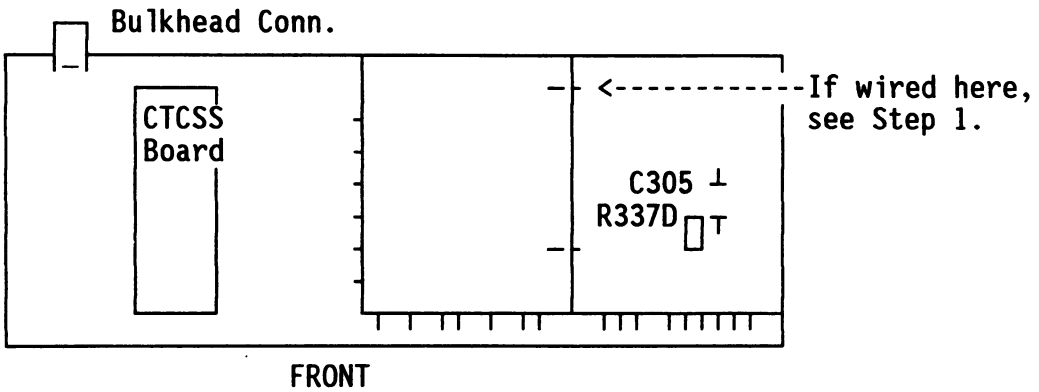


Figure 4-11. Top View of Relm 800 MHz Repeater

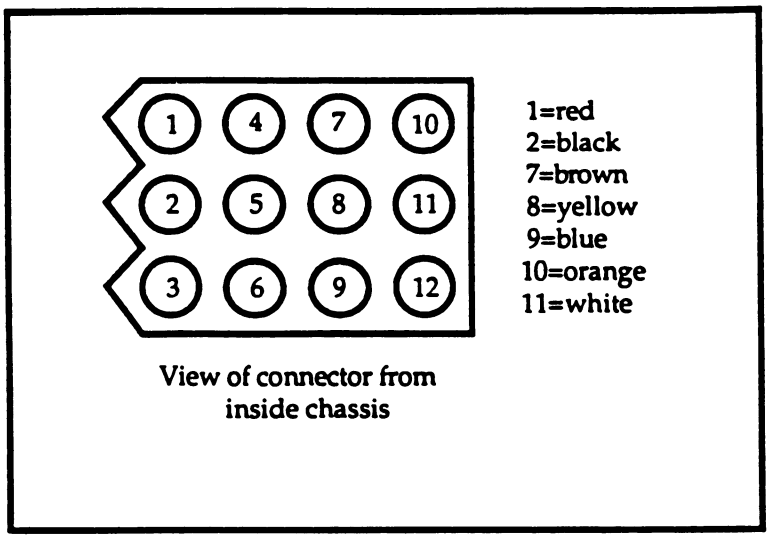


Figure 4-12. Relm Bulkhead Connector Pin-out

[]10. Route the cable along the Regency rear panel (along the bottom chassis) and secure with tie-wraps.

[]11. Set the front panel controls as follow:

VOLUME:	Any position (receiver level to Zetron Model 49 is independent)
SQUELCH:	Any position (Model 49 squelching is independent)
REPEAT/LOCAL:	Set switch to IN (repeat) position

[]12. Connect the Model 49 to the Regency bulkhead connector with the repeater cable (709-7148), which is part of the Zetron cable kit (815-9071). Refer to Figures 4-13 and 4-14 for cable wiring and bulkhead connector location on the repeater.

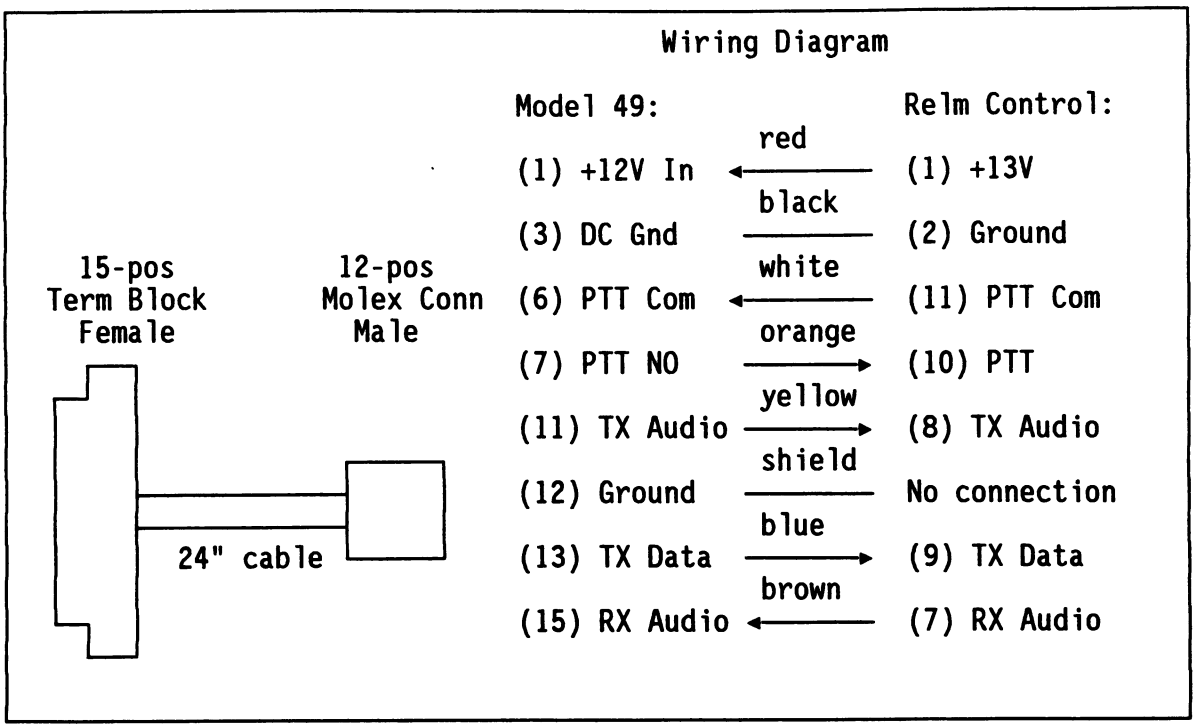


Figure 4-13. Model 49 to Relm Repeater Cable (P/N 709-7148)

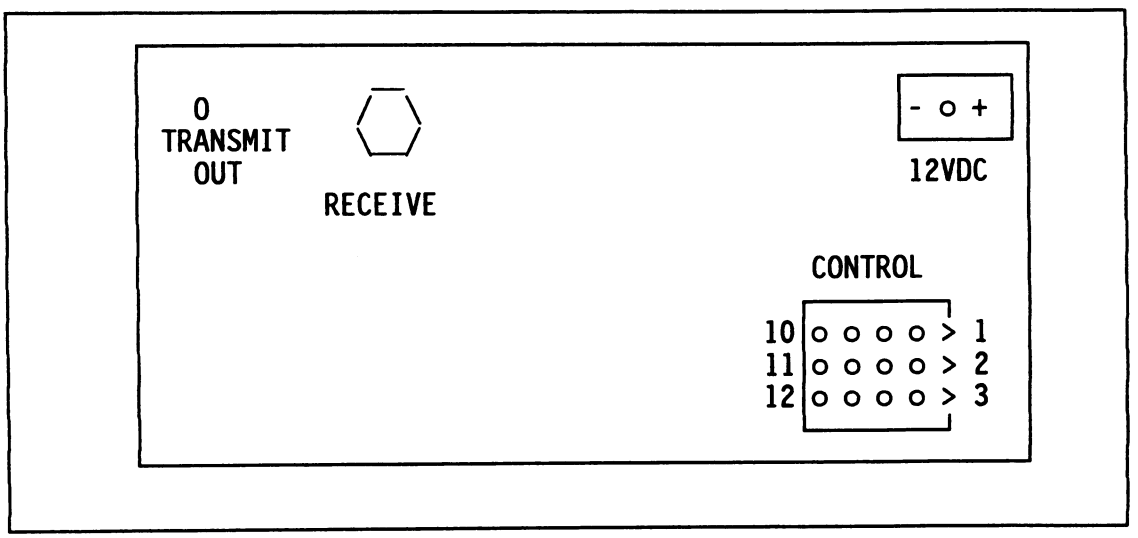


Figure 4-14. Relm Rear Panel

[]13. Repeater Adjustments:

Transmit Level Adjustments:

[]a. Put Model 49 into Test mode: put SW1-1 up, press and hold the connect/disconnect button about 2 seconds, or until the front

panel lights flash and go off. Then release the button. The Model 49 should boot up transmitting data and ring bursts.

During the following steps, verify that the Model 49 "Compat. Mode" is set to "J" (use the following screens: Multibase/Edit/Site Config/Compat. Mode [located near the middle of the screen]). If you need to change the setting, make note of the original setting.

[]b. Disconnect the blue and yellow wires (pins 11 & 13) from the radio connector on the Model 49.

[]c. Connect a 1000-Hz audio oscillator between the yellow wire (disconnected above) and the base station ground lead (pin 3 - radio connector on Model 49).

[]d. While monitoring transmitter deviation with a service monitor, adjust the audio oscillator until the modulation level doesn't increase with any further increase in the output of the audio oscillator.

[]e. Double the output level of the audio oscillator (to insure that you are well into the transmitters limiter).

[]f. Adjust the transmitter modulation pot (R337D) for 4.0 kHz (assuming 5.0 kHz total channel deviation). Disconnect the audio oscillator after this adjustment is complete.

[]g. Reconnect the blue lead to pin 13 of the Model 49 radio connector.

[]h. Adjust the Model 49 TX DATA for 0.95-kHz deviation.

[]i. Reconnect the yellow lead to pin 11 of the Model 49 radio connector.

[]j. Adjust the Model 49 TX AUD for 4.5-kHz deviation during ring bursts.

[]k. Turn off Test mode: set SW1-1 down and reset. To reset, press and hold the connect/disconnect button about 2 seconds, or until the front panel lights flash and go off. Then release the button.

Squelch Adjustments:

[]l. With NO Receive carrier applied to the repeater, adjust the Model 49 SQUELCH fully CW. The "CARRIER" LED should light. Adjust slowly CCW until the LED goes off steady.

Receive Level Adjustments:

[]m. Inject 1 mV Receive carrier directly into the Repeater RX Antenna port.

[]n. With 1-kHz tone modulating at 4-kHz deviation, adjust the Model 49 RX AUD potentiometer until 1 V p-p (354 mVrms) is measured at Model 49 TP5.

[]o. With 100-Hz tone modulating at 0.8-kHz deviation (without the 1-kHz tone), verify 240 mVpp (85 mVrms) at TP5.

[]p. Remove the service monitor, and reconnect the antenna. Test the repeater using radios having VALID ID numbers.

[]12. Proceed to "Step 6: Making Trunking Connections".

G. SEA 220-MHz REPEATER

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	A=TX Flat audio
JP7	A=COR input
JP9	B=RX amp 0 dB gain
JP10	B=TX amp Low range
JP12	B=COR from external (-) noise squelch
JP13	A=300 Hz High pass filtering on repeat audio
JP14	B=Invert TX data polarity
JP16	A=True RX data polarity
JP23	B=Digital Data Decoding
JP24	A=DC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	B=Digital SUBOUT
JP27	Jumpered to JP3 pin 2

Note: J1-4 on the rear panel functions as "SUBIN" and NOT as "GND" for this configuration. Subaudible data is input to this pin from the repeater for processing within the Model 49.

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	[Cross-Busy Output] -- Pin 2 jumpered to JP27 For this application, this jumper provides a "SUPER1" output from the control circuitry to the SEA repeater as an indicator of "TELCO ENABLED" status.
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

[]4. Connect the Model 49 to the SEA 220 MHz Repeater with the SEA Repeater Cable (709-7238) as shown in Figure 4-15.

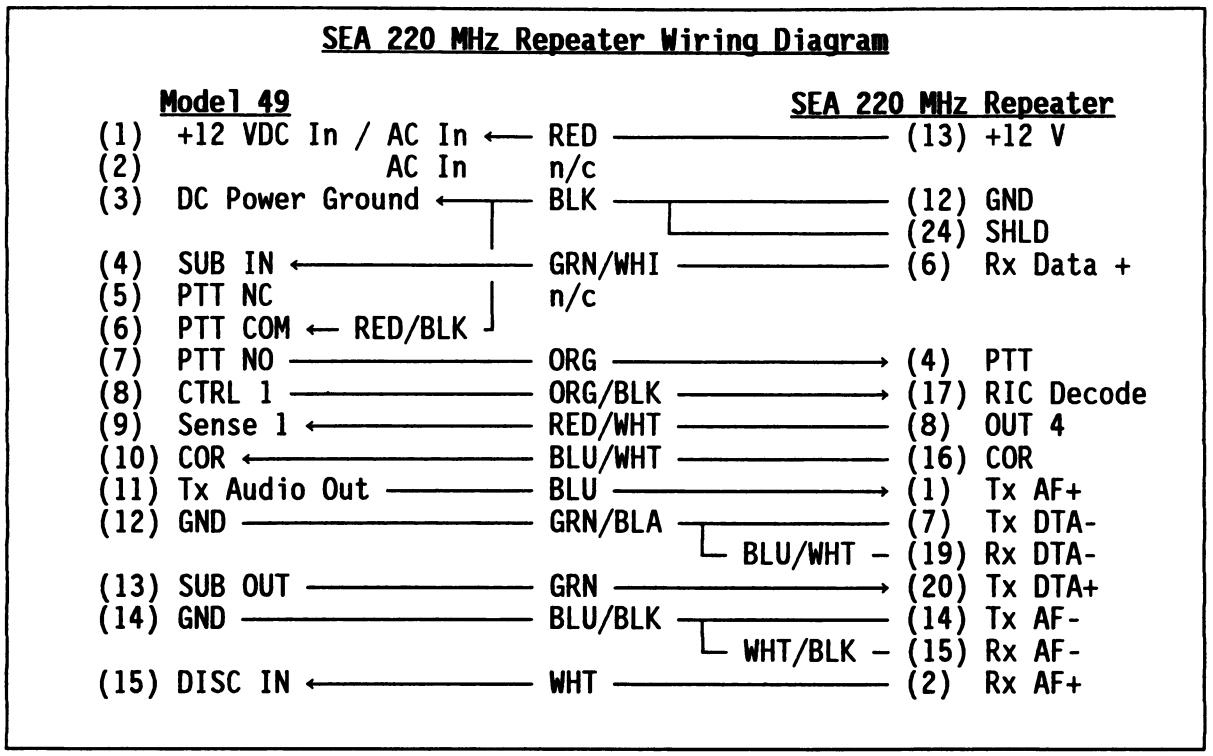


Figure 4-15. Model 49 SEA 220 MHz Repeater Cable (709-7238)

[]5. Set Repeater Levels as follows:

[]a. Verify proper repeater operation and signal levels without the Model 49 connected, per the repeater service manual.

[]b. Verify Model 49 jumper settings per steps 1-3 of this procedure.

[]c. Turn off all mobiles and hand-held units in the area.

[]d. Place an oscilloscope probe on the Model 49 rear panel connector J1-15.

[]e. Generate a test signal from an ESP504 mobile, operating in field test mode, with the PGM button depressed to enable a 1,000 Hz Test Tone. The mobile's test mode should be set on the repeater channel for dispatch or interconnect ID. A second mobile programmed similarly may be used to confirm repeat audio level balance.

[]f. Key up the mobile radio. Note that the input to the Model 49 from the repeater is 500 ±50 mVpp at J1-15 (DISC IN). If it is not, the repeater will need to be adjusted as well (Refer to the repeater manual for that procedure).

Place the oscilloscope probe on TP5, located in front of the "RX AUD" potentiometer. Adjust the RX AUDio level fro 250 mVpp at TP5.

[]g. Place the oscilloscope probe onto TP4, located in front of the "TX AUD" potentiometer. Adjust the TX AUDio level for 300 mVpp at TP4 ... or at J1-11, the output on the rear panel.

[]6. ALTERNATE METHOD TO SUBSTITUTE FOR STEP 5, WITHOUT A REPEATER:

It is possible to perform an initial adjustment without a repeater connected. This operation requires use of a communications service monitor, or an audio signal generator and an oscilloscope. Also, it is necessary to connect a 600 Ω (¼W or larger) resistor between the TX AUDIO output at J1-11 and signal GND at J1-12.

TRANSMIT LEVEL

[]a. Set the TX AUDio pot fully counterclockwise. Set the Model 49 front panel DIP switch A:1 up, A:2 down. Reset the Model 49 by depressing the CONNECT/DISCONNECT switch twice (or hold for approximately two seconds until LED's flash). After re-booting, the Model 49 will invoke TEST MODE and commence continuous transmit of the repeater TEST ID code (defined in Multibase) and ringing tones.

[]b. Place the oscilloscope probe on TP4, located in front of the "TX AUD" potentiometer, in the front service window.

[]c. During ring burst generation, adjust the TX AUDio level to attain 2.0 Vpp (707 mVrms) at TP4, or at the output connection J1-11.

Without the 600 Ω load resistor installed (J1-11 to J1-12), set this level to 3.4 Vpp (1.2 Vrms).

[]d. Set the front panel DIP switch A:1 down, and return A:2 to its prior position. Reset the Model 49 to exit the TEST MODE.

RECEIVE LEVEL

[]e. Connect the Audio Signal Generator to the input at J1-15, and adjust output to 2 Vpp (707 mVrms) at 1 KHz.

[]f. Place an oscilloscope on TP5, located in front of the "RX AUD" potentiometer, in the front service window.

[]g. Adjust the RX AUDio level to attain 1.0 Vpp (354 mVrms) at TP5.

[]7. Refer to the following subsections later in this section to confirm proper operation:

[]a. "Step 6: Making Trunking Connections"
[]b. "Step 7: Testing Dispatch Calls"
[]c. "Step 8: Testing Trunking"
[]d. "Step 9: Testing Interconnect"

[]8. TELCO HYBRID ADJUSTMENTS

Refer to "Step 10: Making Telco Adjustments" later in this sections and perform the procedure outlined in "Hybrid Adjustments".

[]9. TO TELCO and FROM TELCO Level Adjustments

The TO TELCO pot sets the audio level from the Model 49 to the phone line provided by your local CO. The FROM TELCO pot sets the audio level from the local CO into the Model 49.

It is imperative that the FROM TELCO level is set correctly, since improper adjustment may result in excessive background noise and/or feedback, if set too high.

There are two methods which may be used to set the FROM TELCO level. The first utilizes the Dial Tone from the CO, and the second uses DTMF from a landside telephone keypad. Either method can provide good results.

The Repeater Levels and Hybrid Balancing must be completed prior to this procedure for best results.

If using a microwave or RF link with E&M 4-Wire interfacing which requires a maximum transmitted level of +7 dBm, particular care must be exercised to properly configure the E&M 4-Wire TELCO card of the Model 49. Revision "A"-"C" cards require replacement of: (a) resistor R10 with 1.5 KΩ to accommodate -16 dBm output (TO TELCO) and; (b) R13 with 75 KΩ to accommodate +7 dBm input (FROM TELCO). Revision "D" cards require reconfiguration of jumpers JP5 and JP6.

TO TELCO

[]a. Place the Model 49 into TEST MODE by setting DIP switch A:1 up, and pressing the CONNECT/DISCONNECT button until the LED's flash (approximately 2 seconds), to reset the Model 49. The Model 49 will continuously transmit ringing tones.

DIP switch A:2 determines the ID code transmitted during TEST MODE. Place this switch up or down (when A:1 is up) and then reset the Model 49 to invoke the following ID code outputs:

A:1 UP; A:2 DOWN	Repeater Number + [253] Busy Code
A:1 UP; A:2 DOWN	Repeater Number + TEST ID Code

[]b. Call into the Model 49 from the Landline. When the Model 49 answers, a 600 Hz tone will be audible to the landline caller (also audible to any "TEST ID" mobile if A:2 is up).

[]c. Adjust the TO TELco pot, located in the front service window, to attain a 600 mVpp (212 mVrms) at the appropriate test point listed below:

End-to-End Full Duplex Card:	Across CR4
DID Card	Across CR2
E&M 4-Wire Card	From R11 ("R11" label end) to GND

[]d. Set DIP switch A:1 down and verify A:2 is set for the desired operating mode. Reset the Model 49 to exit TEST MODE.

FROM TELCO

DIAL TONE Method:

[]e. Using a previously programmed valid Interconnect ID, key up the mobile transceiver and obtain Dial Tone from the local CO.

[]f. With Dial Tone present, adjust the FROM TELCO pot for a signal level of 150 mVpp at TP12 on the Model 49 main board (located inside the front service window), or measure at JB3 pin 11 on the TELCO card.

DTMF Method:

[]g. Establish an Interconnect call.

[]h. From the telephone of the Landline side of the conversation, continually depress the "5" button.

[]i. With the DTMF signal present, Adjust the FROM TELCO pot for a 200 mVpp signal at TP12 on the Model 49 main board (located inside the front service window), or measure at JB3 pin 11 on the TELCO card.

[]10. Proceed to "Step 11: Programming Users and Time" later in this section.

H1. STANDARD RP70K REPEATER

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	B=TX amp low range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	B=Invert TX data polarity
JP16	B=Invert RX data polarity
JP23	A=Analog Data Decoding
JP24	A=DC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

Perform the following repeater modifications to make the RP70K capable of handling the subaudible data requirements of LTR:

[]4. Remove the bottom cover.

[]5. Remove the shields from the TX and RX assemblies.

[]6. Unplug W201 from J201 on the Control Card. Slide the Yellow wire out of W201 pin 2. Refer to Figure 4-16 for location of J201.

[]7. Unplug W207 from J207 on the Control Card. Slide the White wire out of W207 pin 6. Refer to Figure 4-16 for location of J207.

[]8. Connect the Yellow wire to the White wire [Data Input Signal].

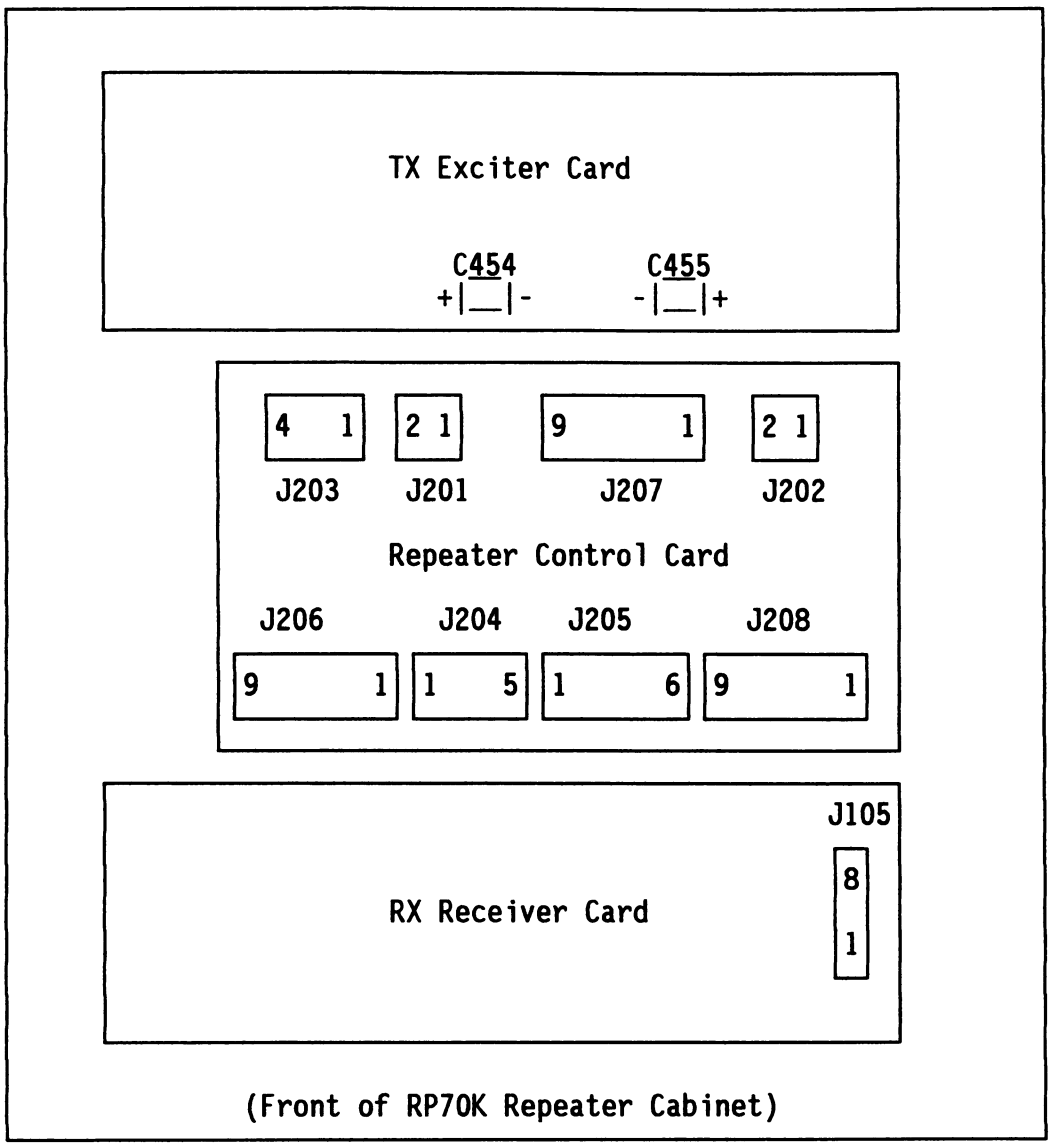


Figure 4-16. Layout of RP70K Cards and Connectors

[]9. Plug connectors W201 [J201] and W207 [J207] back into place. Refer to Figure 4-16.

[]10. Unplug W205 from J205 on the Control Card. Slide the shielded cable from out of connector W205 pins 5&6. Cut the ends, strip back 1/16", and tin the leads. Refer to Figure 4-16 for connector location.

[]11. Unplug W105 from J105 on the Receiver Card. Slide Black and Yellow wires out of pins 1&2. Refer to Figure 4-16.

[]12. Solder the shielded cable from W205 to the wires from W105: White to Yellow, Black to Black. [RX Discriminator Audio] Refer to Figure 4-16.

[]13. Insert the White/Yellow wire into W105 pin 2, the Black/Black wire into W105 pin 1.

[]14. Plug connectors W105 [Rx J105] and W205 [Ctrl J205] back into place.

[]15. Unscrew the 4 mounting screws from the TX Exciter Card and flip it.

[]16. Replace C454 and C455 capacitors with 100 μF 25 V each. Observe correct polarity!

[]17. Reinstall the TX Exciter Card.

[]18. Reinstall the shields and bottom cover.

[]19. Set the repeater front panel controls as follow.

TONE1 and TONEB switches in OUT positions
MONITOR switch in OUT position
BASE/REPEATER switch in IN (base) position
SQL control in IN (preset) position
VOLUME control IN to turn off the speaker or OUT to listen

[]20. Connect the Model 49 to the RP70K with the Generic Repeater Cable (709-7116). Refer to Figure 4-17.

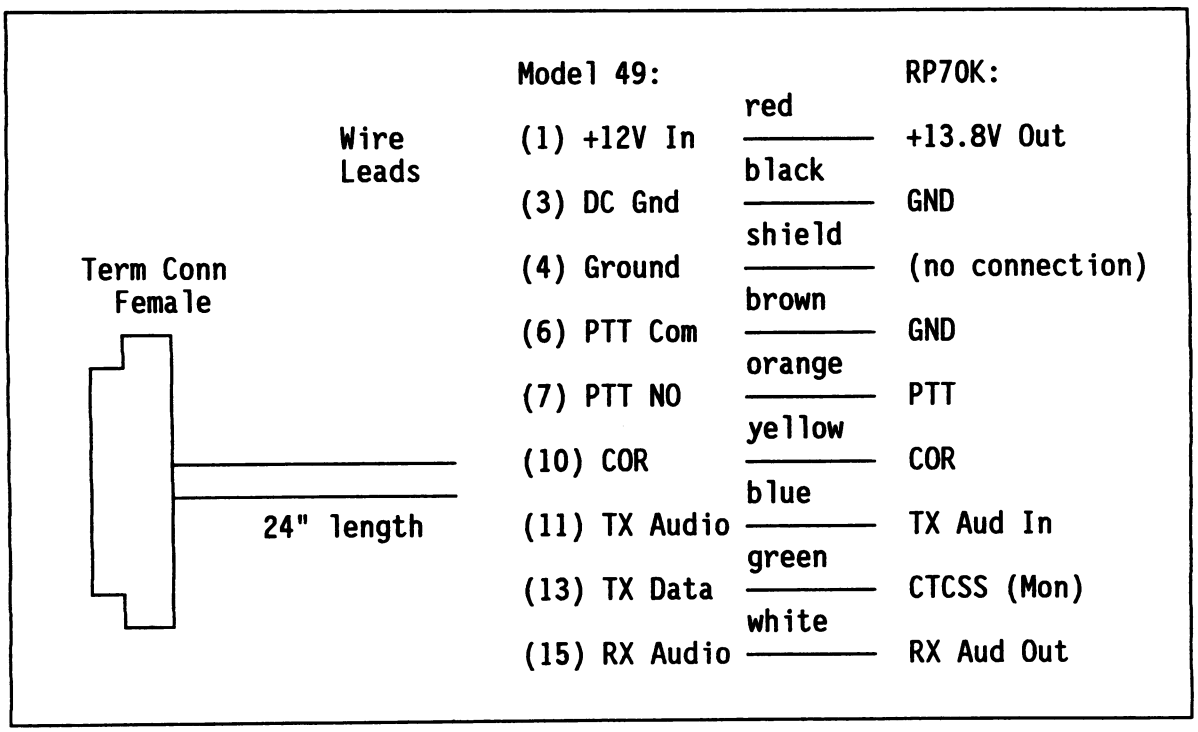


Figure 4-17. Model 49 to Generic Repeater Cable (P/N 709-7116)

[]21. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

Note: You can record your settings on the worksheets at the end of this section.

H2. STANDARD RPT-38 REPEATER

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	A=True TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]4. Connect the Model 49 to the RPT-38 Repeater using the generic repeater interface cable (part #709-7116) and Figure 4-18.

[]5. Connect a jumper wire at the Model 49 end of the cable between pins 4 and 6.

Model 49		709-7116	Standard RPT-38 Repeater Connections			
Function	J1	Wire Color	TB1	Color	RX DB-15	TX DB-15
AC/DC +12V	1	RED	TB-11	RED	9,10	9,10
AC	2					
DC GND	3	BLACK	TB-12	BLA	14,15	14,15
GND	4	SHIELD	NC			
PTT NC	5		TB-3	ORG	NC	4
PTT COM	6	←Add jumper				
PTT NO	7	ORANGE	TB-9	WHI	NC	13
CTL-1	8					
SENSE-1	9					
COR	10	YELLOW	TB-8	GRA	11	NC
TX AUD	11	BLUE	TB-4	YEL	NC	1
GND	12					
SUB OUT	13	GREEN	TB-6	BLU	NC	8
GND	14					
DISC IN	15	WHITE	TB-5	GRN	6	NC
			Remove jumper TB-1	BRN		
			Remove jumper TB-2	RED		

NOTES:

1. The RPT-38 Repeater is configured to facilitate one transmitter T881 module and one receiver T885 module, mounted onto a single 19" rack faceplate.
2. ONLY ONE M49 should be connected to each transmit / receive pair of RF modules, via the "TB" connector. (All Tx/Rx terminations are shown for technical convenience.)

Figure 4-18. Model 49 to Standard RPT-38 Repeater, Cable (P/N 709-7116)

[]6. Verify the RPT-38 T881 Transmitter jumpers, and T885 Receiver jumpers as follows:

T881 Tx Jumpers
PL100 = 3-4
PL101 = 1-2
PL102 = 9-10
PL103 = 3-4

T885 Rx Jumpers
PL100 = 2-3
PL101 = 1-2
PL102 = 1-2
PL104 = 1-2
PL105 = 2-3
PL103 = Place jumper onto pin 3 only (not installed).
PL106 = Place jumper onto pin 3 only (not installed).
Add: Jumper wire soldered from PAD111 [DEMOD O/P] to PAD122 [AUDIO 2] (or to PL106-1).

[]7. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

J1. TAIT 8XX SERIES RACKFRAME REPEATER

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	A=True TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]4. Connect the Model 49 to the Tait Repeater using the generic repeater interface cable (part #709-7116) and Figure 4-19. Be careful to reference the correct rackframe slots for the transmitter module and receiver module applicable for your installation.

[]5. Connect a jumper wire at the Model 49 end of the cable between pins 4 and 6.

Model 49		709-7116	Tait Transmitter Rackframe Connections					Tait Receiver Rackframe Connections				
Function	J1	Wire Color	CH 1	CH 2	CH 3	CH 4	CH 5	CH 1	CH 2	CH 3	CH 4	CH 5
AC/DC +12V	1	RED	TB1-1	TB1-6	TB1-11	TB2-1	TB2-6					
AC	2											
DC GND	3	BLACK	TB1-2	TB1-7	TB1-12	TB2-2	TB2-7					
GND	4	SHIELD	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
PTT NC	5											
PTT COM	6	Add jumper										
PTT NO	7	ORANGE	TB1-5	TB1-10	TB1-15	TB2-5	TB2-10					
CTL-1	8											
SENSE-1	9											
COR	10	YELLOW						TB1-2	TB1-4	TB1-6	TB1-8	TB1-10
TX AUD	11	BLUE	TB1-3	TB1-8	TB1-13	TB2-3	TB2-8					
GND	12											
SUB OUT	13	GREEN	TB1-4	TB1-9	TB1-14	TB2-4	TB2-9					
GND	14											
DISC IN	15	WHITE						TB1-1	TB1-3	TB1-5	TB1-7	TB1-9

NOTES:

1. The Tait Rackframe configuration is configured to facilitate 5 transmitter T881 modules in one rack, and five receiver T885 modules in a second rack.
2. ONLY ONE M49 should be connected to each transmit / receive pair of modules (i.e. Five (5) M49 units are required for five repeaters). All Tx/Rx terminations are shown for convenience.
3. The receiver connections will need to be extended with wires to the receiver rackframe. Shielded wires are preferred, having the shield connected at one end only.

Figure 4-19. Model 49 to Tait Repeater Cable (P/N 709-7116)

[]6. Verify the Tait T881 Transmitter jumpers, and T885 Receiver jumpers as follows:

T881 Tx Jumpers
PL100 = 3-4
PL101 = 1-2
PL102 = 9-10
PL103 = 3-4

T885 Rx Jumpers
PL100 = 2-3
PL101 = 1-2
PL102 = 1-2
PL104 = 1-2
PL105 = 2-3
PL103 = Place jumper onto pin 3 only (not installed).
PL106 = Place jumper onto pin 3 only (not installed).
Add: Jumper wire soldered from PAD111 [DEMOD O/P] to PAD122 [AUDIO 2] (or to PL106-1).

[]7. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

J2. TAIT 8XX SERIES SLIMLINE REPEATER

[]1. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	A=True TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]3. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]4. Connect the Model 49 to the Tait Repeater using the generic repeater interface cable (part #709-7116) and Figure 4-20.

[]5. Connect a jumper wire at the Model 49 end of the cable between pins 4 and 6.

Model 49		709-7116	Tait Slimline Repeater Connections			
Function	J1	Wire Color	TB1	Color	RX DB-15	TX DB-15
AC/DC +12V	1	RED	TB-11	RED	9,10	9,10
AC	2					
DC GND	3	BLACK	TB-12	BLA	14,15	14,15
GND	4	SHIELD	NC			
PTT NC	5		TB-3	ORG	NC	4
PTT COM	6	←Add jumper				
PTT NO	7	ORANGE	TB-9	WHI	NC	13
CTL-1	8					
SENSE-1	9					
COR	10	YELLOW	TB-8	GRA	11	NC
TX AUD	11	BLUE	TB-4	YEL	NC	1
GND	12					
SUB OUT	13	GREEN	TB-6	BLU	NC	8
GND	14					
DISC IN	15	WHITE	TB-5	GRN	6	NC
			Remove jumper TB-1	BRN		
			Remove jumper TB-2	RED		

NOTES:

1. The Tait Slimline Repeater is configured to facilitate one transmitter T881 module and one receiver T885 module, mounted onto a single 19" rack faceplate.
2. ONLY ONE M49 should be connected to each transmit / receive pair of modules (i.e. each Slimline), via the "TB" connector.
   (All Tx/Rx terminations are shown for technical convenience.)

Figure 4-20. Model 49 to Tait Repeater Cable (P/N 709-7116)

[]6. Verify the Tait T881 Transmitter jumpers, and T885 Receiver jumpers as follows:

T881 Tx Jumpers
PL100 = 3-4
PL101 = 1-2
PL102 = 9-10
PL103 = 3-4

T885 Rx Jumpers
PL100 = 2-3
PL101 = 1-2
PL102 = 1-2
PL104 = 1-2
PL105 = 2-3
PL103 = Place jumper onto pin 3 only (not installed).
PL106 = Place jumper onto pin 3 only (not installed).
Add: Jumper wire soldered from PAD111 [DEMOD O/P] to PAD122 [AUDIO 2] (or to PL106-1).

[]7. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

K1. UNIDEN MRS804 REPEATER

[]1. Remove the top cover of the MRS804 or slide it forward in its rack-mounting frame.

[]2. Loosen 2 retainer screws and tilt up the transceiver sub-chassis.

[]3. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]4. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	B=Invert TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]5. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

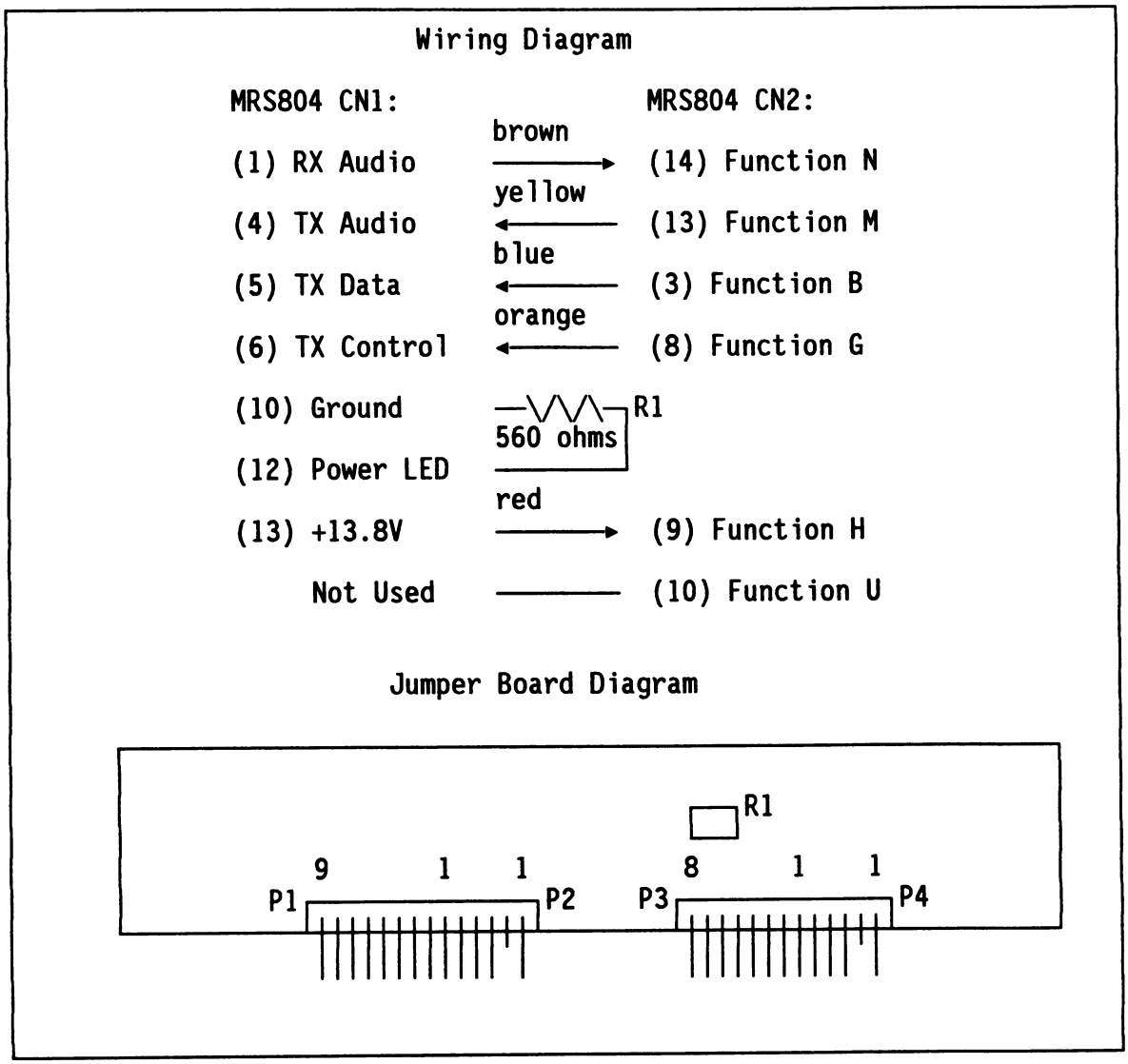
NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]6. Disconnect the Logic/Control as follows:

a. For MRS804S (conventional): disconnect the 13-pin CN1 connector from J601 on the repeater control board. The 14-pin CN2 connector should be loose already.

b. For MRS804T (trunking): disconnect the 13-pin CN1 and 14-pin CN2 connectors from the logic board.

[]7. Connect the Zetron jumper board (Part No. 702-9404) between CN1 and CN2. This board is part of the Zetron MRS804 Cable Kit (815-9112). Note that the Uniden connectors have plastic keys in the pin 2 position. Refer to Figure 4-21 for jumper board details.



Note: If you have an early cable instead of a board, the green wire on the jumper cable will not be used.

Figure 4-21. Zetron/Uniden MRS804 Jumper Board (P/N 702-9404)

[]8. Carefully close and lock the sub-chassis, being careful not to pinch the exciter coaxial cable, nor the power wires.

[]9. Secure the sub-chassis with the locking screws.

[]10. Turn VR103 on the MRS804 exciter about 1/4 turn clockwise to get more adjustment range on the Zetron transmit data deviation. Refer to Figure 4-22 for VR103 location.

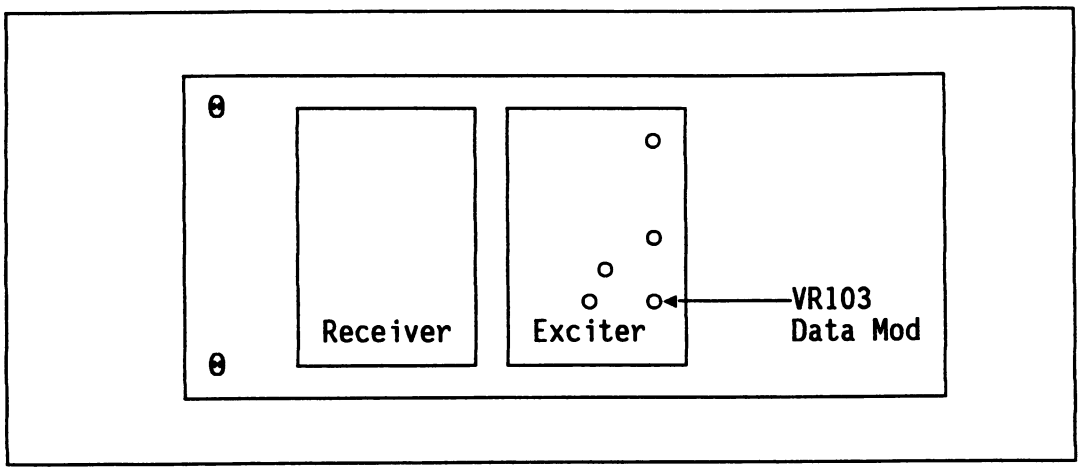


Figure 4-22. Uniden MRS804 Internal Sub-Chassis

[]11. Replace the top cover on the MRS804 or slide it back into its rack-mounting frame.

[]12. Set the front panel controls as follow:

VOLUME	any position (receiver level to Zetron Model 49 is independent)
SQUELCH	any position (squelch level is set in the Model 49)
REPEAT/LOCAL	switch in IN (repeat) position
OPT	switch either position

[]13. Connect the Model 49 to the MRS804 Accessory connector with the repeater cable (709-7132), which was included in the Zetron MRS804 Cable Kit (815-9112). Refer to Figure 4-23 for cable wiring and to Figure 4-24 to locate the "Accessory" connector.

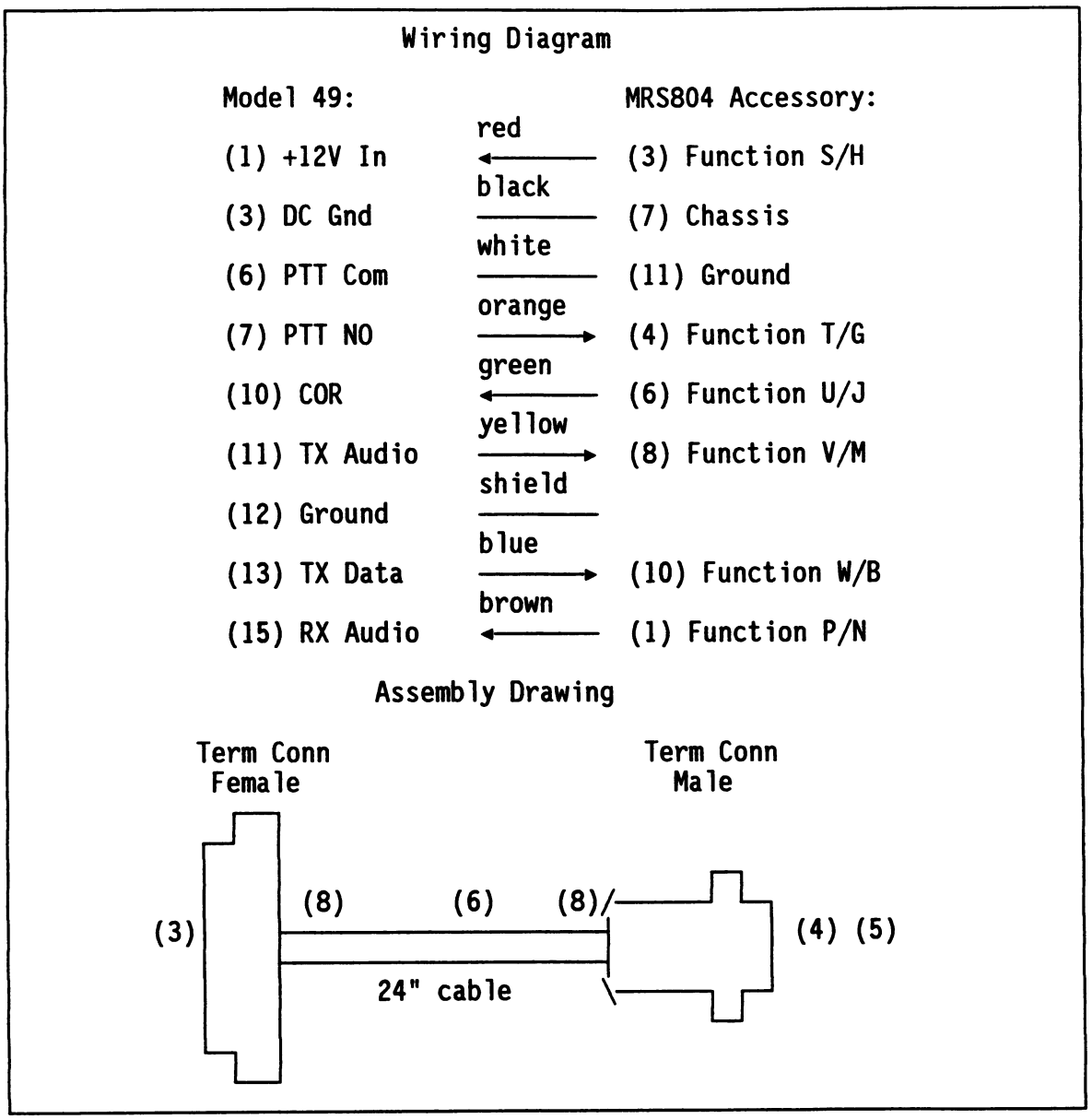


Figure 4-23. Model 49 to Uniden MRS804 Repeater Cable (P/N 709-7132)

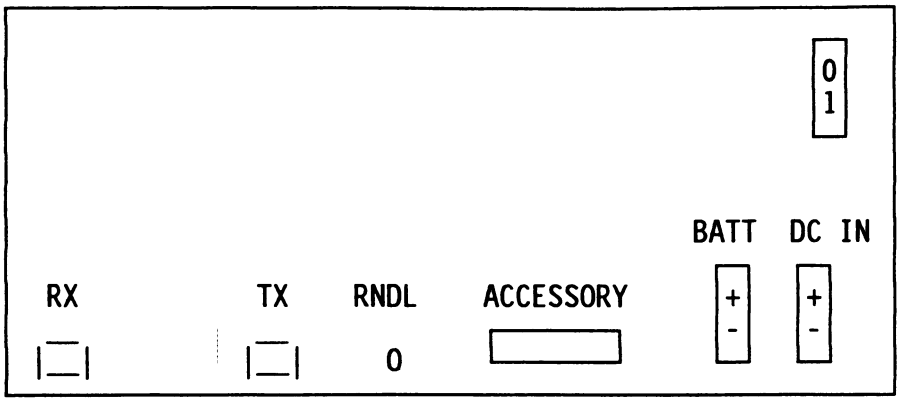


Figure 4-24. Uniden MRS804 Rear Panel

[]14. Set the TX and RX audio and data levels by following the steps listed below.

Note: This procedure requires two service monitors and an LTR encoder. If not all of the equipment is available, follow the procedure described later in "Step 5: Setting Repeater Levels" or "Step 5A: Setting Repeater Levels for V6+ Firmware".

NOISE SQUELCH LEVEL

[]a. Set the first communications monitor to generate an RF signal of 0.25 μV on the repeater receive frequency.

[]b. On the Model 49, set the front panel COR pot to midway.

[]c. On the Model 49, turn the front panel SQ pot counterclockwise until the COR light goes out. Turn the SQ pot clockwise until the COR light just comes on solid.

RECEIVE LEVELS

[]d. Increase the RF signal level to 1 mV, modulated with a 1kHz sine wave at ±4 kHz modulation. Attach an AC voltmeter to TP5, behind the front panel RX pot (Model 49). Adjust the RX AUD pot on the Model 49 for a 0.35 VAC RMS reading on the meter (1 V p-p on an oscilloscope).

[]e. Apply an RF signal at 1 mV output, modulated with the proper LTR data at 1 kHz modulation. Verify that LTR data is present at approximately 240 mVpp at TP5 with no audio.

[]f. The Model 49 CARRIER, TRANSMIT, RX PACKET, TX PACKET and RX DATA QUAL lights should all be lit at this time. If not, double check the LTR polarity jumpers (JP14,JP16), the Repeater and Area switches on the Model 49 front panel, and ensure the proper LTR data is being generated at the communications monitor.

TRANSMIT LEVELS

[]g. Set the second communications monitor to receive on the Repeater transmit frequency.

[]h. Set the TX AUDIO pot fully counterclockwise.

[]i. Adjust the TX DATA pot on the Model 49 main board fully clockwise or to 11 o'clock. Adjust VR103 on the Repeater Transmitter Module for ±1 kHz deviation as measured on the second monitor.

[]j. Modulate the first communications monitor with a 1kHz tone, set the total modulation for 4 kHz (1.6 kHz for 900 MHz), or 5 kHz with subaudible (2.5 kHz for 900 MHz).

[]k. Set the TX AUD pot on the Model 49 front panel halfway or to 6 o'clock.

[]l. Set VR105 on the Repeater Transmitter Module so that the transmitted 1kHz tone (as seen on the second monitor) is just starting to clip at the peaks.

[]m. Set VR104 on the Repeater Transmitter Module so that the total transmitted deviation is 5 kHz (2.5 kHz for 900 MHz).

[]15. Proceed to "Step 6: Making Trunking Connections" later in this section.

K2. UNIDEN MRS802 REPEATER

[]1. Remove the top and bottom covers of the MRS802.

[]2. Verify proper data bus configurations have been set per Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]3. Be sure that the Model 49 repeater interface jumpers are set correctly per the following:

JP1	B=TX discriminator audio
JP7	A=COR input
JP9	A=RX amp 20 dB gain
JP10	A=TX amp high range
JP12	A=COR from internal noise squelch
JP13	B=300 Hz High pass filtering on repeat audio
JP14	B=Invert TX data polarity
JP16	A=True RX data polarity
JP23	A=Analog Data Decoding
JP24	B=AC coupled SUBOUT data
JP25	A=SUBOUT Tx HI level
JP26	A=Analog SUBOUT

[]4. Verify Alarm and Cross-Busy jumper settings per Step 1.4.

JP3	Cross-Busy Output (JP7 may change if using cross-busy)
JP4	Control 2 Output
JP5	Control 3 Output
JP6	Control 4 Output

NOTE: These jumper positions have been found to operate properly with the factory default settings of the repeater. However, the settings of these repeaters may have been changed in the field or elsewhere. Therefore, some of these jumper positions may need to be changed to obtain proper operating levels.

[]5. Disconnect the previously installed repeater logic/control as follows:

a. For MRS800 (conventional): disconnect the 13-pin CN1 connector from the repeater control board. The 13-pin CN2 connector should be loose already.

b. For MRS802 (trunking): disconnect the 13-pin CN1 and CN2 connectors from the logic board underneath the repeater frame.

[]6. Connect the Zetron jumper cable (Part No. 708-7153 in the 815-9072 cable kit) between CN1 and CN2. The 7-position Zetron jumper connects its orange wire to CN2's orange wire. The 13-position end connects its red wire to CN1's red wire. This jumper cable is depicted in Figure 4-25.

Note: Connectors CN1 and CN2 in the MRS802 repeater each have 13 positions. CN2 is the one with a short pink wire loop from pins 1 and 4, and an orange wire to pin 13. CN1 has a red wire to pin 13.

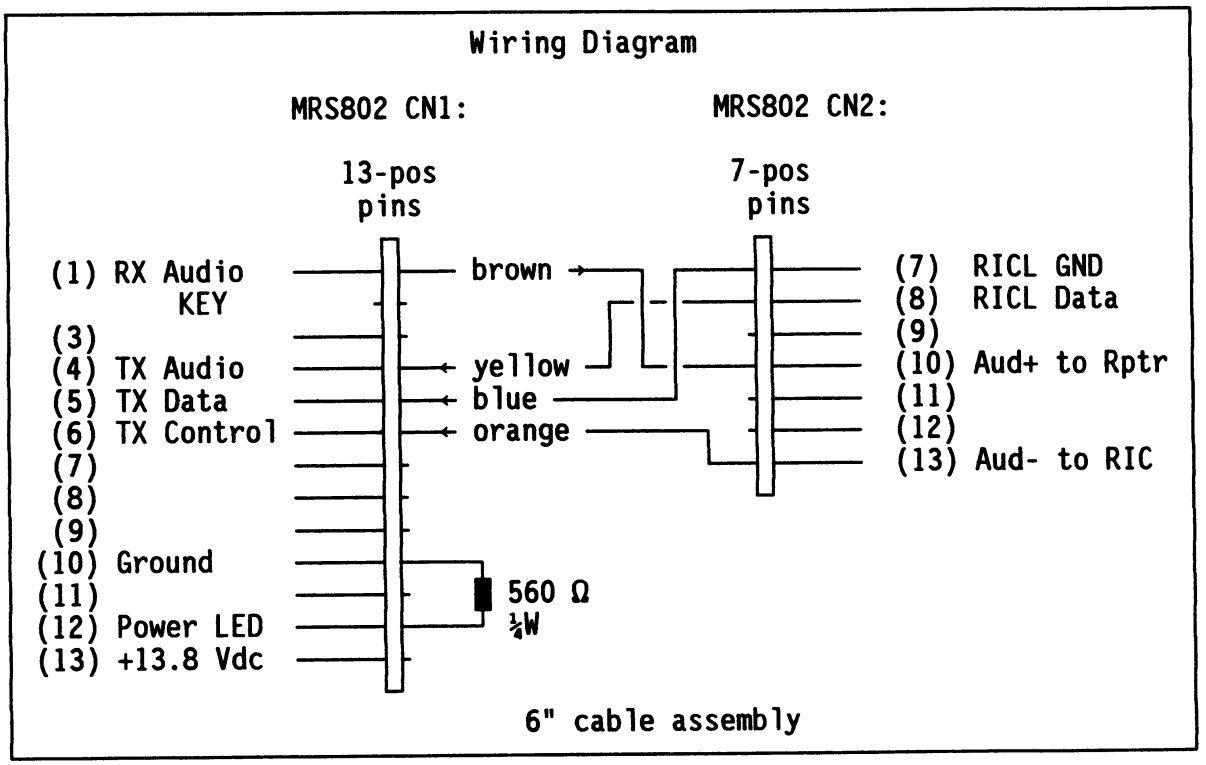


Figure 4-25. Zetron/Uniden MRS802 Jumper Cable (P/N 709-7147)

[]7. Tuck the Zetron jumper cable under the main chassis plate, making sure that it does not short to the chassis.

[]8. Turn the DATA pot R32 on the Local Oscillator about 1/4 turn clockwise to get more adjustment range on the LTR transmit data deviation. Refer to Figure 4-26 to locate R32.

[]9. Replace the covers on the MRS802.

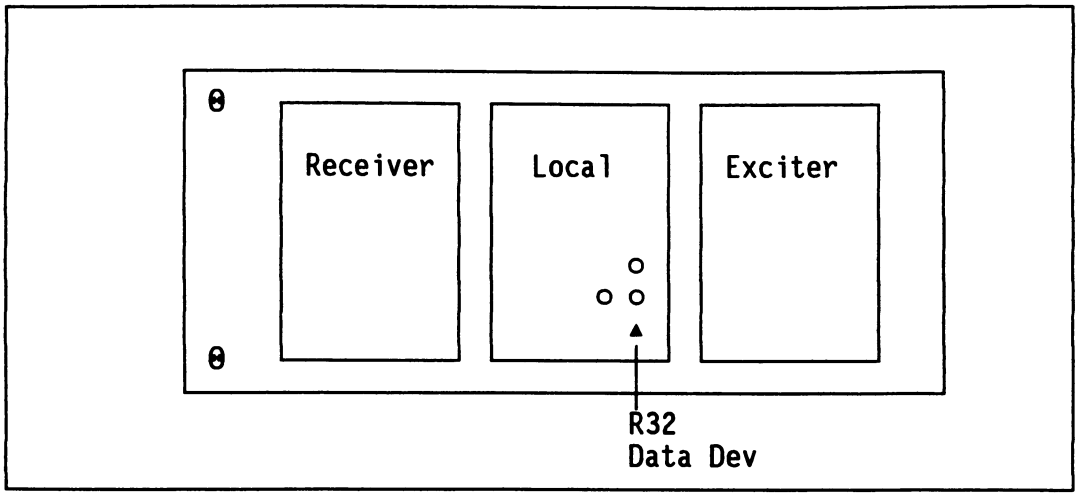


Figure 4-26. Uniden MRS802 Internal Sub-Chassis

[]10. Set the MRS802 front panel controls as follow:

VOLUME	Any position (receiver level to Zetron Model 49 is independent)
SQUELCH	Any position (squelch level is set in the Model 49)
REPEAT/LOCAL	Switch set to "IN" (repeat) position
OPT	Switch either position

[]11. Connect the Model 49 to the MRS802 ACC (ARX780) connector with the MRS802 Repeater cable (709-7147, part of cable kit 815-9072). Refer to Figure 4-27 for the wiring diagram of this cable.

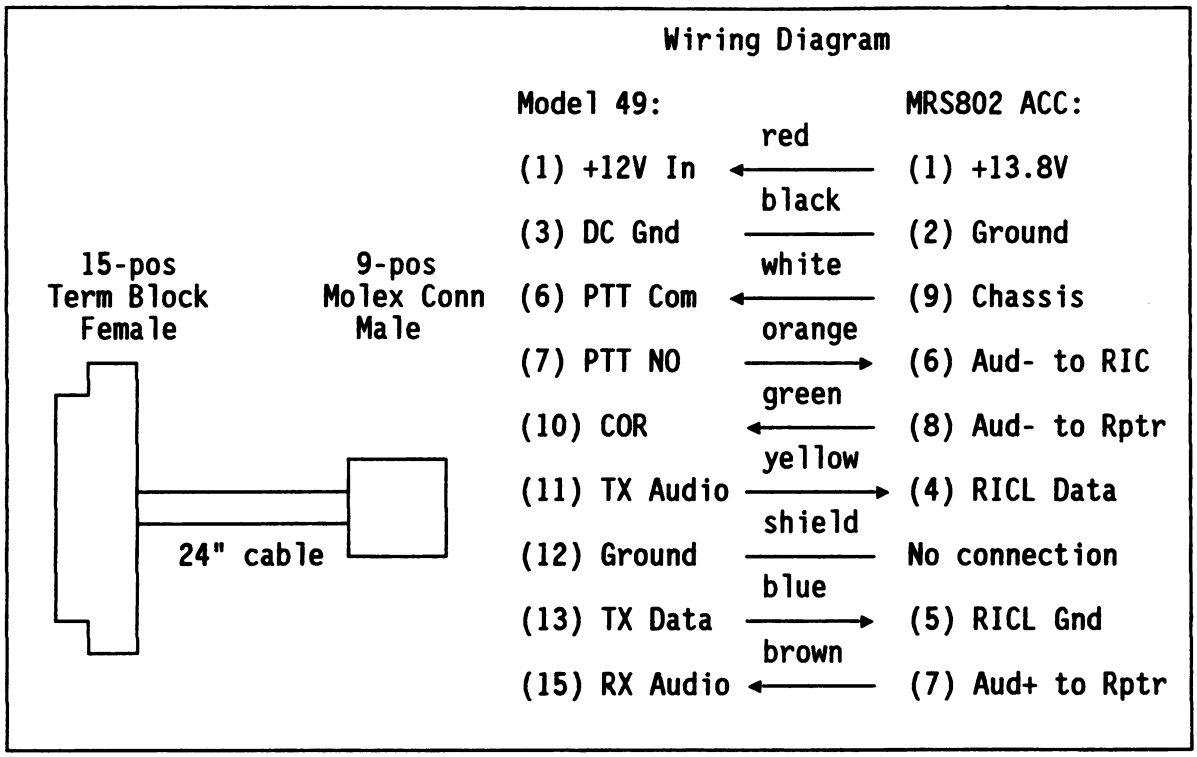


Figure 4-27. Model 49 to Uniden MRS802 Repeater Cable (P/N 709-7147)

[]12. Set the TX and RX audio and data levels by following the procedure described in "Step 5: Setting Repeater Levels".

Note: You can record your settings on the worksheets at the end of this section.

Step 5: Setting Repeater Levels

The Model 49 LTR Trunking Repeater Manager will perform reliably only after the signaling levels of the repeater and telco interfaces have been properly aligned. The following procedure outlines a general method for configuring the Model 49 for 800 MHz trunking service. This procedure also applies to the Model 42. Some repeater interfaces may require prior modification before the adjustments can be done.

This procedure requires use of a Communications Service Monitor, a mobile transceiver programmed with the "Test ID" (programmed into the Model 49 "Repeater Config" database), and an Audio Tone Generator capable of generating 0 dBm into a 600 Ω balanced line. A line-isolated oscilloscope or frequency-selective voltmeter is recommended for voltage measurements.

Before beginning, verify that the Model 49 Prompt Tone Levels are set to maximum in the Site Config... for versions 4.xx-6.15 Main Firmware units. For Version 6.16 and higher, Test Mode is always at maximum output.

REPEATER ADJUSTMENTS

The transmitter exciter and receiver sections of the repeater must be properly aligned per manufacturer specifications before the mobile transceiver can communicate with the Radio Frequency (RF) components of the trunking system whatsoever. When aligning the receiver, be sure to align the discriminator balance to prevent LTR Data degradation. Refer to the repeater service manual provided from the manufacturer.

Verify that the transmitter limiter is properly configured to limit at 5 kHz total carrier deviation (2.5 kHz for 900 MHz Band) as follows:

[]1. Monitor the transmitter output using the Communications Service Monitor.

Note: DO NOT overload the service monitor input. See the operator's manual provided from the manufacturer.

[]2. Temporarily disconnect the Model 49 TX AUDIO wire from J1 (Radio Interface) on the rear of the Model 49 by loosening the screw in the orange Weidmüller connector, pin 11, and removing the wire (Blue for 709-7116 Generic Cable).

[]a. Place the Model 49 into Test Mode by setting SW1-1 UP; then press and hold the RESET (labeled CONNECT / DISCONNECT) switch until the front LEDs flash. Release the RESET switch.

The Model 49 TX LED should illuminate immediately and remain lit. SYNC and POLL may illuminate later.

[]b. Adjust **TX DATA** until 1.0 kHz carrier deviation is attained.

[]c. Inject a 1kHz sinewave tone to the TX AUDIO input port of the repeater (Blue Wire) using the Audio Tone Generator (Be sure that no DC coupling occurs which may cause carrier deviation).

[]d. Increase the generator output level, while monitoring the transmitter modulation with the Service Monitor, until limiting begins. The deviation should be approximately 3.5 kHz of audio modulation + 1 kHz LTR data modulation, for a total channel deviation ≈4.5 kHz.

[]e. Increase the Audio Generator output to at least double the previous level, ensuring hard-limiting operation. Verify that total deviation does not exceed 5.0 kHz (2.5 kHz for 900 MHz Trunking). Re-align as required.

[]3. TX AUDIO ADJUSTMENT:

Re-connect the TX AUDIO to the Model 49. 20 Hz Ring bursts should be transmitted at a rate of 2 sec ON / 2 sec OFF.

Version 6.xx and higher Main Firmware ONLY:

Advance the Model 49 Tx Test Mode 4 by pressing RESET twice, then waiting 2 seconds and repeating until at Mode 4. Pressing too frequently resets the unit.

The **Tx Test Modes** are listed below:

Tx Test Mode 1	LTR Data & Ring Tone Bursts
Tx Test Mode 2	LTR Data Only
Tx Test Mode 3	LTR Data & 3 kHz Steady Tone
Tx Test Mode 4	3 kHz Steady Tone Only

[]a. Preset the **Model 49 TX AUD** pot to maximum (fully CW) and adjust the TX AUDIO pot of the repeater until limiting begins, ≈4.5 kHz total carrier deviation. (Adjust during ring bursts for Ver. 4.xx only)

[]4. Rev S+ Model 49 units only, monitor U7-pin 14, and adjust **TX TONE** as noted:

Ver 6.xx units operating in Tx Test Mode 4, must be set so that U7-14 measures 1.95 VP-P (-1 dBm, 690 mVRMS).

Ver 4.xx units should be set to 1.80 VP-P (-1.7 dBm, 636 mVRMS) during ringing.

[]5. Adjust the **Model 49 TX AUD** to attain 3.0 kHz carrier deviation in TX TEST Mode 4.

Set Ver 4.xx units to attain maximum non-distorted deviation during ring bursts.

[]6. Adjust the **Model 49 TX DATA** to attain 0.950 kHz carrier deviation in TX TEST Mode 2.

Set Ver 4.xx units to attain 0.950 kHz deviation between ring bursts (data only transmission).

[]a. If SW1-2 is DOWN (SW2-1 UP), then the mobile transceiver should be ringing (check JP14 if not ringing).

SW1-2 UP transmits BUSY ID, code 253.

[]7. RX AUDIO ADJUSTMENT:

[]a. Connect the Communications Service Monitor output directly to the Receive Antenna port of the repeater. With no carrier applied, adjust **SQUELCH** (R55) fully CW. Verify that the CARRIER LED goes on steady. (Model 49 Test/Normal Mode SW1-1 setting is irrelevant.)

[]b. Adjust **SQUELCH** (R55) slowly CCW until the CARRIER LED just goes off steady (no further).

[]c. Inject a standard test receive carrier at a level of 1 mVRF (-47 dBm) modulated by a 1 kHz sinusoidal audio tone at 4 kHz Carrier Deviation. Adjust **RX AUD** (R54) to attain 1.0 VP-P (-6.8 dBm, 354 mVRMS) at TP5 (RX AUD).

[]d. Modulate the test carrier with a sinusoidal 100 Hz tone at 1 kHz Carrier Deviation to approximate data transmission.

Verify ≈246 mVP-P (-19 dBm, 87 mVRMS) at TP5 (RX AUD).

[]e. Be sure the Model 49 is in Normal Operating Mode (SW1-1 DOWN & RESET). Reconnect the receive antenna to the repeater.

Key the mobile transceiver having the TEST ID code previously programmed into the Model 49.

Observe LEDs DS1(R), DS2(T), DS3(Q) while the transceiver is keyed. These LEDs are located under the Voice Prompts Card, if installed, which may need to be removed temporarily.

The Receive [LTR packets] LED should illuminate briefly and then commence steady flashing (indicating each LTR data packet received).

The Qualified [as valid LTR packet] LED should flash after the first R flicker and go on steady after the T goes on steady.

The Transmit [LTR packets] LED should go on steady after the initial received packet (R) is decoded, qualified OK (Q), and the LTR handshake is concluded.

NOTE: If the CARRIER LED flashes each time the mobile keys, and the R and Q LEDs do not illuminate, check JP16.

This concludes Dispatch-Only Operation adjustments.

INTERCONNECT ADJUSTMENTS

[]8. Dial into the Model 49 from the landline while the Model 49 is in Test Tx Mode (SW1-1 UP, then RESET-Refer to Step 2.a). Upon answering the telco line, the Model 49 will drop into Telco Test Mode 1.

Double pressing the CONNECT / DISCONNECT Switch at 2-second or longer intervals will toggle to the next mode.

The **Telco Test Modes** are listed below:	
Telco Test Mode 1	600 Hz Steady Sinusoidal Tone
Telco Test Mode 2	1,000 Hz Steady Sinusoidal Tone
Telco Test Mode 3	2,500 Hz Steady Sinusoidal Tone
Telco Test Mode 4	No Tone. To/From Tel voice audio paths open

[]a. Rev S+ Model 49 units only - Preset PH TONE:

Select Telco Test Mode 2 (1 kHz tone). Pre-set **PH TONE** (R53) fully CCW (min), and **TO TEL** (R52) fully CW (max).

Monitor TO TEL test point TP11 and increase **PH TONE** until the AGC circuit activates and the signal decreases in amplitude. Continue to increase **PH TONE** until 500 mVP-P (≈-13 dBm, 174 mVRMS) is attained at TP11.

[]b. Hybrid Balance:

In Telco Test Mode 2, monitor the FROM TEL test point TP12. An oscilloscope is strongly recommended for this procedure. If not *previously* set, preset the **FROM TEL** to the midpoint (i.e. slot vertical).

Adjust **BAL R**, **BAL C**, **SW1**, **C**, and **HI** for minimum signal level at TP12. Typically 20 mVP-P or less can be attained.

[]c. Set FROM TEL Level:

Select Telco Test Mode 4 (silence). Using a balanced 600 Ω tone

generator, inject a 1kHz test tone signal onto the telco line (at test-tone level of -10 dBm for E-E trunks, 0 dBm for E&M T1 trunks, etc.).

Adjust the Model 49 **FROM TEL** potentiometer to attain 4 kHz audio deviation on the Repeater TX frequency, as measured off-air using the Communications Service Monitor.

Remove the tone generator from the telco line and place the Model 49 into Normal Operating Mode (SW1-1 DOWN & RESET).

[]d. Place an interconnect call using the mobile test transceiver to a landline with an affiliated live volunteer. Press and hold DTMF 0 from the landside phone. Verify approximately 3.5 kHz audio deviation of the Repeater Tx carrier. Discontinue DTMF 0.

[]e. Set TO TEL Level:

While an interconnect call is connected (established in Step 7.d.), and after the last "Interdigit Timer" has expired, press and hold the mobile transceiver DTMF 0 key. Verify that off-air modulation of the Mobile Tx frequency (Repeater Rx frequency) is approximately 2.8 kHz (or less). This is important to avoid overdriving the telco line.

For 2-wire circuits, E-E or DID, transmit a 1 kHz sinewave at maximum deviation (4kHz) and adjust the Model 49 **TO TEL** until 4.0 VP-P (+5.23 dBm, 1.414 VRMS) is attained at TP11 (TO TEL). After 3 seconds the amplitude will drop 10 dBm per FCC telco requirements. Adjust for up to 3 seconds, then un-key and re-key to continue adjustments as required. (Normal voice is well below this level.) This will result in TO TEL maximum audio between 0 and -3 dBm, dependant upon line impedances, etc.

For E&M 4-Wire trunks, monitor the TO TEL audio line pair and set as required for the specific trunk.

The DTMF audio transmitted TO TEL should be non-distorted. When held for longer than 3 seconds, DTMF digits should not activate the telco power limiter circuit (i.e. decrease in amplitude). The 941 Hz component of the DTMF "0" tone should be approximately 10 dBm below maximum audio level of the TO TEL signal (1kHz mod. tone at 4 kHz dev.).

This concludes step 5, Setting Repeater Levels.

Step 6: Making Trunking Connections

[]1. Connect the Repeater Bus by daisy chaining (Repeater Bus channel 1 to Repeater Bus channel 2, etc.) shielded BNC cables among all logic units.

[]2. Connect the Subscriber Bus by daisy chaining (Subscriber Bus channel 1 to Subscriber Bus channel 2, etc.) shielded BNC cables among all *Zetron* logic units.

More detailed descriptions of these buses and their configurations are provided in "Trunking Connections in Detail" later in this section.

Step 7: Testing Dispatch Calls

When the memory is cleared, the Model 49's default program will make all IDs valid for dispatch calls, since "unassigned" users are defined as valid by firmware defaults. This fact allows us to test dispatch calls.

Note: if the "Unassigned Users" are set as "invalid" in the "Site Configuration" window of the "Edit" column, specific Dispatch ID codes will have to be entered and validated into the "User" table. For more information, refer to *Model 49 Multibase Operation Manual* (Part No. 025-9173) or to *Model 49 Multibase, Version 6.1 or Above Operation Manual* (Part No. 025-9297).

[]1. Program two mobiles with the same ID for dispatch.

[]2. Key up the first mobile. The carrier and transmit LED on the front of the Model 49 should come on.

[]3. While the mobile is keyed up the second mobile should hear what the person on the first mobile is saying.

Step 8: Testing Trunking

To test trunking it is necessary that two mobiles are programmed with two different dispatch IDs. These IDs should be homed on the same channel.

[]1. Use the *Model 49 Multibase Operation Manual* (Part No. 025-9173) or *Model 49 Multibase, Version 6.1 or Above Operation Manual* (Part No. 025-9297) to program site configuration and repeater configuration.

[]2. Check the IDs programmed into the mobiles by testing each mobile one at a time for dispatch. Verify that they home on the same channel.

[]3. Key up the first mobile. The home channel's transmit and carrier LED's should come on. With the first mobile still keyed up, key up the second mobile with the second ID. At this time one of the other Model 49s on the system should have its transmit and carrier LED's on.

[]4. While keeping the second mobile keyed, *unkey* the first mobile. The second mobile should stay on the trunked-to channel, while the home repeater should remain transmitting "GO-TO" packets for the second mobile.

[]5. Unkey the second mobile. Both repeaters should drop to receive status.

Step 9: Testing Interconnect

The installation of telco cards alone does not enable the Model 49 for interconnect operation. EPROMs must also be upgraded to enable the option. To view the current EPROM settings, execute a cOmm49, status info from Multibase or Ebase.

The interconnect option can be verified visually by inspecting the Model 49 main board to confirm each of the correct components are installed. These components are listed in the following table.

Interconnect Component Description	Model 49 Board Location/Telco Card Part Number	
	Rev. A – Q	Rev. S and Higher
48 VDC switching regulator IC	U1	U57
DTMF receiver IC	U21	U23
1200 baud modem IC	U37	U21
Interconnect EPROM set	U29, U31	U29, U31, U20 (tone generator)
One of the following telco cards:		
DID telco interface care	702-9229	702-9446
End-to-End telco interface card	702-9283	702-9669
E&M 4-wire telco interface card	702-9228	702-9445

To test the interconnect, it is necessary to have one ID in a mobile programmed for interconnect.

1. Use the database software to program the Model 49's site configuration and repeater configuration for interconnect. Refer to *Model 49 Multibase, Version 6.1 or Above Operation Manual* (Part No. 025-9297) or to *Model 49 Ebase Operation Manual* (Part No. 025-9402).

2. Use the Multibase or Ebase manual to program the proper ID for interconnect. Be sure to program the ID to match the capabilities of the mobile.

3. Program a mobile LTR transceiver with appropriate channel information and ID code.

4. Key up the mobile. The Model 49 should open the correct audio paths and return a dial tone to the mobile, and the transmit, carrier , and telco LEDs on the front of the Model 49 should go on.

   Note that on a *full-duplex* mobile, it is not necessary to unkey before dial tone will be heard. On a *half-duplex* mobile, it *is necessary* to key up and then unkey before dial tone will be heard.

Step 10: Making Telco Adjustments

As discussed earlier, audio levels to and from the Model 49 as well as hybrid adjustments are performed on the telco card.

In the following procedure, you will first set the hybrid using the internal tone generator, then set the TO and FROM levels for proper modem operation, following up with a final hybrid adjustment.

HYBRID ADJUSTMENTS
Depending upon the TELCO interface card utilized, proceed to the pertinent Hybrid Balancing instructions below.

If E&M Type I 4-Wire TELCO Card is used, no Hybrid circuitry needs to be balanced. Proceed to "To and From Level Adjustments" later in this subsection.

DID (702-9229) HYBRID BALANCING PROCEDURE

[]1. Set both the TO and FROM levels fully clockwise. This is referred to as the 11 o'clock position.

[]2. Connect a telephone line to the Model 49.

[]3. Connect an AC voltmeter to test point 12 (FROM TEL) on the main board. TP12 is located second from left on the main board, through the access window of the front panel. The far left pin is the ground reference point.

[]4. Activate the Model 49 Test Mode as follows:

Place DIP switch A:1 to the UP position. Press the front panel CONNECT/DISCONNECT switch twice (or hold for a few seconds until LEDs flash) to force the Model 49 to reset and read the front panel switches.

[]5. Now place a telephone call to the Model 49.

[]a. The Model 49 will enter one of four modes each time you press the front panel CONNECT/DISCONNECT button twice (be careful not to press twice too frequently, or the Model 49 will reset).

The four TELCO Test Modes are as follows:

* 600 Hz (2.4 KHz carrier deviation)
* 1.0 KHz (3.4 KHz carrier deviation)
* 2.5 KHz (4.2 KHz carrier deviation)
* NO Tone Generated; telephone audio path open to/from mobile.

[]b. Adjust BAL-R and BAL-C for the minimum voltage reading on the meter, for all three tones (this may not be minimal for any one tone).

[]c. Repeat step (b.) twice or until no further change is observed.

[]6. Once achieved, set DIP switch A:1 down, then press and hold the CONNECT/DISCONNECT button until the Model 49 performs a soft reset.

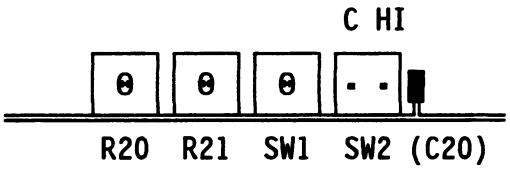
FULL DUPLEX E-E (702-9669) HYBRID BALANCING PROCEDURE

[]1. Set both the TO and FROM levels fully clockwise on the Model 49 Main Board. This is referred to as the 11 o'clock position.

[]2. Connect a telephone line to the Model 49.

[]3. Connect an AC voltmeter to either Test Point 12 (From Tel) on the main board or pin 11 of the telco card. TP12 is located for easy access from the front, on the main board near the left end of the front panel window.

[]4. Along the front edge of the End-to-End Card, there are two variable resistors, one sixteen position rotary switch, and one two-position dipswitch as illustrated below:



R20: [BAL R] Adjusts Resistance of hybrid balance.
R21: [BAL P] Adjusts composite phasing of hybrid balance.
SW1: (16 position rotary) Adjusts capacance of hybrid balance.
SW2-A: [C] Inserts 2.2 μF series-wired capacitance to match TELCO CO for short lines when UP.
SW2-B: [HI] Selects capacitance range for SW1 adjustment. Low range = UP; High range = DOWN.

[]5 Place the Model 49 into Test Mode:

Place DIP switch A-1 of the Main Board to the UP position.

Place A-2: UP — M49 generates ID code 253 (repeater busy)
DOWN — M49 generates TEST ID code

Press the front panel Connect/Disconnect button twice (or hold depressed until the LEDs flash) to force the Model 49 to reset and read the front panel switches.

[]6. Using another telephone, dial the number of the phone line connected to the Model 49.

[]7. When the Model 49 answers the call, *TELCO Test Mode* will be initiated and a 600Hz tone should be heard in the telephone receiver.

Four TELCO Test Modes can be accessed sequentially by twice depressing the CONNECT/DISCONNECT switch for each mode. (Pressing the CONNECT/DISCONNECT switch too rapidly will reset the M49, re-initiating the TELCO Test Mode.) The M49 will rotate through all modes until Test Mode is aborted. The four TELCO Test Modes are:

* 600 Hz
* 1.0 KHz
* 2.5 KHz
* NO Tone Generated; telephone audio path open to/from mobile having the Test ID.

[]8. Be sure 600 Hz mode is active. Set the following:
* R21 [BAL P] to 12 o'clock
* SW1 to 0
* SW2 [C] and [HI] both DOWN.

[]9. While monitoring the FROM TEL TP12 on the main board, adjust R20 (far left pot) on the E-E Balance Board for a null.

[]10. Press the Connect/Disconnect button on the front panel 2 times. The tone should change to 1000Hz.

[]11. While monitoring FROM TEL TP12, switch SW1 between the "0" and "F" positions. Mentally note the change of level. Change SW2 [C] and [HI] positions, repeating the SW1 test for each SW2 setting. Leave SW2 settings where SW1 "0" and "F" levels differ the least.

[]12. Rotate SW1 and adjust R20 [BAL R] to obtain a null at FROM TEL TP12.

[]13. Press the Connect/Disconnect button 2 times again. The tone should now be 2500Hz.

[]14. Rotate SW1 and adjust R20 [BAL R] to obtain a null at FROM TEL TP12.

[]15. Now press the Connect/Disconnect button 2 more times. The tone should go away.

[]16. Wait 5 seconds and press the Connect/Disconnect button 2 more times. The Model 49 should now be sending the 600Hz tone again. If you do not wait 5 seconds, the Model 49 will reset and you will need to start over again.

[]17. Repeat the null adjustment of R20 and SW1 for each Test Mode tone frequency approximately 3 more times to get the appropriate nulls. [typically < 60 mVpp (20 mVrms)]

[]18. Your hybrid should be balanced at this point.

[]19. If the null is unsatisfactory, Repeat step 11 for a different test mode frequency, followed by steps 12 through 17 to null the hybrid after reconfiguring.

TO AND FROM LEVEL ADJUSTMENTS

The FROM TELCO pot will adjust the audio gain from the phone line into the Model 49. Just beyond the telco card, the audio from the phone will go through an AGC circuit on the main board.

The TO TELCO adjustment is designed to set the audio gain from the Model 49 voice processing to your local telephone Central Office (C.O.).

The PH TONE adjustment is designed to set the audio gain from the Model 49 Tone Generator to your local telephone Central Office (C.O.). This affects prompt tones and DTMF redialing from the Model 49.

There are two methods provided for adjustment of the TO and FROM TELCO pots. Both methods are used for E-E, DID, or E&M telco cards. One method uses dial tone and the second method uses DTMF. Each method has unique benefits. When adjusting using dial tone, the dial tone signal is at a known level but the C.O. loss is unknown. When adjusting using DTMF, the C.O. loss is known but the DTMF level is unknown.

When using the Model 49 in a direct AUTONET configuration, it is suggested to first adjust the TO TELCO pots on both Model 49's, and secondly use the DTMF procedure for adjusting the FROM TELCO pots.

DIAL TONE METHOD

[]1. FROM TELCO adjustments:
- []a. Complete the hybrid balance procedure.
- []b. Complete the TX and RX AUDIO adjustment procedures.
- []c. Using a valid Interconnect ID, key up the Mobile radio and obtain dial tone.
- []d. While dial tone is present adjust the FROM TELCO pot to obtain 150 mVpp (≈35 mVrms) at TP12.

It is extremely important that the FROM TELCO pot not be turned up too high as background noise and feedback may become a problem.

[]2. TO TELCO adjustments:
- []a. Put the Model 49 into the test mode by placing dip switch A1 up and depressing the connect/disconnect button twice (or hold until LEDs flash).
- []b. Call into the Model 49 from the landside. When the Model 49 answers, a 600 Hz tone should be heard by the landside user.
- []c. Depress the connect/disconnect button twice. A 1000 Hz tone should be heard.
- []d. Adjust the PH TONE pot for a 1.5 Vpp or (≈530 mVrms) signal measured at TP11 (TO TEL).
- []e. Take the Model 49 out of the test mode by placing dipswitch A1 down and depressing the CONNECT/DISCONNECT button until the LEDs flash.
- []f. Place a call to/from a Test Mobile. While holding the Mobile DTMF 5 depressed, monitor TP11 (TO TEL) and adjust the TO TEL pot for 1.5 Vpp (≈530 mVrms). Voice should be approximately 3 Vpp (≈1.06 Vrms) after this adjustment is completed.

The TO and FROM TELCO levels should be close but may need to be fine tuned for personal taste.

Vrms measurements may vary significantly due to meter frequency bandwidths or evaluation techniques utilized by the meter. Oscilloscope measurements are preferable.

If there is an E&M card that is connected to a microwave, adjust the TO TELCO pot to match the desired input level of the microwave.

DTMF METHOD

[]1. FROM TELCO adjustments:
- []a. Complete the hybrid balance procedure.
- []b. Complete the TX and RX AUDIO adjustment procedures.
- []c. Establish an Interconnect call.
- []d. From the phone side continuously depress the 5 button.
- []e. While the digit 5 is being depressed:
  - * Adjust the FROM TEL pot for a 150 mVpp (≈35 mVrms) signal at TP12 on the main board.

 - OR -

  - * Adjust the FROM TEL pot on the main board until the transmitter carrier total deviation is at 3.0 KHz.

It is extremely important not to turn the FROM TELCO pot up too high as background noise and feedback may become a problem.

[]2. TO TELCO adjustments:
- []a. Put the Model 49 into the test mode by placing dip switch A1 up and depressing the connect/disconnect button twice, or hold until LEDs flash.
- []b. Call into the Model 49 from the landside. When the Model 49 answers, a 600 Hz tone should be heard by the landside user.
- []c. Depress the connect/disconnect button twice. A 1000 Hz tone should be heard.
- []d. Adjust the PH TONE pot for a 1.5 Vpp (≈530 mVrms) signal measured at TP11.
- []e. Take the Model 49 out of the test mode by placing dipswitch A1 down and depressing the CONNECT/DISCONNECT button until the LEDs flash.
- []f. Place a call to/from a Test Mobile. While holding the Mobile DTMF 5 depressed, monitor TP11 (TO TEL) and adjust the TO TEL pot for 1.5 Vpp (≈530 mVrms). Voice should be approximately 3 Vpp (≈1.06 Vrms) after this adjustment is completed.

The TO and FROM TELCO levels should be close but may need to be fine tuned for personal taste.

Vrms measurements may vary significantly due to meter frequency bandwidths or evaluation techniques utilized by the meter. Oscilloscope measurements are preferable.

If there is an E&M card that is connected to a microwave, adjust the TO TELCO pot to match the desired input level of the microwave.

Step 11: Programming Users and Time

To finish installing the system all of the user information needs to be programmed in for individual customers. Use the Multibase Manual to assist with this. Refer to *Model 49 Multibase Operation Manual* (Part No. 025-9173) or to *Model 49 Multibase, Version 6.1 or Above Operation Manual* (Part No. 025-9297).

Some of the advanced operating features of the Model 49 utilize its built-in clock chip that keeps track of the time of day and day of week. These features include deferred access during non-prime time, air time accumulation during prime and non-prime time, repeater loading statistics by the hour, all repeaters busy statistics by the hour, and telephone call detail: date, time-of-day marking, call status codes.

The clock chip is built into the socket underneath memory chip U27 and keeps time even during power failures. You set the clock by selecting "Other" in the Multibase Comm Menu. When the detailed Other Menu comes up, select "Set Date & Time."

Multibase will connect to the site selected and allow you to set the time and date while you are connected (on-line) to the Model 49. You can set the clock for the site's local time. This may be different from your office clock.

Note: The time and date are automatically cloned to all Zetron units at the site which are connected to the Zetron Subscriber bus. Additionally, the slaves are all reset by the Master Model 49 at midnight daily to ensure consistent clock synchronization between repeater controllers for billing purposes.

HINT

Before you leave the repeater site, turn around and take one last look at the Model 49 front panel LEDs.

On the Subscriber Master unit (switch B:1=ON - left-hand switch on group of 8), the POLL LED should be almost steady. Some flashing may be detectable.

On the Subscriber Slave units (switch B:1=OFF), the POLL LED should flash briefly in response to the master.

Note: For specific information about your repeater, see individual subsections in this section. If your repeater is not listed, contact Zetron for assistance.

TRUNKING CONNECTIONS IN DETAIL

After you have tested each Model 49 connected to its designated repeater operating in "single channel trunking", connect it to other logic units and make sure that they "trunk" and work properly with all of your channels. See Figures 4-28 and 4-29.

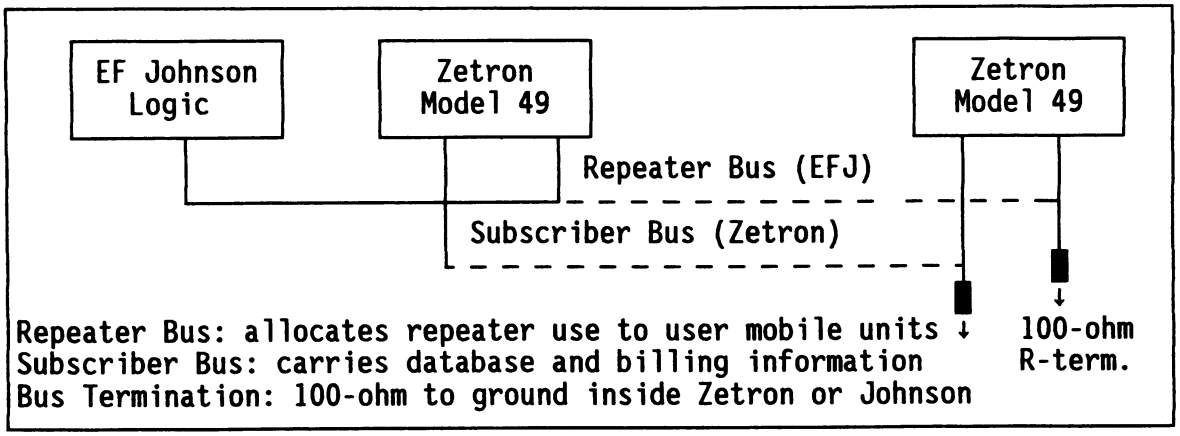


Figure 4-28. Model 49 Trunking Buses (Johnson Compatible)

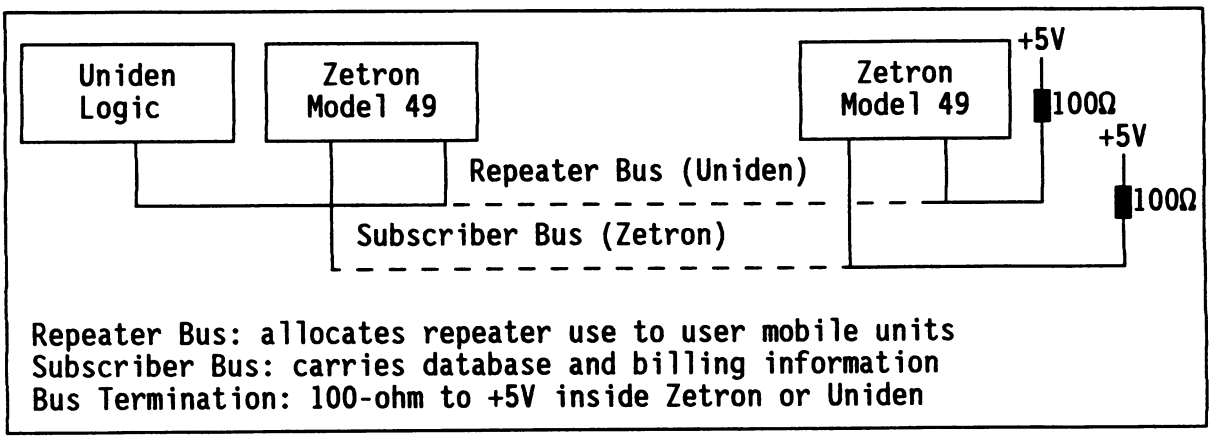


Figure 4-29. Model 49 Trunking Buses (Uniden Compatible)

Here is a simple checklist to make sure you have set up your system:

[]1. Set the Bus Jumpers in all Zetron Model 49s for electrical and timing compatibility with E.F. Johnson HDB or Uniden RNDL buses as follows:

JP11 Repeater Bus Timing
A=EFJ HDB B=Uniden RNDL
JP17,19 Subscriber Bus Electrical
A=EFJ hardware B=Uniden hardware
JP18,20 Repeater Bus Electrical
A=EFJ hardware B=Uniden hardware
JP21 Subscriber Bus Termination
A=EFJ 100 ohm pull-down B=Uniden 100 ohm pull-up C=jumper storage
JP22 Repeater Bus Termination
A=EFJ 100 ohm pull-down B=Uniden 100 ohm pull-up C=jumper storage

Note: The Zetron Subscriber Bus will operate with EFJ or Uniden Hardware compatibility. For safeguards in case the repeater and subscriber buses get cross-connected by accident, set jumpers JP17-JP20 all to A or B. Then both buses will have same electrical characteristics. **You only need one termination resistor on each bus.** It is easiest to track the location of the terminating resistor if it resides at the "Master" unit for the specific data bus.

[]2. Connect the daisy-chain Repeater Bus shielded BNC cables among all logic units.

[]3. Connect the daisy-chain Subscriber Bus shielded BNC cables among all logic units.

[]4. Terminate <u>one point</u> of each bus with a 100 ohm resistor. For EF Johnson, the termination is a resistor to ground. Like the terminators shipped with EFJ LTR systems, you can use a BNC connector with a resistor soldered inside of it.

-CAUTION-
The 50Ω EFJ terminations provide an excessive load for the bus drivers used in the M49 and therefore may cause random bus errors. If BNC terminations are desired, be sure that total DC resistance of the terminations equals no less than 100 Ω.
e.g. 1 termination @ 100 Ω for single point method
OR 2 terminations @ 220 Ω , one for each end of the bus

On Model 49s, you can set JP21 and JP22 in one of the units for termination (the bus master is easiest to remember).

For Uniden, the termination is a resistor connected to +5 volts. On Uniden MRS804 and MRS802 repeaters, you connect the resistor by leaving the pink wire loop intact on connector CN2 in one of the logic units (on other units, cut the wire loop). On Model 49s, you can set JP21 and JP22 in one of the units for termination (the bus master is easiest to remember).

[]5. Set the DIP switch on one logic unit on the Repeater Bus Sync to be Master and all other units to be Sync Slaves. On the Zetron Model 49, this is switch B:2 Master=Up, Slave=Down (8-position switch, second position from the left - see "Hardware Layout" at the end of this section). Refer to your EFJ or Uniden manuals for information on their switches.

[]6. Set the DIP switch on one Zetron unit to be the Subscriber Bus Poll Master and all other units to Poll Slaves. This is switch B:1 Master=Up, Slave=Down (8-position switch, first position on the left - see "Hardware Layout" at the end of this section).

[]7. Set the Area DIP switch to be the same on every unit (area 0 or 1). On the Model 49 this is switch B:3 Area 1=Up, Area 0=Down (8-position switch, third position from the left). Refer to your EFJ or Uniden manuals for information on their switches. Area 0/1 status *must* correspond to mobile transceiver programming.

[]8. Set the DIP switches on each unit to its assigned repeater number. On the Model 49 this is switches B:4 through B:8 coded in binary (right-most 5 positions of 8-position switch - see table at the end of this section). Refer to your EFJ or Uniden manuals for information on their switches.

Note: Only repeater numbers 1 through 20 are valid; other settings will stop a logic unit from working.

[]9. Program the Repeater Config information in Multibase for all repeater channels to be used, including non-Zetron ones. Update all of your Zetron Model 49s so that they know about *all* of the channels.

[]10. Set the Validate DIP switch A:2 (4-position switch, second position from the left on Zetron Model 49s as follows:

If all of your Zetron logic units are performing their own validation from Multibase settings, set the Validate DIP switch A:2=Down on all Zetron units. The units will also check for validation information from a "validator box" should it place information in slot 21 of the Repeater Bus.

If you want a Zetron Model 49 to act as a "validator box" for non-Zetron units, then you must make a Zetron unit the Repeater Bus Sync Master (step 5 above). On the Zetron Sync Master unit B:2=Up, set its Validate DIP switch A:2=Up. On all other Zetron units, set the Validate DIP switch A:2=Down.

If you have a "validator box" and want to use it exclusively for validation for your Zetron units (Zetron units will ignore Multibase validation bits), then set the Validate DIP switch A:2=Up on all of the Zetron units. In addition, the Repeater Bus Sync Master cannot be a Zetron unit, so all of the Zetron units should have switch B:2=Down.

[]11. If you are using the Model 49 to validate users on non-Zetron channels, you must program the IDs with Multibase into the User ID database. This can be a time-consuming task when you only want to invalidate a few users.

To make your job easier, the Model 49 can treat all unprogrammed user IDs as automatically Valid or Invalid. Program the "Unassigned Users" in the Site Config database as you wish. Then, you only have to program the particular users in the User ID database that are opposite to your unassigned default choice.

VOICE PROMPTS

Field installation of the voice prompts card (702-9391)

1. Remove power from the Model 49, remove the top cover, plus in the voice prompt card into J3, and secure the card with the screw provided.

> **Caution:**
>
> If the voice card is installed improperly, it will be destroyed on power up.
>
> On newer revision boards, the voice card goes into J4/J5, not J3. In addition, J4/J5 on some boards have 6 pins each, for a total of 12 slots. The standard voice card has only 10 pins. It is imperative that the card be installed all the way towards the rear of the Model 49 chassis. That leaves the front two holes unused.

2. Using Multibase, enable operation of the voice prompts in the "Repeater Config." submenu of the Edit column.
3. Call into the Model 49 from a landside line and record the voice prompts. (See below)
4. Call into the Model 49 from a landside line and listen to the recorded message. Adjust R5 on the voice prompt card to match the audio level of the voice prompts to interconnect audio.
5. Reinstall the top cover.

Voice Prompt List

For Model 49 units equipped with version 6.10 firmware, the prompt set has been completely reconfigured and is detailed in the *Model 49 Multibase, Version 6.1 or Above Operation Manual* (Part No.025-9297).

For Model 49 units equipped with version 7.xx firmware, the prompt set has been completely reconfigured and is detailed in the *Model 49 Ebase Operation Manual* (Part No. 025-9402).

The following is a list of the available voice prompts for firmware version 6.9 and earlier. Message numbers one and two have a maximum length of 7.5 seconds. All other messages have a maximum length of 3.7 seconds.

1. Message One is the "Welcome" message. This message comes on after the phone line is answered and before the beep or dial tone prompt is sent. DTMF can be entered during the voice message. This is for experienced users who don't want to listen to the whole message. When the first DTMF digit is received, the voice message will stop. Dial click detection is not enabled until after the voice message so anyone using a rotary phone will need to wait until after the voice message to begin dialing. If the message is not recorded the beep or dial tone prompt will be sent immediately.
2. Message Two is the "Your call cannot be completed at this time" message. This message comes on if the mobile does not answer the call after the mobile ringing timeout period, or the mobile ID called is busy. The line is disconnected after this message is sent out to the calling party. If this message is not recorded, a reorder tone (fast busy) will be sent to the calling party.
3. Message Three is the "Thank You" Message. This message comes on after a valid mobile ID has been entered by the calling party. If this message is not recorded the M49 will go directly to ringing.

4. Message Four is the "Please wait, your call is being processed" message. This message comes on if the Model 49 is busy redialing for PTC Autonet or Autodial applications. If this prompt is not recorded, the M49 will issue two short beeps.

5. Message Five is the "The number you dialed is invalid" message. This message comes on if the number dialed is not a valid user ID (one that is not programmed in the unit). If this message is not recorded the M49 will issue a reorder tone and disconnect the call.

6. Message Six is the "Number is not valid, please retry" message. If the number dialed had an error, the caller may try one more time before getting the invalid message above.

7. Message Seven is the "Please Proceed" message. This is issued to inbound dialers after their call has been connected to an Autonet user. Since no ringing is audible to an Autonet dialing party from another LTR site, this prompt notifies them to begin conversation.

8. Message Eight is the "Alarm on Repeater" message. This message comes on if "alarms" has been set up in Multibase and an alarm condition has occurred. This message is played out to the mobile ID that has been designated to receive alarm messages.

Programming Voice Prompts

GAINING ACCESS
To gain access to programming voice prompts on the Model 49 with an End-to-End card installed or an E&M card with End-to-End emulation, wait for the prompt then dial 00 followed by the test ID. The Model 49 will respond with two ding-dongs indicating that the Model 49 is now ready to receive voice prompt commands.

To gain access to programming voice prompts on the Model 49 with a DID card installed, an E&M card with DID emulation, or overdial access number set to "yes" in site configuration, dial an invalid phone number, wait for the reorder tones, then dial 00 followed by the test ID.

VOICE PROMPT COMMANDS
The following commands are used to program the voice prompts:

0	for	Erase
2	for	Play
9	for	Record
*	for	Stop Recording Message
##	for	Hang up phone line

The following prompts are heard to guide you:

Two Ding-Dongs:	This prompt is sent when you first enter the programming mode.

Fast Busy Tone:	This prompt is sent if you wait too long between recording. The Model 49 hangs up the line after this prompt.
Three Ding-Dongs:	This prompt is sent after an invalid command or message number.
Six Beeps:	This prompt is sent at the beginning of recording a message.
Eight Beeps:	This prompt is sent to indicate a message is being erased.
One Ding-Dong:	This prompt is sent after a message has been erased or the maximum length of the message has been recorded.

Commands are given by keying in a series of numbers. The first number is the command code, the next is the message number.

For example, if you enter 02, you are telling the Model 49 you wish to erase message number 2. You will hear eight beeps verifying that the message is being erased.

If you enter 22, you wish to play message number 2. The message will play immediately after receiving the command.

If you enter 92, you wish to record message number 2. You will hear six beeps indicating start recording. Record your message and then enter * to indicate stop recording.

DIAL CLICK DECODER

Field installation of the dial click decoder card (702-9242):

[]1. Remove power from the Model 49, remove the top cover, plug in the dial click card into J8, and secure the card with the screw provided.

[]2. Using Multibase enable operation of the dial click card in the "Dial Click Decode Mode" submenu of the "Repeater Config." menu under the Edit column.

[]3. Call into the Model 49 using a rotary phone.

[]4. Once it has answered the call, use the rotary phone to dial a zero. Adjust R6 to where the light pulses on the LED have a 50% duty cycle.

[]5. Reinstall the top cover.

HARDWARE LAYOUT

Figure 4-30 shows the location of the Model 49 daughter cards, pots, and test points.

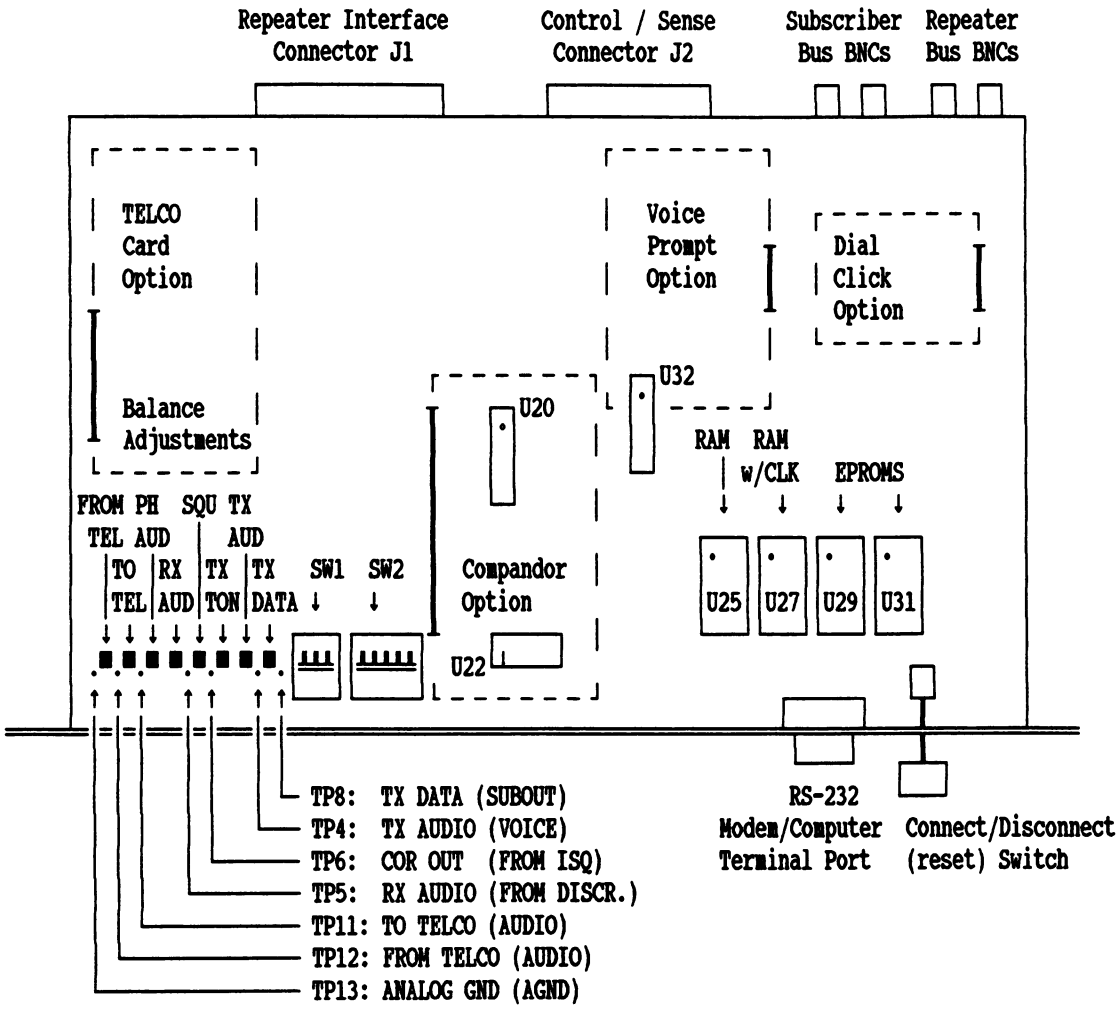


Figure 4-30. Daughter Card Locations, Pots, and Test Points

Note: The telephone interface card fits snugly into the rear panel. It's easiest to remove and install it by removing the screws retaining the rear panel as shown in Figure 4-31.

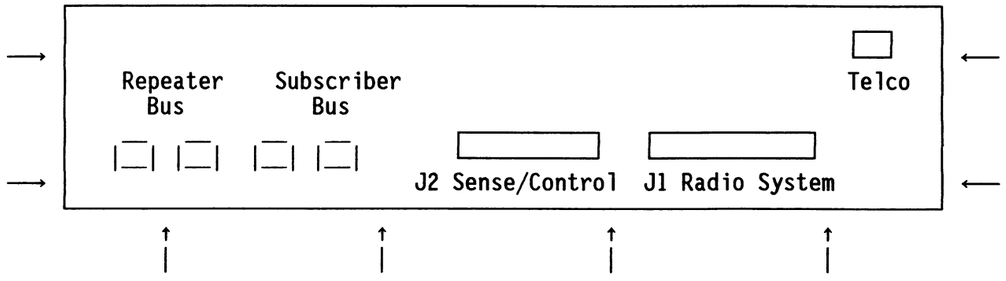


Figure 4-31. Locations of Rear Panel Screws

Figure 4-32 shows the configuration of the dip switches.

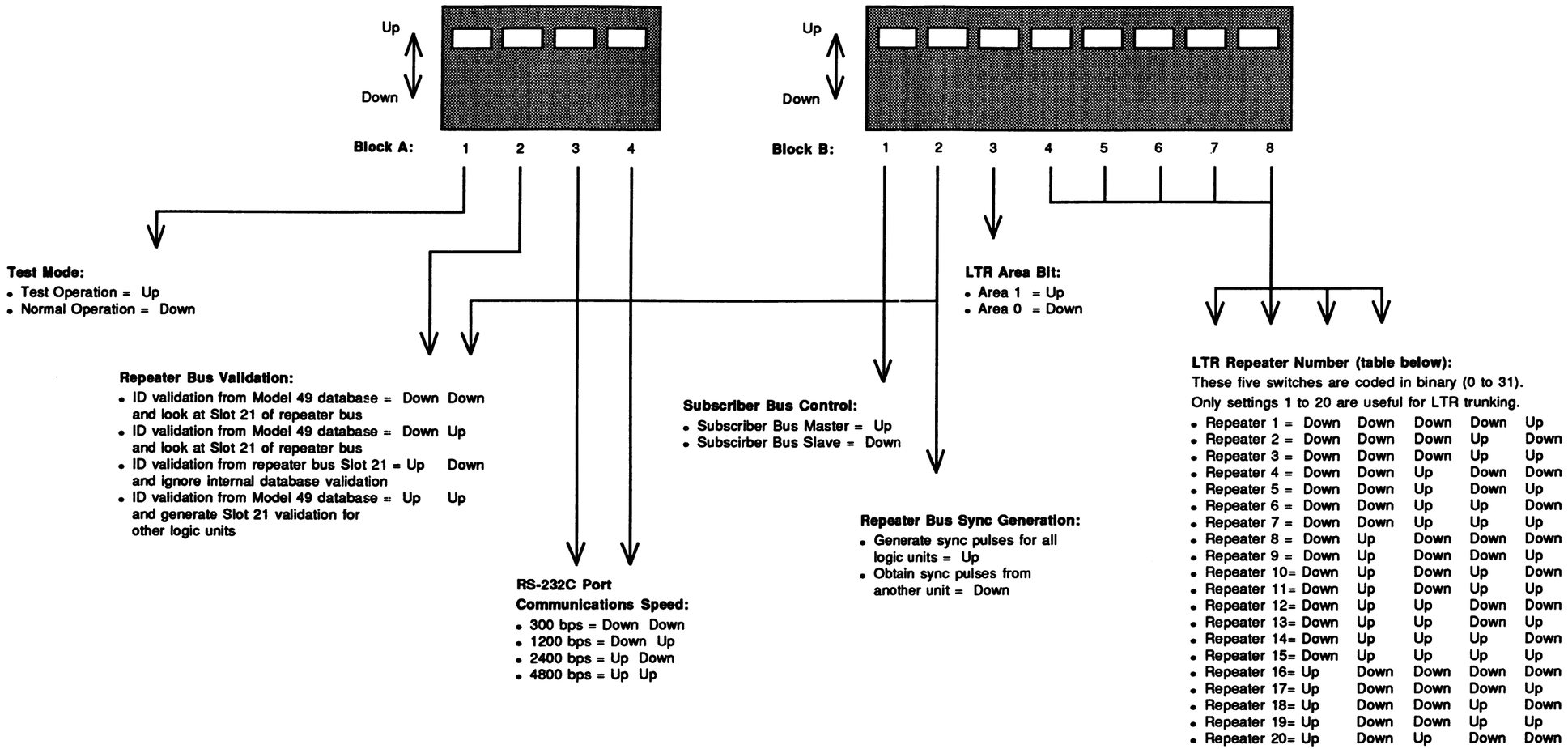
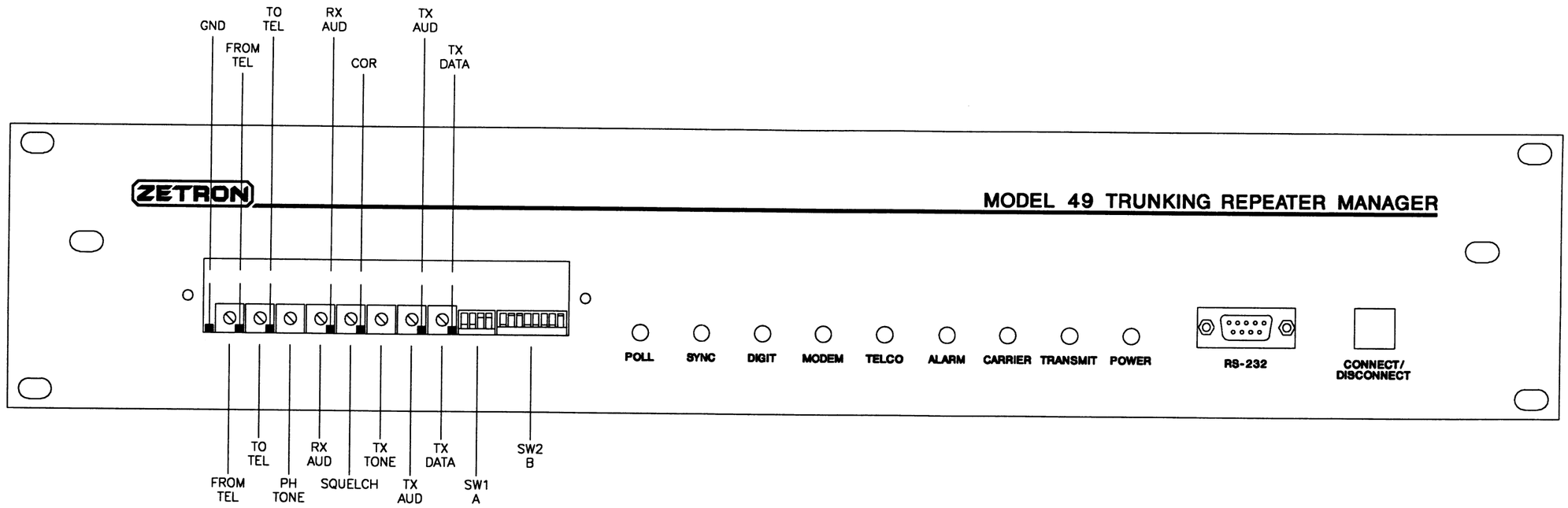
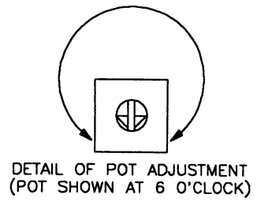


Figure 4-32. Dip Switch Configuration

Figure 4-33 shows the location of the pots, dip switches, test points, and LEDs (after removing the front cover lens).





024-0126A

Figure 4-33. Model 19 Pots, Dip Switches, and LEDs

MODEL 49 INSTALLATION WORKSHEET

Use this page to record details about your Model 49 installation.

Site Location: _____

Repeater Number: _____

Install Date: _____

Main Board, Part No. 702-9202, Revision _____

Protocol Board, Part No. 702-9218, Revision _____

Compandor, Part No. 702-9276, Revision _____

Telco Interface:

DID, Part No. 950-9252, Revision _____

End-to-End Duplex, Part No. 950-9241, Revision _____

E&M, Part No. 950-9253, Revision _____

Other Options:

Dial Click, Part No. 702-9010, Revision _____

Voice Prompts, Part No. 702-9391, Revision _____

Pot Settings on Main Board:

Pot Name	Label	Setting	Functional Description
From Tel Level	R51	____ o'clock	TELCO to M49 Audio Level
To Tel Level	R52	____ o'clock	M49 to TELCO Audio Level
PH Audio	R53	____ o'clock	Alert Tone to TELCO Level
RX Audio Level	R54	____ o'clock	Disc Input from Repeater
Internal Squelch	R55	____ o'clock	M49 Squelch Adjustment
TX Tone Level	R56	____ o'clock	Alert Tone to Mobile Level
TX Audio Level	R57	____ o'clock	M49 to Repeater Audio Level
TX Data Level	R59	____ o'clock	M49 to Repeater Data Level

Pot Settings on E-E Full Duplex Interconnect Card:

Pot Name	Label	Setting	Functional Description
Balance Low	R11	____ o'clock	600 Hz Adjust
Balance Med	R10	____ o'clock	1.0 KHz Adjust
Balance Hi	R9	____ o'clock	2.5 KHz Adjust

Pot Settings on DID Interconnect Card:

Pot Name	Label	Setting	Functional Description
Balance R	R33	____ o'clock	Adjust Line Resistance
Balance C	R34	____ o'clock	Adjust Line Reactance

Pot Settings on E&M 4W Interconnect Card:

No adjustments located on this card for Model 49 Revision S+ versions.

LTR SITE CONFIGURATION WORKSHEET

Use this page to record details about your LTR site configuration.

Repeater Bus

___ EFJ Bus ___ Uniden Bus

Sync master is channel ____ Termination resistor is on channel ____

Validation is Zetron channel ____ or Other unit brand/model _____

Repeater numbers are set on dip switches in each logic unit ___

System is set for area: ___ 0 ___ 1

Subscriber Bus

Poll master is channel ____ Termination resistor is on channel ____

Air Time Billing

___ ZEBRA ___ Uniden ARX-850 ___ Radio-Pac _____ Other

Other Options

Morse ID is generated by channel _____
Other equipment installed _____

Repeater Channels

Repeater Number	Repeater RF Brand/Model	Logic Unit Brand/Model	Interconnect Brand/Model	Air time Accumulation
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

5. GENERAL HARDWARE INFORMATION

5. GENERAL HARDWARE INFORMATION

SOFTWARE UPDATE

> **CAUTION**
> If you have more than one Model 49, you must update all of your units to the same revision of main software (U29, U31 chips) so that the units are compatible with one another.

When a factory update is shipped for installation into the Model 49, new software chips that contain the operating software may have to be changed. The software is generally contained in two chips with 28 pins to be plugged into sockets U29 and U31 for dispatch or interconnected units.

Update packages from Zetron include detailed procedures for installation. Please use them first, since they may be more specific than those contained in this section. The instructions provided in this section are back-up procedures in the event that an update package was not provided with your package. Please notify Zetron if you did NOT receive an update package. Call the Mobile Systems Division customer support personnel at (206) 820-6363 (8 a.m. - 5 p.m. PST/PDT).

If you are not installing any new options, but merely updating the firmware EPROMs (U29, U31), follow the "Simple Update Installation" procedure on page 5-3.

Upgrades from firmware versions 4+ to versions 6+, or any upgrades involving more than just the EPROMs (U29, U31) must follow the "Full Update Installation" procedure detailed later in this section.

Usually, updates also entail replacement of Multibase with a newer version. Refer to *Model 49 Multibase Operation Manual* (Part No. 025-9173) or to *Model 49 Multibase, Version 6.1 or Above Operation Manual* (Part No. 025-9297).

The label on your software PROMs contain important information and is similar to Figure 5-1.

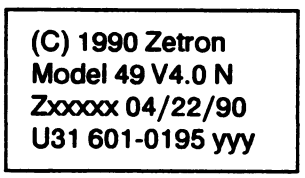


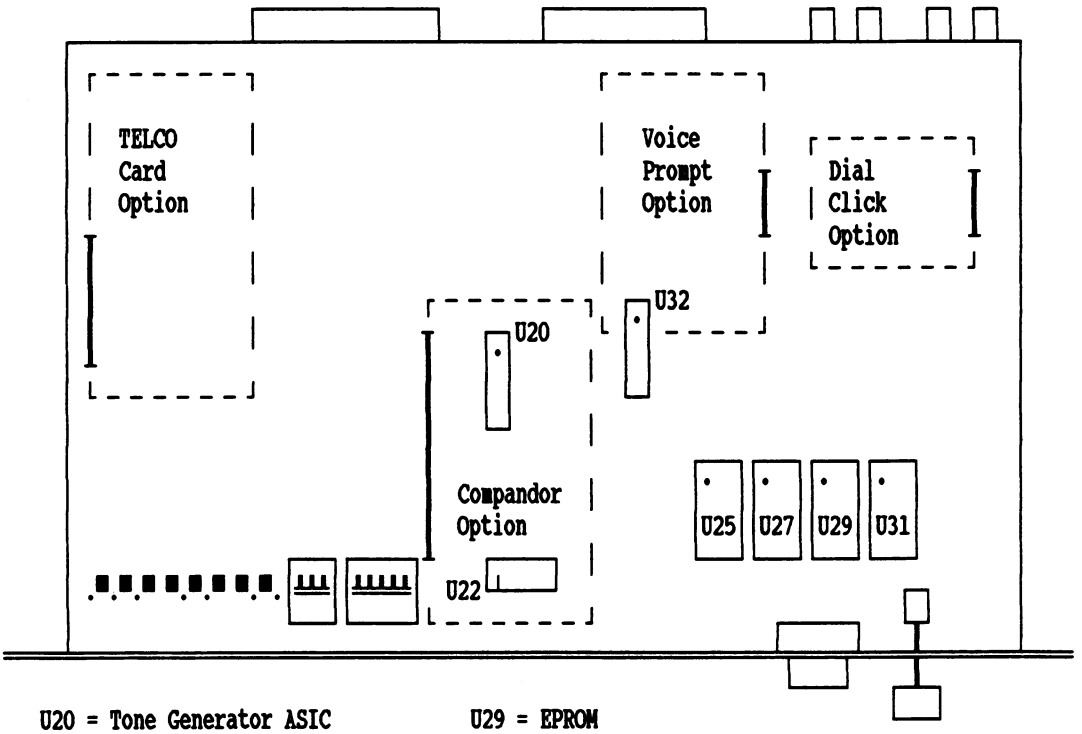
Figure 5-1. Sample Software PROM Label

The software version number is the "4.0" following the letter "V". The last character on the line determines compatibility with the revision of main board hardware (702-9202.1). "H" PROMs are used for all Model 49 Rev H and later hardware.

The "xxxxx" is your sales order number and should match the PROM that you are removing from the unit. The last line reminds you that the chip goes into socket location U31 or U29 and contains options "yyy". These options are:

DIS=dispatch with CW ID
INT=interconnect which includes CW ID
SDR=interconnect with SMDR call detail buffer and CW ID

Some field installed options, such as the interconnect and SMDR options, require a larger RAM chip as well as a PROM chip. The RAM chip that requires replacement may contain information that you want to save, such as air time totals or repeater loading. Before replacing a RAM chip, be sure you have used Multibase to retrieve all of the data you want to save. Then you can proceed with the update. Critical IC locations are shown in Figure 5-2.



U20 = Tone Generator ASIC
U22 = MF Decoder
U25 = RAM + Battery Socket
U27 = RAM + Battery Socket + Clock
U29 = EPROM
U31 = EPROM
U32 = LTR Protocol ASIC

Figure 5-2. Physical Location of RAM and PROM Chips

HINT
Read all of the following instructions and call Zetron for any necessary clarification before starting your update.

If the battery sockets have been inadvertently removed from the Main Board sockets XU25 and XU27 during an upgrade, they *absolutely must* be returned to their respective sockets. Reversing these will cause loss of clock function in the Model 49, and subsequent clock-related errors will occur.

The U25 Battery Socket contains an 8-pin IC, visible only when the RAM is carefully removed, causing a total loss of RAM data memory.

The U27 Battery Socket contains a 16-pin IC, visible only when the RAM is carefully removed, causing a total loss of RAM data memory.

SIMPLE UPDATE INSTALLATION

> CAUTION
> If 1) you are installing new option cards, 2) your update requires a new Multibase, or 3) you are upgrading main software from version 4.x to version 6.x, refer to the Full Update Installation instructions.
>
> Your Air Time Accumulation and Call Detail Buffer will be erased inside the Model 49s.

[]1. Disconnect the Repeater Bus and Subscriber Bus cables from the back of the Model 49 you are to update.

[]2. Power off the unit and remove it from its installed location so you can work on it. Remove the top cover to expose the main circuit board.

[]3. Remove the old PROM U31 and replace it with the new one.
Remove the old PROM U29 and replace it with the new one.

Note: Be sure that the orientation notch on the new PROM matches the white ink outline on the circuit board.

[]4. Take some time to look carefully at all of the pins of the chip that you have installed. Be sure that all the pins are in their proper places, fully inserted, and not bent underneath.

[]5. Turn on the power and make sure that the front panel lights display in a normal manner.

[]6. Perform a Memory Hard Reset.

[]7. Reconnect the Repeater Bus and Subscriber Bus cables in the back.

[]8. In about 30 seconds, the POLL light on the Subscriber Master may pulse about once per second as it clones its new data into the Model 49. The full data cloning takes about 2 minutes -- be patient. Cloning may not be necessary.

[]9. Using your mobile or portable radio, make sure that the unit performs its trunking radio function.

[]10 Replace the top cover of the unit.

[]11 Return the old part to Zetron in protective packaging.

FULL UPDATE INSTALLATION

> CAUTION
> Use this procedure to retrieve the Model 49 RAM contents before doing your update. This will put your Air Time Accumulators, Call Detail Buffer, and Repeater Loading data into your office computer. In most applications this procedure is preferred.

[]1. Retrieve current air time totals, call detail records, and repeater loading data (if the information is important to you) using "Comm Retrieve" from Multibase on your office computer. Backup your data to floppy diskettes with the Backup menu item.

[]2. Install your new Multibase by running the INSTALL program on the floppy diskette from Zetron. It will ask you questions and guide you through the installation process. The installation will create backups of your old database data files in case you need them.

[]3. Run Multibase and fill in any fields that apply to your new option.

[]4. If you are going out to the site to install the chips and option cards into your units, have an assistant available at your office computer to load the new database settings into the site, or load the data from a portable computer which has been loaded with the new Multibase data. Remember to use the Zetron serial cable (not a standard RS-232 cable) for "local" interfacing from portable computers.

[]5. Install your new hardware as follows:

> CAUTION
> Be sure that the orientation notch on each integrated circuit matches the white ink outline on the circuit board.

[]a. Remove the old PROM U31 and replace it with the new one.
Remove the old PROM U29 and replace it with the new one.

[]b. If you received a card and a set of chips for the Interconnect option, install them as follows:

Chip Type	Location	Function
27C256	U29	Firmware EPROM
27C256	U31	Firmware EPROM
73K212	U21	Modem U21
75T204	U23	DTMF Decoder U23
ASIC	U20	Tone Generator U20
SG3524	U57	-48 V Regulator

[]c. If you received a set of chips for FASTNet compatibility or the Selective Calling option (V6+), which may include Ghost Repeater operation and/or Autopath, the upgrade includes three (or possibly four) IC chips per Model 49. These must be carefully installed as matched sets, so verify the Zetron order numbers and option byte numbers as matching prior to installation. The Multibase screen will indicate a mismatch of this type in two modes: (1) startup screen when Model 49 access is initially attained; (2) the Status Report will show a mismatch. Install the chips as follows:

Chip Type	Location	Function
27C256	U29	Software EPROM
27C256	U31	Software EPROM
ASIC	U20	Tone Gen ASIC
ASIC	U32	LTR ASIC

[]d. Take some time now to look carefully at all of the pins of the parts you have installed. Be sure that all the pins are in their proper places, fully inserted, and not bent underneath.

[]6. Disconnect the Repeater Bus and Subscriber Bus cables from all of the Model 49s.

[]7. Perform a Memory Hard Reset to <u>each</u> Model 49.

[]8. Reconnect the Repeater Bus and Subscriber Bus cables to all Model 49s and non-Zetron logic units.

[]9. Leave all of the Zetron units (Model 42s, Model 49s, ARX800Bs) powered off, except the Subscriber Master Unit (the one with switch B:1 ON). Observe the front panel lights. The POLL light should come on steadily, indicating that this unit is the Subscriber Master.

[]10 Power up the "Poll Master" Model 49 and do a Memory Soft Reset.

[]11 Have your assistant use Multibase to perform a Comm Update Entire Database to load the database settings into the master unit. Messages in the Status window on the office computer should show a successful update of that one channel.

[]12 After the update to the Subscriber Master, power up the other Zetron logic units. The POLL light on the Subscriber Master should pulse about once per second as it clones its new data into all of the Model 49s (this also includes Model 42s and ARX800Bs). The full data cloning takes about 2 minutes -- be patient.

If cloning does not work, double check the connections on all of your BNC cables running among the Repeater Buses and the Subscriber Buses. Also try cycling power off, then on, to the Subscriber Master Unit to make it locate all of the slave units and perform the data cloning.

[]13 Using your mobile or portable radio, make sure that the system performs its trunking radio function.

[]14 Return the old parts to Zetron in protective packaging.

INTERCONNECT OPTION

This option package provides interconnect service in the Model 49 between the radio repeater system and a telephone, RF, or microwave system. You can place calls from land line to mobile and/or mobile to land line. With Multibase, you designate which repeaters are capable of interconnect, whether incoming/outgoing/both calling is permitted, and which user IDs are allowed interconnect service.

> Note: You should enter all of your interconnected repeater channels into Multibase, whether they are Zetron, Johnson, or Uniden. Information about the repeaters is used by the Model 49 Intelligent Free Repeater Allocation software to provide the best chance of mobile users to get an interconnected channel when they want one.

Adding Interconnect to a Dispatch Unit

If you are adding the Interconnect Option to a Dispatch Model 49, you will be plugging an interface card into the Model 49, installing a kit of integrated circuits with a new operating software PROM chip, connecting your telco/microwave line, adjusting the telephone levels and hybrid balance, and setting up Multibase.

Install the kit of parts, following the instructions described earlier in this section entitled "New Option Installation Checklist". Then follow the steps in "Step 5: Setting Repeater Levels" in Section 4.

> Note: Don't forget to set up Multibase for interconnect before you attempt to make a test call.

Interconnect Setup
If your Model 49 came equipped from the Zetron factory with the Interconnect Option already installed, you will be connecting your telco/RF/microwave line, performing a full repeater setup including adjusting the telephone levels and hybrid balance, and setting up Multibase. There are detailed instructions in section 4 to help you install your interconnected Model 49 onto your repeater. Zetron applications engineers are also available.

> Note: Don't forget to set up Multibase for interconnect before you attempt to make a test call.

End-End Telco Interface Card
A 702-9667 End-End Telco Interface connects your Model 49 to a regular subscriber telco line. Each card has two audio level adjustments (to and from telco). The 702-9227 card has two hybrid balance adjustments, and the 702-9283 card has three adjustments.

To the rear of the telco interface card is a modular RJ-11C style telephone jack that carries all necessary signals for interfacing to a telephone or microwave system. See Figure 5-3 for connector pin out assignments.

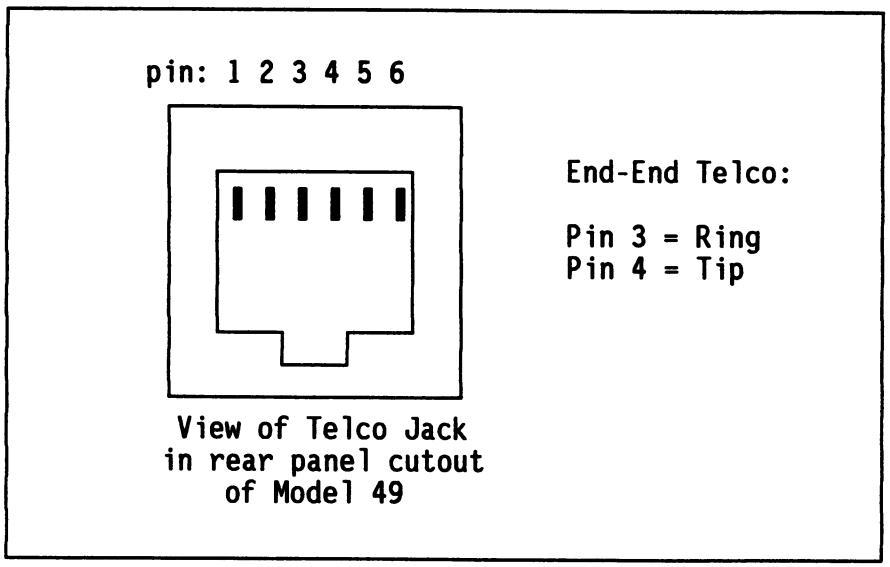


Figure 5-3. Pin out for End-End RJ11-C Telco Jack

Ask your telephone company whether your phone line uses "loop start" or "ground start" line supervision. Ground start supervision informs the Model 49 when the phone party disconnects, thereby speeding up call processing.

The 702-9283 card has a dual-transformer hybrid balance circuit with three adjustment pots and a coarse capacitor selection jumper. The best balance can be obtained by sending high, low, and mid-band test tones through the interconnect while adjusting the three balance pots. In most circumstances, JP1 on the 702-9283 card will have little effect upon the balance.

For ground start lines, it is necessary to cut the trace going from pin-4 of K2 to ground and install a 470-ohm resistor there.

DID Telco Interface Card

A 702-9446 Selector Level/DID Telco Interface card connects your Model 49 to a central or tandem office selector level telco line. The card has two adjustments for hybrid balance and two audio level pots (to and from telco). The telco interface connector and connections are shown in Figure 5-4.

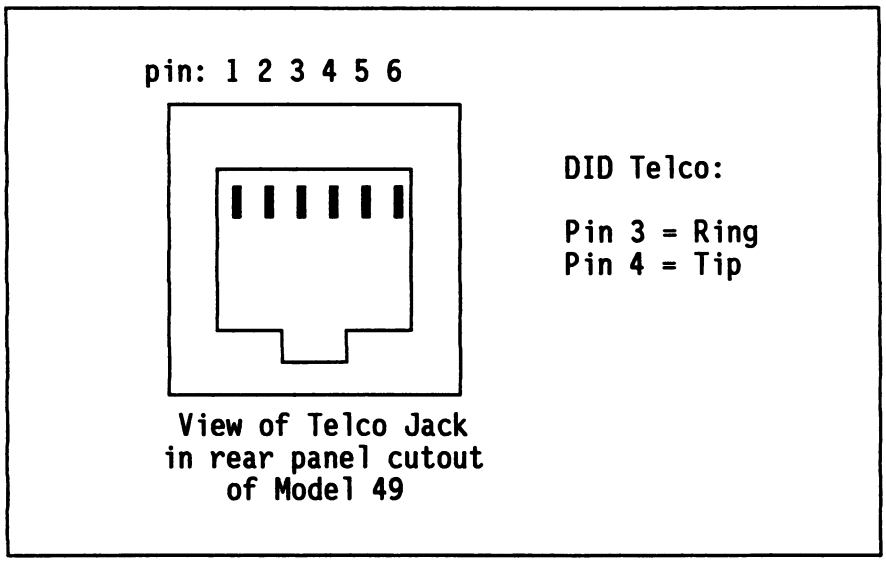


Figure 5-4. Pin out for DID RJ11-C Telco Jack

Connection to the telephone system follows standardized practices. The Model 49 provides a chassis ground referenced -48 volt power supply across the tip/ring telephone wire pair. When the Model 49 is idle, -48 appears on the Ring lead with ground on Tip. When the Model 49 answers a call, -48 appears on the Tip lead with ground on Ring. You can adjust the Model 49's -48V supply with the pot on the motherboard underneath the telephone interface card. There are no jumpers to set on the DID card.

Ask your telephone company for the following information and make sure to program the Rptr Config Interconnect settings in Multibase with this information:

1. Line Supervision: __Immediate Dial (Pulse) __ Wink Start (DTMF)
2. Feed Digits: __Two __Three __Four

An easy way to test your DID equipped Model 49 is to plug an ordinary telephone right into the modular connector on the back. You can pick up the receiver, dial in the feed digits, and speak to a mobile radio.

> Note: If DID works with a phone set but does not seem to work correctly when connected to the telco line, 1) make sure you have a DID trunk from the phone company and 2) try reversing the Tip and Ring wires.

E&M 4-Wire Telco Interface Card
A 702-9445 E&M Telco Interface card connects your Model 49 to an RF, microwave or leased telephone line that carries two wire pairs (4 wires) for audio and one pair for call supervision (E-lead and M-lead). The card has two adjustments for audio level (to and from telco). Telco pin-out and connector layout is shown in Figure 5-5.

The audio on each tip-ring wire pair is balanced using transformer isolation to and from the interface connector:

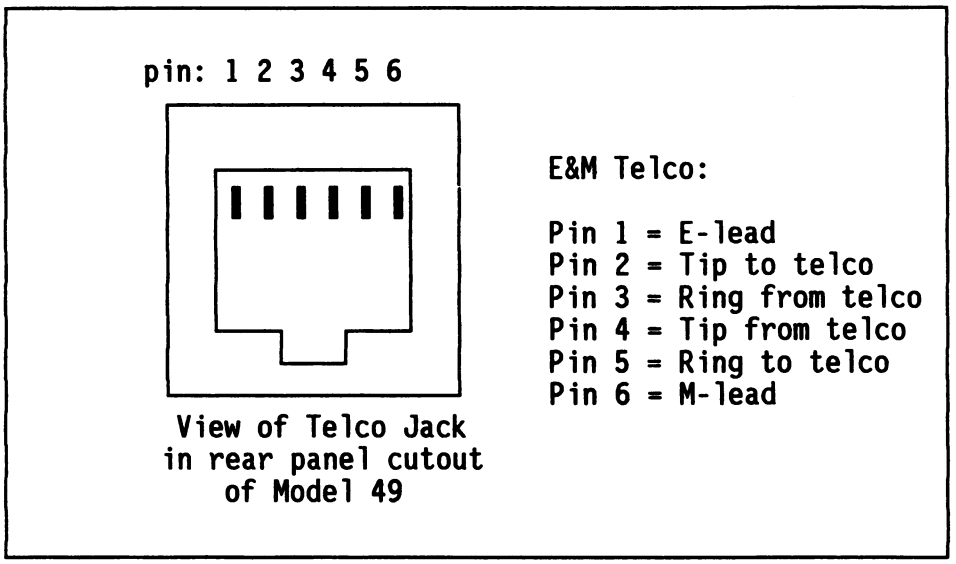


Figure 5-5. Pin out for E&M RJ11-C Telco Jack

The jumper settings on the card give you flexibility in connecting the card to Bell Standard Type I or Type V E&M trunks:

JP1 selects the supervision leads (E or M) for sense and control
A = E is sense, M is control
B = M is sense, E is control

JP2 selects the control relay contacts for normally open or normally closed
A = control relay is normally open (N.O.)
B = control relay is normally closed (N.C.)

JP3 sets the sense lead to see ground or minus voltage as "off-hook" incoming
A = minus voltage from telco means "off-hook"
B = ground from telco means "off-hook"

JP4 sets the control lead to assert ground or -48V as "off-hook" for outgoing
A = ground to telco means "off-hook"
B = -48V to telco means "off-hook"

Note: You can adjust the Model 49's -48V supply with the pot on the motherboard underneath the telephone interface card.

For revision B E&M 4-Wire Telco cards there are two additional jumpers plus an added position "C" at jumper JP3. These enhancements have been added to facilitate microwave level signaling through this card. There are also in-line fuses added for TELCO regulatory compliance.

JP3C now provides an off-hook sense operation similar to JP3A, but functional at plus or minus 5 - 12 VDC signaling levels.

The jumper settings on the previous page plus the new additional jumper settings listed below apply to E&M 4-Wire Rev D boards.

JP3 sets the sense lead to see ground or minus voltage as "off-hook" incoming
A = minus voltage (-48V) from telco means "off-hook"
B = ground from telco means "off-hook"
C = plus or minus microwave voltage (5V - 12V) means "off-hook"

JP5 selects the FROM TEL audio level as "standard" (high) or "microwave" (low)
A = Standard From Tel audio levels (-10 dBm)
B = Microwave From Tel audio levels (-16 dBm max)

JP6 selects the TO TEL audio level as "standard" (low) or "microwave" (high)
A = Standard To Tel audio levels (0 dBm max)
B = Microwave To Tel audio levels (+7 dBm max)

TEST MODE

Various test modes can be enabled in the Model 49 using the front panel dip switches A:1 and A:2. The different test modes are as follows:

Switch A:1 up, A:2 down. The Model 49 will continuously transmit the test ID code that has been programmed in the Multibase Repeater Configuration screen and send "ringing tones" out the transmitter.

If an interconnect call is made into the Model 49, the Model 49 will answer and continuously send one of three tones to the phone. To change the tone being sent, press the front panel CONNECT/DISCONNECT button; each time the button is pressed a new tone is selected. If the button is pressed 4 or more times in a 2-second period the Model 49 will reset. The available tones are at a frequency of 400, 1000 and 2500 Hz.

FRONT PANEL LIGHTS

Main Board Lights
These lights are labeled on the front panel.

POLL Indicates polling activity on the Zetron Subscriber Bus between Model 49s. If the Model 49 has been designated as the Master (switch B:1 Up), then the POLL light will be ON steady. The poll light on the slave units (switch B:1 Down) will flash when polled by the master unit.

During database cloning, the POLL light will flash briefly about once per second. Cloning of the full database takes approximately 2 minutes. If a POLL light is not lit, check cabling on both buses for continuity and terminating resistors.

SYNC This LED responds to the high-speed Repeater Bus and indicates sync activity. If the Model 49 has been designated as the Sync Master (switch B:2 Up), then the SYNC light indicates that sync is being generated. The SYNC lights on all of the slave units (switch B:2 Down) show that they are receiving sync from the master.

If a sync light is not lit, check the Repeater Bus cabling for a break in continuity or a missing bus terminating resistor. On E.F. Johnson logic, the sync light is labeled SYNC; on Uniden it's labeled RCD.

DIGIT When a DTMF digit is received from the mobile or telephone party, then this LED blinks. This LED is used only on Model 49s equipped with the interconnect option package.

MODEM When the Model 49's internal modem is in use this LED lights. This LED is used only on Model 49s equipped with the interconnect option.

TELCO When the telephone interconnect card is active this LED lights. This LED is used only on Model 49s equipped with the interconnect option.

ALARM This LED lights when an Alarm condition has been sensed.

CARRIER This LED lights when the Model 49 has detected RF carrier from the repeater. Also refer to jumper settings on JP12 and JP14.

TRANSMIT This LED lights when the Model 49 has activated PTT (push-to-talk) to put the repeater into transmit.

POWER This green LED lights when 12V power is present to the Model 49.

Main Board Lights Not Visible from the Front Panel
These are located under the Voice Prompts Card, if installed.

TX PACKET This LED lights when the Model 49 is transmitting LTR subaudible data packets to the LTR mobile through the repeater.

RX PACKET This LED lights when a sync code pattern is recognized in the received sub-audible data packet from the LTR mobile through the repeater. The light turns off at the end of a packet.

RX QUAL This LED lights when a legitimate sub-audible data packet is received from the LTR mobile through the repeater. This light turns off when a packet error is received or when the RF carrier drops.

Compandor Card Lights
Two LEDs are visible when the Model 49 top cover is removed.

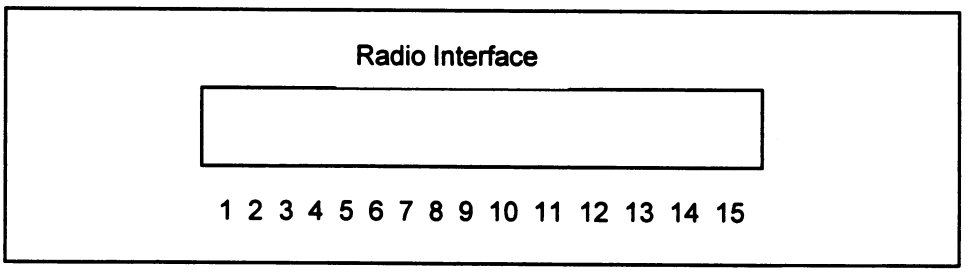
EXPAND This LED lights when the Model 49 is expanding the dynamic range of audio from the mobile radio to the telephone line. (receive expandor)

COMPRESS This LED lights when the Model 49 is compressing the dynamic range of audio from the telephone line to the mobile radio. (transmit compressor)

REPEATER CONNECTIONS

Use a shielded cable between the Model 49 rear panel terminal block labeled "Radio Interface" and your radio repeater equipment. This terminal block is detachable, so you or Zetron can pre-wire cables for fast installation and service.

Figure 5-6 shows the signals available at the Model 49's radio connector.



1=AC/+12V	4=GND	7=PTT NO	10=COR	13=SUB OUT
2=AC	5=PTT NC	8=CTL 1	11=TX OUT	14=GND
3=DC GND	6=PTT COM	9=SENSE 1	12=GND	15=DISC IN

Figure 5-6. Model 49 Rear Panel Radio Connector

AC/DC Power — Apply 10.5 to 14 VAC between pins 1 and 2 *or*
Apply 12 to 15 VDC between pins 1 and 3

PTT Relay — Obtain contact closure on pin 6 to key the transmitter. Connect lead to pin 5 or 7. The relay life is about 7 years when the idle packet timer is set for every 10 seconds in Multibase. If you wish to use open collector transistor PTT drive, solder a wire jumper in position JP8 (near K1) on the Model 49 main board and remove relay K1. PTT signaling will be found on the Radio Interface connection at pin 6 (PTT COM). Pin 6 will go to ground when PTT is active.

Caution: If the Model 49 is turned off or power to it fails and the repeater is left on, pin 6 will go to ground, which will key the repeater until the Model 49 is turned back on or until the repeater is turned off.

CTL1 — Used when the Model 49 is sharing the repeater with another controller.

SENSE 1 — Used when the Model 49 is sharing the repeater with another controller.

COR — Carrier Operated Relay input. Apply carrier indication from the receiver, if available, to pin 10. The double jumpers of JP12 in positions B selects negative polarity receiver COR, and in position C selects positive polarity receiver COR. The front panel COR control sets voltage threshold. (We recommend that you use the Model 49 noise squelch circuit: set JP12 = A (ISQ), pin 10 is ignored, set the COR pot to 12 o'clock, and adjust the front panel squelch level while no receive signals are present).

TX OUT Pin 11 is transmit audio from the Model 49 to the repeater exciter. Set jumper JP10 for coarse level (A=high, B=low), and adjust front panel pot for fine level. Set jumper JP13 for repeat audio filtering (A=direct, B=300 Hz hi-pass filtering)

SUB OUT Pin 13 is sub-audible transmit data from the Model 49 to the repeater exciter. Inject this 10 Hz to 150 Hz signal into the DPL/DCG input on your transmitter. Adjust the TX Data level as described in Section 4, "Step 5: Setting Repeater Levels".

Note: Make sure your transmitter can handle low frequency DPL data!

DISC IN Apply audio from the repeater receiver to pin 15. The signal's bandwidth should be 10 Hz to 10 kHz, containing high frequency noise, voice audio, and sub-audible data. Set jumper JP9 for coarse level (A=20, B=0), and adjust front panel pot for fine level. Set jumper JP1 for receive audio flatness (A=flat, B=deemphasis for discriminator). Adjust RX Audio level and RX Data level on the Main Card as described in Section 4, "Step 5: Setting Repeater Levels".

Note: Use discriminator audio from the receiver's 2nd IF, ahead of any squelch or filter circuitry.

Shield Ground your cable shield at only one end, preferably the Model 49 end.

Ground Do not rely on the cable shield to carry ground. Use pin 3 for power ground, pin 4 for PTT return (except when configured to operate with SEA 220 MHz repeaters, then use pin 3), and pins 12 and 14 for any twisted ground signals. Do not combine high PTT keying current inputs onto the same ground wire as your low level audio or data signals.

Note: Repeater cables are available from Zetron for popular repeaters (contact a sales engineer).

REPEATER TIMING

There are two important settings in the Site Config and Repeater Config databases that relate to operational timing settings for your repeaters. You need to make sure that these settings are correct for your system, otherwise you will experience problems such as mobiles failing to access the system, audio squelch tail, dropped calls, etc.

Zetron engineers could probably have made these values fixed, but that might not have worked with every repeater. The settings of concern are shown below along with the Zetron recommended values:

Keyup Delay	0.02 sec (Repeater Config)
COR Hold Time	0.30 sec (Site Config)

Keyup Delay
The Keyup Delay is the time from the Model 49 closing the PTT relay to transmit, until it begins sending LTR data packets to the mobile. Any repeater suitable for trunking must be able to come to full power in less than .1 sec (100 milliseconds). This is necessary for the fast LTR handshaking that occurs each time a mobile user presses PTT. Due to software processing delays, the Model 49 adds about .01 to .02 sec (10 to 20 milliseconds) to the value programmed in Multibase. The recommended total delay becomes about 35 milliseconds. Lengthen this time if you are sure that your repeater is slow. If you make it too long or too short, however, mobiles will not "get in" on the first try.

COR Hold Time
The COR (carrier squelch) Hold Time is the time from the Model 49 losing mobile carrier, until the Model 49 considers that the mobile is done transmitting. This time is used by the Model 49 whenever the mobile RF signal fades without a normal "turn off" packet. If the RF carrier fades and then returns in less than the COR Hold Time, then the mobile call continues normally.

If you make this time too long, then you will hear a squelch tail from the mobile when the signal is weak and the Model 49 misses the "turn off" packet. If you think the Model 49 is missing too many turn-off packets, check the adjustment of the SQUELCH and COR pots and settings of jumper JP12.

COR Mute Time
This carrier squelch Mute Time is the time from the Model 49 losing mobile carrier, until the Model 49 mutes audio. This applies to dispatch operation only.

This time is fixed at .1 sec (100 milliseconds). If mobile carrier fades and comes back within this time period (for example due to RF multi-path) the Model 49 keeps the audio path active continuously, without introducing picket-fencing.

Packet Loss Time
This is the time from the Model 49 losing valid data packets from the mobile it was receiving, until the Model 49 drops the mobile call. RF fade, skip, or interference from other trunking system mobiles can cause loss of receive packets. (For example, other mobiles capture the LTR receiver) The packet loss time is set to a fixed 2 second value.

Repeater Hold Time
The Repeater Hold Time that appears in the Site Config database is useful, but not critical to system operation. The Repeater Hold Time keeps the repeater transmitter keyed after a dispatch mobile releases PTT. A value of 1 to 3 seconds can reduce thermal stresses on the RF power amp from keying up and down.

Repeater Timeout Timer
The Repeater Timeout that appears in the Site Config database is useful, but not critical to system operation. The Repeater Timeout causes a mobile to become invalid and mutes the audio if a dispatch mobile has stayed keyed continuously for too long.

ASSIGNING INTERCONNECT CHANNELS

Smart Free Channel Allocation

The Zetron Model 49, with compatible repeater bus circuitry, built-in interconnect, and smart database gives you flexibility in adding interconnect to your existing E.F. Johnson or Uniden LTR trunking system. You can place the Model 49s in any channel in your system; adding new ones or replacing existing ones. Where you place the Zetron units can improve the trunking efficiency of your system, as we explain.

EFJ systems operate best when you place all of your interconnected channels together, consecutively numbered. This is because EFJ systems "trunk up", that is, they send mobiles to the next "higher numbered" repeater when they are busy. Uniden systems give you a little more flexibility by allowing each interconnect to "point" to the next preferred channel for trunking, so you can trunk up, down, or spread out your interconnected channels.

Zetron's Intelligent Repeater Channel Allocation designates the next free repeater based upon whether the home channel is capable of handling outgoing interconnect (mobile to land line) calls. Since each Model 49 knows these channels from the information you have programmed into Multibase, it can point to another channel of like capability when it is busy.

Mobiles homed on outgoing interconnect channels will trunk to an interconnected channel as long as one is available. Similarly, mobiles homed to dispatch channels will not trunk to an interconnect channels until all of the dispatch-only channels are full. With mobiles homed on a Zetron Model 49, your users will make interconnect calls more easily, improving your system's grade of service.

To activate this feature, you simply fill in the capabilities of all of your trunking channels into the Multibase programming system in the Repeater Config database. The Model 49s then know where to trunk dispatch and interconnect home channel users.

All Zetron Channels

With Intelligent Repeater Channel Allocation, your Zetron units are smart and trunk efficiently, regardless of how you number them and regardless of which channels are dispatch-only or interconnected.

Johnson and Zetron Interconnect

Suppose you already have some interconnected channels from EFJ and are going to add in some new Zetron ones. You want to let your EFJ channels continue to "trunk up", so put your Zetron units just above your Johnson units. Mobiles homed on the Johnson interconnect channels will find more interconnects available and find it easier to get an interconnect. Mobiles homed on the new Zetron channels, won't trunk up; they will go directly to a free interconnect (Johnson or Zetron) as available.

Make sure that you program the Repeater Config information in Multibase with all of your Johnson channels so that the Zetron units know which channels are capable of outgoing interconnect.

Uniden and Zetron Interconnect
Suppose you already have some interconnected channels from Uniden and are going to add in some new Zetron ones. You want to let your Uniden channels continue to "trunk up or down", so put your Zetron units just above (if trunking up) or below (if trunking down) your Uniden units. Mobiles homed on the Uniden interconnect channels will find more interconnects available and find it easier to get an interconnect. Mobile homed on the new Zetron channels, won't trunk up or down; they will go directly to a free interconnect (Uniden or Zetron) as available.

Make sure that you program the Repeater Config information in Multibase with all of your Johnson channels so that the Zetron units know which channels are capable of outgoing interconnect.

Busy Mobile Handling
The Zetron Model 49 is smarter than the average interconnect. If a phone caller tries to reach a mobile who is already on another interconnect call, the Model 49 plays "busy tones" to the phone party. This saves air time and notifies the phone caller to try again later. Other interconnects are not as smart and waste billable air time by just "ringing" the mobile, who cannot receive the call anyway.

Zetron DID Interconnect
If you are going to put a Zetron DID-equipped Model 49 into your existing Johnson or Uniden system, you can do this without having to reprogram your mobiles, as long as the mobiles are equipped with System Scan. Since DID equipped Model 49s cannot not make outgoing calls, the mobiles should not be programmed to recognize a DID Model 49 channel as interconnected. However, if you have different home channel assignments in the mobile for dispatch IDs and interconnect IDs, the mobile user should use system scan to receive both types of calls.

A DID channel can handle land line to mobile interconnect calls as well as mobile to mobile dispatch calls. When a dispatch call is in progress and a land line caller comes in on the DID, the Model 49 gives ringing tones to the phone caller until the talking dispatch mobile releases PTT. Then, the Model 49 gives the channel to the DID caller, and the dispatch traffic gets trunked to another channel.

Phone callers will get through faster on the DID trunk if you do not home a lot of dispatch users on the DID Model 49. Dispatch traffic will start up on their own home channels first and tend to keep the DID channels more open. Regardless of the mobile's home channel, it can get sent to the DID Model 49 to receive a call, by the home/ID information put onto the repeater bus. You assign any DID number to any mobile ID in the Multibase User ID screen.

REPEATER SHARING

The Model 49 (with main software version 3.5 and later) can share the repeater with a Zetron conventional control terminal (Model 45B Z-Patch Interconnect or Model 48B Repeater Manager). You can thereby provide LTR and conventional operation, with some limitations, on the same repeater frequency at the same site.

First of all, your conventional mobiles must be equipped with "busy channel lockout". This provides the necessary privacy to which trunking customers are accustomed.

Second, separate telephone lines must be provided to the terminals (sharing of a common phone line between the terminals is not done; after all, when it rings, which one should answer?).

Third, conventional sub-audible digital channel guard (DCG/DPL) has not been tested for compatibility and may false the Model 49, making it think an LTR mobile is attempting access. Also, some CTCSS tones may also false some LTR data codes.

For mobile to mobile and mobile to land line calling, each terminal listens to the RX discriminator audio from the repeater's receiver. If an LTR mobile accesses the channel, the Model 49 decodes the LTR data packet and takes control of the channel by activating its CTL1 relay (closure to ground) and PTT relay (closure to ground). Conversely, if a conventional mobile accesses the channel with its CTCSS tone, the Model 45/48 decodes the tone and takes control of the channel by activating its PTT relay. When the channel is in use by one of the terminals, the other one ignores the RX discriminator input.

For land line to mobile calling, each control terminal watches its incoming telephone line. When a call arrives, and the radio channel is available, the respective terminal takes the radio channel by activating its relay outputs. If a phone call comes into either control terminal and the radio channel is already in use, the phone line will be answered (to check for access by a computer for database update, billing retrieval, or system monitoring). If the calling party is not a computer modem, then the caller is given "reorder" tones for a few seconds and the call is disconnected.

Figure 5-7 shows you how to wire a Zetron Model 49 to a Zetron Model 45 or 48. The RX discriminator audio, TX audio output, TX sub-audible output, and PTT transmitter keying are connected in pairs to the repeater. The adjustments of the TX output levels on the two control units is interdependent since each output places an electrical load on the other.

It will be necessary to apply the PTTs of the Model 49 and Models 45 and 48 into an 'OR' gate. The output of the 'OR' gate should go to the PTT of the repeater.

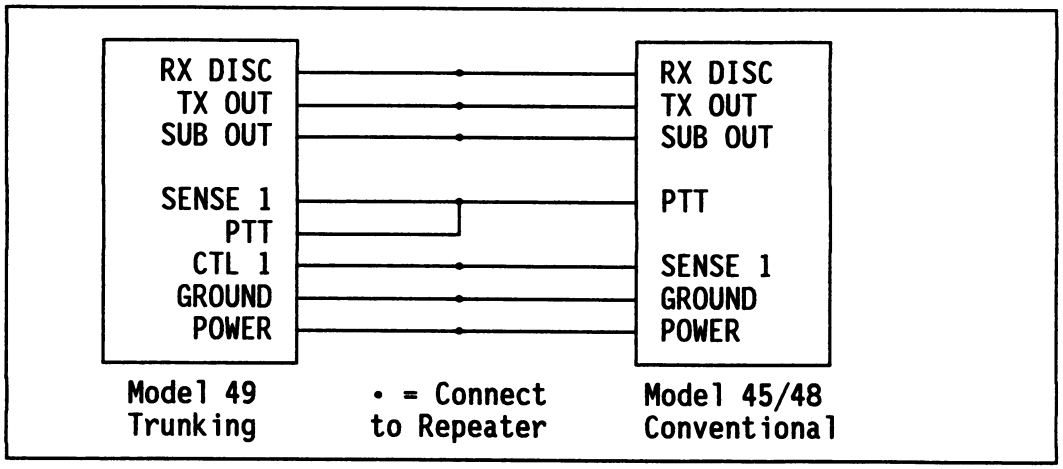


Figure 5-7. Model 49 to Model 45/48 Connection Diagram

To keep calls flowing smoothly, make sure to set the Repeater Hold Time on each control terminal to 2 to 5 seconds. Make this value long enough so that a pair of mobiles can have the channel for the duration of a "back and forth" dispatch call. You don't want the channel to drop and the other terminal to grab it between the PTTs of two mobile parties who are conversing.

If you have more than one repeater that you wish to share between Model 49s and conventional controllers, trunking becomes tricky. LTR mobiles that are homed on the Model 49s return there for trunking instructions. If the conventional controller has the channel tied up, the LTR mobiles are stuck and do not trunk. Therefore, to make trunking work, you need to home your LTR mobiles onto Model 49s that have free access to their repeaters (not shared). Other Model 49s can share repeaters and be used as "trunk to" channels; just don't home any mobiles there.

ALARM MONITORING

The Model 49 has 3 external alarm inputs (Sense 1, 2, & 3). These inputs are analog (or 5 volts). The inputs are protected by 6.2-volt Zener diodes.

If the alarm feature is enabled, the voltage reading that is obtained is compared against the ranges programmed in the repeater configuration. If the reading is outside the valid range, that alarm is set. The Model 49 also has relay outputs that can be used in conjunction with the alarms to turn on a fan, etc. If programmed correctly, when an alarm is set, an output relay will be set. These relays are identified as control 2, 3, & 4. These relays can be made either normally open (N.O.) or normally closed (N.C.)

The following jumper selections determine whether the control relay output is N.O. or N.C.:

	Position	
	A	B
CTL2 JP4	N.O.	N.C.
CTL3 JP5	N.O.	N.C.
CTL4 JP6	N.O.	N.C.

6. TELEPHONY SIGNALING

6. TELEPHONY SIGNALING

E-E LOOP START

Idle Condition
Looking toward the CO (central office) switch, the Ring lead is attached to the battery (-48 VDC) and the Tip to ground. Both Tip and Ring are open, looking toward the Model 49.

Outgoing Call
An outgoing call is originated when the Model 49 seizes the trunk by applying a loop closure across the tip-ring (T-R) leads, causing current to flow in the loop between the Model 49 and the CO. The CO senses the current flow and attaches a digit receiver to the circuit in preparation for receiving address information. Once the equipment is attached, the CO provides dial tone to the Model 49. The Model 49 then passes dial tone through to the mobile caller. The caller's dialed information gets regenerated after dial tone is detected or after the "Start Supervision Seek Time" has elapsed if no dial tone is detected.

Incoming Call
An incoming call from the CO is originated when the CO applies ringing voltage on the facility toward the Model 49, superimposed on the -48 VDC battery voltage. The ringing signal is 105V, 20 Hz, 2 sec on, 4 sec off.

The Model 49 detects the ringing voltage and answers the call by closing the loop. Upon sensing loop current, the CO disconnects the ringing generator and completes the call by establishing an audio path to the Model 49. At this time the Model 49 plays the go ahead prompt to the CO or landside user and waits for the over dial digits.

Call Disconnect
Either the calling or called party may disconnect the call by going on hook. However, a landside disconnect signal is not required to be relayed to the Model 49 by the CO under the loop signaling format. There is no change of state; Ring remains connected to battery, and Tip to ground. Special equipment must be available at the CO to send a disconnect signal. The COs that have this capability will give a battery reversal (i.e., place the battery on the Tip and ground on the Ring), which the Model 49 can detect and disconnect on.

The Model 49 will disconnect by going on hook or opening the loop toward the CO.

DIRECT INWARD DIALING

DID trunks allow a landside caller to directly dial a mobile served by a Model 49 without the necessity of the caller over dialing an ID. All calls over DID trunks originate from the switched public network and terminate at a Model 49; therefore, DID trunks are called "1-way incoming trunks".

Idle Condition
This is when both the Model 49 and the CO are on hook. In a DID configuration, the Model 49 looks like the CO and the CO looks like the phone; therefore, the Model 49 will place ground on the Tip and -48 VDC on the Ring and the CO will not allow loop current to flow.

The Call
A DID call is initiated when the landside calling party goes off hook and sends address digits to the originating CO. The call is routed through the public network to the terminating CO. Up to this point, the call is handled in the same manner as other calls placed over the public switched network.

The CO switch determines the trunk group (in this case, a DID trunk group) over which the call is to be completed to the customer's Model 49. In addition, the CO switch determines the number of extension digits that are to be transmitted to the Model 49, and whether to send these digits via MF or DTMF protocol. In general, the extension digits will consist of from two to four of the station digits. The station digits are the last four digits dialed by the calling party.

The CO seizes an idle circuit in the DID trunk group by going off hook or closing the loop.

For an Immediate Start Line: The CO will then send the feed digits some time later (a minimum of 150ms); therefore, the Model 49 must be ready to receive the digits very quickly. The Model 49 will translate those feed digits and start ringing the appropriate ID. When the call is answered, the Model 49 gives an answer supervision or reverse battery back to the CO. This reverse battery means that the Model 49 places -48 VDC on the Tip and ground on the Ring. The CO sees this and connects the audio through to both sides. Figure 6-1 illustrates the entire process.

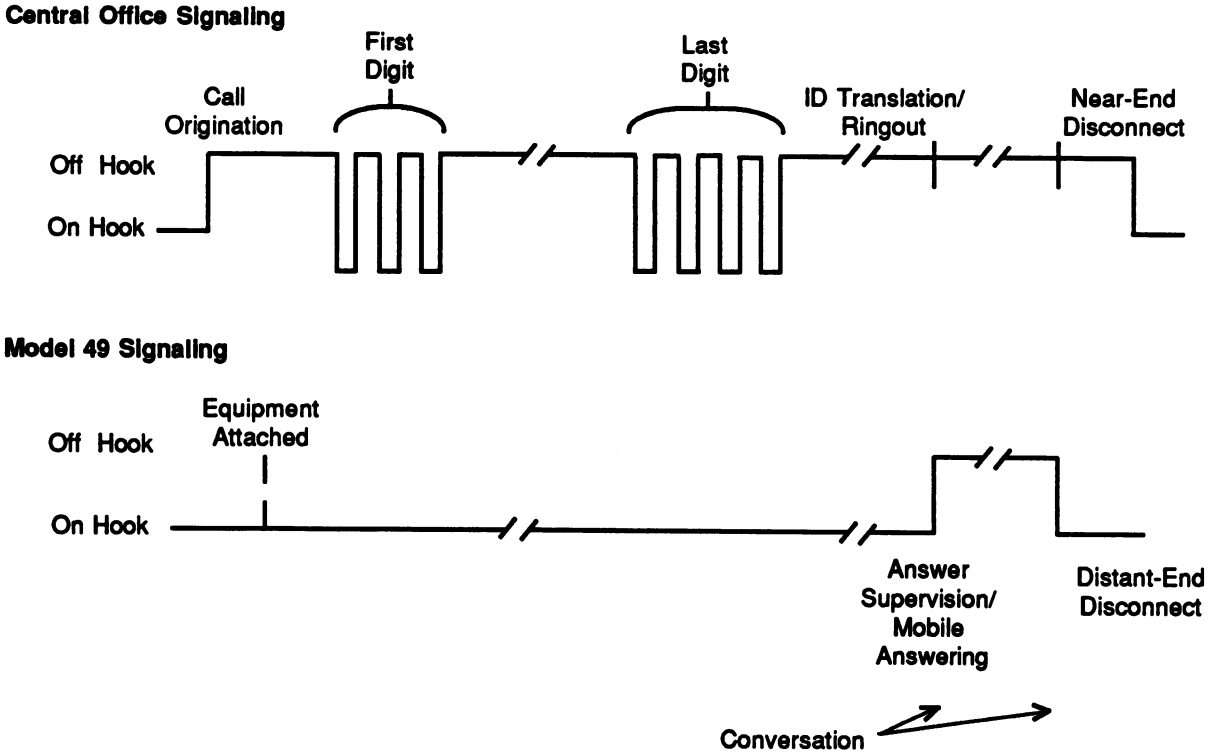


Figure 6-1. Immediate Start, Entire Call

For a Wink Start Line: When the Model 49 is ready to receive the extension digits, it sends out a "wink" in the form of a temporary battery reversal. This reverse battery means that the Model 49, momentarily, places -48 VDC on the Tip and ground on the Ring. This is the start dialing signal to the CO, which then sends the feed digits to the Model 49. The Model 49 will translate those feed digits and start ringing the appropriate ID. When the call is answered the Model 49 gives an answer supervision or reverse battery back to the CO. The CO sees this and connects the audio through to both sides. Figure 6-2 illustrates the entire process.

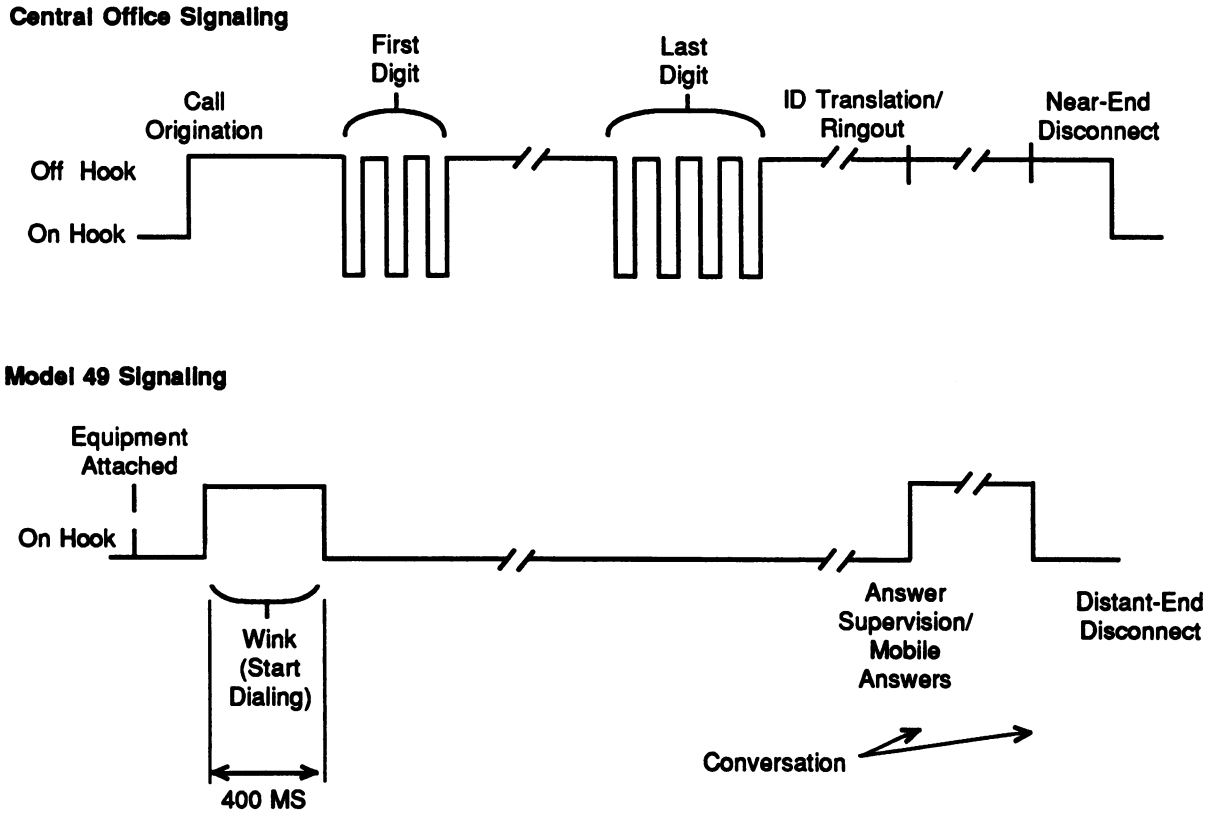


Figure 6-2. Wink Start, Entire Call

Call Disconnect

Either party may disconnect the call by going on hook. The CO does this by opening the loop causing current to quit flowing, which the Model 49 will see. The Model 49 will disconnect by going back on hook which the CO sees and opens the loop.

TYPE I FOUR-WIRE WITH E&M SIGNALING

Type I service is unique in that these trunks can be used to do DID calls and outbound calls. It also has improved audio for several reasons. Two hybrids are eliminated, signal levels are more tightly specified, and acceptable line losses are smaller.

Only two conditions are represented by E&M signaling, on hook and off hook. By convention, switching equipment, such as a PBX and the Model 49, transmits on its M lead (mouth) and receives on its E lead (ear).

The conventions used to represent on hook and off hook states for E&M Type I are summarized below.

State	From M49 to CO (M lead)	From CO to M49 (E lead)
on hook	Ground	Open
off hook	-48 VDC	Ground

For the proper signaling to take place an Inverted M Lead Protocol is used so that the M (mouth) lead signals the E (ear) lead, as shown in Figure 6-3.

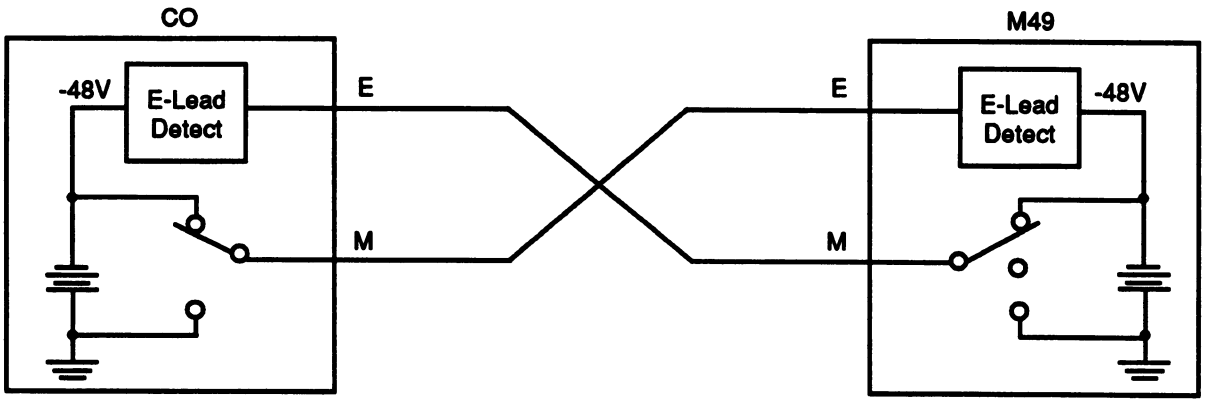


Figure 6-3. Inverted M Lead Protocol

Figure 6-4 shows the entire picture. The Tip1 and Ring1 leads are for audio from the CO to the Model 49, while the Tip2 and Ring2 leads are for audio from the Model 49 to the CO.

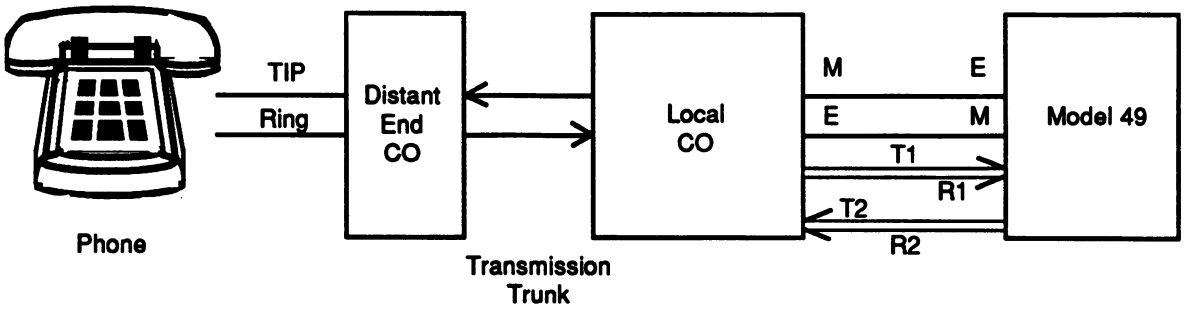


Figure 6-4. Type I Four-Wire with E&M Signaling

Idle Condition
Figure 6-5 illustrates the idle condition (on hook) for Type I E&M signaling between a Model 49 and telco interface equipment. To signal off hook to the telco equipment, the Model 49 switches its M lead from ground to -48 VDC. To signal to the Model 49 that the distant end has gone off hook, the telco equipment grounds the E lead.

Incoming DID Call
Either Immediate or Wink Start signaling can be used. With E&M four-wire, everything is identical to two-wire except the E and M leads do the signaling of the off hook and on hook conditions. This is illustrated in Figures 6-5 and 6-6.

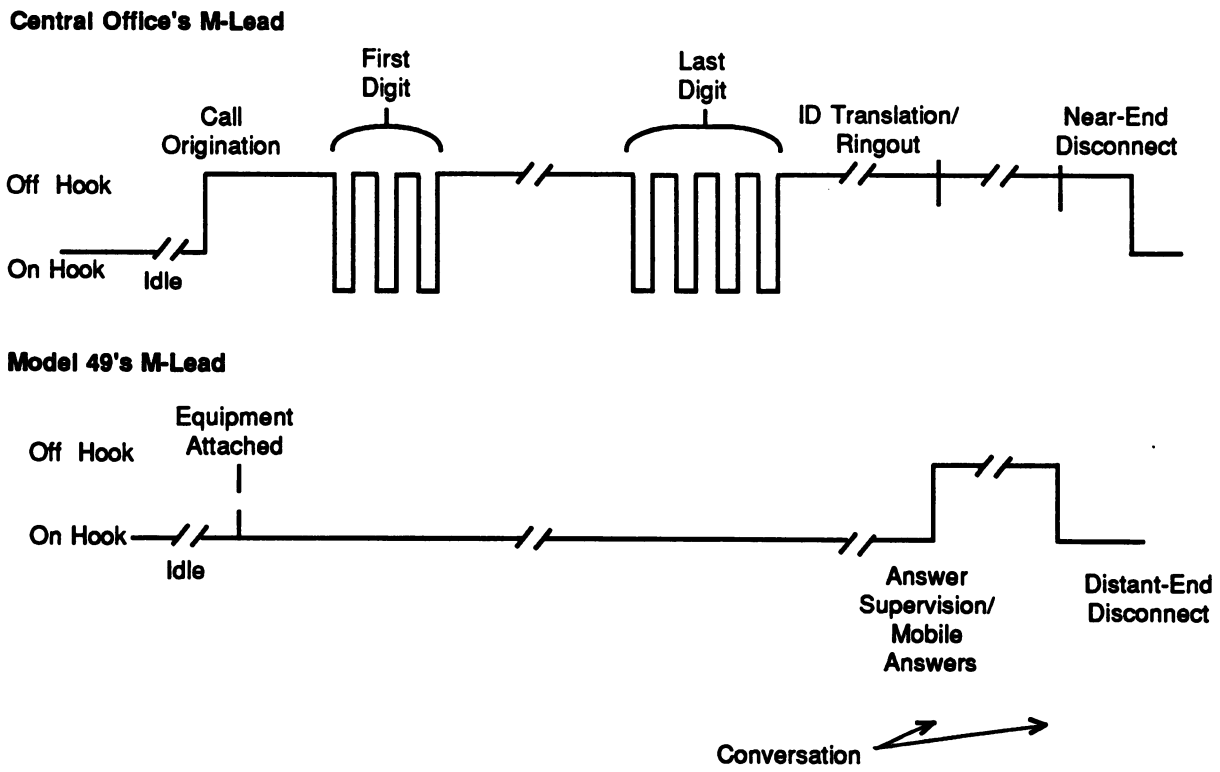


Figure 6-5. Immediate Start, Entire Call

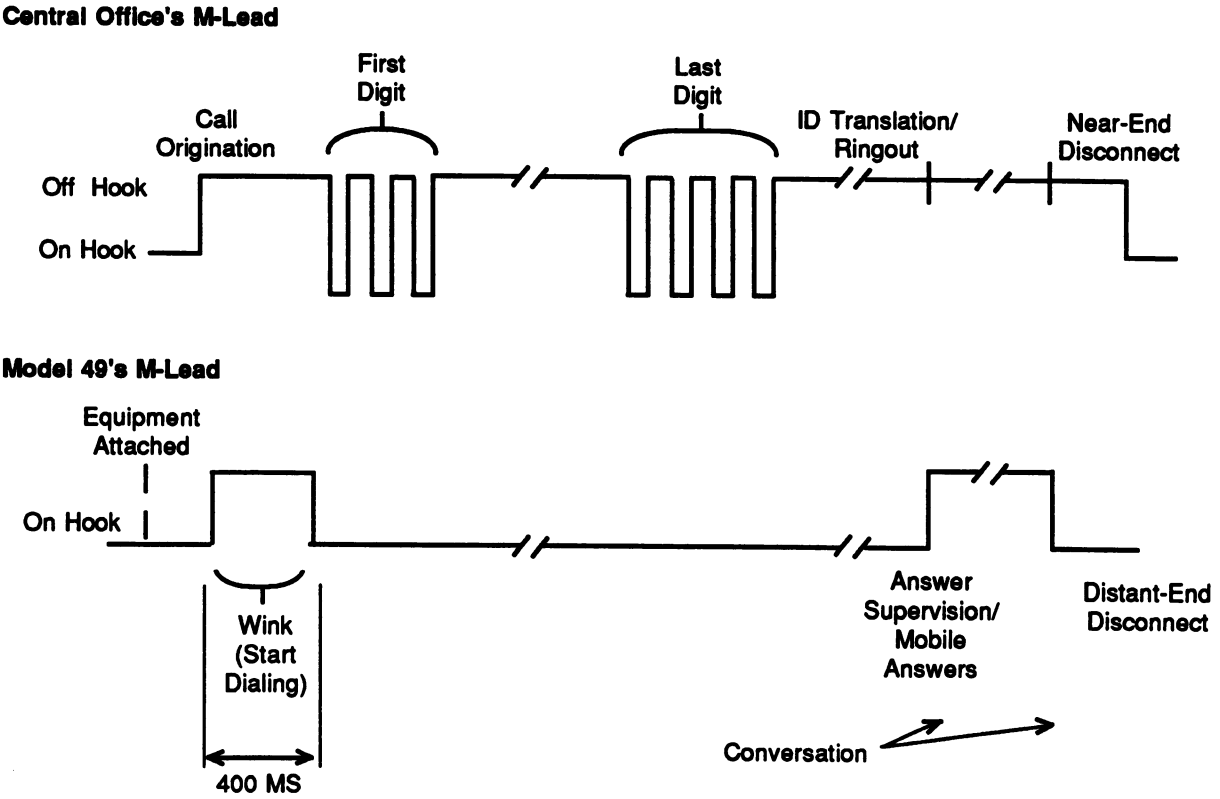


Figure 6-6. Wink Start, Entire Call

Outgoing Calls

An outgoing call is originated when the Model 49 seizes the trunk by going off hook with its M-lead. The CO sees this and attaches a digit receiver to the circuit in preparation for receiving address information. Once the equipment is attached, the CO provides dial tone to the Model 49. The Model 49 then passes dial tone through to the mobile caller. The callers dialed information gets regenerated after dial tone is detected or after the "Start Supervision Seek Time" has elapsed if no dial tone is detected.

Once the CO is done routing the call it will send ringback to the Model 49. And when the landside phone is answered and goes off hook an off hook condition is sent back to the Model 49. At this point the CO will connect the audio through in both directions and the call has been established. Either the Model 49 or the caller can disconnect the call by going on hook. When the caller goes on hook, the CO signals the Model 49 on the Model 49's E-lead by going on hook as well. Figure 6-7 illustrates this entire process.

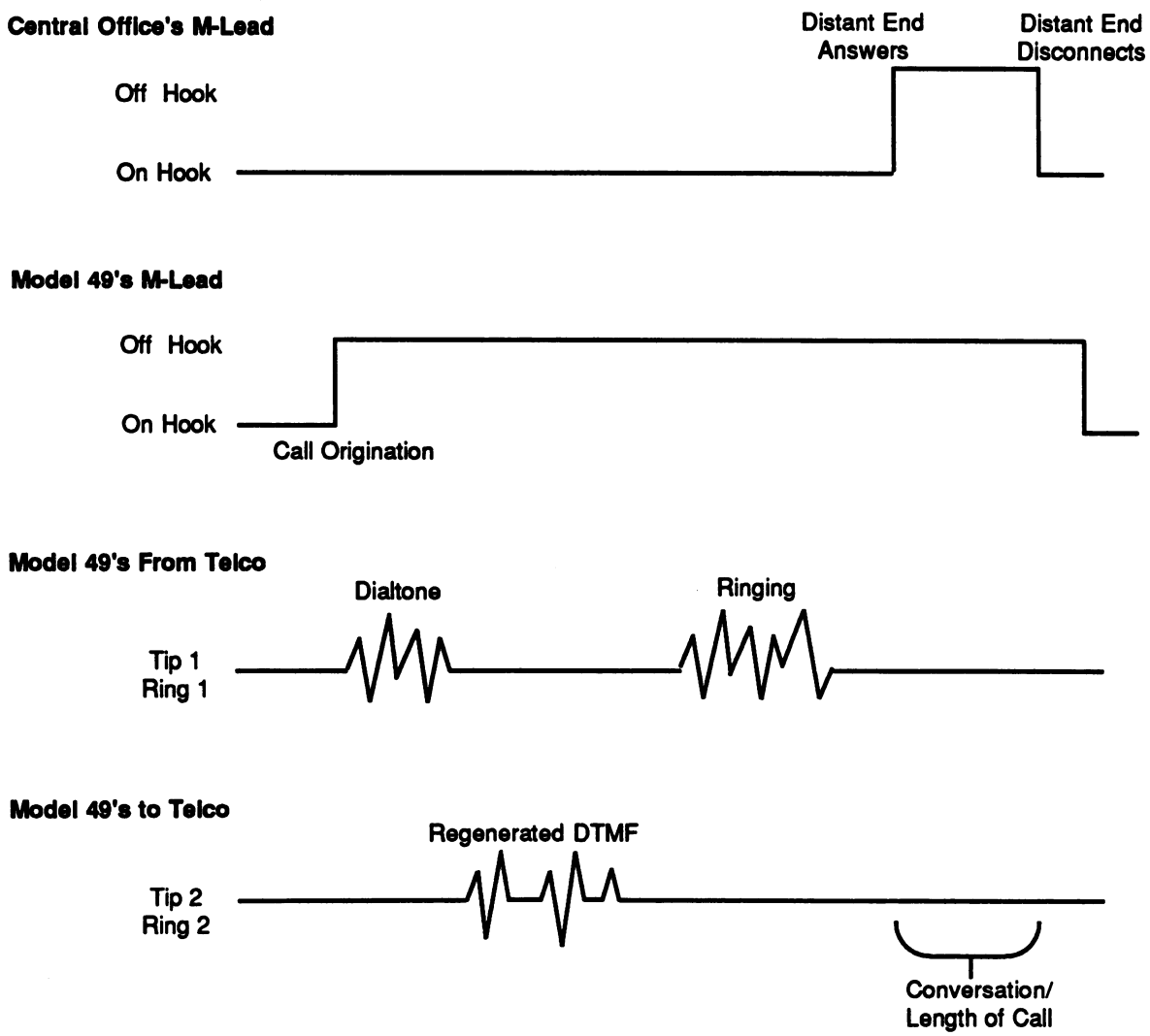


Figure 6-7. Outgoing Calls

DIRECT AUTONET

A direct Autonet setup has two Model 49s directly connected via RF link, microwave link, or leased line. These two Model 49s are located at different sites and can only process dispatch or direct Autonet or PTC calls. Each Model 49 must have an E&M telco card installed for Autonet calling.

Figure 6-8 shows the suggested wiring for a direct Autonet call.

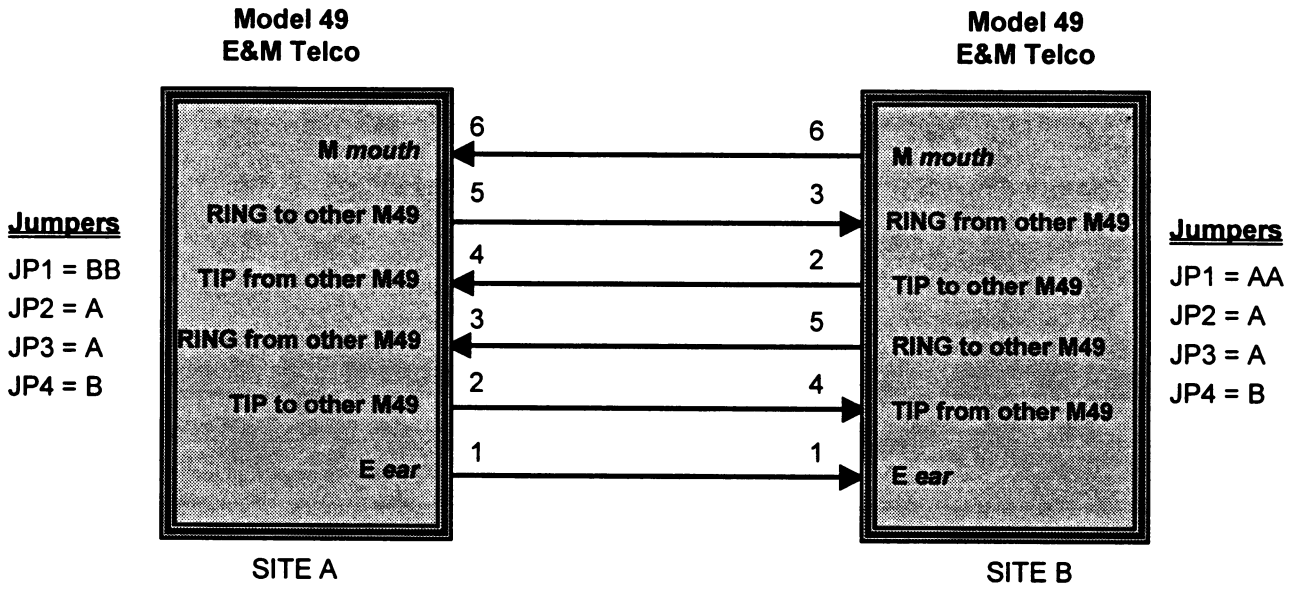


Figure 6-8. Direct Autonet Configuration

The following table shows the off hook and on hook conditions of the two Model 49s.

State	Site A Model 49	Site B Model 49
on hook	Open on E	Open on M
off hook	-48 V_{DC} on E	-48 V_{DC} on M

A call is initiated when the user keys up with an autonet or push-to-connect interconnect ID that is programmed for direct link. The calling Model 49 goes off hook. A short time later, the calling Model 49 sends the DTMF overdial. After the called Model 49 receives the DTMF overdial, it responds with a DTMF B9 to confirm that direct connect autonet is occurring.

After the B9, the off hook signal from each site becomes an indication that a mobile is keyed at the site. Conversely, the on hook condition does not end the call, instead it indicates no mobile is currently keyed at the site. The call is terminated by a long DTMF # or when the

turn around timer expires (no mobile keyed at *either* site for the number of seconds set for the turn around timer).

Figure 6-9 shows direct autonet calls.

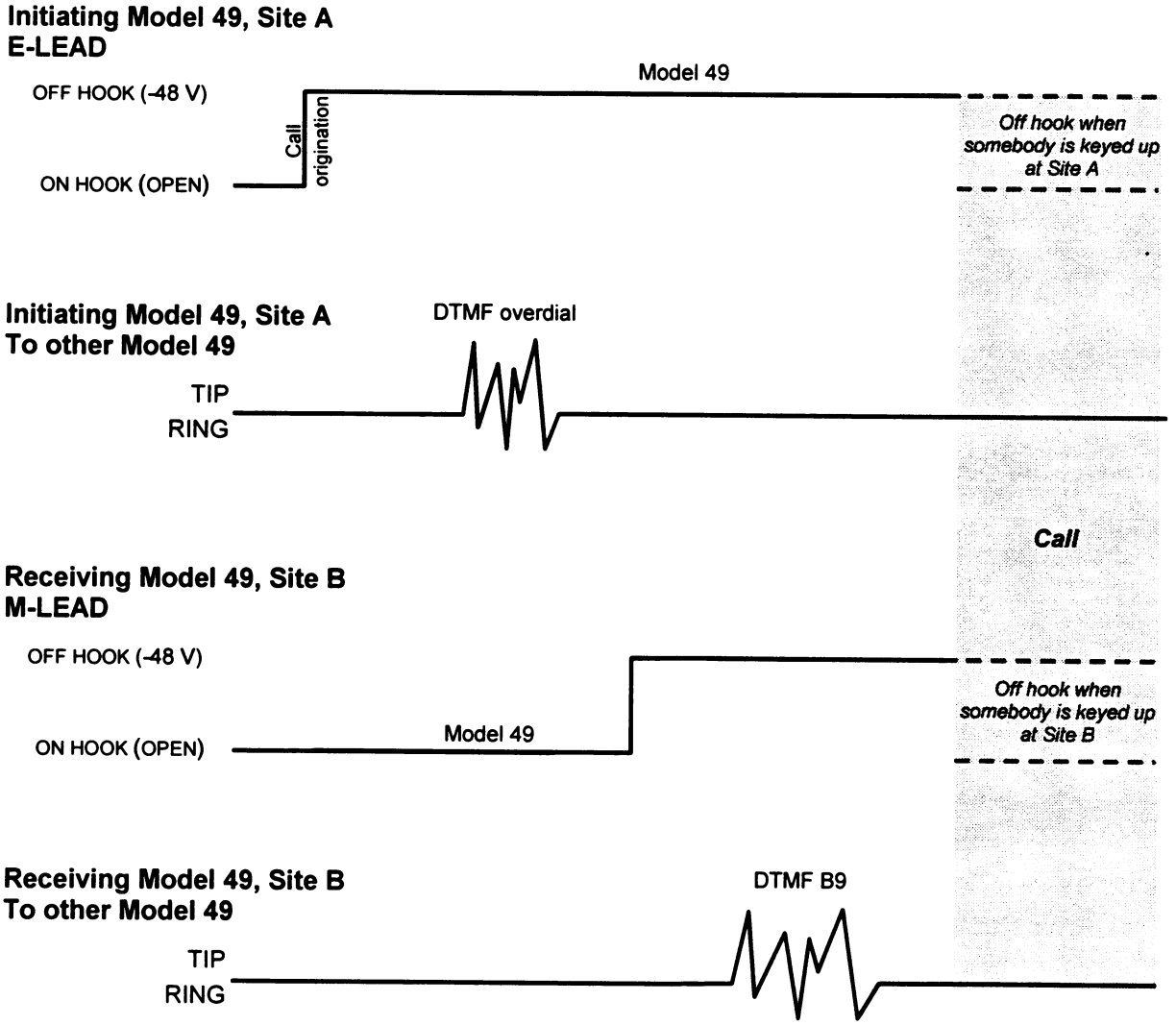
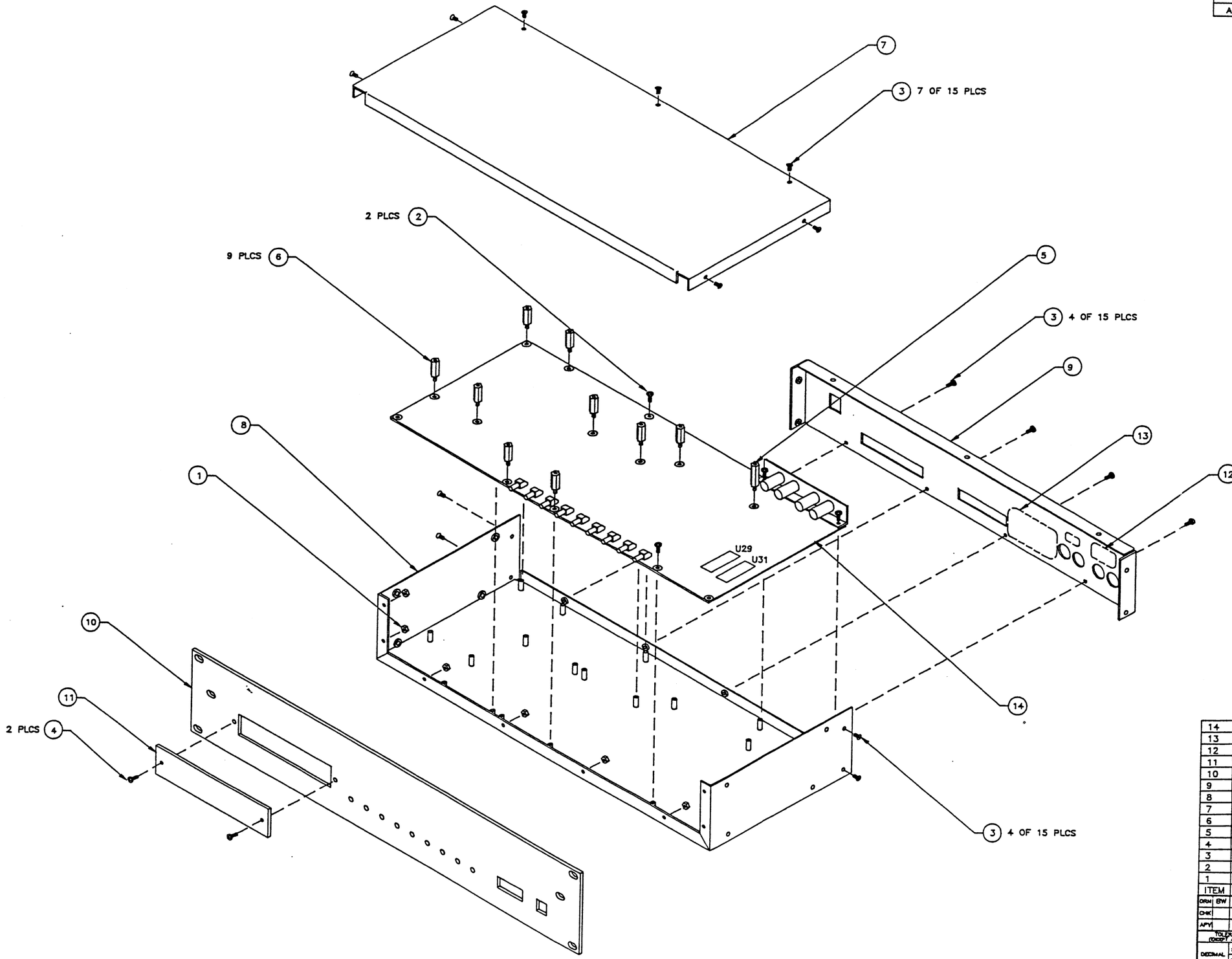


Figure 6-9. Autonet Call Sequence

7. REPAIR

REVISION	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
A	RELEASE	BW			8-2-95

NOTE: REFERENCE 901-9147



ITEM	QTY.	PART NUMBER	DESCRIPTION
14	1	702-9202	M49 CONTROL CARD
13	1	415-9669	SERIAL NUMBER DECAL
12	1	415-9643	ZETRON HOLOGRAM DECAL
11	1	415-9419	M49 LENS
10	1	415-9416-1	FRONT PANEL
9	1	415-9415-1	REAR PANEL
8	1	415-9414	BOTTOM CHASSIS
7	1	415-9413	TOP COVER
6	9	250-0105	440X5/8 STANDOFF W/STD
5	1	250-0104	440X1/2 STANDOFF W/STD
4	2	220-0213	440X3/8 SCREW BLACK
3	15	220-0212	440X3/8 FH PHILLIPS
2	2	220-0108	440X1/4 PAN PHILLIPS
1	8	210-0001	440 KEP NUT PLATED

DRN BW 8-2-95
CHK
APV
TOLERANCES (UNLESS OTHERWISE SPECIFIED)
DECIMAL ±.XX ±.01 ±.XXX ±.005
ANGULAR ∠ ± 1°

ZETRON

ZETRON INCORPORATED
12034 134TH COURT NORTHEAST
REDMOND, WASHINGTON 98052-2433

TITLE
MODEL 49
TRUNKING REPEATER MANAGER

SIZE D | DRAWING NUMBER 024-0183 | REV. A

SCALE: NONE | DO NOT SCALE DRAWING | SHEET 1 OF 1

Model 49 Interconnect Option 950-9167

ITEM	QTY	ZETRON P/N	DESCRIPTION	REFERENCE
1.	1	011-0086	INSTALLATION INSTRUCTIONS	
2.	1	316-7840	REGULATOR, SWITCHING	U1
3.	1	321-0204	DTMF RECEIVER	U21
4.	1	321-0222	5V 1200 BAUD SINGLE CHIP MODEM	U37
5.	1	322-7256	32Kx8 CMOS EPROM	NOTE 1
6.	1	709-7000	6 COND MODULAR CABLE 10'	

NOTES:

Notes are for production use only.

Model 49 SMDR Option 950-9168

ITEM	QTY	ZETRON P/N	DESCRIPTION	REFERENCE
1.	1	011-0086	INSTALLATION INSTRUCTIONS	

Model 49 Control Board 702-9202AB

LEGEND:
+ = OPTION, INSTALL PER CUSTOMER ORDER
# = NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY
= = SUBSTITUTE PART

Item	Qty	Reference	Part No.	Description	Part Value
1	1	R183	101-0033	RESISTOR,22 OHM,1/4W,5%,CARBON FILM	22
2	3	R107,R108,R109	101-0047	RESISTOR,47 OHM,1/4W,5%,CARBON FILM	47
3	6	R29,R88,R136,R173,R174, R187	101-0049	RESISTOR,100 OHM,1/4W,5%,CARBON FILM	100
4	3	R11,R3,R127	101-0057	RESISTOR,220 OHM,1/4W,5%,CARBON FILM	220
5	9	R140,R143,R149,R150,R155, R156,R157,R159,R162	101-0061	RESISTOR,330 OHM,1/4W,5%,CARBON FILM	330
6	1	R105	101-0065	RESISTOR,470 OHM,1/4W,5%,CARBON FILM	470
7	2	R106,R102	101-0066	RESISTOR,510 OHM,1/4W,5%,CARBON FILM	510
8	24	R10,R50,R61,R67,R72,R73, R76,R81,R85,R112,R122, R128,R139,R142,R153,R158, R166#,R170,R171,R177, R178,R179,R180,R184,R185	101-0073	RESISTOR,1.0K OHM,1/4W,5%,CARBON FILM	1.0K
9	1	R36	101-0074	RESISTOR,1.2K OHM,1/4W,5%,CARBON FILM	1.2K
10	4	R68,R77,R101,R121	101-0075	RESISTOR,1.5K OHM,1/4W,5%,CARBON FILM	1.5K
11	4	R42,R43,R115,R138	101-0081	RESISTOR,2.2K OHM,1/4W,5%,CARBON FILM	2.2K
12	1	R96	101-0083	RESISTOR,2.7K OHM,1/4W,5%,CARBON FILM	2.7K
13	1	R152	101-0084	RESISTOR,3.0K OHM,1/4W,5%,CARBON FILM	3.0K
14	6	R25,R62,R89,R120,R137, R147,R168#	101-0085	RESISTOR,3.3K OHM,1/4W,5%,CARBON FILM	3.3K
15	1	R86	101-0087	RESISTOR,3.9K OHM,1/4W,5%,CARBON FILM	3.9K
16	5	R12,R83,R97,R123,R165#, R181	101-0089	RESISTOR,4.7K OHM,1/4W,5%,CARBON FILM	4.7K
17	1	R35	101-0091	RESISTOR,5.6K OHM,1/4W,5%,CARBON FILM	5.6K
18	0	R26#	101-0092	RESISTOR,6.2K OHM,1/4W,5%,CARBON FILM	6.2K
19	1	R60	101-0093	RESISTOR,6.8K OHM,1/4W,5%,CARBON FILM	6.8K
20	9	R20,R38,R80,R103,R110, R118,R126,R134,R154#, R161	101-0097	RESISTOR,10K OHM,1/4W,5%,CARBON FILM	10K
21	7	R5,R15,R16,R17,R44,R47, R69	101-0101	RESISTOR,15K OHM,1/4W,5%,CARBON FILM	15K
22	1	R74	101-0103	RESISTOR,18K OHM,1/4W,5%,CARBON FILM	18K
23	1	R99	101-0104	RESISTOR,20K OHM,1/4W,5%,CARBON FILM	20K
24	8	R7,R8,R13,R23,R28,R30, R32,R119	101-0105	RESISTOR,22K OHM,1/4W,5%,CARBON FILM	22K
25	1	R98	101-0106	RESISTOR,24K OHM,1/4W,5%,CARBON FILM	24K
26	7	R1,R4,R14,R63,R66,R164#, R186,R34	101-0107	RESISTOR,27K OHM,1/4W,5%,CARBON FILM	27K
27	5	R9,R19,R45,R94,R100	101-0109	RESISTOR,33K OHM,1/4W,5%,CARBON FILM	33K
28	1	R75	101-0111	RESISTOR,39K OHM,1/4W,5%,CARBON FILM	39K
29	14	R21,R48,R79,R82,R84,R91, R92,R93,R113,R114,R124, R125,R176,R188	101-0113	RESISTOR,47K OHM,1/4W,5%,CARBON FILM	47K
30	4	R2,R3,R64,R65	101-0114	RESISTOR,51K OHM,1/4W,5%,CARBON FILM	51K
31	5	R6,R33,R46,R95,R104	101-0115	RESISTOR,56K OHM,1/4W,5%,CARBON FILM	56K
32	1	R78	101-0118	RESISTOR,75K OHM,1/4W,5%,CARBON FILM	75K
33	7	R22#,R49,R70,R87,R111, R117,R130,R132	101-0121	RESISTOR,100K OHM,1/4W,5%,CARBON FILM	100K
34	3	R71,R116,R131	101-0125	RESISTOR,150K OHM,1/4W,5%,CARBON FILM	150K
35	2	R27, RX3 **NOTE 11**	101-0129	RESISTOR,220K OHM,1/4W,5%,CARBON FILM	220K

Model 49 Control Board 702-9202AB (Continued)

Item	Qty	Reference	Part No.	Description	Part Value
36	3	R37,R40,R172	101-0131	RESISTOR,270K OHM,1/4W,5%,CARBON FILM	270K
37	0	R90#	101-0139	RESISTOR,560K OHM,1/4W,5%,CARBON FILM	560K
38	5	R31#,R41,R129,R133,R135, R167#,R175	101-0145	RESISTOR,1.0M OHM,1/4W,5%,CARBON FILM	1.0M
39	1	R141	101-0148	RESISTOR,2.0M OHM,1/4W,5%,CARBON FILM	2.0M
40	2	R24,R160	101-0160	RESISTOR,10M OHM,1/4W,5%,CARBON FILM	10M
41	1	R148	103-0022	RESISTOR,0.22 OHM,1W,5%,METAL OXIDE,FLAMEPROOF	0.22 1W
42	0	R18#,R169#,R182#	103-0030	RESISTOR,30 OHM,5W,5%,WIREWOUND,FLAMEPROOF	30 5W
43	1	R146	104-0110	RESISTOR,36.5K OHM,1/4W,1%,100PPM/C,METAL FILM	36.5K 1%
44	2	R57,R51	107-0003	POT,2K OHM,1 TURN,R/A	2K
45	2	R53,R56	107-0010	POT,10K OHM,1 TURN,R/A	10K
46	1	RX2 **NOTE 11**	107-0012	POT.500K OHM,1 TURN,R/A	500K
47	3	R54,R55,R59	107-0015	POT,50K OHM,1 TURN,R/A	50K
48	0	R163#	107-0202	POT,2K OHM,1 TURN	2K
49	1	R52	107-0203	POT,200KOHM,1 TURN,R/A	200K
50	0	R58#	107-0502	POT,50KOHM,1 TURN	50K
51	2	R189,R190	109-0049	RESISTOR,100 OHM,1/8W,5%,CARBON FILM	100 1/8W
52	1	R144	109-0073	RESISTOR,1.0K OHM,1/8W,5%,CARBON FILM	1.0K 1/8W
53	1	RX1 **NOTE 10**	109-0139	RESISTOR,56OK OHM,1/8W,5%,CARBON FILM	560K 1/8W
54	1	R145	115-0196	RESISTOR,1.96K OHM,1/4W,1%,METAL FILM	1.96K 1%
55	1	R151	115-0357	RESISTOR,3.57K OHM,1/4W,1%,METAL FILM	3.57K 1%
56	3	RP2,RP3,RP9	119-0006	R-NETWORK,10K OHM x 9,BUSSED,SIP-10	10K
57	2	RP8,RP7	119-0008	R-NETWORK,10K OHM x 7,BUSSED,SIP-08	10K
58	1	RP6	119-0014	R-NETWORK,47K OHM x 8,ISOLATED,DIP-16	47K
59	2	RP4,RP5	119-0021	R-NETWORK,R/2R,100K/200K,SIP-10	100K/200K
60	1	RP1	119-0026	R-NETWORK,2K OHM x 4,ISOLATED,SIP-08	2K
61	1	C93	150-0096	CAP,1000pF,1KV,10%,CERAMIC DISC,Y5P	.001 1KV
62	4	C113,C114,C139,C140	151-0001	CAP,10pF,100V,10%,CERAMIC NPO	10pF
63	3	C18,C74,C76	151-0010	CAP,100pF,100V,10%,CERAMIC NPO	100pF
64	14	C21,C29,C61,C62,C63,C64, C65,C105,C108#,C118#, C148,C149,C150,C151,C155, C156	151-0020	CAP,.001uF,100V,10%,CERAMIC X7R	.001
65	2	C126,C125	151-0022	CAP,22pF,100V,10%,CERAMIC NPO	22pF
66	4	C19,C38,C73,C75	151-0027	CAP,270pF,100V,10%,CERAMIC NPO (USE 151-0028)	270pF
67	1	C68	151-0028	CAP,270pF,100V,5%,CERAMIC NPO	270pF
68	2	C102,C101	151-0033	CAP,33pF,100V,10%,CERAMIC NPO	33pF
69	6	C8,C25,C47,C54,C56,C159	151-0047	CAP,470pF,100V,10%,CERAMIC NPO	470pF
70	1	CX1 **NOTE 8**	151-0095	CAP,.0047uF,100V,10%,CERAMIC X7R	.0047
71	3	C66,C67,C86	151-0120	CAP,.01uF,50V,10%,CERAMIC X7R	.01
72	52	C2,C22,C31,C37,C51,C69, C80,C81,C87,C88,C89,C90, C95,C96,C98,C99,C103, C107,C109,C110,C111,C112, C116,C117,C119,C120,C121, C122,C123,C124,C127,C128, C129,C130,C131,C132,C133, C134,C135,C136,C137,C138, C141,C142,C144,C152,C153, C157,C158,C160,C161,C162	151-0181	CAP,.1uF,50V,10%,CERAMIC X7R	.1
73	1	C12	151-0199	CAP,.47uF,50V,5%,POLYESTER	.47
74	9	C13,C14,C15,C17,C26,C44, C83,C100,C115	152-0012	CAP,.1uF,50V,5%,POLYESTER	.1
75	1	C55	152-0047	CAP,47uF,25V,20%,NON-POLAR ELECTROLYTIC	47
76	1	C58	152-0050	CAP,10uF,100V,20%,NON-POLAR ELECTROLYTIC,RADIAL	10 100V
77	3	C7,C20,C36	152-0080	CAP,.22uF,50V,5%,POLYESTER	.22 50V
78	3	C49,C50,C104	152-0085	CAP,.01uF,50V,5%,POLYESTER	.01
79	6	C3,C27,C40,C42,C45,C46	152-0088	CAP,.0047uF,50V,5%,POLYESTER	.0047

Model 49 Control Board 702-9202AB (Continued)

Item	Qty	Reference	Part No.	Description	Part Value
80	3	C57,C59,C60	152-0089	CAP,.001uF,50V,5%,POLYESTER	.001
81	2	C43,C6	152-0122	CAP,.022uF,50V,5%,POLYESTER	.022 50V
82	2	C5,C39	152-0130	CAP,.033uF,50V,5%,POLYESTER	.033 50V
83	3	C28,C71,C72	152-0152	CAP,.0015uF,50V,5%,POLYESTER	.0015
84	4	C4,C41,C52,C53	152-0250	CAP,.047uF,50V,5%,POLYESTER	.047
85	6	C10,C16,C70,C77,C78,C154	154-0025	CAP,1uF,35V,10%,TANTALUM	1 TANT
86	1	C30	154-0100	CAP,10uF,16V,10%,TANTALUM	10 TANT
87	1	C11	154-0335	CAP,3.3uF,16V,TANTALUM	3.3 16V
TANT					
88	13	C23,C24,C32,C35,C48,C79, C84,C85,C97,C143,C145, C146,C147	155-0052	CAP,10uF,35V,20%,RADIAL,Al-E	10
89	1	C9	155-0053	CAP,22uF,35V,RADIAL,Al-E	22
90	1	C94	155-0076	CAP,100uF,100V,20%,AXIAL,Al-E	100 100V
91	5	C33,C34,C82,C91,C106	155-0077	CAP,100uF,25V,20%,RADIAL,Al-E	100
92	1	C92	155-0140	CAP,3300uF,25V,20%,AXIAL,Al-E	3300 25V
93	10	E1,E2,E3,E4,E5,E6,E7,E8, E9,E10	305-0001	BEAD,3B FERRITE,W/LEADS	
94	1	L1	305-0136	INDUCTOR,470uH,570mA,10%	470UH
95	11	DS1,DS2,DS3,DS4,DS5,DS6, DS7,DS8,DS9,DS10,DS11	311-0011	LED,RED,DIFFUSED,5mm CYLINDRICAL	
96	1	DS12	311-0012	LED,GREEN,DIFFUSED,5mm CYLINDRICAL	
97	1	U55	316-0232	RS232 DRIVER +5V CMOS,2KV ESD TEST,DIP-16	232
98	2	U7,U1	316-0324	OP-AMP,BIPOLAR,358 EQUIVALENT,QUAD,DIP-14	324
99	9	U2,U3,U5,U8,U10,U11,U13, U14,U15,U34#	316-0358	OP-AMP,BIPOLAR,DUAL,DIP-8	358
100	1	U4	316-0570	AGC,DUAL,DIP-16	570
101	0	U57+	316-3524	REGULATING PWM IC,DIP-16	3524
102	1	VR1 **NOTE 1**	316-7805	REGULATOR,+5V,1.5A,TO-220	7805
103	1	U44	317-5121	RCVR,DUAL LINE,DIP-16	SN75121
104	1	U47	317-5122	RCVR,TRIPLE LINE,DIP-16	SN75122
105	1	U52	317-5138	XCVR,QUAD BUS,DIP-16	SN75138
106	0	U23+	321-0204	RCVR,DTMF,DIP-14	75T204
107	0	U21+	321-0222	MODEM,1200 BAUD,5V,SINGLE CHIP,DIP-28	73K212
108	0	U20^,U32^	321-0751	MICRO,CMOS,3.5 TO 12MHZ,0 TO 70C,DIP-24	ASIC 001
109	2	U25,U27	321-1001	SRAM,128K x 8,100nS, 50uA,0 TO 70C,DIP-32	128K x 8
SRAM					
100	1	U54	321-2181	UART,2681,DUAL,DIP-40	2681
111	1	U35 **NOTE 7**	321-6811	UP-HC MOS,PLCC-52	68HC11A0
112	0	U29^,U31^	322-7256	EPROM,CMOS,32K x 8,250nS,DIP-28	27C256
EPROM					
113	2	U9,U6	323-4053	ANALOG SWITCH,TRIPLE SPDT,DIP-16	4053
114	0	U22+	323-8207	DECODER,MF,DIP-20	78A207
115	4	U45,U48,U49,U51	324-4138	DECODER,1 OF 8,DIP-16	74HC138
116	1	U42	324-4153	MUX,4 INPUT,DUAL,DIP-16	74HC153
117	2	U16,U17 **NOTE 5**	324-4165	SIP-INPUT,SERIAL OUTPUT 8-BIT SR,HC	74HC165
118	2	U46,U43	324-4259	LATCH,HC,8-BIT,ADDRESSABLE,DIP-16	74HC259
119	1	U37	324-4373	LATCH,HC,3-STATE,NON-INVERT,TRANSPARENT,OCTAL,DIP-2	74HC373
110	3	U24,U26,U30	324-4374	FLIP-FLOP,D,HC,3-STATE,NON-INVERTING,OCTAL,DIP-20	74HC374
121	1	U36	324-7400	NAND,HC,2 INPUT,QUAD,DIP-14	74HC00
122	1	U41	324-7408	AND,HC,2 INPUT,QUAD,DIP-14	74HC08
123	4	U12,U33,U50,U56	324-7414	INVERTER,SCHMITT,MOTOROLA THRESHOLDS,HEX,DIP-14	74HC14
124	2	U53,U28	324-7432	OR,HC,2 INPUT,QUAD,DIP-14	74HC32
125	1	U40	325-4244	BUFFER,HCT,3-STATE,OCTAL,DIP-20	74HCT244
126	3	U18,U19,U39	325-4374	FLIP-FLOP,D,HCT,REG 3-STATE	74HCT374
127	1	Q1	340-0002	XSTR,NPN,.2A,45V,Veb>6.5V,BETA>400,TO-92	MPSA18
128	1	Q11	340-0008	XSTR,MOSFET,P-TYPE,8A,100V,RDS=0.4 OHM	MTP8P10
129	1	U38	340-2003	RELAY DRIVER 50V/.5A,-20 to +85C,DIP-16	2003

Model 49 Control Board 702-9202AB (Continued)

Item	Qty	Reference	Part No.	Description	Part Value
120	0	Q13#	340-3055	XSTR,NFET,12A,60V	3055
131	5	Q6,Q8,Q9,Q10,Q12	340-3904	XSTR,NPN,40V/200MA,TO92	2N3904
132	4	Q2,Q3,Q4,Q5	340-3906	XSTR,PNP,40V/200MA,TO92	2N3906
133	1	Q7	340-5460	XSTR,JFET,P-CHAN,40V,5MA,TO92 PKG	2N5460
134	11	CR1,CR2,CR3,CR4,CR5,CR6, CR7,CR9,CR15,CR16,CR17#, CR18,CR19#	342-3009	DIODE,SILICON,100V,250MW	1N4148
135	4	CR10,CR11,CR12,CR13	342-3011	DIODE,SILICON,1A ,1000V	1N4007
136	1	CR14	342-4935	DIODE,SILICON,FAST,1A,200V	1N4935
137	1	CR8	343-3030	DIODE,ZENER,6.2V,1W,5%	6.2V
138	1	SW3	371-0005	SWITCH,SLIDE,DPDT,MOM,END ACTUATED	
139	1	SW1	371-0007	SWITCH,DIP,04 POS,SIDE ACTUATED	
130	1	SW2	371-0008	SWITCH,DIP,08 POS,SIDE ACTUATED	
141	1	Y4	376-0358	XTAL,3.579545MHZ,CL=18pF,HC-49	3.58MHZ
142	1	Y3	376-0737	XTAL,7.3728MHZ,CL=18,20pF,HC-49	7.3728MHZ
143	1	Y1	376-1106	XTAL,11.0592MHZ,CL=18pF,HC-49	11.0592MHZ
144	1	Y2	376-1600	XTAL,16.000 MHZ,CL=18,20pF,HC-49	16.000MHZ
145	5	K1,K2,K3,K4,K5	380-0001	RELAY,SPDT,12V,150K OP@1A,24VDC	
146	1	J7	401-0021	CONN,D-SUB,9,FEMALE,PCB-RA,PLASTIC	
147	1	J1	401-0059	CONN,HDR,15POS,.200"CTR,MALE,OPEN END,ORANGE,PCB-H	
148	1	J2	401-0086	CONN,HDR,12POS,.200"CTR,MALE,OPEN END,ORANGE,PCB-H	
149	1	J3 **NOTE 2**	401-0221	BNC BULKHEAD RECEPTACLE	
150	3	J4,J5,J6	401-6005	6-POS FEMALE	
151	9	TP1,TP2,TP3,TP9,TP10, TP14,TP15,TP16,TP17#, TP18#,JP27	403-0001	01 OF 401-0052	
152	0	JP2#,JP8#,JP15#,JP28#	403-0002	02 OF 401-0052	
153	19	JP1,JP3,JP4,JP5,JP6,JP7, JP9,JP10,JP11,JP13,JP14, JP16,JP17,JP18,JP19,JP20, JP24,JP25,JP26	403-0003	03 OF 401-0052	
154	2	JP22,JP21	403-0004	04 OF 401-0052	
155	1	JP23	403-0202	04 OF 401-0552 [2 x 2]	
156	1	JP12	403-0204	08 OF 401-0552 [4 x 2]	
157	1	P1	404-2016	16 OF 401-0180	
158	7	TP4,TP5,TP6,TP7#,TP8, TP10,TP11,TP13	406-0001	01 OF 401-0108	
159	1	P3	406-0012	12 OF 401-0108	
160	1	P2	406-0016	16 OF 401-0108	
161	1	F1	416-1576	FUSE,AGC,1 AMP, FAST-BLOW	1A
162	5	XVR1,XJ7 **(2)**, BNC BRACKET **(2)**	210-0001	NUT,KEP,4-40,S-Zn	
163	2	XJ7	220-0102	SCREW,4-40 x 3/8, PAN PHL,S-Zn	
164	3	XVR1,BNC BRACKET **(2)**	220-0108	SCREW,4-40 x 1/4,PAN,PHL,S-Zn	
165	4	XY1-4	236-0005	INSULATOR,HC-18,CRYSTAL	
166	1	XVR1 **NOTE 1**	381-0004	HEATSINK,TO-220,STAMPED,LRG W/ SOLDER TABS	
167	2	XJ7	401-0042	CONN,D-SUB,LOCK SCREWS	
168	25	XJP1, 3-7, 10, 11, 17-22, 24 -26 **(POS A)** XJP23 **(POS A & A) (2)** XJP9, 13, 14 ,16 **(POS B)** XJP12 **(POS ISQ) (2)** **NOTE 4**	402-3040	JUMPER,MINI,0.1 x 0.2 x 0.37"	
169	9	XU2,3,5,8,10,11,13-15	407-0008	SKT,DIP-8	
170	11	XU1,7,12,23,28,33,36,41,50,53, 56	407-0014	SKT,DIP-14	

Model 49 Control Board 702-9202AB (Continued)

Item	Qty	Reference		Part No.	Description	Part Value
171	18	XU4,6,9,16,17,38,42-49,51,52, 55,57		407-0016	SKT,DIP-16	
172	9	XU18,19,22,24,26,30,37,39,40		407-0020	SKT,DIP-20	
173	2	XU20,32		407-0023	SKT,DIP-24,SKINNY	
174	3	XU21,29, 31		407-0028	SKT,DIP-28	
175	2	XU25,27	**NOTE 3**	407-0032	SKT,DIP-32	
176	1	XU54		407-0040	SKT,DIP-40	
177	1	XU35		407-0052	SKT,PLCC-52,.080 JEDEC	
178	4"	XJ3	**NOTE 2**	408-0012	WIRE,22GA,SOLID,COPPER,TIN PLATED	
179	8"	**NOTE 11**		408-2405	WIRE,24AWG(19x36),600V,105C,PVC,GREEN	
180	8"	**NOTE 11**		408-2409	WIRE,24AWG(19x36),600V,105C,PVC, WHITE	
181	1	PCB		410-9202K	MODEL 49 CONTROL BOARD	
182		XJ3	**NOTE 2**	415-9712A	MODEL 49 BNC BRACKET	
183	1	PWR BUS		416-0003	3 POS-BUS BAR	
184	1	XU25	**NOTE 3**	416-1215	SKT,SMART,64/256K/1MEG	DS1213D
185	1	XU27	**NOTE 3**	416-1218	SKT,SMART WATCH,64/256/1MEG	DS1216D
186	2	XF1		416-3040	FUSE CLIP	
187	9	XDS4-12		417-0010	LED MOUNT	
188	1"		**NOTE 11**	525-1498	TUBING,SHRINKABLE,2:1,1/8"DIA,POLYOLEFIN,BLACK	
189	A/R	XVR1	**NOTE 1**	561-0001	THERMAL COMPOUND	
190	A/R		**NOTE 11**	561-0003	ADHESIVE,CONTACT CEMENT	
191	A/R		**NOTE 11**	561-0010	TAK PAK	

NOTES:
Notes are for production use only.

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E&M 4-Wire Interface 702-9445 Rev. A

LEGEND:
+ = OPTION
# = NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY

Item	Quantity	Reference	Part	Description	Mfg.Part No.
1	1	R13	101-0010	1 OHM 1/4W 5% CARBON FILM	1/4-5%
2	1	R14	101-0057	220 OHM 1/4W 5% CARBON FILM	
3	3	R2,R9,R11	101-0067	560 OHM 1/4W 5% CARBON FILM	
4	1	R12	101-0068	620 OHM 1/4W 5% CARBON FILM	
5	1	R10	101-0073	1K 1/4W 5% CARBON FILM	
6	1	R15	101-0075	1.5K 1/4W 5% CARBON FILM	
7	1	R7	101-0085	3.3K 1/4W 5% CARBON FILM	
8	1	R16	101-0089	4.7K 1/4W 5% CARBON FILM	
9	3	R5,R6,R18	101-0097	10K 1/4W 5% CARBON FILM	
10	1	R8# *NOTE 1, R17	101-0101	15K 1/4W 5% CARBON FILM	
11	1	R3	101-0109	33K 1/4W 5% CARBON FILM	
12	1	R4	103-2015	150 OHM 2W 5% CARBON FILM	BWH-150-5%
13	1	R1	103-3300	3.3K 1W 5% CARBON FILM	
14	2	RV1,RV2	105-0001	VARISTOR 250V AC	V250LA20
15	0	R19#	107-0501	5K POT 1 TURN	3386P-1-502
16	0	R20#	107-0502	50K POT 1 TURN	3386P-1-503
17	3	C8,C9,C10	152-0012	.1 UF 50V +-5% POLYESTER	ECQ-V1H104JZ
18	2	C3,C4	152-0085	.01 UF 50V +- 5% POLYESTER	ECQ-V1H103JZ
19	1	C6	155-0013	4.7 UF 100 VOLT RADIAL ALUMINUM ELECTROLYTIC	ECE-A2AU4R7
20	3	C1,C2,C5	155-0052	10 UF 35V +-20% RADIAL ALUMINUM ELECTROLYTIC	ECEA1VU100
21	1	C7	155-0083	470 UF 10 VOLT RADIAL ALUMINUM ELECTROLYTIC	ECEA-1AU471
22	2	T1,T2	305-0600	600:600 OHM AUDIO	MR671-0064
23	1	U1	311-1001	OPTO ISOLATOR, BI-POLAR	H11AA1
24	1	U2	316-0358	OP-AMP, DUAL	LM358N
25	1	Q1	340-0014	NPN DARLINGTON	MPSA14/MPSA13
26	2	CR1,CR2	342-3009	SILICON .50 SP	1N4148
27	1	K1	380-0001	SPDT 12V	M2-12HG-C
28	1	J1	401-0080	6-PIN LO PRO R/A TELCO	520250-3
29	1	J2	401-0150	6-POS THRU PCB CONNECTOR	22-14-2064
30	2	JA3,JB3	401-0151	8-POS THRU PCB CONNECTOR	22-14-2084
31	3	JP2,JP3,JP4	403-0003	3 OF 401-0052	
32	1	JP1	403-0202	4 OF 401-0052 [2X2]	
33	5	XJP1,XJP2,XJP3,XJP4 (POS A)	402-3040	MINI JUMPER	
34	1	XU1	407-0006	SKT, 06 PIN DIP	
35	1	XU2	407-0008	SKT, 08 PIN DIP	
36	1	PCB	410-9228B	PCB	

NOTES:
Notes are for production use only.

E&M 4-Wire Interface 702-9445 Rev. C

LEGEND:

= NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY
+ = OPTION (INSTALLED PER CUSTOMER ORDER)

ITEM	QTY	COMPONENT REFERENCE	PART NO.	DESCRIPTION	MANUFACTURE P/N
1	4	R1,R2,R3,R4	101-0010	1 OHM 1/4W 5% CARBON FILM	1/4-5%
2	1	R20	101-0057	220 OHM 1/4W 5% CARBON FILM	
3	1	R6	101-0061	330 OHM 1/4W 5% CARBON FILM	
4	4	R5,R9,R16,R22	101-0067	560 OHM 1/4W 5% CARBON FILM	
5	2	R19,R10	101-0073	1K 1/4W 5% CARBON FILM	
6	1	R241	101-0075	1.5K 1/4W 5% CARBON FILM	
7	1	R23	101-0085	3.3K 1/4W 5% CARBON FILM	
8	1	R17	101-0090	5.1K 1/4W 5% CARBON FILM	
9	2	R15,R27	101-0101	15K 1/4W 5% CARBON FILM	
10	1	R21	101-0105	22K 1/4W 5% CARBON FILM	
11	3	R13,R18,R26	101-0109	33K 1/4W 5% CARBON FILM	
12	3	R11,R12,R14	101-0113	47K 1/4W 5% CARBON FILM	
13	1	R8 (NOTE 1)	103-2015	150 OHM 2W 5% CARBON FILM	BWH-150-5%
14	1	R7 (NOTE 1)	103-3300	3.3K 1W 5% CARBON FILM	
15	2	RV1,RV2	105-0001	VARISTOR 250V AC	V250LA20
16	0	R25#	107-0005	5K POT 1 TURN R/A	3386X-1-502
17	0	R28#	107-0010	10K POT 1 TURN R/A	3386X-1-103
18	1	C4	151-0047	470PF 50V +-10%/5% CERAMIC, TEMPERATURE STABLE	CW15C471K
19	2	C2,C1	151-0120	.01UF 50V +-10% CERAMIC, TEMPERATURE STABLE	CW15C103K
20	3	C7,C8,C9	151-0180	.1UF 50V +-10% CERAMIC, UNSTABLE	AVXSR205E104MAA
21	1	C6	152-0012	.1 UF 50V +-5% POLYESTER	ECQ-V1H104JZ
22	1	C5	155-0013	4.7 UF 100 VOLT RADIAL ALUMINUM ELECTROLYTIC	ECE-A2AU4R7
23	2	C3,C11	155-0052	10 UF 35V +-20% RADIAL ALUMINUM ELECTROLYTIC	ECEA1VU100
24	1	C10	155-0083	470 UF 10 VOLT RADIAL ALUMINUM ELECTROLYTIC	ECEA-1AU471
25	2	T1,T2	305-0600	600:600 OHM AUDIO	MR671-0064
26	1	U1	311-1001	OPTO ISOLATOR, BI-POLAR	H11AA1
27	1	U2	316-0358	OP-AMP, DUAL	LM358N
28	1	U3	324-7414	HEX SCHMIDT	SN74HC14N
29	1	Q1	340-0014	NPN DARLINGTON	MPSA14/MPSA13
30	2	CR1,CR2	342-3009	SILICON .50 SP	1N4148
31	1	K1	380-0001	SPDT 12V	M2-12HG-C
32	1	J1	401-0080	6-PIN LO PRO R/A TELCO	520250-3
33	1	J2	401-0150	6-POS THRU PCB CONNECTOR	22-14-2064
34	2	JB3,JA3	401-0151	8-POS THRU PCB CONNECTOR	22-14-2084
35	4	JP2,JP4,JP5,JP6	403-0003	3 OF 401-0052	
36	1	JP3	403-0004	4 OF 401-0052	
37	1	JP1	403-0202	4 OF 401-0052 [2X2]	
38	7	XJP1(AA),XJP2(C),XJP3(A), XJP4(A),XJP5(A),XJP6(A)	402-3040	MINI JUMPER	
39	1	XU1	407-0006	SKT, 06 PIN DIP	
40	1	XU2	407-0008	SKT, 08 PIN DIP	
41	1	XU3	407-0014	SKT, 14 PIN DIP	
42	1	PCB	410-9228D	PCB, E&M 4-WIRE TRUNK CARD II	

NOTES: Notes are for production use only.

DID/CO Interface 702-9446 Rev. A

LEGEND:
+ = OPTION
# = NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY

Item	Quantity	Reference	Part	Description	Mfg.Part No.
1	3	R1,R16,R25	101-0049	100 OHM 1/4W 5% CARBON FILM	
2	4	R9,R15,R19,R22#,R26	101-0065	470 OHM 1/4W 5% CARBON FILM	
3	1	R21,R27#	101-0073	1K 1/4W 5% CARBON FILM	
4	2	R14,R18,R28#,R29#,R32#	101-0075	1.5K 1/4W 5% CARBON FILM	
5	0	R30#,R31#	101-0085	3.3K 1/4W 5% CARBON FILM	
6	3	R2,R5,R17# *NOTE 3,R24	101-0097	10K 1/4W 5% CARBON FILM	
7	1	R3	101-0105	22K 1/4W 5% CARBON FILM	
8	1	R23	101-0113	47K 1/4W 5% CARBON FILM	
9	1	R20	101-0119	82K 1/4W 5% CARBON FILM	
10	1	R4	101-0129	220K 1/4W 5% CARBON FILM	
11	1	R6	101-0145	1M 1/4W 5% CARBON FILM	
12	2	R7,R8	104-0048	75 OHM 1/2W .1%	CMF-6075R0BT-2
13	4	R10,R11,R12,R13	104-0114	49.9K 1/8W .1%	RNC-55J4992BS
14	2	RV1,RV2 *NOTE 1	105-0001	VARISTOR 250V AC	V250LA20
15	0	R33# *NOTE 2, R35# *NOTE 4,R36#	107-0501	5K POT 1 TURN	3386P-1-502
16	0	R34# *NOTE 2	107-0502	50K POT 1 TURN	3386P-1-503
17	3	C2,C5,C9	152-0012	.1 UF 50V +-5% POLYESTER	ECQ-V1H104JZ
18	0	C11#	152-0080	.22 UF 50V +-5%	ECQ-V1H224JZ
19	1	C8	152-0088	.0047UF 50V +-5% POLYESTER	ECQ-B1H472JZ
20	2	C7,C10	152-0089	.001 UF 50V +-5% POLYESTER	ECQB1H102JZ
21	2	C1,C6	155-0013	4.7 UF 100 VOLT RADIAL ALUMINUM ELECTROLYTIC	ECE-A2AU4R7
22	1	C3	155-0052	10 UF 35V +-20% RADIAL ALUMINUM ELECTROLYTIC	ECEA1VU100
23	1	C4	155-0079	100 UF 100V +50%-10% RADIAL ALUMINUM ELECTROLYTIC	ECEA2AV101S
24	1	C12	155-0083	470 UF 10 VOLT RADIAL ALUMINUM ELECTROLYTIC	ECEA-1AU471
25	2	E1,E2	305-0007	BEAD FERRITE PLZ	56-590-65-3
26	1	T1	305-1540	LO SIZE/COST PHONE HYBRID XFMR	671-1540
27	1	U3	311-0008	OPTO ISOLATOR	4N26
28	2	DS1,DS2	311-0028	28V LAMP	2187D
29	1	U4	316-0358	OP-AMP, DUAL	LM358N
30	1	U1	324-7414	HEX SCHMIDT	74HC14
31	1	U2	340-2003	RELAY DRIVER 50V/.5A	ULN2003
32	3	Q1,Q2,Q4	340-3904	NPN 40V/200MA	2N3904
33	1	Q3	340-4250	PNP 60V BETA >250	MPS4250A
34	2	CR1,CR2	343-3035	1W 12V +-5% .50 SP	1N4742A
35	2	K1,K2	380-0030	DPDT 12V COIL MINI RELAY	FBR244ND012/02CP
36	1	J1 *NOTE 1	401-0080	6-PIN LO PRO R/A TELCO	520250-3
37	1	J2	401-0150	6-POS THRU PCB CONNECTOR	22-14-2064
38	2	JA3,JB3	401-0151	8-POS THRU PCB CONNECTOR	22-14-2084

DID/CO Interface 702-9446 Rev. A (Continued)

Item	Quantity	Reference	Part	Description	Mfg.Part No.
39	1	R33	107-0005	5K POT 1 TURN R/A	
40	1	R34	107-0015	50K POT 1 TURN R/A	
41	1	XU3	407-0006	SKT, 06 PIN DIP	
42	1	XU4	407-0008	SKT, 08 PIN DIP	
43	1	XU1	407-0014	SKT, 14 PIN DIP	
44	1	XU2	407-0016	SKT, 16 PIN DIP	
45	1	PCB	410-9229B	PCB	

NOTES:
Notes are for production use only.

End-End Full Duplex Interface 702-9669 Rev. A

LEGEND:
+ = OPTION
/ = NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY

Item	Quantity	Reference	Part	Description	Mfg.Part No.
1	1	R5	101-0065	470 OHM 1/4W 5% CARBON FILM	
2	1	R14	101-0067	560 OHM 1/4W 5% CARBON FILM	
3	1	R12	101-0068	620 OHM 1/4W 5% CARBON FILM	
4	1	R3	101-0081	2.2K 1/4W 5% CARBON FILM	
5	4	R9,R10,R13,R17	101-0090	5.1K 1/4W 5% CARBON FILM	
6	4	R11,R16,R18,R19	101-0097	10K 1/4W 5% CARBON FILM	
7	1	R4	101-0105	22K 1/4W 5% CARBON FILM	
8	1	R15	101-0113	47K 1/4W 5% CARBON FILM	
9	2	R8,R7	101-0129	220K 1/4W 5% CARBON FILM	
10	1	R6	103-3300	3.3K 1W 5% CARBON FILM	
11	2	RV1,RV2	105-0001	VARISTOR 250V AC	V250LA20
12	2	R2,R1 (NOTE 1)	106-0047	4.7 OHM 1/2W 5% FUSIBLE	BW1/2F-4.7OHM5%B
13	1	R20	107-0003	2K POT 1 TURN R/A	3386X-1-202
14	1	R21	107-0004	500 OHM POT 1 TURN R/A	3386H-1-501
15	1	C4	151-0020	.001UF 50V +-10% CERAMIC, TEMPERATURE STABLE	CW15C102K
16	3	C3,C9,C10	151-0180	.1UF 50V +-10% CERAMIC, UNSTABLE	AVXSR205E104MAA
17	1	C1	152-0021	.47 UF 250V +-10% POLYESTER	713A1KK474PK251SM
18	1	C2	152-0080	.22 UF 50V +-5%	ECQ-V1H224JZ
19	4	C11,C12,C13,C17	152-0085	.01 UF 50V +- 5% POLYESTER	ECQ-V1H103JZ
20	3	C6,C8,C18	152-0088	.0047UF 50V +-5% POLYESTER	ECQ-B1H472JZ
21	1	C7	152-0089	.001 UF 50V +-5% POLYESTER	ECQB1H102JZ
22	2	C16,C15	152-0130	.033 UF 50V 5% POLYESTER	ECQ-V1H333JZ
23	1	C14	152-0250	.047 UF 50V 5% POLYESTER	ECQ-V1H473JZ
24	2	C20,C19	154-0050	4.7UF 16V TANT	ECSFICE475
25	1	C5	155-0052	10 UF 35V +-20% RADIAL ALUMINUM ELECTROLYTIC	ECEA1VU100
26	2	T2,T1	305-1540	LO SIZE/COST PHONE HYBRID XFMR	671-1540
27	2	U3,U2	311-0008	OPTO ISOLATOR	4N26
28	1	U1	311-1001	OPTO ISOLATOR, BI-POLAR	H11AA1
29	1	U5	316-3403	QUAD OP AMP	MC3403P
30	1	U4	324-7414	HEX SCHMIDT	SN74HC14N
31	2	Q1,Q2	340-3904	NPN 40V/200MA	2N3904
32	3	CR1,CR2,CR3	342-3009	SILICON .50 SP	1N4148
33	2	CR5,CR4	343-3035	1W 12V +-5% .50 SP	1N4742A
34	1	SW1	371-0042	HEX ROTARY SWITCH RA	DRD-16RA
35	1	SW2	371-0052	2 POS. DIP SWITCH	1-435802-3
36	2	K2,K1	380-0030	DPDT 12V COIL MINI RELAY	G5V-2
37	1	J1	401-0080	6-PIN LO PRO R/A TELCO	520250-3
38	1	J2	401-0150	6-POS THRU PCB CONNECTOR	22-14-2064
39	2	JA3,JB3	401-0151	8-POS THRU PCB CONNECTOR	22-14-2084
40	3	XU1,XU2,XU3	407-0006	SKT, 06 PIN DIP	
41	2	XU4,XU5	407-0014	SKT, 14 PIN DIP	
42	1	PCB	410-9669A	PCB, E-E FULL DUPLEX INTERFACE (FCC)	

NOTES: Notes are for production use only.

Model 49 Compandor Card 702-9276 Rev. C

= NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY
+ = OPTION (INSTALLED PER CUSTOMER ORDER)

ITEM	QTY	COMPONENT REFERENCE	PART NO.	DESCRIPTION	MANUFACTURE P/N
1	1	R20	101-0047	47 OHM 1/4W 5% CARBON FILM	
2	1	R17	101-0057	220 OHM 1/4W 5% CARBON FILM	
3	2	R25,R26	101-0061	330 OHM 1/4W 5% CARBON FILM	
4	2	R4,R19	101-0066	510 OHM 1/4W 5% CARBON FILM	
5	1	R18	101-0073	1K 1/4W 5% CARBON FILM	
6	2	R10,R11#,R16#,R23	101-0089	4.7K 1/4W 5% CARBON FILM	
7	1	R2	101-0092	6.2K 1/4W 5% CARBON FILM	
8	5	R1,R13,R14,R22,R24	101-0097	10K 1/4W 5% CARBON FILM	
9	1	R5	101-0099	12K 1/4W 5% CARBON FILM	
10	2	R15,R21	101-0101	15K 1/4W 5% CARBON FILM	
11	2	R9,R12	101-0105	22K 1/4W 5% CARBON FILM	
12	2	R7,R8	101-0109	33K 1/4W 5% CARBON FILM	
13	2	R3,R6	101-0113	47K 1/4W 5% CARBON FILM	
14	9	C1,C2,C6,C9,C10,C11,C18, C19,C20,C22#,C23#	152-0012	.1 UF 50V +-5% POLYESTER	ECQ-V1H104JZ
15	2	C7,C8	152-0085	.01 UF 50V +- 5% POLYESTER	ECQ-V1H103JZ
16	3	C4,C16,C21	154-0025	1 UF 35V TANTALUM	ECS-F-35E1
17	2	C5,C15	155-0012	2.2 UF 100V +50-10% RADIAL ALUMINUM ELECTROLYTIC	ECEA2AV2R2S
18	1	C12	155-0013	4.7 UF 100 VOLT RADIAL ALUMINUM ELECTROLYTIC	ECE-A2AU4R7
19	1	C14	155-0052	10 UF 35V +-20% RADIAL ALUMINUM ELECTROLYTIC	ECEA1VU100
20	2	C13,C17	155-0077	100UF 25V +-20% RADIAL ALUMINUM ELECTROLYTIC	ECEA1EU101
21	2	DS1,DS2	311-0011	LED RED FLUSH	TLSR-5201
22	2	U2,U4	316-0358	OP-AMP, DUAL	LM358N
23	1	U3	316-0575	COMPANDOR	NE575N
24	1	U1	323-4053	3PDT SWITCH	MC144053
25	1	U5	324-4259	LATCH, 8 BIT ADDRESSABLE	74HC259
26	1	JP1	403-0003	3 OF 401-0052	
27	1	JA1 *NOTE 1	407-0108	SKT, 8 PIN SIP	65780-044
28	2	JB1,JC1 *NOTE 1	407-0110	SKT, 10 PIN SIP	65780-046
29	1	XJP1 (POS. A)	402-3040	MINI JUMPER	
30	2	XU2,XU4	407-0008	SKT, 8 PIN DIP	
31	2	XU1,XU5	407-0016	SKT, 16 PIN DIP	
32	1	XU3	407-0020	SKT, 20 PIN DIP	
33	1		410-9276B	PCB	

NOTES:
Notes are for production use only.

Model 49 Voice Card Parts List 702-9391 Rev. C

LEGEND:
= NOT INSTALLED
^ = INSTALLED ON HIGHER ASSEMBLY
+ = OPTION, INSTALL PER CUSTOMER ORDER

ITEM	QTY	COMPONENT REFERENCE	PART NO.	DESCRIPTION	MANUFACTURE P/N
1	1	R6	101-0073	1K 1/4W 5% CARBON FILM	
2	1	R3	101-0090	5.1K 1/4W 5% CARBON FILM	
3	1	R2 *NOTE 2	101-0105	22K 1/4W 5% CARBON FILM	
4	1	R4	101-0121	100K 1/4W 5% CARBON FILM	
5	1	R1 *NOTE 2	101-0129	220K 1/4W 5% CARBON FILM	
6	1	R5	107-0501	5K POT 1 TURN	3386P-1-502
7	2	C3,C5	151-0010	100 PF 50V +-10% CERAMIC, TEMPERATURE STABLE	CW15C101K
8	1	C12	151-0199	.47 UF 50V +-5% POLYESTER	ECQV1H474JZ
9	2	C7,C11	152-0085	.01 UF 50V +- 5% POLYESTER	ECQ-V1H103JZ
10	3	C1 *NOTE 2, C4,C10	152-0089	.001 UF 50V +-5% POLYESTER	ECQB1H102JZ
11	4	C2,C6,C8,C9	154-0025	1 UF 35V TANTALUM	ECS-F-35E1
12	4	U5,U6,U7,U8	321-8256	32K X 8 RAM LP	HPD43256-15L
13	1	U4	323-8830	STATIC VOICE REC/PLAY LSI	T8830
14	1	U2	324-4132	QUAD NAND SCHMIDT	MCH74HC132
15	1	U3	324-7414	HEX SCHMIDT	74HC14
16	1	U1	324-7427	TRIPLE 3 INPUT NOR	74HC27
17	2	Q1,Q2	340-3904	NPN 40V/200MA	2N3904
18	1	CR1	342-3008	DO NOT USE - GERMANIUM .50 SP	1N100
19	1	CR2	342-3009	SILICON .50 SP	1N4148
20	1	Y1	376-0500	500 KHz CER RESONATOR	CSB500E
21	2	P1,P2 *NOTE 1	401-6008	5-POS MALE ROUND	26-51-0051
22	1	TP1	403-0001	1 OF 401-0052	
23	0	JP1#	403-0002	2 OF 401-0052	
24	1	BT1	416-0002	LITH CELL BATT	BR2325
25	1	*NOTE 3	251-1240	440X.062 FIBER	
26	3	XU1,XU2,XU3	407-0014	SKT, 14 PIN DIP	
27	4	XU5,XU6,XU7,XU8	407-0028	SKT, 28 PIN DIP	
28	6	XJP2,XJP3 (POS B) XJP4 (POS A & B) XJP5 (POS A & D)	408-0001	WIRE JUMPER	
29	1	PCB	410-9193C	M4X\64 VOICE CARD	
30	1	XBT1 *NOTE 4	415-9432	BATTERY INSULATOR	
31	1	XBT1	416-0001	LITH COIN BATT HOLDER	BH906
32	A/R	*NOTE 3	561-0010	TAK PAK	

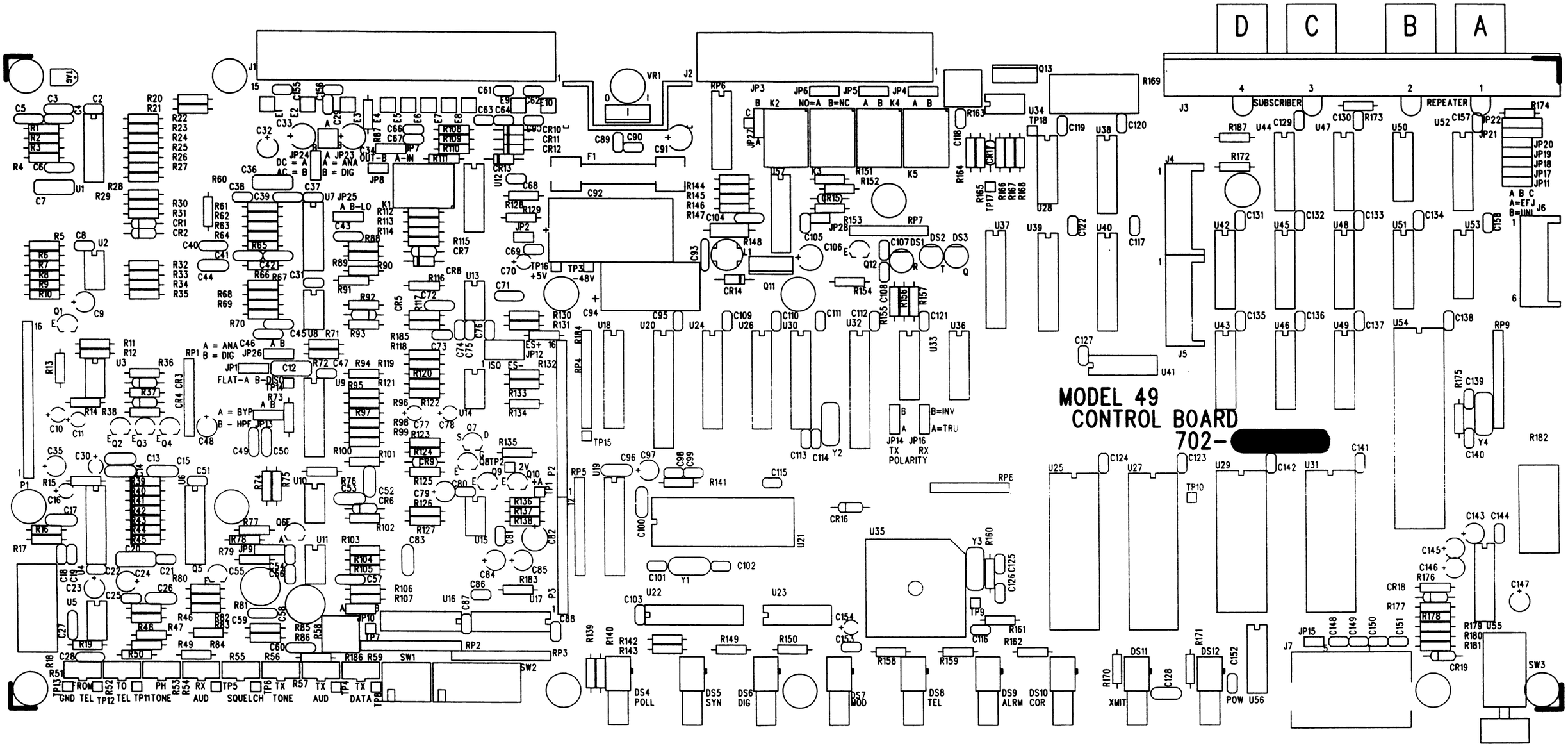
NOTES:
Notes are for production use only.

Model 4XB Dial Click Parts List 702-9242 Rev. E

= NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY
+ = OPTION (INSTALLED PER CUSTOMER ORDER)

ITEM	QTY	COMPONENT REFERENCE	PART NO.	DESCRIPTION	MANUFACTURE P/N
1	1	R22	101-0065	470 OHM 1/4W 5% CARBON FILM	
2	1	R12,R25#	101-0071	820 OHM 1/4W 5% CARBON FILM	
3	2	R1,R13,R19#,R26#	101-0081	2.2K 1/4W 5% CARBON FILM	
4	6	R4,R5,R8,R9,R11,R15#, R16#,R20#,R21#,R24#,R28#, R29	101-0097	10K 1/4W 5% CARBON FILM	
5	2	R7,R14,R27#,R31#	101-0101	15K 1/4W 5% CARBON FILM	
6	2	R2,R3,R17#,R18#	101-0123	120K 1/4W 5% CARBON FILM	
7	1	R6,R30#	107-0504	200K POT 1 TURN	3386P-1-204
8	1	C4,C9#	151-0020	.001 UF 50V +-10% CERAMIC, TEMPERATURE STABLE	CW15C102K
9	1	C1,C10#	151-0120	.01 UF 50V +-10% CERAMIC, TEMPERATURE STABLE	CW15C103K
10	3	C2,C3,C6#,C7#,C11	151-0180	.1 UF 50V +-10% CERAMIC, UNSTABLE	AVXSR205E104MAA
11	2	C5,C8,C12#	154-0025	1 UF 35V TANTALUM	ECS-F-35E1
12	2	C13,C14,C15#,C16#	155-0055	22 UF 25V +50%-10% AXIAL ALUMINUM ELECTROLYTIC	TLB1E220M
13	1	DS1,DS2#	311-0010	LED RED LAMP	HLMP3300
14	1	VR1	316-0005	REGULATOR 5V LOW POWER	LM78L05
15	2	U1,U2,U3#,U4#	316-0358	OP-AMP, DUAL	LM358N
16	1	Q1,Q2#	340-3904	NPN 40V/200MA	2N3904
17	1	CR5,CR7#	342-0103	SCHOTTKEY .37V @ 20MA	SD103A
18	3	CR1,CR2,CR3#,CR4#,CR6, CR8#	342-3009	SILICON .50 SP	1N4148
19	2	JA1,JB1 *NOTE 1	401-6008	5-POS MALE	09-64-1051
20	2	TP1,TP2,TP3#	403-0001	1 OF 401-0052	
21	2	XU1,XU2	407-0008	SKT, 8 PIN DIP	
22	1		410-9119B	PCB	

NOTES:
Notes are for production use only.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TX RX
POLARITY
DS4 POLL
DS5 SYN
DS6 DIG
DS7 MOD
DS8 TEL
DS9 ALRM
DS10 COR
DS11 XMIT
DS12 POW
GND TEL
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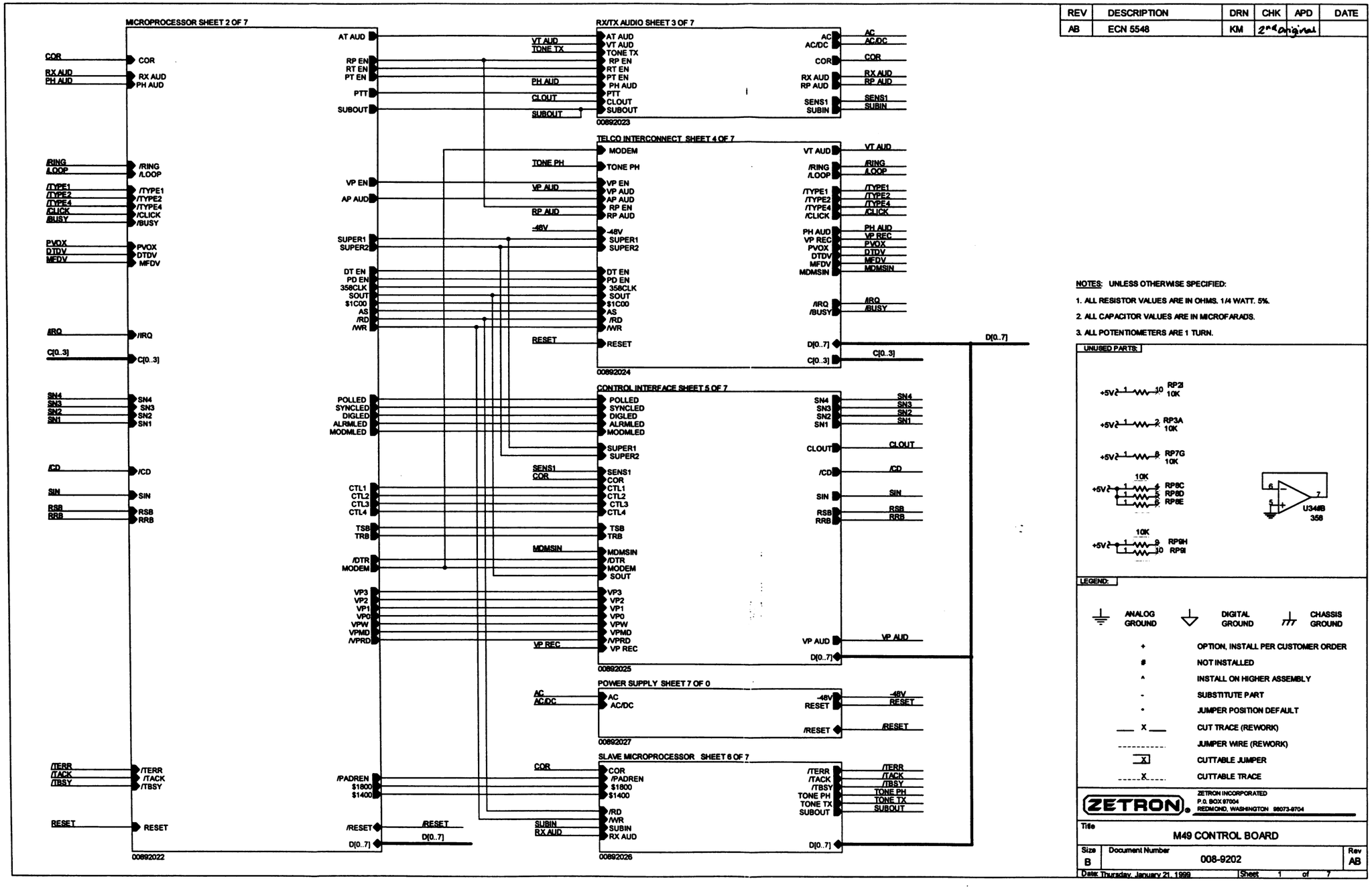


NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTOR VALUES ARE IN OHMS. 1/4 WATT. 5%.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. ALL POTENTIOMETERS ARE 1 TURN.

UNUSED PARTS:

LEGEND:

ANALOG GROUND | DIGITAL GROUND | CHASSIS GROUND

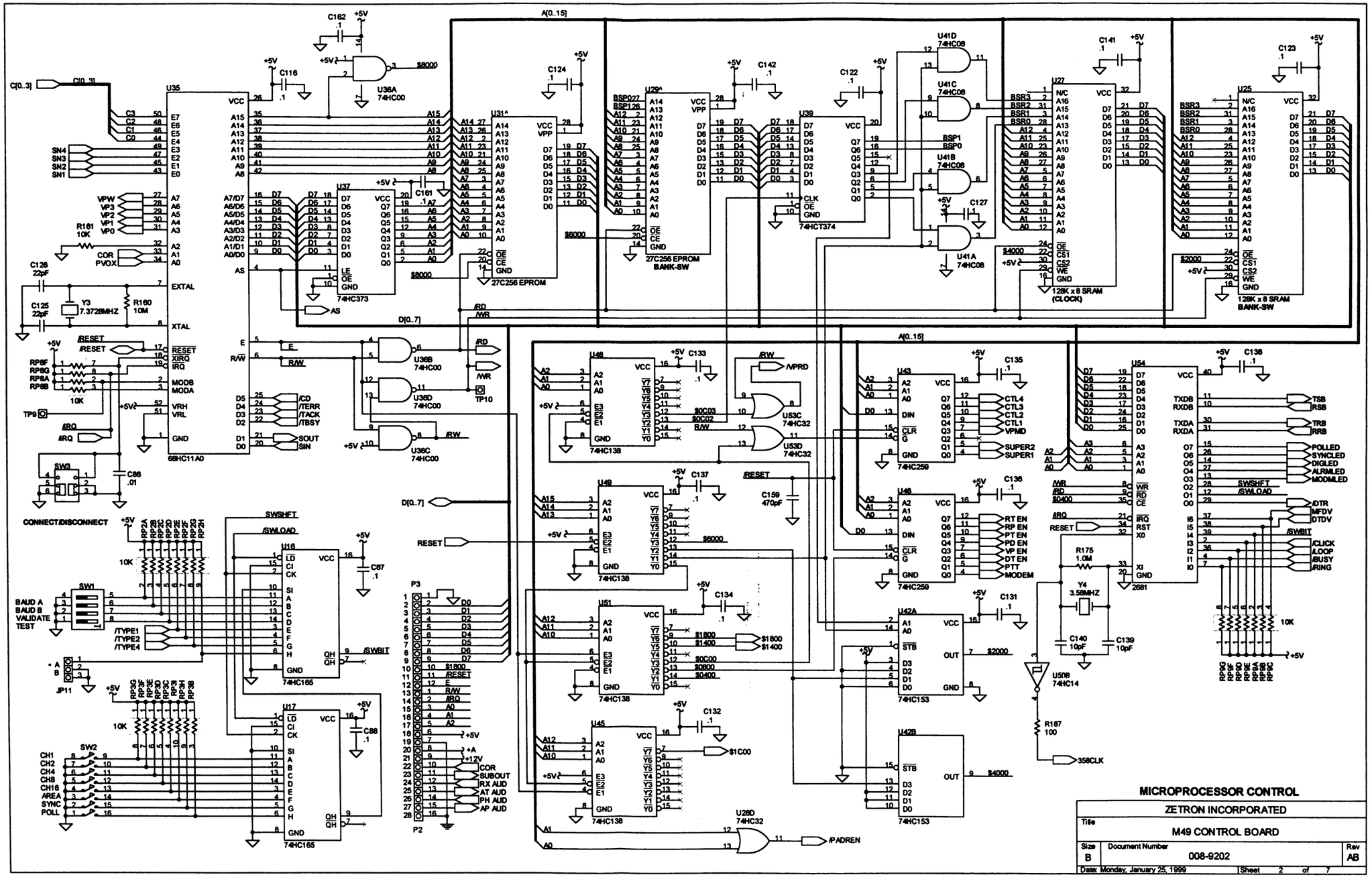
+	OPTION, INSTALL PER CUSTOMER ORDER
#	NOT INSTALLED
^	INSTALL ON HIGHER ASSEMBLY
-	SUBSTITUTE PART
•	JUMPER POSITION DEFAULT
— X —	CUT TRACE (REWORK)
----------	JUMPER WIRE (REWORK)
X	CUTTABLE JUMPER
X	CUTTABLE TRACE

ZETRON INCORPORATED
P.O. BOX 97004
REDMOND, WASHINGTON 98073-9704

Title: M49 CONTROL BOARD

Size	Document Number	Rev
B	008-9202	AB

Date: Thursday, January 21, 1999 Sheet 1 of 7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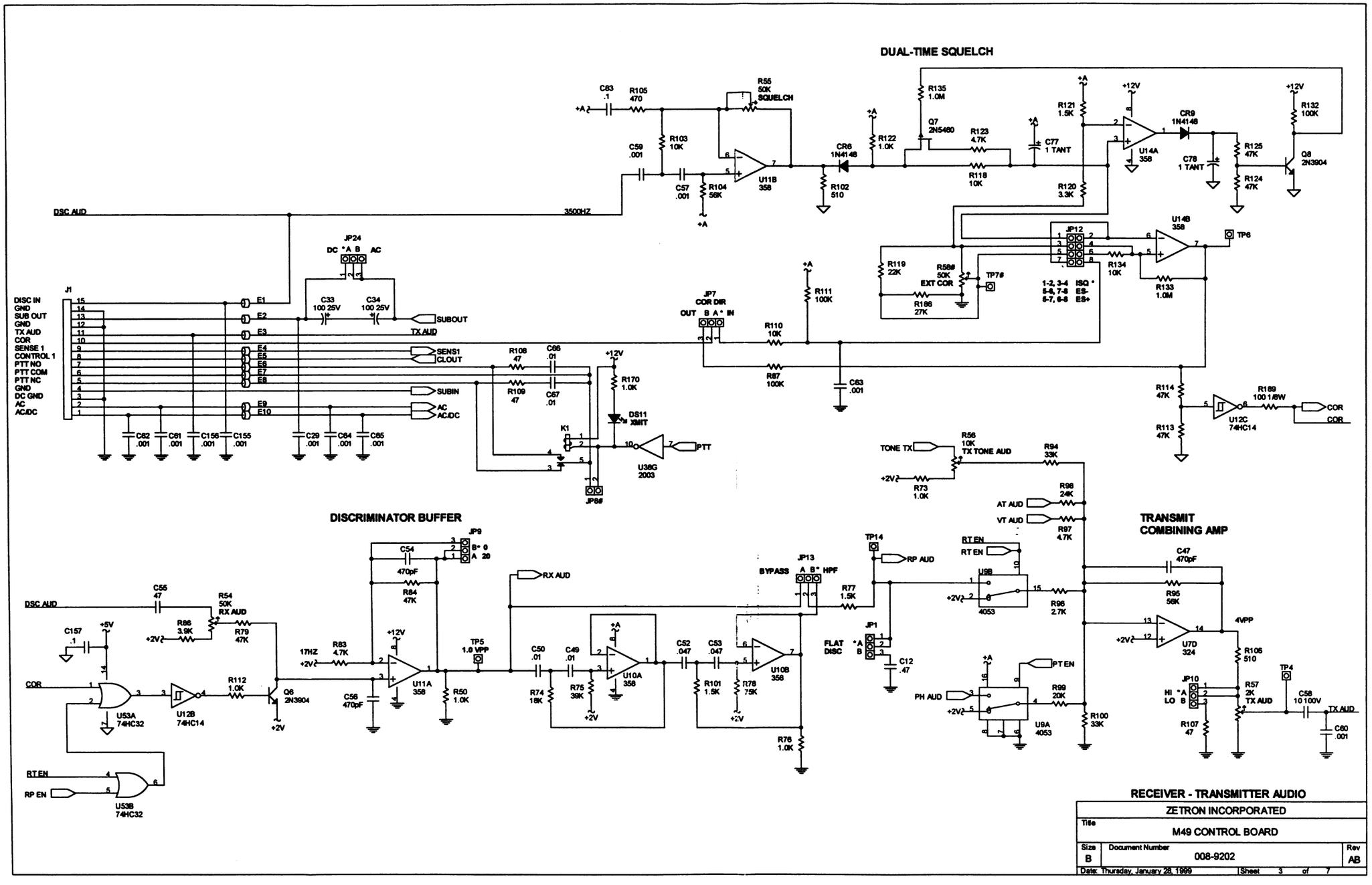
ZETRON INCORPORATED
M49 CONTROL BOARD
008-9202
AB
Monday, January 25, 1999
Sheet 2 of 7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U11B 358
CR6 1N4148
R102 510
R122 1.0K
R135 1.0M
Q7 2N5460
R123 4.7K
R118 10K
C77 1 TANT
R121 1.5K
R120 3.3K
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CR9 1N4148
C78 1 TANT
R125 47K
R124 47K
R132 100K
Q8 2N3904
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J1
DISC IN
GND
SUB OUT
GND
TX AUD
COR
SENSE 1
CONTROL 1
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PTT COM
PTT NC
GND
DC GND
AC
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E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
C33 100 25V
C34 100 25V
SUBOUT
TX AUD
SENS1
CLOUT
SUBIN
AC
AC/DC
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C81 .001
C156 .001
C155 .001
C29 .001
C84 .001
C85 .001
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R87 100K
C63 .001
R111 100K
R119 22K
R58 50K EXT COR
R186 27K
TP7
JP12
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5-6, 7-8 ES-
6-7, 6-8 ES+
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TP6
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R109 47
C67 .01
+12V
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DS11 XMIT
K1
U38G 2003
PTT
JP8
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R113 47K
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R189 100 1/8W
COR
COR
TONE TX
R56 10K TX TONE AUD
+2V
R73 1.0K
R94 33K
R98 24K
AT AUD
VT AUD
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JP9 B 0 A 20
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DSC AUD
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+2V
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R96 2.7K
TRANSMIT COMBINING AMP
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R95 56K
U7D 324
4VPP
R106 510
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TP4
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RECEIVER - TRANSMITTER AUDIO
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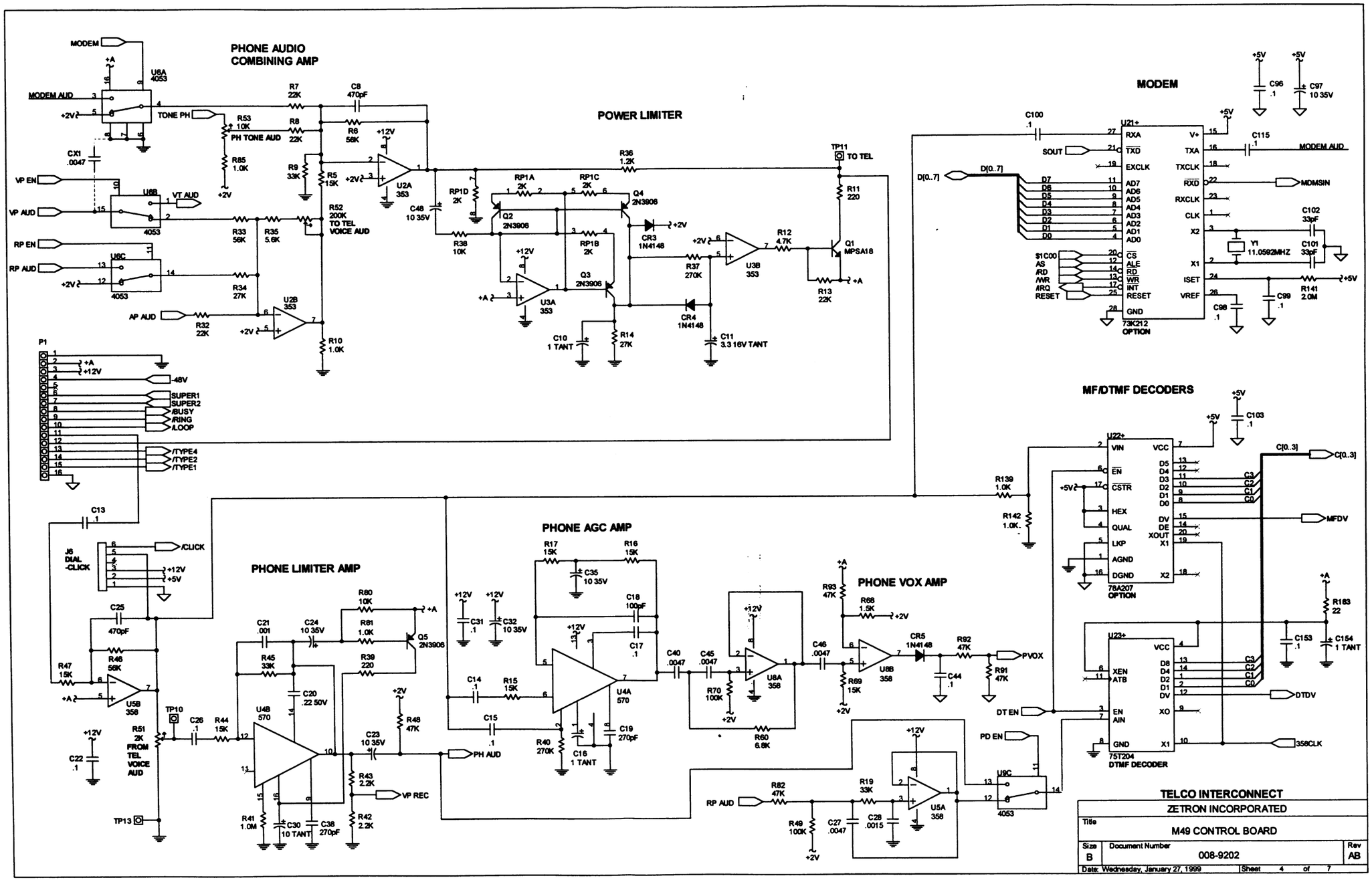
Size B
Document Number 008-9202
Rev AB
Date: Thursday, January 28, 1999
Sheet 3 of 7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MODEM
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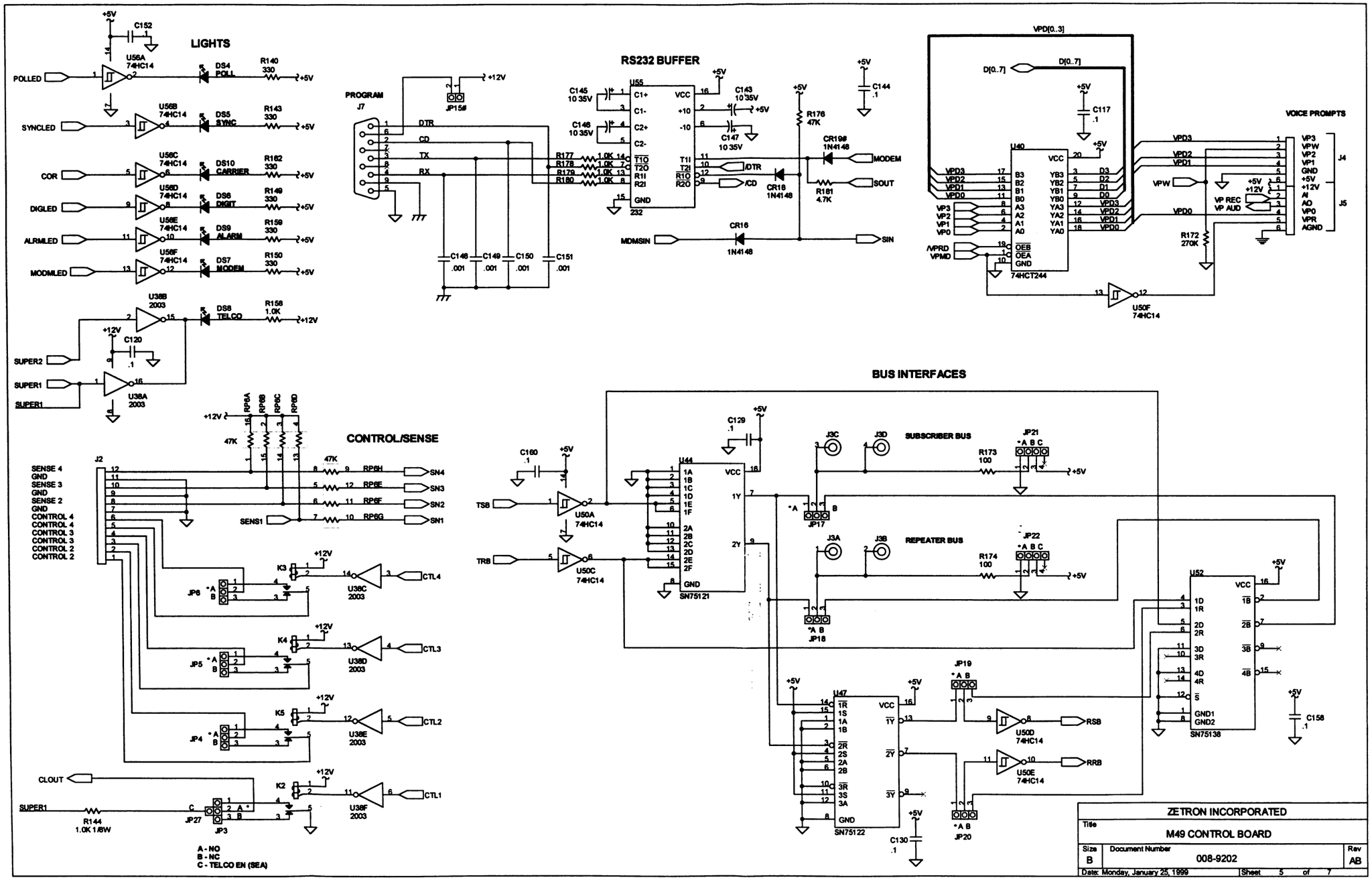
ZETRON INCORPORATED
M49 CONTROL BOARD
008-9202
AB
Wednesday, January 27, 1999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DS6 DIGIT
DS9 ALARM
DS7 MODEM
DS8 TELCO
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R149 330
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C151 .001
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VP AUD
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J5
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REPEATER BUS
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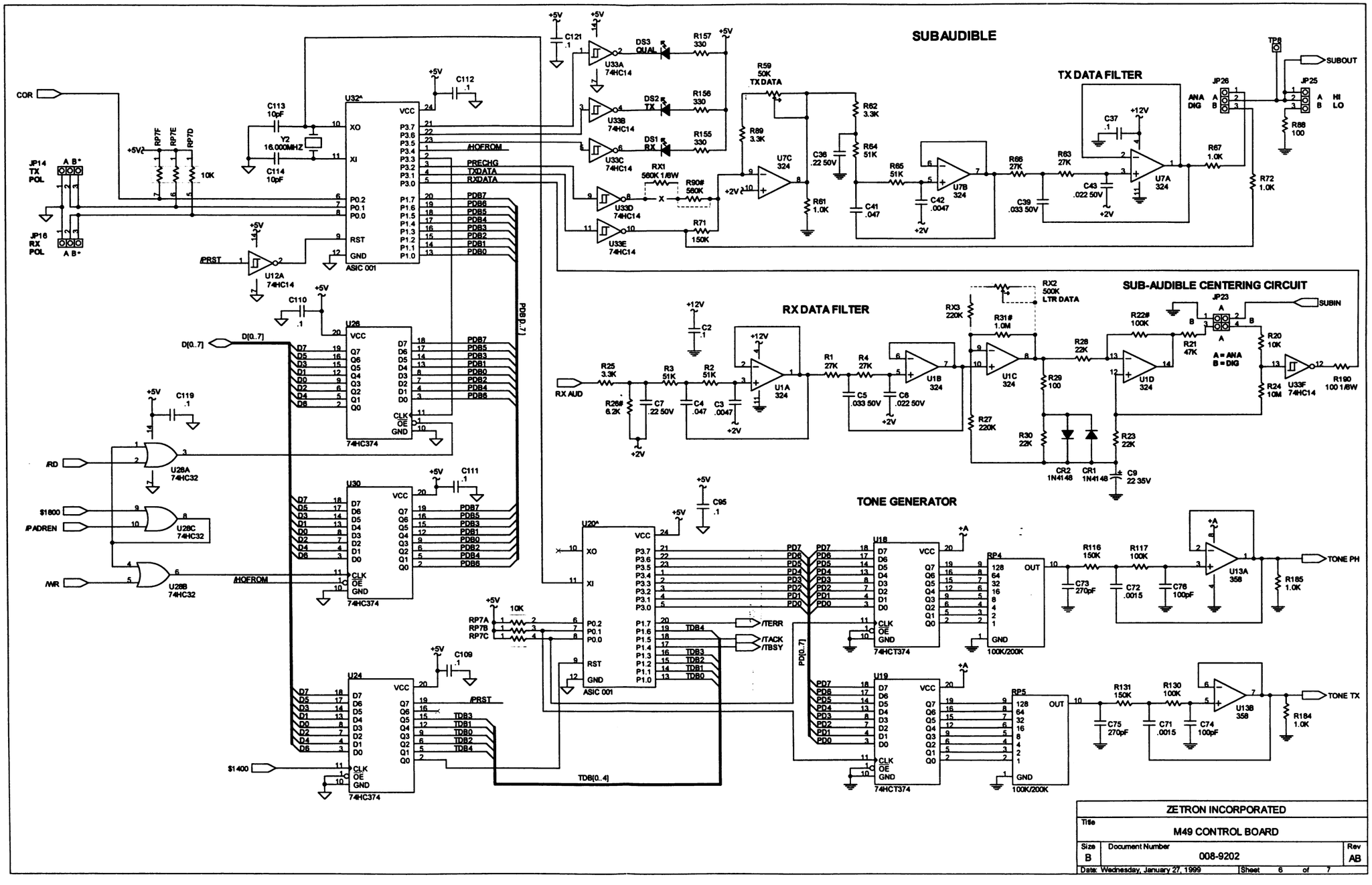
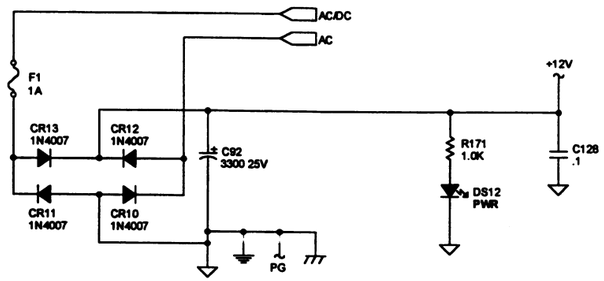
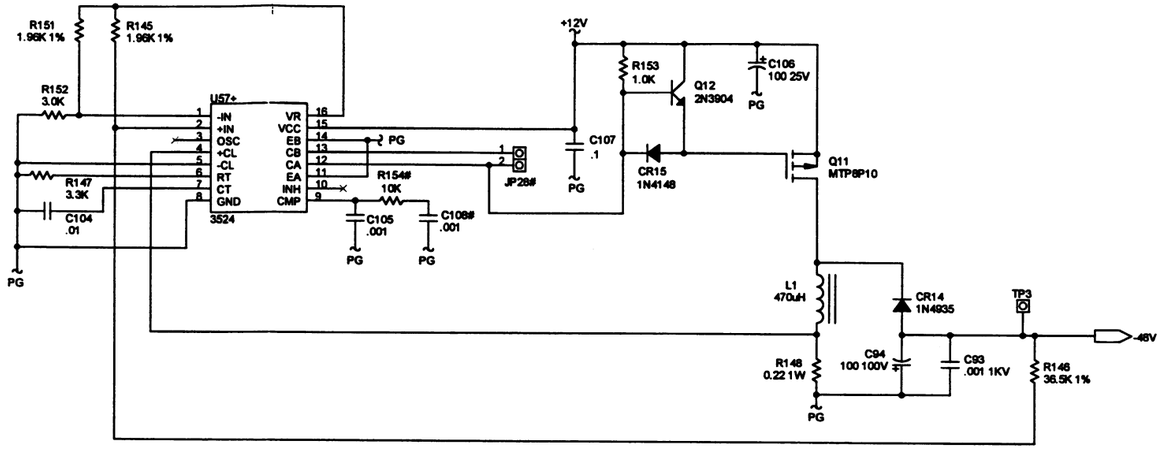
JP22
R173 100
R174 100
JP17
JP18
U44
SN75121
C129 .1
C160 .1
U50A 74HC14
U50C 74HC14
TSB
TRB
U47
SN75122
JP19
JP20
U50D 74HC14
U50E 74HC14
RSB
RRB
C130 .1
U52
SN75138
C158 .1
CONTROL/SENSE
SENSE 4
SENSE 3
SENSE 2
CONTROL 4
CONTROL 3
CONTROL 2
SENS1
SN4
SN3
SN2
SN1
RP6A
RP6B
RP6C
RP6D
RP6E
RP6F
RP6G
RP6H
47K
K3
K4
K5
K2
JP6
JP5
JP4
JP3
JP27
U38C 2003
U38D 2003
U38E 2003
U38F 2003
CTL4
CTL3
CTL2
CTL1
CLOUT
R144 1.0K 1/8W
A - NO
B - NC
C - TELCO EN (SEA)
ZETRON INCORPORATED
M49 CONTROL BOARD
008-9202
Size B
Rev AB
Date: Monday, January 25, 1999
Sheet 5 of 7


SUBAUDIBLE
TX DATA FILTER
SUB-AUDIBLE CENTERING CIRCUIT
RX DATA FILTER
TONE GENERATOR
COR
JP14 TX POL
JP16 RX POL
Y2 16.000MHZ
U32A
ASIC 001
/PRST
U12A 74HC14
U26
74HC374
D[0..7]
PDB[0..7]
/RD
/WR
$1800
/PADREN
U28A 74HC32
U28B 74HC32
U28C 74HC32
/HOFROM
U30
U24
$1400
U20A
TDB[0..4]
/PRECHG
/TXDATA
/RXDATA
/TERR
/TACK
/TBSY
PD[0..7]
DS3 QUAL
DS2 TX
DS1 RX
U33A 74HC14
U33B 74HC14
U33C 74HC14
U33D 74HC14
U33E 74HC14
U7C 324
U7B 324
U7A 324
TP8
SUBOUT
JP26 ANA DIG
JP25 HI LO
U1A 324
U1B 324
U1C 324
U1D 324
U33F 74HC14
JP23
SUBIN
A = ANA
B = DIG
U18
U19
74HCT374
RP4
RP5
100K/200K
U13A 358
U13B 358
TONE PH
TONE TX
ZETRON INCORPORATED
M49 CONTROL BOARD
Document Number 008-9202
Size B
Rev AB
Date: Wednesday, January 27, 1999
Sheet 6 of 7

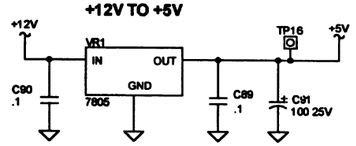
AC/DC INPUT



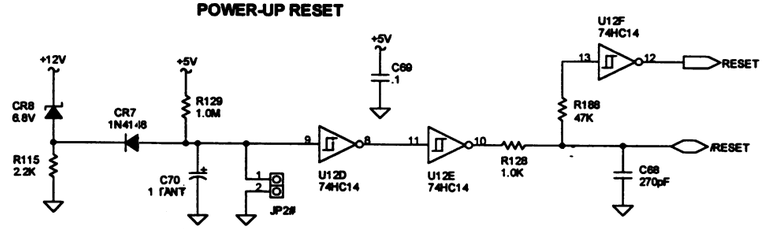
+12V TO -48V INVERTER

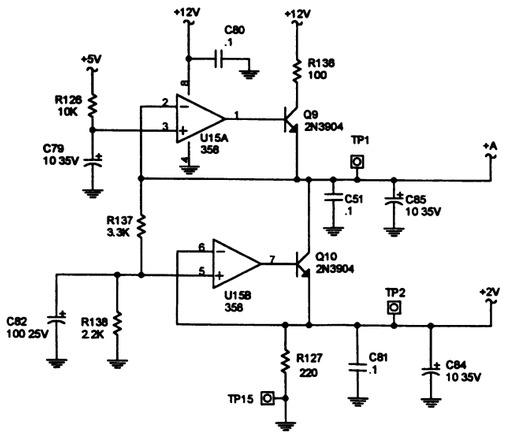


+12V TO +5V

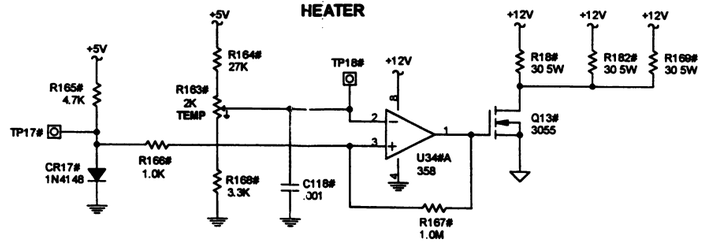


POWER-UP RESET





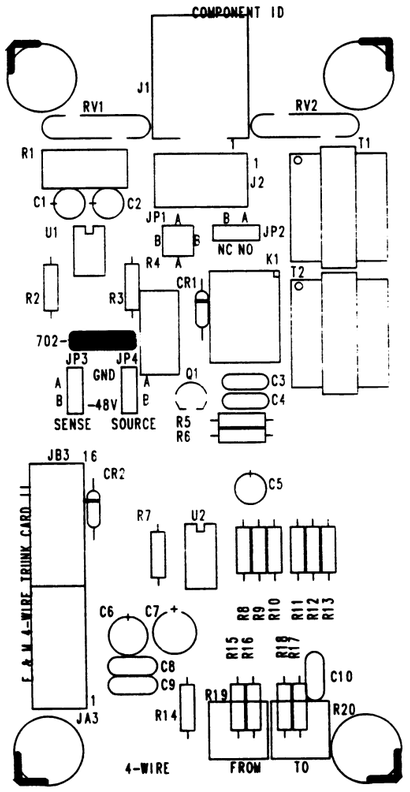
HEATER



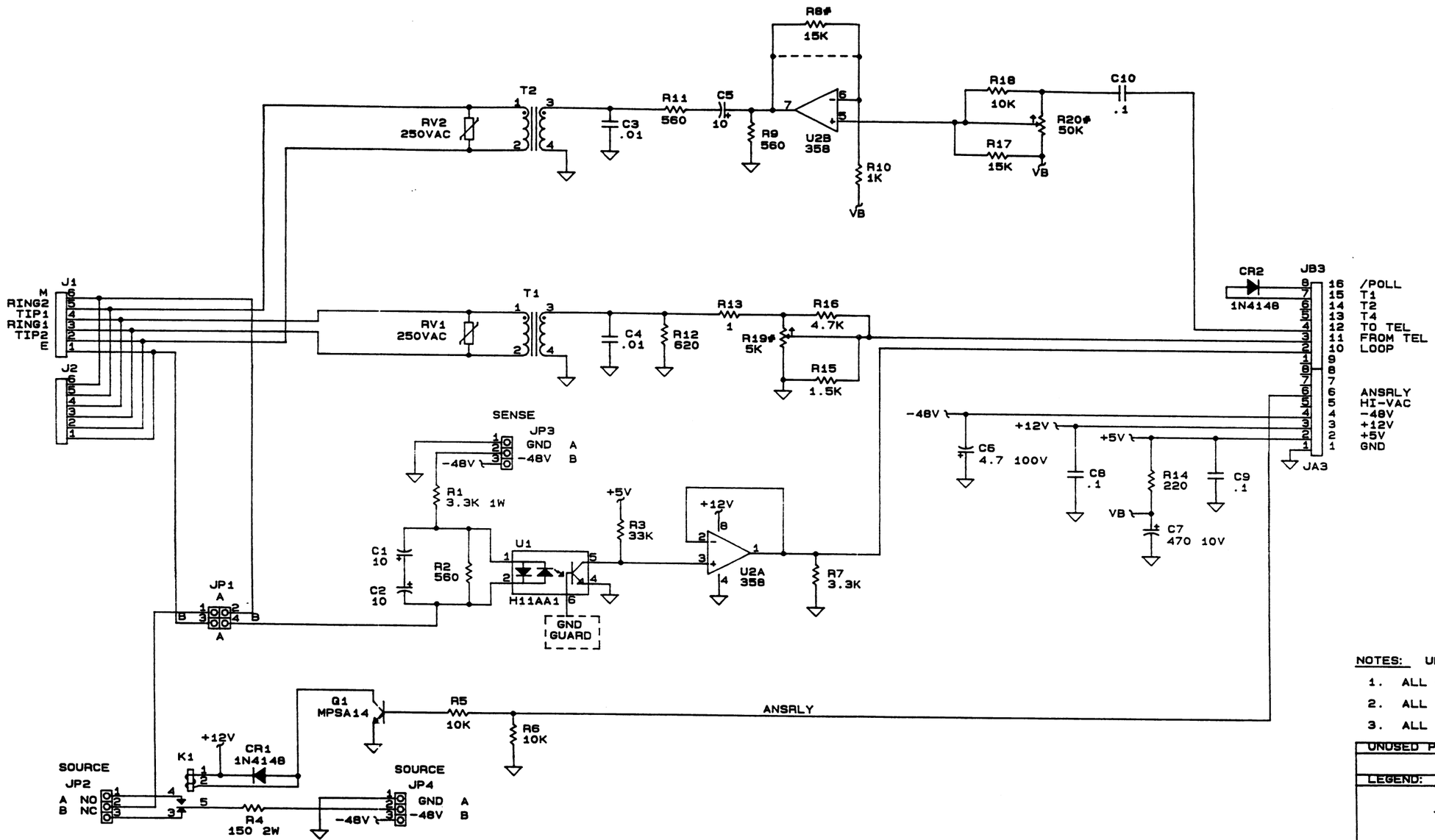
POWER SUPPLY

ZETRON INCORPORATED		
Title: M49 CONTROL BOARD		
Size: B	Document Number: 008-9202	Rev: AB
Date: Thursday, January 28, 1999	Sheet 7 of 7	

E&M 4-Wire Interface Silkscreen 702-9445 Rev. A



REV	DESCRIPTION	DRN	APP	DATE
A	RELEASE	KM	[illegible]	3/17/92



FOR MICROWAVE SYSTEMS:

R17 from 15K to 1K for 7Vpp in = -16dBm out
R13 from 1 to 6.2K for +7dBm in = 0.45Vpp out

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.

UNUSED PARTS:

LEGEND:

+	OPTION, INSTALL PER CUSTOMER ORDER.
-	INSTALLED ON HIGHER ASSEMBLY.
#	NOT INSTALLED.
——X——	CUT TRACE.
- - - - - - - - - -	JUMPER WIRE.

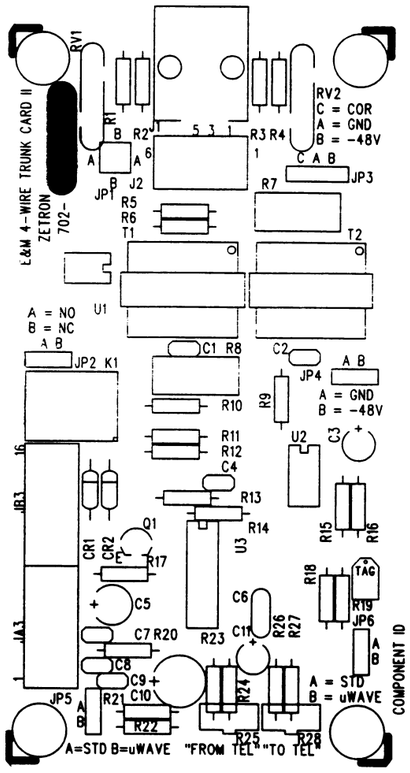
ZETRON, INC.
12335 134th COURT N.E.
REDMOND, WA 98052-2433

Title: E&M 4-WIRE INTERFACE

Size	Document Number	REV
B	008-9445	A

Date: March 7, 1992 Sheet 1 of 1

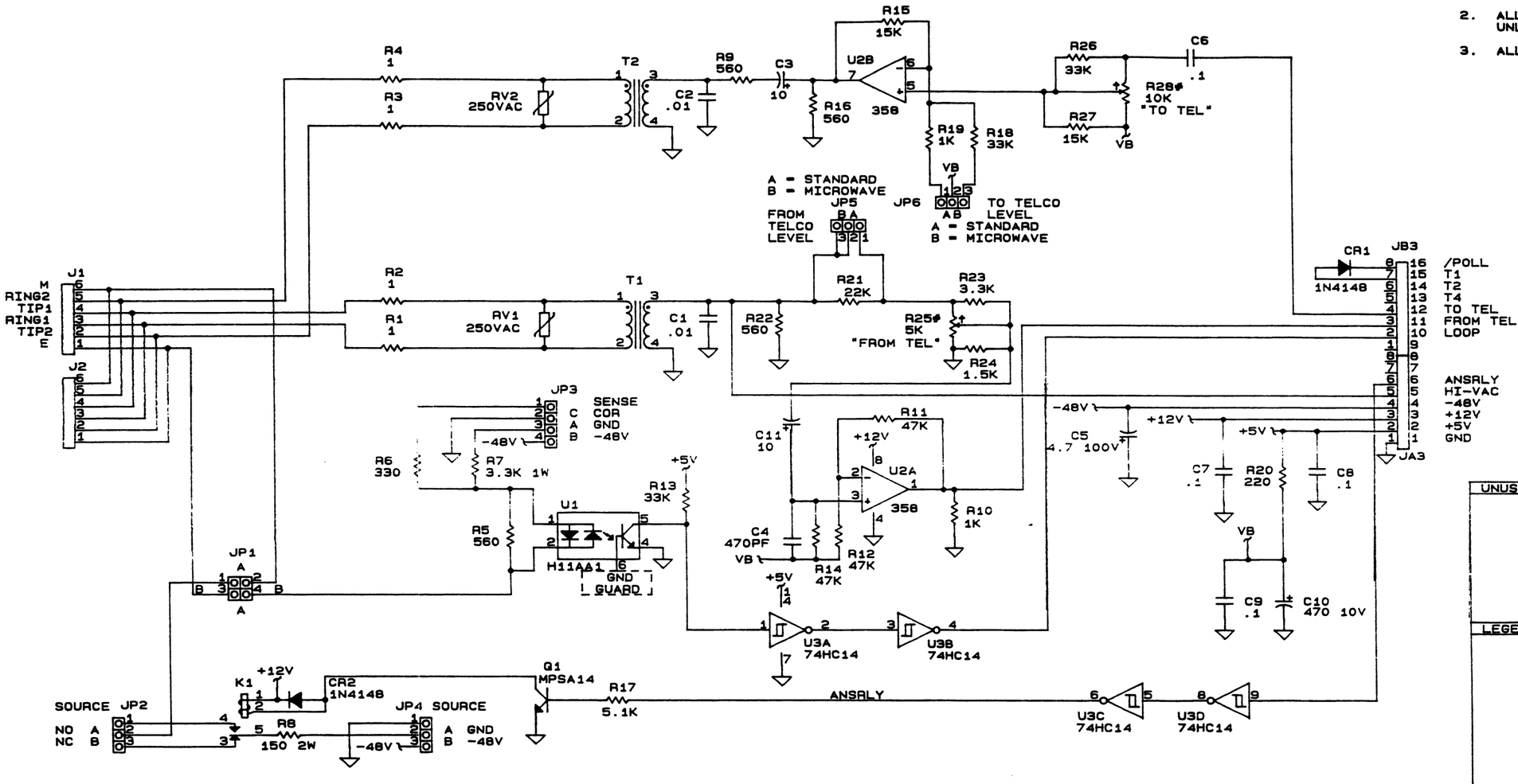
E&M 4-Wire Interface Silkscreen 702-9445 Rev. C



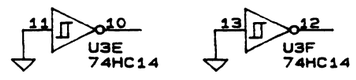
REV	DESCRIPTION	DRN	APD	DATE
A	RELEASE			
B	HCN 2381			5.9.96
C	HCN 2534	DW		4.19.98

NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS +/- 5% AND ARE 1/4 WATT. UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. ALL POTENTIOMETERS ARE 1 TURN.



UNUSED PARTS:



LEGEND:

⏚	ANALOG GROUND
⏚	CHASSIS GROUND
⏚	DIGITAL GROUND
+	OPTION, INSTALL PER CUSTOMER ORDER.
^	INSTALLED ON HIGHER ASSEMBLY.
#	NOT INSTALLED.
——×——	CUT TRACE.
- - - - - - - - - -	JUMPER WIRE.

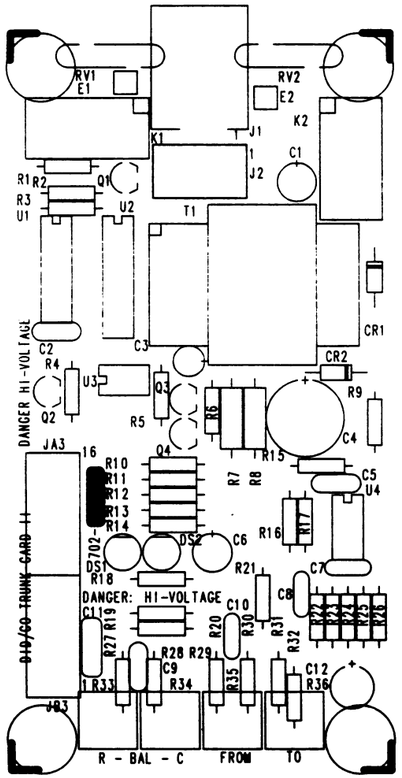
ZETRON, INC.
12335 134th COURT N.E.
REDMOND, WA 98052-2433

Title: M492 E&M 4-WIRE INTERFACE

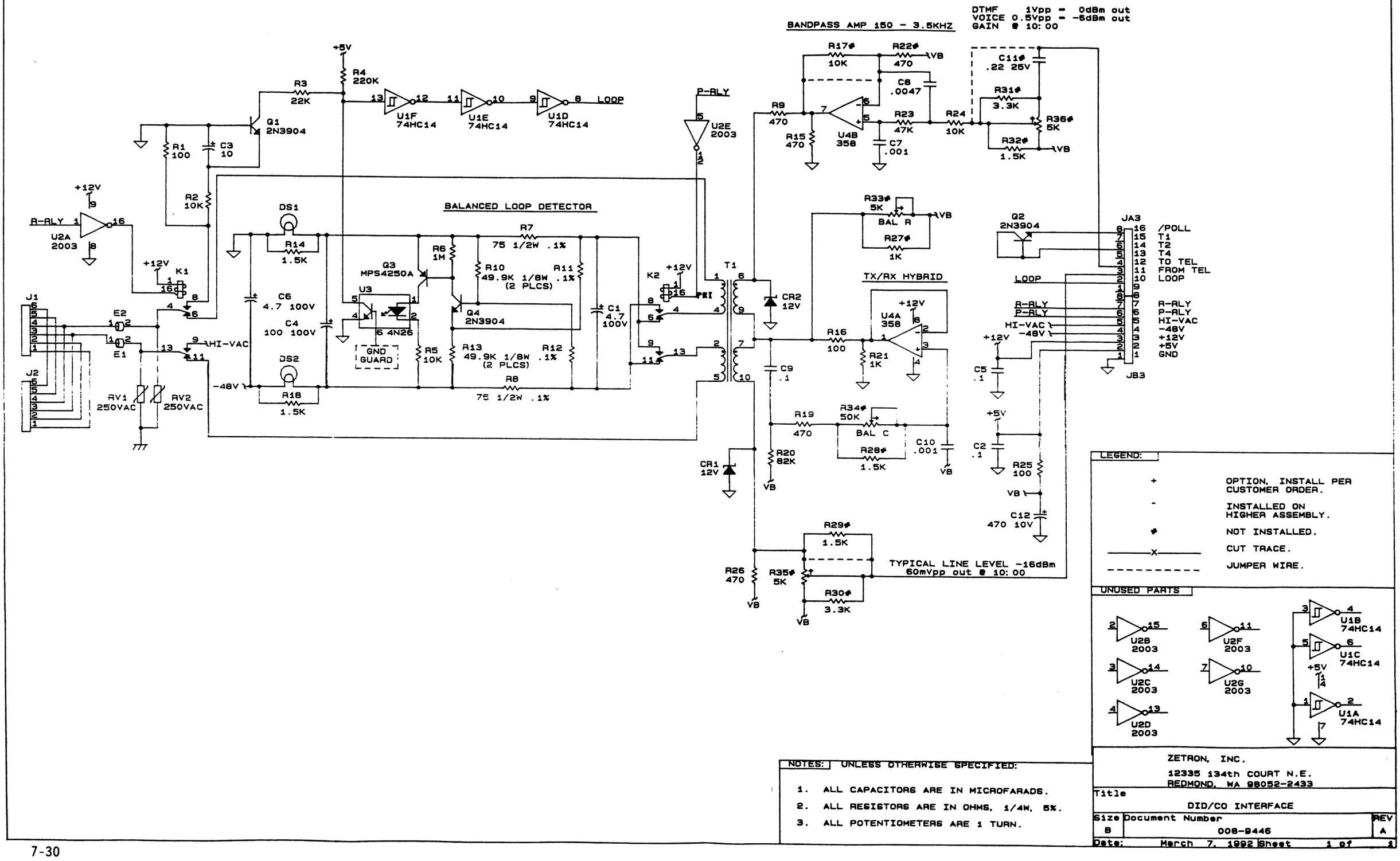
Size	Document Number	REV
B	008-9445	C

Date: April 19, 1994 Sheet 1 of 1

DID/CO Interface Silkscreen 702-9446 Rev. A



REV	DESCRIPTION	DN	APD	DATE
A	RELEASE	KM	[illegible]	3/10/92



LEGEND:

+	OPTION. INSTALL PER CUSTOMER ORDER.
-	INSTALLED ON HIGHER ASSEMBLY.
#	NOT INSTALLED.
——x——	CUT TRACE.
- - - - - - - - - -	JUMPER WIRE.

UNUSED PARTS

U2B 2003 (2, 15)
U2F 2003 (6, 11)
U1B 74HC14 (3, 4)
U2C 2003 (3, 14)
U2G 2003 (7, 10)
U1C 74HC14 (5, 6)
U2D 2003 (4, 13)
U1A 74HC14 (1, 2)

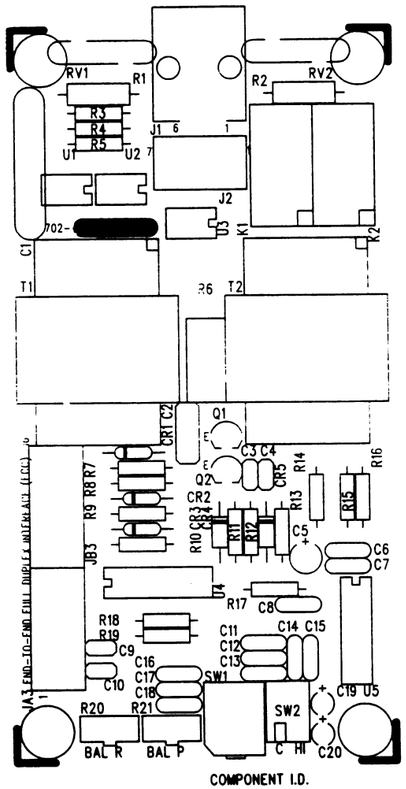
NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL CAPACITORS ARE IN MICROFARADS.
2. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.
3. ALL POTENTIOMETERS ARE 1 TURN.

ZETRON, INC.
12335 134th COURT N.E.
REDMOND, WA 98052-2433

Title		
DID/CO INTERFACE		
Size: B	Document Number: 008-9446	REV: A
Date: March 7, 1992	Sheet 1 of 1	

End-End Full Duplex Interface Silkscreen 702-9669 Rev. A



COMPONENT I.D.

REV	DESCRIPTION	DN	APD	DATE
A	RELEASE	DW		3-15-94

+5V R18 10K — GS-RLY — U4C 74HC14 — U4D 74HC14

+5V R19 10K — LS-RLY — U4B 74HC14 — U4A 74HC14

+12V CR3 1N4148 — K2 — Q2 2N3904 — R10 5.1K

+12V CR2 1N4148 — R9 5.1K — Q1 2N3904

+12V — K1

J1 — RING / TIP — R2 4.7-1/2F

J2 — R1 4.7-1/2F

RV1 250VAC — RV2 250VAC

R6 3.3K 1W — -48V

C1 .47 250V

T1 — VB

T2 — VB

R14 560 — U5C 3403 — CR4 12V

C6 .0047 — R15 47K — R16 10K — C7 .001

C20 4.7 TANT — C19 4.7 TANT — SW2A

R20 2K "BAL R" — R21 500 "BAL P"

C14 .047 — SW2B

C18 .0047 — C15 .033 50V — C11 .01 — C13 .01 — C12 .01 — C17 .01 — C16 .033 50V

SW1 CP CN — "BAL C"

R12 620 — CR5 12V

LOOP DETECTOR

+5V R8 220K — U3 4N26 — GND GUARD — U4E 74HC14

R5 470

+5V R7 220K — U2 4N26 — GND GUARD — U4F 74HC14

GS/I+ RING/I-

RING DETECTOR

R4 22K — U1 H11AA1 — GND GUARD — R3 2.2K — C2 .22 50V

R13 5.1K — C8 .0047 — R17 5.1K — U5D 3403 — VB

CR1 1N4148

U5A 3403 — C4 .001

+12V C9 .1 — +5V C10 .1 — R11 10K — C5 10 — C3 .1

JB3

16	/POLL
15	T1
14	T2
13	T4
12	TO TEL
11	
10	GS/I+
9	RD/I-
8	BUSY
7	GSRLY
6	LSRLY
5	HI-VAC
4	-48V
3	+12V
2	+5V
1	GND

JA3

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.

UNUSED PARTS:

U5B 3403

LEGEND:

+	OPTION, INSTALL PER CUSTOMER ORDER.
-	INSTALLED ON HIGHER ASSEMBLY.
#	NOT INSTALLED.
—x—	CUT TRACE.
- - - - -	JUMPER WIRE.

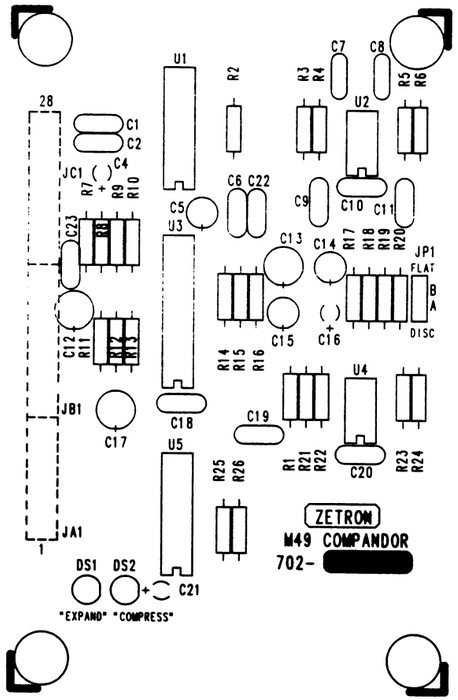
ZETRON, INC.
12335 134th COURT N.E.
REDMOND, WA 98052-2433

Title: E-E FULL DUPLEX INTERFACE (FCC)

Size: B | Document Number: 008-9669 | REV: A

Date: March 14, 1994 | Sheet 1 of 1

Model 49 Companding Card Silkscreen 702-9276 Rev. C



REV	DESCRIPTION	DN	APD	DATE
A	RELEASE	GWH		6/5/90
B	ECN 1009	GWH		6/25/90
C	ECN 1718	DW		12-18-92

AUDIO HIPASS 300Hz

JA1 GND 1, D0 2, D1 3, D2 4, D3 5, D4 6, D5 7, D6 8, D7 9
JB1 -SEL 10, -RES 11, E 12, R/W 13, -IRQ 14, A0 15, A1 16, A2 17, +5V 18
JC1 GND 19, +A 20, +12V 21, COR 22, SUBOUT 23, RXAUD 24, ATAUD 25, PHAUD 26, APAUD 27, GND 28

U5 74HC259: A2, A1, A0, DIN, CLR, G, GND, VCC, Q7, Q6, Q5, Q4, Q3, Q2, Q1, Q0
+5V, C21 1 TANT
R26 330, DS1 "EXPAND"
R25 330, DS2 "COMPRESS"

U1A 4053: C2 .1 FROMTEL, Vref
U1B 4053: C1 .1 RXAUD, Vref

"COMPRESSED": U1C 4053, R2 6.2K, R1 10K
"UNCOMPRESSED"

R14 10K, C22# .1, R16# 4.7K, R15 15K

U3: IN+, IN-, OUT, RECT, GAIN, COMP, VCC, C OUT, RECT GAIN, COMP, IN+, IN-, OUT, RECT GAIN, COMP, GND, REF
Vref, +A, C15 2.2 100V, C18 .1, C17 100
C23# .1, R11# 4.7K, R12 22K, R13 10K, C12 4.7 100V
R9 22K, R8 33K, R7 33K, C4 1 TANT
C13 100, C6 .1, C5 2.2 100V

RXAUD: C7 .01, C8 .01, R5 12K, R6 47K, Vref
U2A 358: C10 .1
C11 .1, R4 510, C9 .1, R3 47K, Vref
U2B 358
R19 510, R18 1K, R24 10K
JP1 FLAT DISC, R17 220, C14 10, R20 47, C16 1 TANT
U4A 358: C20 .1, Vref, R23 4.7K

FROMTEL: C19 .1, R21 15K
U4B 358: R22 10K, Vref, R10 4.7K

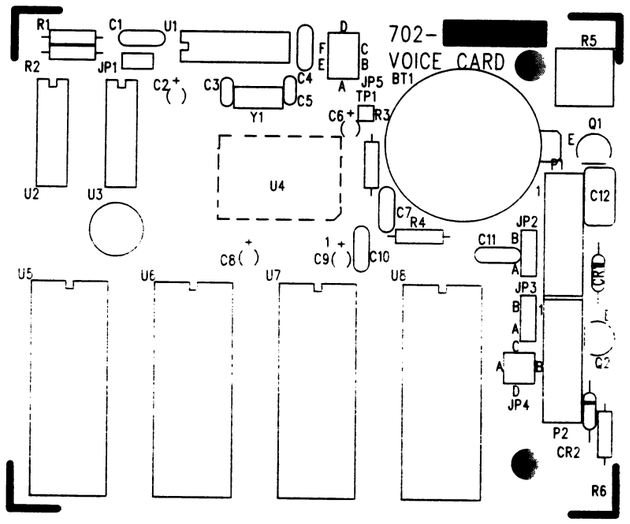
NOTES: UNLESS OTHERWISE SPECIFIED.
1. ALL CAPACITORS ARE IN MICROFARADS.
2. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.
3. ALL POTENTIOMETERS ARE 1 TURN.

LEGEND:
+ OPTION, INSTALL PER CUSTOMER ORDER.
- INSTALLED ON HIGHER ASSEMBLY.
NOT INSTALLED.
—X— CUT TRACE.
- - - - - - JUMPER WIRE.

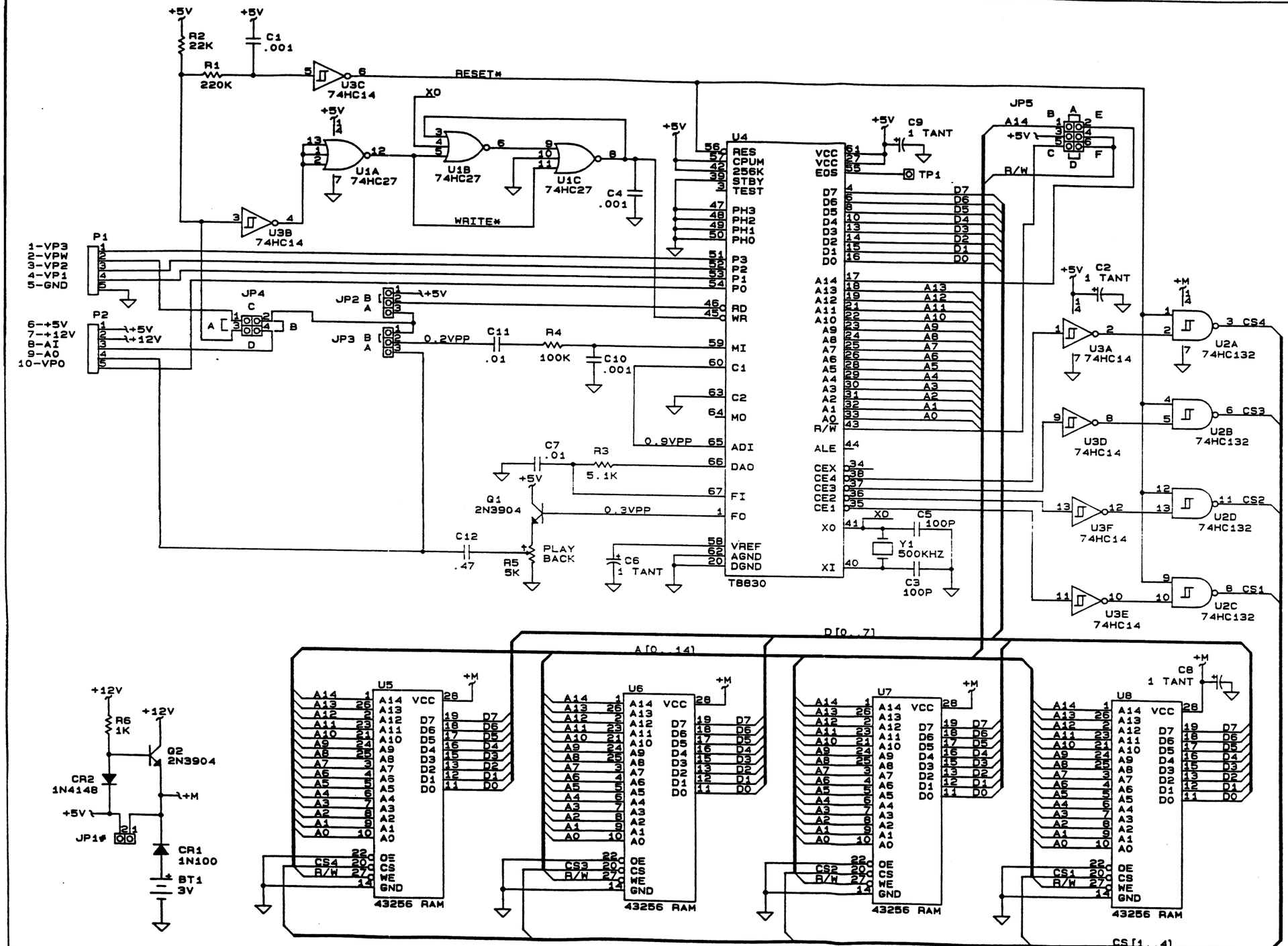
ZETRON, INC.
12335 134th COURT N.E.
REDMOND, WA 98052-2433

Title: M49 COMPANDOR
Size: B | Document Number: 008-9276 | REV: C
Date: June 27, 1990 | Sheet 1 of 1

Model 49 Voice Card Silkscreen 702-9391 Rev. C



REV	DESCRIPTION	DN	APR	DATE
A	RELEASE	KN		
B	ECN 1478	KM	KM	4/8/91
C	ECN 1657	KN		



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.

UNUSED PARTS:

LEGEND:

+	OPTION, INSTALL PER CUSTOMER ORDER.
-	INSTALLED ON HIGHER ASSEMBLY.
#	NOT INSTALLED.
——x——	CUT TRACE.
- - - - -	JUMPER WIRE.

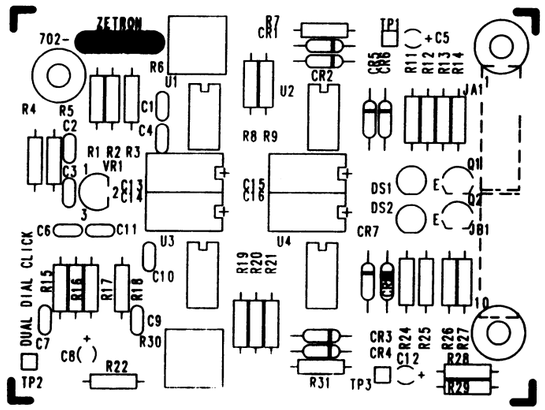
ZETRON, INC.
12335 134TH COURT N.E.
REDMOND, WASHINGTON, 98052-2433

Title: MODEL 49 VOICE CARD

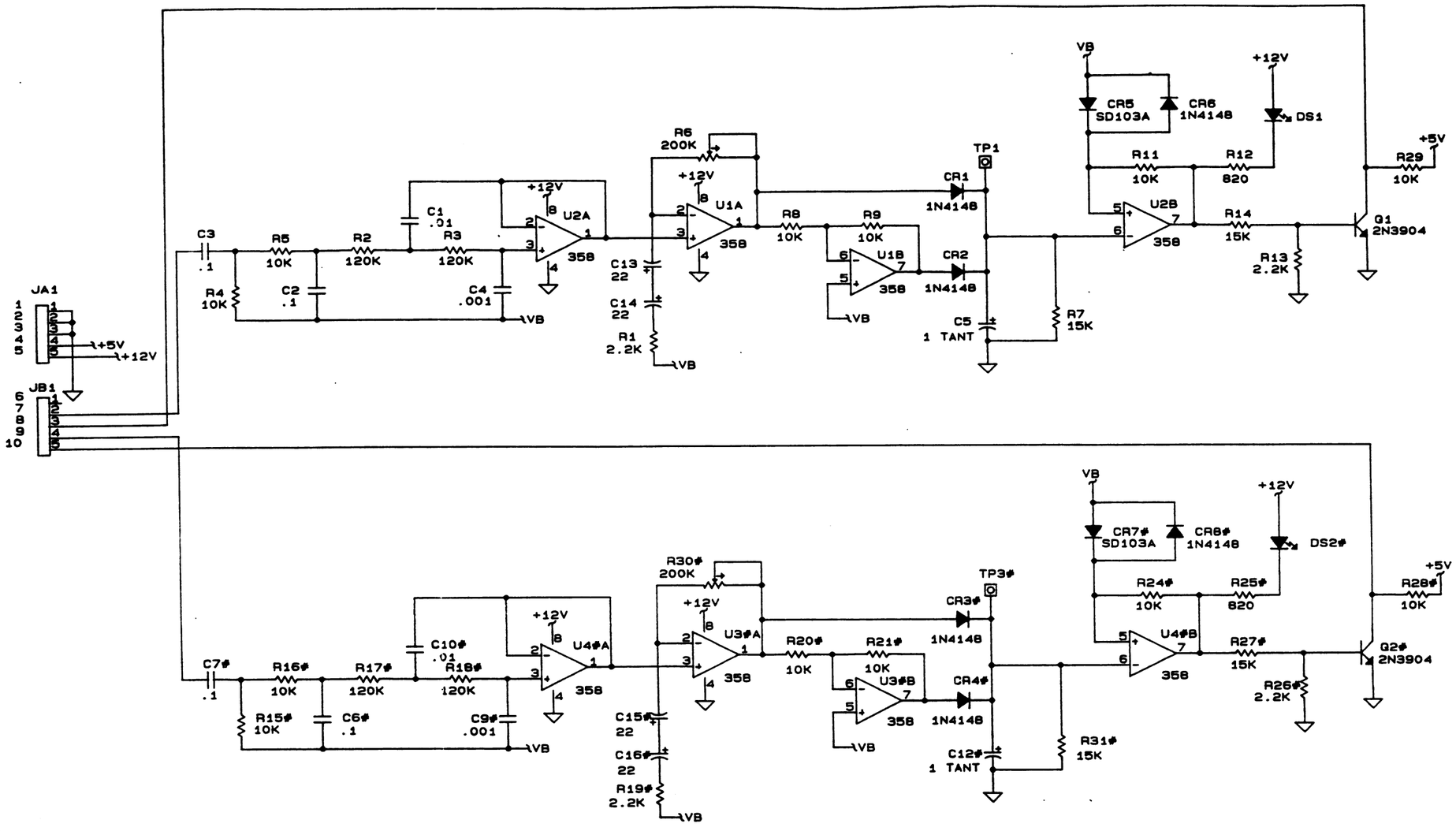
Size: B | Document Number: 008-0391 | REV: C

Date: October 2, 1991 | Sheet 1 of 1

Model 4XB Dial Click Card Silkscreen 702-9242 Rev. E



REV	DESCRIPTION	DN	APD	DATE
D	ECN 817	GH		
E	ECN 964	GH	JCV	4-30-90



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.

LEGEND:

+	OPTION, INSTALL PER CUSTOMER ORDER.
-	INSTALLED ON HIGHER ASSEMBLY.
#	NOT INSTALLED.
———X———	CUT TRACE.
- - - - - - - - - -	JUMPER WIRE.

ZETRON, INC.

12335 134th COURT N.E.
REDMOND, WA 98052-2433

Title: M4XB DIAL CLICK

Size	Document Number	REV
B	008-9242	E

Date: April 30, 1990 Sheet 1 of 1

8. TROUBLESHOOTING

8.TROUBLESHOOTING

The following flowchart is included to assist experienced electronic service technicians in troubleshooting common problems that may be encountered during installation of the Model 49 into an LTR system. Each paragraph in the right-hand column of the flowchartdeals with an observed fault symptom, possible causes for the symptom, and some recommended remedies.

Begin diagnosis at the "start" of the troubleshooting flowchart and follow the path to the fault experienced. Should you require assistance beyond this chart, please contact Zetron (see the front cover of this manual for the phone number).

The general structure of the flowchart is:

Start

⇩

Set-Up

⇩

Power-on (Power Supplies)

⇩

Sync?

⇩

Poll?

⇩

Carrier LED/Squelch

⇩

Idle Mode

⇩

Test Mode Operation

⇩

Dispatch Operation

⇩

Interconnect Operation

⇩

Computer Access (Local/Modem)

⇩

Alarm Operation

⇩

Cross-Busy Operation

TROUBLESHOOTING FLOWCHART

Start
↓
Set-up Dipswitches, Jumpers, Repeater →Refer to Section 4.
↓
Power-On
Normal Boot
↓ ↓
Yes NO → **Verify Power Supplies:**
(TP13 is GND reference)
↓
+12 Vdc @ C92 (+) [10.5-16.0]
* check F1 (1A)
* check CR10, 11, 12, 13
* check C92 (short?)
* check C128 (short?)
↓
+ 5 Vdc @ TP16 [4.75-5.25]
* check VR1
* check C91
* check C90
* check C89
↓
+A = +5 Vdc @ TP1 [4.75-5.25]
* check C85
* check C51
* check U15A
↓
+2 Vdc @ TP2 [1.90-2.10]
* check C84
* check C81
* check U15B
↓
-48 Vdc @ TP3 [45.6-50.4]
* check U57p15 = +12 Vdc
Unloaded waveforms below:
↓
* check U57p12 for square wave
56μs @+12Vdc plus 1 Vp+ half
sinewave (≈10 damped cycles)
6 μs @ 0.6 Vdc
↓
* check CR15 anode (Q11 gate)
56μs @+12Vdc plus 2Vp-p
damped sinewave (≈19 cycles)
6 μs @ 1 Vdc
↓
* check CR14 cathode (Q11 Tab)
6μs @ +12 Vdc
2μs @ -50 Vdc (wider loaded)
2μs @ +12 Vdc
52μs very damped oscillation
(≈18 cyc damped,less loaded)
↓
Power Supplies OK ←
↓

↓

Sync present

Observe LED on M49 face.

↓ ↓

Yes NO → Verify 1 "Master" at LTR Site
SW2-2: up = master
down = slave

↓

* Verify SYNC BUS termination
(only *ONE* M49 terminated)
JP22 = A if EFJ Terminated
= B if Uniden Terminated
= C if NOT Terminated

For ease of mind, terminate only the "master" M49 unit.

↓

* Hardware failure - trace path:
U35 μProcessor data→ U54 DUART→
"TRB"signal→U50C (p5→p6)
→U44p9 (EFJ) or U52p2 (Uniden)
* Soft Reset M49. Hold CONNECT / DISCONNECT button until LEDs flash.

Poll present

Observe LED on M49 face.

↓ ↓

Yes NO → Verify 1 "Master" at LTR Site
SW2-1: up = master
down = slave

↓

* Verify POLL BUS termination
(only *ONE* M49 terminated)
JP21 = A if EFJ Terminated
= B if Uniden Terminated
= C if NOT Terminated

For ease of mind, terminate only the "master" M49 unit.

↓

* Hardware failure - trace path:
U35 μProcessor data→ U54 DUART→
"TSB"signal→U50A (p1→p2)
→U44p7 (EFJ) or U52p7 (Uniden)
* Soft Reset M49. Hold CONNECT / DISCONNECT button until LEDs flash.

↓

Carrier LED off when repeater idle

↓ Yes / No → Re-adjust M49 SQUELCH
Refer to Section 4

↓

* JP12 Set properly:
  ISQ = 1-2, 3-4
  EXT- = 5-6, 7-8
  EXT+ = 5-7, 6-8

↓

* TP6 low if Disc In quiet, and Carrier LED lights
* Disc In ≈ 2 Vpp noise *Idle*

↓

Idle Packets transmitting normally @ correct intervals

↓ Yes / No → Verify Multibase Programming

↓

* "Idle Msg Time" in Edit/Site Config. sets interval between messages

↓

* "Turn Off Idle Msg" in Edit/Repeater Config. Should be set to "N" for most LTR site applications.

Test Mode Operation
This mode provides a means of determining Repeater and/or M49 hardware faults.

↓ → Test Mode Tests

↓

* Note SW1-2 position for later restoration if changed.

↓

* Invoke Test Mode as follows:
  - SW1-1: UP Enables Test Mode
  - SW1-2: DOWN Tx TEST ID code
    UP Tx ID=253 (BUSY)
  - Soft Reset M49 by pressing and holding CONNECT/DISCONNECT switch on front until LEDs flash (approximately 2 sec).

↓

Operating Mode

↓

1. Transmit Test
   * Invoke Test Mode, M49 should begin transmitting ringing with selected LTR ID code.
   * Verify status of Tx signal with RF Service Monitor set to Tx carrier frequency.

(continued next page)

↓

(Normal Operation)

↓

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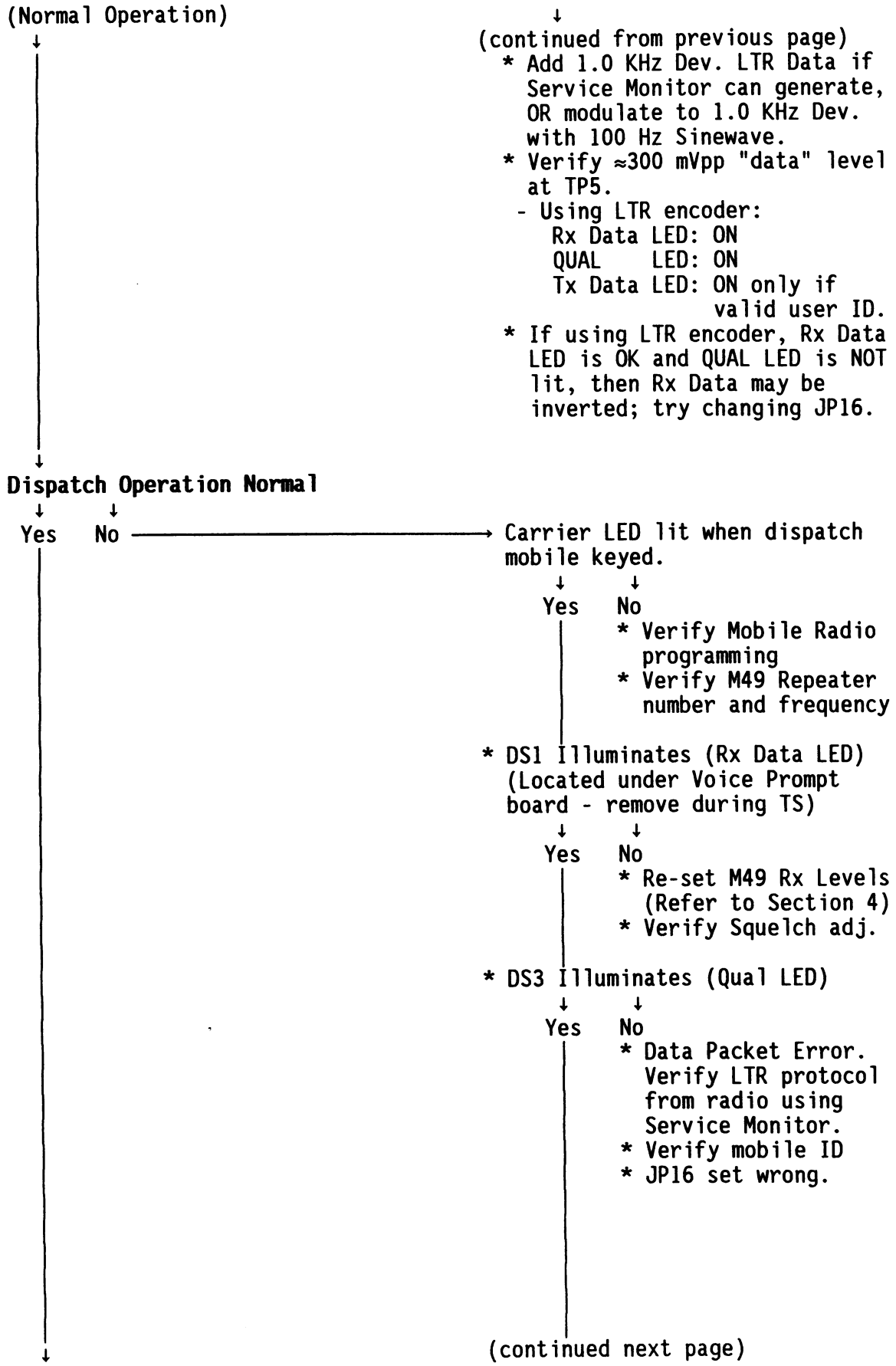
* 800 MHz FCC specs require:
  - Data Deviation = 800-1.2 KHz
  - Audio Dev.(max) = 3.5 KHz
  - Total Max Dev = 4.7 KHz
  - Refer to Section 4 for more details of adjust procedure.
* If either of these signals are missing, trace cable wiring from diagram for specific repeater in Sect. 4.
* Verify correct LTR ID code using service monitor or LTR decoder attached to "demod" output from service monitor or program mobile w/ TEST ID. Does Mobile ring ?
* If Tx Data wrong, may be inverted; Try changing JP14.
* If Tx Data waveform is ramped or distorted, mobile won't decode correctly, if at all.

↓

2. Receiver Tests
   * Resume Operating Mode
     - Set SW1-1 Down.
     - Restore SW1-2 to original setting.
     - Soft Reset M49.
   * M49 should be transmitting idle packets at programmed intervals (Multibase Edit/ Site Config./Idle Msg Time).
   * Connect RF Service Monitor direct to Rx Antenna port of repeater.
     - For combined Tx/Rx ports, temporarily disconnect the PTT drive from M49 J1-5 or 7
   * With NO carrier applied, set M49 INT Squelch as follows:
     - Set COR pot to 6 O'clock (↓)
     - Rotate SQUELCH fully CW; CARRIER LED should be lit.
     - Adjust SQUELCH CCW until CARRIER LED just goes off steady.
   * Inject 1 mVrms RF Carrier modulated to 4.0 KHz Dev. by 1.0 KHz Sinewave Tone.
   * Verify 1 Vpp @ TP5 (M49) using oscilloscope. Adjust RX AUD as needed.

(continued next page)


(Normal Operation)
(continued from previous page)
* Add 1.0 KHz Dev. LTR Data if Service Monitor can generate, OR modulate to 1.0 KHz Dev. with 100 Hz Sinewave.
* Verify ≈300 mVpp "data" level at TP5.
- Using LTR encoder:
Rx Data LED: ON
QUAL LED: ON
Tx Data LED: ON only if valid user ID.
* If using LTR encoder, Rx Data LED is OK and QUAL LED is NOT lit, then Rx Data may be inverted; try changing JP16.
Dispatch Operation Normal
Yes
No
Carrier LED lit when dispatch mobile keyed.
Yes
No
* Verify Mobile Radio programming
* Verify M49 Repeater number and frequency
* DS1 Illuminates (Rx Data LED) (Located under Voice Prompt board - remove during TS)
Yes
No
* Re-set M49 Rx Levels (Refer to Section 4)
* Verify Squelch adj.
* DS3 Illuminates (Qual LED)
Yes
No
* Data Packet Error. Verify LTR protocol from radio using Service Monitor.
* Verify mobile ID
* JP16 set wrong.
(continued next page)

(Normal Operation)

↓

↓

(continued from previous page)

* DS2 Illuminates (Tx Data LED)

↓ ↓

Yes No

* Multibase, Firmware, or LTR ASIC (U32) error. Verify proper versions and Edit User Config.

↓

* Mobile aquires M49 OK, but no audio allowed by M49.
  * User Id Invalid ! Verify Multibase and update M49 memory.
  * Verify ID in mobile

↓

Note: If a mobile is trunked off from the home repeater, the home repeater remains keyed until the trunked-unit drops. ("GO TO" packets are transmitted to the mobile from the home repeater.)

↓

* Slow Repeater Access from one or more mobiles - OR - too many retries for system access.
  * Carefully examine mobile Tx Data signal for key-up transients (degrade decoder performance).
  * Examine mobile Tx carrier frequency stability.
  * JP24 set incorrectly; may cause Tx carrier shift when key-up occurs.
  * Verify correct M49 Firmware and LTR ASIC versions.
  * Reset Tx Data Baud rate to 300 Baud at mobile if adjustable.
  * Co-channel interference.
  * Multibase User Validation programmed incorrectly. Refer to Multibase Manual
    025-9173 < V6.1
    025-9297 ≥ V6.1

↓

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(Dispatch Operation Normal-OK)

↓

↓

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* Access problems: Occasional or consistent difficulty.
  * Wrong Repeater # set in M49 Refer to Section 4.
  * Rx or Tx Data Level too high or too low; Refer to Section 4
  * Repeater Hold Time too long Receiver misses data packets from mobile.
  * Keyup Delay too short; mobile not receiving complete data packets.
  * Weak RF signal: check Rx antenna and/or receiver alignment.
  * Low DC input level to M49; Verify 10.5 Vdc - 16.0 Vdc.
  * M49 Internal Squelch adj. Refer to Section 4.
  * Multibase User Validation programmed incorrectly. Refer to Multibase Manual
    025-9173 < V6.1
    025-9297 ≥ V6.1

↓

* Good Access on home repeater; No trunking through system.
  * Repeater Bus not wired between repeaters.
  * Repeater Bus cabling crossed with Subscriber Bus
  * Bus termination errors. Refer to Section 4.
  * Multiple Sync Masters on Repeater OR Subscriber Bus.
  * M49 Repeater Number Wrong. Refer to Section 4.
  * RFI on the Data Buses. 100 MHz BW Oscilloscope or higher required to observe RFI effectively.
    - No Terminations ?
    Contact Zetron Applications
  * Firmware Versions NOT same in all M49s at one site. Contact Zetron for upgrades

↓

(continued next page)

(Dispatch Operation Normal-OK)

↓

Interconnect Operation Normal

NOTE: Be sure Dispatching works correctly before this test.

↓ Yes

↓ No → Land to Mobile calling does not operate.

* Multibase Errors Possible:
  - Repeater NOT configured.
  - TELCO card NOT configured.
  - Incoming Calls = N.
  - User ID NOT Type = I.
  - User ID NOT valid.
  - Call Limits = 0.
  - Answer Time too short in Site Config.
  - Dial Click Decode enabled w/o Decoder Bd installed.
  - Site Config Load Table too restricted for current repeater loading. (may require another ch.)
* Hardware Failures Possible:
  - Wrong TELCO Card type for wire lines in use.
  - TELCO Card jumpers not properly configured; refer to Section 4 for setup.
  - FROM TEL level too low.

↓

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↓

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* Audio Pickett Fencing.
  * COR HOLD TIME too short in multibase parameters; Set > 0.3 sec in Site Conf.
  * Weak RF; need better antenna for coverage area.

↓

* Squelch Tails frequently.
  * COR HOLD TIME too long in multibase parameters; Set shorter time duration.

↓

* Data Noise audible to mobile.
  * Tx Data Deviation set too high.
  * JP24 incorrectly set.
  * Intermodulation between Tx and Rx sections of repeater circuitry; contact repeater manufacturer.

↓

(Interconnect Operation Normal-OK)

↓

(continued from previous page)

* Interconnect Mobiles can't draw dial tone. [M→L Dialing]
  * Multibase Errors Possible:
    - Repeater NOT configured.
    - TELCO card NOT configured.
    - Outgoing Calls = N.
    - User ID NOT Type = I.
    - User ID NOT valid.
    - Call Limits = 0.
    - Start Supervision Seek Time set too short.
    - Site Config Load Table too restricted for current repeater loading. (may require another ch.)
  * Hardware Failures Possible:
    - Wrong TELCO Card type for wire lines in use.
    - TELCO Card jumpers not properly configured; refer to Section 4 for setup.
    - FROM TEL level too low.

↓

* Interconnect Mobiles draw dial tone OK, calls not connecting.
  * Multibase Errors possible:
    - Min/Max number of DTMF digits allowed in Site Config. not set correctly.
    - DTMF first or Inter-digit timing in Site Config.
    - Toll Restricted in User ID
    - Prefix Restricted or NOT Allowed in Site Config.
  * Hardware Failures possible:
    - FROM TEL audio too low or too high; refer to Sect.4.
    - TO TEL audio too low or too high; refer to Sect.4.
    - TELCO Card Hybrid circuit unbalanced; (NOT E&M 4W) Refer to Section 4.

↓

(Interconnect Operation Normal-OK)

↓

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↓

* Mobile Calls sometimes dropped.
  * Multibase Errors possible:
    - COR Hold Time in Site Conf set too short.
    - Repeater Hold Time in Site Config. too long.
    - Mobile turn-around timer expired in Site Config. Interconnect window; key ½-duplex mobiles more frequently or increase timer setting.
    - Call Limit too short in Site Config.Interconnect.
    - System Loading too full; relax load restrictions in Site Config.
    - Second Dial Tone detector falsing on voice; disable "2nd Dial Tone/DTMF Thru" in Site Config. (set = N).
  * Hardware failures possible:
    - M49 Internal Squelch not properly adjusted; refer to Section 4.
    - False "#" detection;
      1. Decrease FROM TEL adj.
      2. Hybrid Balance wrong.
      Refer to Section 4.
    - Too Low/high Data Dev. set
    - Repeater Alignment errors; Refer to repeater mfr alignment specifications.

↓

* System not trunking all INT users.
  * One or more repeaters NOT in multibase data.
  * Interconnect user homed on Dispatch-only Repeater.
  * Mobile not programmed for all repeaters.

↓

(Interconnect Operation Normal-OK)

↓

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↓

* Land to Mobile audio muting.
  * M49 Internal Squelch adj; Refer to Section 4
  * COR Hold Time in Multibase Site Config. set too short.
  * Rx Data Level too low/high at repeater; verify RF alignments per mfr specs.
  * Weak RF Signal; check rptr antenna, RF preamp, and receiver alignment.

↓

* Mobile to Land Audio muting.
  * Tx Data Level too low/high at repeater; verify RF alignments per mfr specs.
  * RF fade to mobile; try re-keying mobile. This may indicate RF coverage problem at repeater site.

↓

* Squelch Tails frequently.
  * COR HOLD TIME too long in multibase parameters; Set shorter time duration.

↓

* Data Noise audible to mobile.
  * Tx Data Deviation set too high.
  * JP24 incorrectly set.
  * Intermodulation between Tx and Rx sections of repeater circuitry; contact repeater manufacturer.

Local Computer Access Normal

Yes / No → Local Access Problems

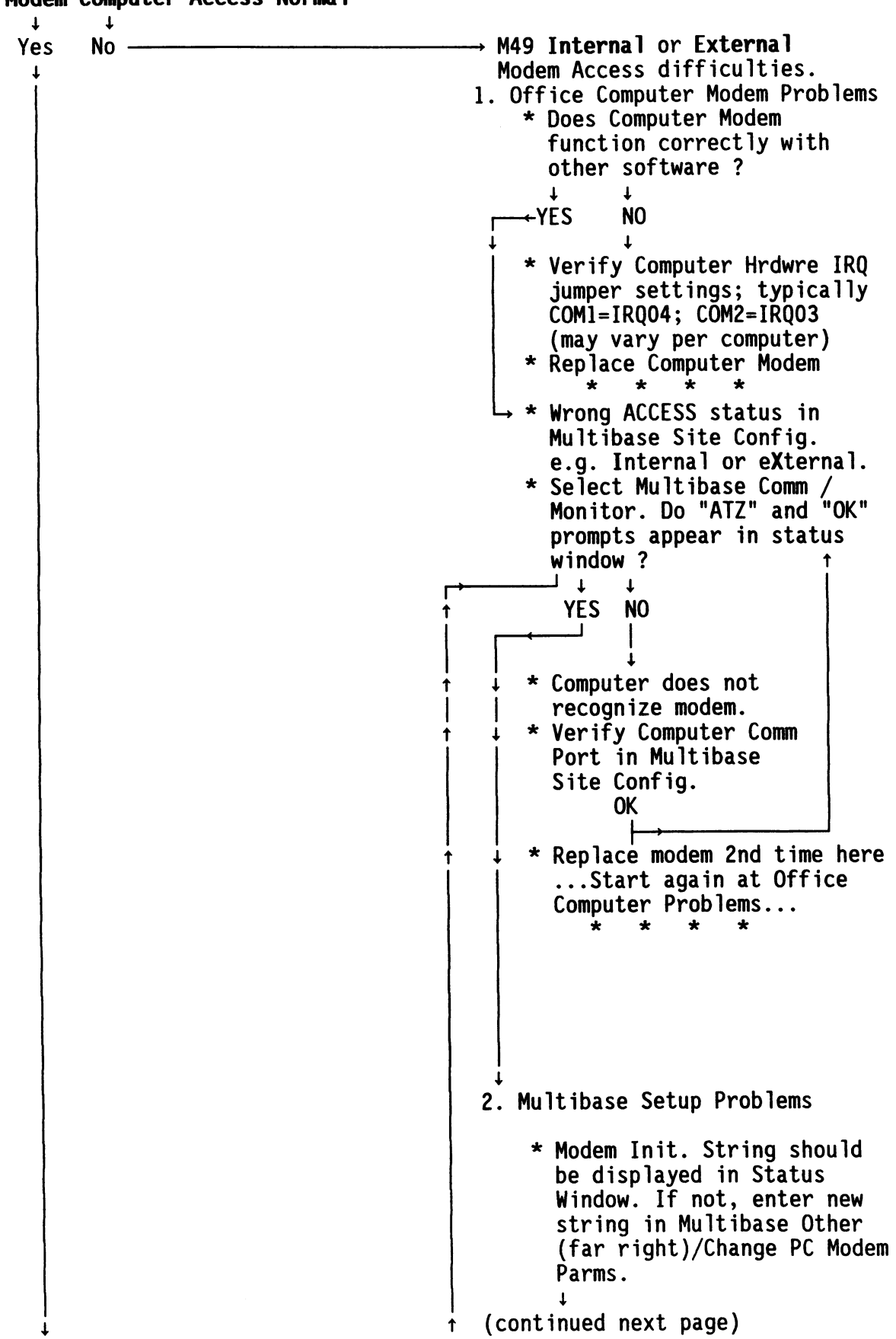
* Verify Computer Comm Port in Multibase Site Config.
* Computer Hardware IRQ jumper settings; typically COM1=IRQ04; COM2=IRQ03 this may vary per computer.
* Verify Baud Rate in M49 hardware matches Multibase Site Config.

M49 SW1-3	M49 SW1-4	Multibase Baud Rate
Down	Down	300
Down	Up	1200
Up	Down	2400
Up	**UP**	**4800**
(default)		

Soft Reset M49 following switch changes. Hold CONNECT / DISCONNECT button until LEDs flash.

* Wrong ACCESS status in Multibase Site Config.
* Verify programming cable per figure 2.2 or 2.3 in the appropriate multibase manual, using an Ω-meter.
* "Access Denied" message... Password Corrupted; hard reset M49 at site and reprogram or re-clone.
* No Sync Master or multiple masters on RPTR or SUBSC bus; Refer to Section 4, Installation Step 1.
* Low DC Input Power; Verify 10.5 Vdc - 16.0 Vdc.
* Verify U40 (RS-232 I/O) operating:
  - Pin 2 = -(9-10) Vdc
  - Pin 6 = +(9-10) Vdc
* M49 not Repeater 1 - 20; reset SW2-4 through SW2-8; Refer to Section 4; Be sure to soft reset M49.
* Incompatible Multibase; install correct version...

↓ ← Local Access OK ←


Modem Computer Access Normal
Yes
No
M49 Internal or External
Modem Access difficulties.
1. Office Computer Modem Problems
* Does Computer Modem function correctly with other software ?
YES
NO
* Verify Computer Hrdwre IRQ jumper settings; typically COM1=IRQ04; COM2=IRQ03 (may vary per computer)
* Replace Computer Modem
* * * *
* Wrong ACCESS status in Multibase Site Config. e.g. Internal or eXternal.
* Select Multibase Comm / Monitor. Do "ATZ" and "OK" prompts appear in status window ?
YES
NO
* Computer does not recognize modem.
* Verify Computer Comm Port in Multibase Site Config.
OK
* Replace modem 2nd time here ...Start again at Office Computer Problems...
* * * *
2. Multibase Setup Problems
* Modem Init. String should be displayed in Status Window. If not, enter new string in Multibase Other (far right)/Change PC Modem Parms.
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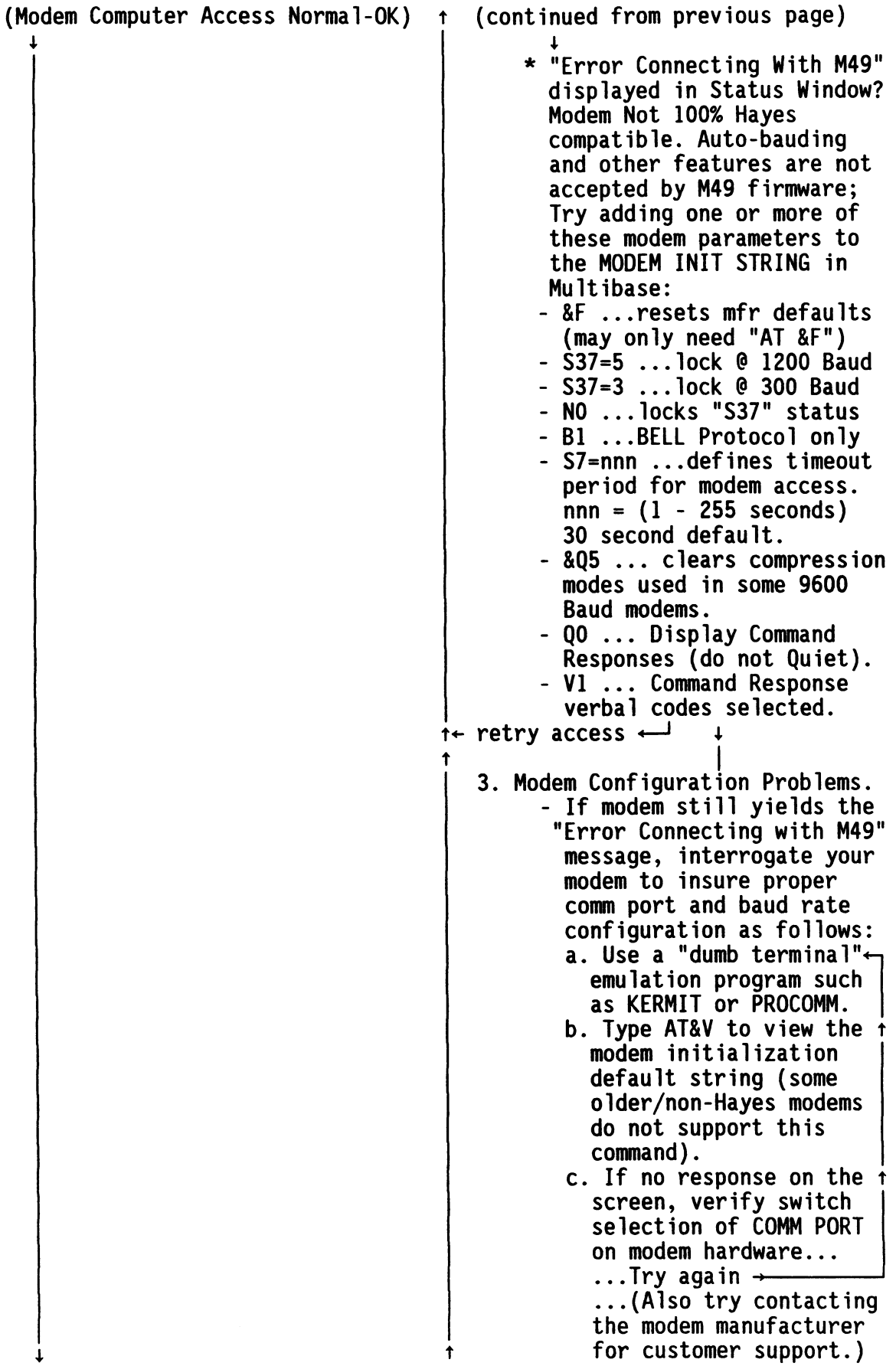

(Modem Computer Access Normal-OK)
(continued from previous page)
* "Error Connecting With M49" displayed in Status Window? Modem Not 100% Hayes compatible. Auto-bauding and other features are not accepted by M49 firmware; Try adding one or more of these modem parameters to the MODEM INIT STRING in Multibase:
- &F ...resets mfr defaults (may only need "AT &F")
- S37=5 ...lock @ 1200 Baud
- S37=3 ...lock @ 300 Baud
- N0 ...locks "S37" status
- B1 ...BELL Protocol only
- S7=nnn ...defines timeout period for modem access. nnn = (1 - 255 seconds) 30 second default.
- &Q5 ... clears compression modes used in some 9600 Baud modems.
- Q0 ... Display Command Responses (do not Quiet).
- V1 ... Command Response verbal codes selected.
retry access
3. Modem Configuration Problems.
- If modem still yields the "Error Connecting with M49" message, interrogate your modem to insure proper comm port and baud rate configuration as follows:
a. Use a "dumb terminal" emulation program such as KERMIT or PROCOMM.
b. Type AT&V to view the modem initialization default string (some older/non-Hayes modems do not support this command).
c. If no response on the screen, verify switch selection of COMM PORT on modem hardware...
...Try again
...(Also try contacting the modem manufacturer for customer support.)

(Modem Computer Access Normal-OK)

(continued from previous page)

d. Verify this string:
B1 X2/X4 V1 E1 Q0
The exact order is not critical for entry of these modem commands.

e. Note any differences for entry into Multibase MODEM INIT STRING.

f. Test for dial tone access by modem:
- ▸type ATH1...Off-Hook the computer modem »»» Dial Tone on «««
- ▸type ATH0...On-Hook the computer modem »»» Dial Tone off «««
- ▸If modem will not seize Dial Tone, contact the modem sales/service office for your modem.

retry access ←

NO "Error Connecting with M49"

2.a. Multibase Setup Problems

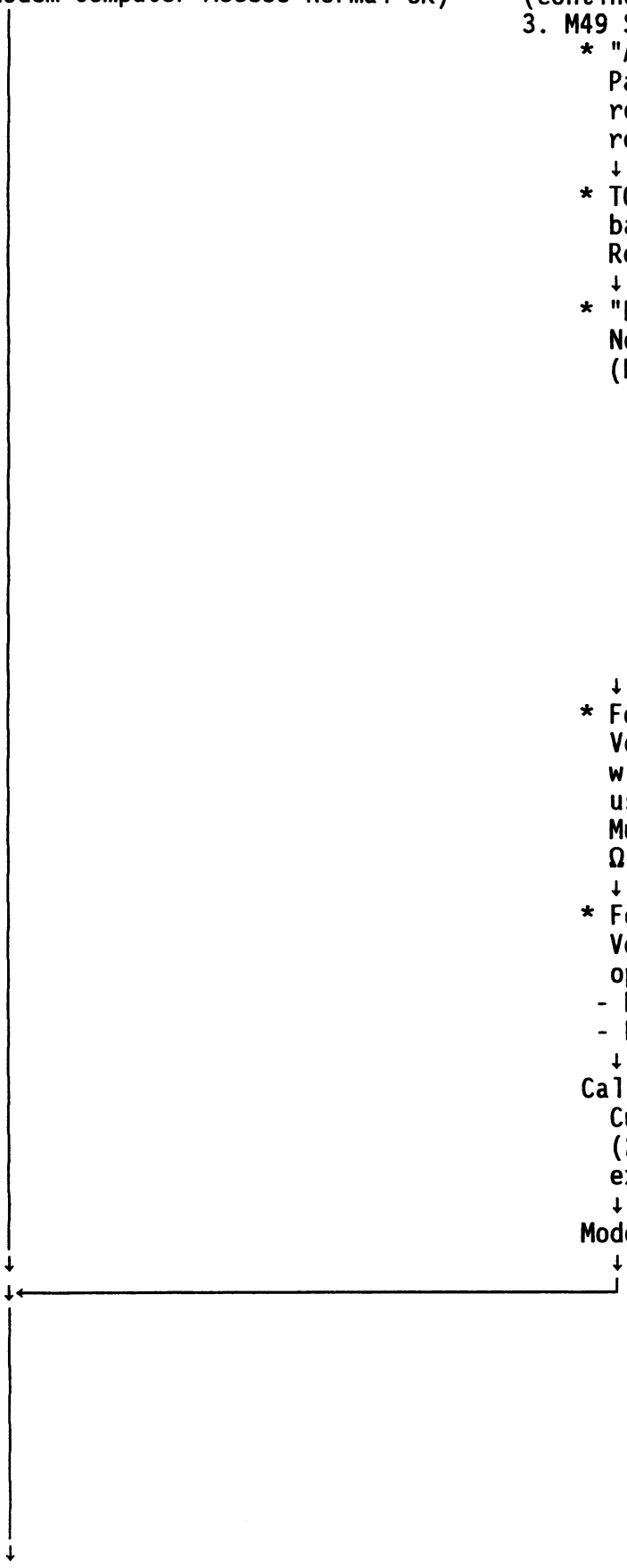
* "Connect <baud>" displaying wrong baud rate (none=300)
* Verify Baud Rate in M49 hardware matches Multibase Site Config. selection.

M49 SW1-3	M49 SW1-4	Multibase Baud Rate
Down	Down	300
Down	Up	1200
Up	Down	1200
Up (default)	**UP**	**1200**

Soft Reset M49 following switch changes. Hold CONNECT / DISCONNECT button until LEDs flash.

(continued next page)

(Modem Computer Access Normal-OK)



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3. M49 Site Problems
   * "Access Denied" message... Password Corrupted; hard reset M49 at site and reprogram or re-clone.
     ↓
   * TO TEL, FROM TEL, or hybrid balance not correctly set; Refer to Section 4.
     ↓
   * "Error on Zetron Bus" No SUBSC Bus POLL syncing (Poll LED off) due to:
     Cloning in progress;
     NO Poll Master;
     multiple Poll Masters;
     too many SUBSC Bus terminations;
     NO SUBSC Bus termination;
     EFJ and Uniden SUBSC Bus configurations both simultaneously exist on SUBSC Bus.
     ↓
   * For External Modems w/M49: Verify external modem cable wiring to the M49 RS-232 using figure 2-6 in the Multibase manual, and an Ω-meter.
     ↓
   * For External Modems w/M49: Verify U40 (RS-232 I/O) operating:
     - Pin 2 = -(9-10) Vdc
     - Pin 6 = +(9-10) Vdc
     ↓

Call Zetron Mobile Systems Customer Service at (206) 820-6363 if still experiencing difficulty.

↓

Modem Computer Access OK now.

↓

Alarm Operation OK

↓ ↓

Yes No → Are ALARMS enabled (Y) in Site Config. of Multibase ?

↓

* Are INPUTS wired to the M49?
  * Sense 2: J2-7 (GND)
    J2-8 Input 0-5 Vdc
  * Sense 3: J2-9 (GND)
    J2-10 Input 0-5 Vdc
  * Sense 4:J2-11 (GND)
    J2-12 Input 0-5 Vdc

↓

* Inputs Enabled in Multibase ?
  * EDIT/Repeater Config./ Alarms Enabled = Y
  * Sense (2,3,and/or 4) Y/N

↓

* Alarm input limits set ?
  * Low and High limits may be set 0-5 Vdc. External input conditioning may be required between alarm input signal source and M49
  * Alarm status activates if: Input ≤ Low Limit, OR IF Input ≥ High Limit

↓

* SMDR Alarm set in Multibase ?
  * Alarm status active if SMDR buffer has 288 (≈1 day) or less records remaining to be filled...Download Time!

↓

* Sync Alarm set in Multibase ?
  * Alarm status active if the Repeater Bus (HDB; RNDL) sync signal is absent.

↓

* Are Alarm outputs enabled ?
  * Control 2,3,4 outputs are enabled (Y/N) in Alarm window of Repeater Config.
  * Control outputs jumpered for N.O. or N.C. operation.

Control Output	NO	NC
CTRL 2 @ J2-1,2	JP4A	JP4B
CTRL 3 @ J2-3,4	JP5A	JP5B
CTRL 4 @ J2-5,6	JP6A	JP6B

* Contact Closure Ratings:
  - 1A @ 24 Vdc RES max.
  - 0.5A @ 120 VAC RES max.

↓

(Alarm Operation OK)

↓

Cross-Busy Operation OK

↓ ↓

Yes No → Cross-Busy input wired to M49 ?

- * Sense 1 Input @ J1-9, Referenced to GND.
- * Input range = 0 - 5 Vdc
- * Active Input = 0 - 0.5 Vdc

↓

* Cross-Busy Output wired to controller of system sharing repeater ?
  - * CTRL 1 Output @ J1-8, Referenced to GND.
  - * JP3=A; N.O. Relay closure
  - * JP3=B; N.C. Relay Closure
  - * Contact Closure Ratings:
    - 1.0 A @ 24 Vdc RES
    - 0.5 A @ 120 Vac RES

↓

* Cross-Busy Delay set correctly in Multibase Edit/Site Config.
  - * [0-7] x 100 msec = Delay. Default = 0.

↓

System Operation should be Normal

↓

(Continued from previous page)

* M49 set to call an Alarm ID ?
  - * Will call ALARM ID if one or more of selected (Y/N) alarms are active: (Sense 2,3,4; SMDR; SYNC)
  - * ALARM ID entered in Site Config. after ALARMS = Y.
  - * Alarm Repeats set ? Alarm calls to ALARM ID repeat specified # times. (Default = 0 repeats)
  - * Alarm Interval set ? Time lapse between repeats. (0-999 sec; Default = 0) NOTE: Be sure Repeats AND Intervals are both setup.

9. APPENDIX

9. APPENDIX

GLOSSARY

ACCPAC- Accounting software.

ASCII- American Standard Code for Information Interchange.

Call Detail- A detailed listing of interconnect calls that were made. This would include the ID, phone number called, time of day call was made, and length of call.

Carrier- Unmodulated RF energy that carries desired information.

CAS- Carrier Activated Squelch. See COR.

Channel- A specific transmitter frequency and receiver frequency for electromagnetic signals.

CO- Central Office. A switching system serving a group of customer lines within a particular area.

COG- Centralized Operations Group. A group within the phone company that takes interface orders.

Comm Port- Communications port. Device used in a computer to talk with the outside world.

Companding- Process that improves the telephone interconnect audio fidelity. This is done by reducing the noise introduced by radio signal propagation.

Conventional- Community style repeater with no trunking.

COR- Carrier Operated Relay. Circuit used to detect that the carrier signal is present.

COS- Carrier Operated Squelch. See COR.

CTCSS- Continuous Tone Carrier Squelch System. Subaudible tone signaling used to mute a receiver.

CTL- Control. An output on the M49 that is used for cross-busying and alarms.

dB- Decibel. A method of comparing two signals on a logarithmic scale.

dBm- Decibel Measurement Relative To One Milliwatt. A method of comparing a signal's power against 1 milliwatt. This ratio is based on the logarithmic scale.

DID- Direct Inward Dialing. Type of telephone line that represents a bank of sequential numbers. When a caller dials one of the numbers, the phone equipment signals the last 2 to 7 digits of the phone number across the phone wire pair.

Dispatch- A mobile to mobile call.

DPL- Digital Private Line. Digitally coded system for two-way radio.

DSC- Digital Squelch Control. See DPL.

E&M 4 Wire- Earphone and Mouthpiece. Type of line that carries two wire pairs (4 wire) for audio and one pair for call supervision (E-lead and M-lead.)

E-E- End to End. Transmits and receives telephone signals over two wires.

Full Duplex- A call in which audio can be transmitted and received at the same time.

GAZELLE- Automatic download program for the Model 42/49 billing data. The AUTOZ49 program dials M49 LTR sites and downloads data automatically at a pre-programmed time.

Group- Term used in LTR mobile programming to designate an ID in a System.

Half Duplex- A call in which audio may be sent in only one direction at a time.

HDB- High-speed Data Bus. EF Johnson label for the Repeater Bus.

Home- A channel in an LTR system that mobiles listen to for trunking information.

ICAB- InterConnect Accounting Bus. Uniden's accounting bus for LTR repeater networks. NOT directly compatible with the Zetron Subscriber Bus, but may be translated-to or monitored-by a Zetron Model 494 Accounting Bus Manager.

icom- A plug-in circuit containing both a crystal and temperature compensator.

ID- Identification. A three-digit number used in LTR to designate a user on a particular home repeater.

Interconnect- A landside-to-mobile or mobile-to-landside call.

ISQ- Internal Squelch. Circuit that is used to detect audio signal and mute the signal if only noise is found.

LTR- Logic Trunked Radio. EF Johnson signaling format used for trunked radio systems.

MMDD- Month digits (MM) and day digits (DD)

Packet- Data transmitted by a mobile or repeater that is used to control the trunking and security features of LTR.

Poll Master- Channel in Zetron LTR system that controls the Subscriber Bus.

PSTN- Public Switch Telephone Network.

PTC- Push To Connect. A method of initiating a call. A person only needs to key up and the call is started.

PTT- Push To Talk. A switch closure that activates the transmitter.

RAM- Random Access Memory. Electronic device used to store information.

RCC- Radio Common Carrier.

Repeater Bus- Communications line used on LTR equipment to share channel activity between channels. The Sync LED indicates this activity.

RIC- Repeater Interconnect Controller. EF Johnson's interconnect logic.

RNDL- Repeater Network Data Link. Uniden's version of the Repeater Bus.

RUS- Receiver Unoperated Squelch. See COR.

Sense- An input on the M49 that is used for cross-busying and alarms.

Simplex- A call in which audio may be sent in only one direction.

SMDR- Site Management Detail Records. See Call Detail.

SMR- Specialized Mobile Radio.

Subaudible Data- Signaling format used in LTR for data exchange between mobiles and the repeater managers. This data is transmitted below the audible region at approximately 300 Hz.

Sub Out- An output signal from the M49 that goes to the repeater, and is then transmitted by the repeater. This signal is the subaudible data.

Subscriber Bus- Communications line that carries database and billing data between Zetron's M49, M42, M494. The Poll LED indicates this activity.

Sync- A signal the Sync Master applies to the Repeater Bus. This signal is used for timing by the channels to properly control data on the Repeater Bus.

Sync Master- Channel in LTR system that generates sync on the Repeater Bus.

System- Term used in LTR mobile programming to define a group of channels making up a "trunk group", and a home channel within that group.

TLA- Trunk Line Accounting. EF Johnson's accounting bus for their LTR equipment. NOT directly compatible with the Zetron M49 Subscriber Bus, but may be translated-to or monitored-by the Model 494 Accounting Bus Manager.

TOT- Time Out Timer. Term used in programming LTR mobiles that sets the maximum time the mobile can remain keyed-up.

Trunked- A mobile that has gone to a non-home channel as the home channel is busy.

Trunking- The pooling of a group of radio channels in which all users have automatic access to all channels.

VOX- Voice Operated Relay. A circuit that detects if there is voice present.

ZEBRA- Zetron's billing software.

MODEL 49 LOW POWER CONVERSION

By performing the following operations, the idle current may be significantly reduced as noted below.

Typical Standard Idle Current = 460 mAdc
Typical Low Power Idle Current = 240 mAdc

* Replace U54 with Low Power version DUART
  Standard 2681 DUART: Zetron p/n 321-2181
  Low Power 2692 DUART: Zetron p/n 321-2182

* Remove Driver IC for front panel LEDs - U56

* Optionally Replace or remove the current limiting resistors for the POWER and CARRIER LEDs to further decrease power use:

  Power LED: R171 = 2.2K Ohm p/n 101-0081
  (or remove to disable)
  Carrier LED: R162 = 510 Ohm p/n 101-0066
  (or remove to disable)

Installation Procedure

[]1. Verify proper data bus configurations have been set per Section 4, Step 1.2.

JP11	bus type
JP17-20	bus polarities
JP21,22	terminations

[]2. Be sure that the Model 49 repeater interface jumpers are set correctly per the specific repeater to be used. Refer to specific repeater models in Section 4 (listed in "Step 4: Installing and Modifying the Repeater").

[]3. Verify Alarm and Cross-Busy jumper settings per Section 4, Step 1.4.

JP3	A or B:Cross-Busy Output (JP7 may change if using cross-busy)
JP4	A or B:Control 2 Output
JP5	A or B:Control 3 Output
JP6	A or B:Control 4 Output

[]4. Connect the Model 49 to the repeater of choice.

[]5. Follow the instructions in Section 4, "Step 5: Setting Repeater Levels".

OPTIONAL END-TO-END TELCO CARD USE

Normally, the 950-9547 (702-9669 board) End-to-End telco adapter card is used with the Model 49 Repeater Manager, for 702-9202 revisions S and higher.

It is possible, however, to utilize the 950-9241 (702-9283 board with 702-9312 piggy-back Balance Board) End-to-End telco adapter card, which was used with earlier Model 49 units.

To use these early type boards, perform the following procedure:

[]1. Set the "FROM" potentiometer to the 7 o'clock position.

[]2. Set the "TO" potentiometer to the 2 o'clock position.

[]3. Cover these two pots with tape to prevent subsequent adjustment.

[]4. Perform all level adjustments for TO / FROM TELCO using the front panel potentiometers and test points as indicated in Section 4 of this manual.

POWER CONVERSION TABLE

Power Conversion Table for 600 Ohm Load

Power		Single Tone		Dual Tone	
(dBm)	(mW)	(Vp-p)	(Vrms)	(Vp-p)	(Vrms)
10	10.00	6.93	2.45	9.80	3.47
9	7.94	6.17	2.18	8.73	3.09
8	6.31	5.50	1.95	7.78	2.75
7	5.01	4.90	1.73	6.94	2.45
6	3.98	4.37	1.55	6.18	2.19
5	3.16	3.90	1.38	5.51	1.95
4	2.51	3.47	1.23	4.91	1.74
3	2.00	3.09	1.09	4.38	1.55
			(mVrms)		
2	1.59	2.76	975	3.90	1.38
1	1.26	2.46	869	3.48	1.23
	(uW)				
0	1000.0	2.19	775	3.10	1.10
					(mVrms)
-1	794.3	1.95	690	2.76	976
-2	631.0	1.74	615	2.46	870
-3	501.2	1.55	548	2.19	774
-4	398.1	1.38	489	1.96	693
-5	316.2	1.23	436	1.74	615
-6	251.2	1.10	388	1.55	548
		(mVp-p)			
-7	199.5	979	346	1.38	488
-8	158.5	872	308	1.23	435
-9	125.9	777	275	1.10	389
				(mVp-p)	
-10	100.0	693	245	980	347
-12	63.1	550	195	778	275
-14	39.8	437	155	618	219
-16	25.1	347	123	491	174
-18	15.9	276	97.5	390	138
-20	10.0	219	77.4	310	110
-22	6.31	174.0	61.5	246	87.0
-24	3.98	138.2	48.9	196	69.3
-26	2.51	109.8	38.8	155	54.8
-28	1.59	87.2	30.8	123	43.5
-30	1.00	69.3	24.5	98.0	34.7

MODEL 49 AUDIO ENHANCEMENTS

The following pages illustrate optional field modifications that may be performed on Zetron Model 49 Repeater Managers or Uniden ARX800B Control Cards for the MRS804ZX Repeaters.

These suggested modifications do not effect any major performance improvements, but instead enhance perceived audio quality from the perspective of the system user. These suggestions are provided for consideration, but are in no way required. Each component change is accompanied in the affiliated text by an explanation of resulting effect.

Additionally, please note the references to "FCC compliance". Model 49 units operated outside the jurisdiction of the USA Federal Communications Commission (FCC) may not require the telco power limiter circuit. This can be disabled as noted in the included figures.

The information provided on the following pages will significantly improve overall system signaling levels and performance for FASTNet users, particularly where DTMF overdialing into telco lines may have been a problem for some system users. The system operator's modem access to the Model 49 through FASTNet should also be substantially improved.

Model 49 Rev H-Q Models

Verify that the following resistor values are installed into the Main Board. Figure 8-1 shows the approximate board locations of these resistors.

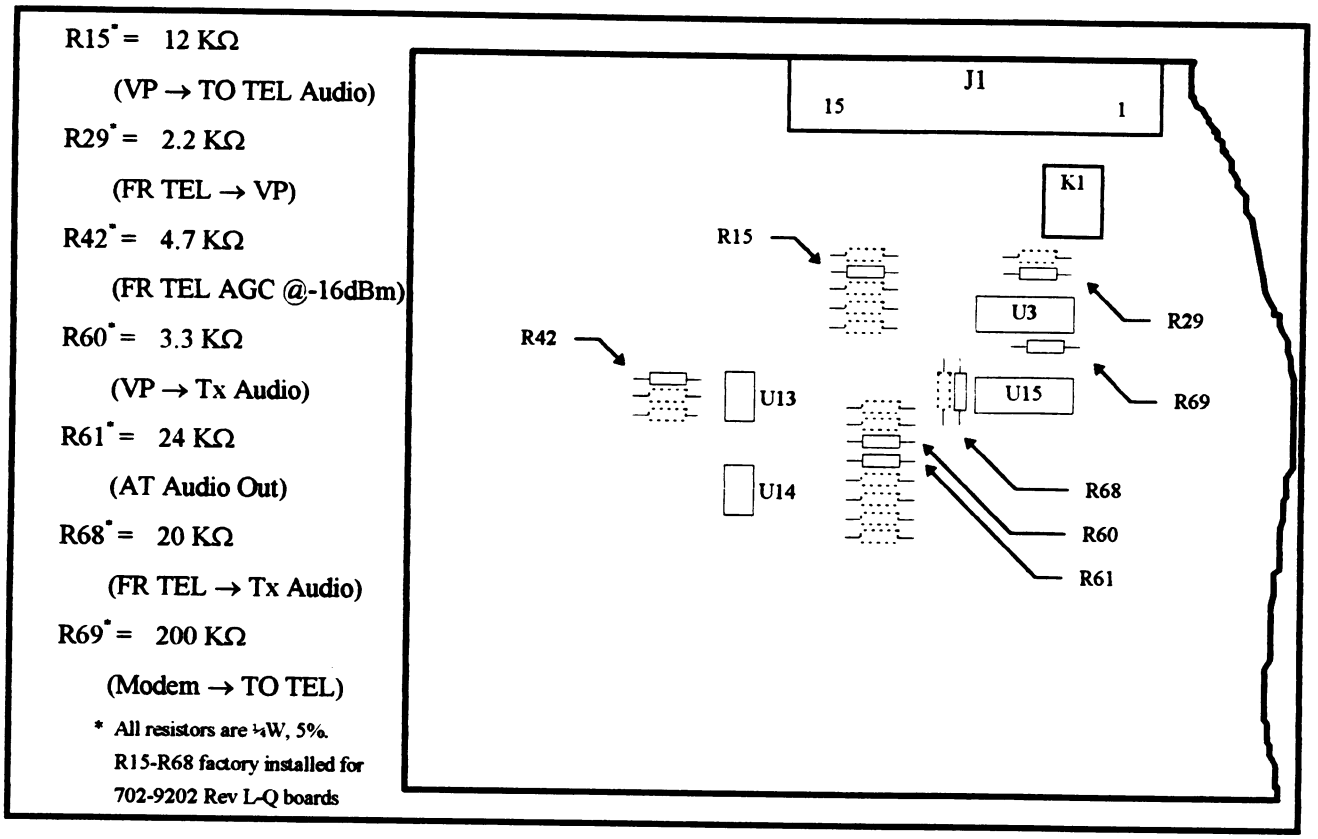

Figure 8-1: Model 49 Rev H-Q Resistor Locations

Additionally, if using the optional Compandor Card, and the Compandor Card is Rev A or B, remove R11 & R16 of the Compandor Card, and replace R1 with a 10 KΩ, ¼W, 5% resistor.

Model 49 Rev S-Y Models

R35 must be replaced as noted in to increase audio output to the phone line. R96 must be replaced to ensure a 1:1 ratio for repeat audio input/output.

Model 49 operators subject to FCC (USA) control must use the telco power limiter circuitry to comply with Part 68 of the FCC regulations. This circuit allows for occasional audio peaks above 0 dBm to be transmitted down phone lines, but sustained high level signals must be decreased (≈10 dBm) by the power limiter. Model 49 operators should correct the power limiter delay timing (from 0.5 sec to 1.5 sec) by replacing C11 as noted in Figure 8-2.

Model 49 operators outside of the jurisdiction of the FCC (USA) may not need to utilize the telco power limiter circuitry (TO TEL). This circuit can be defeated as noted in Figure 8-2.

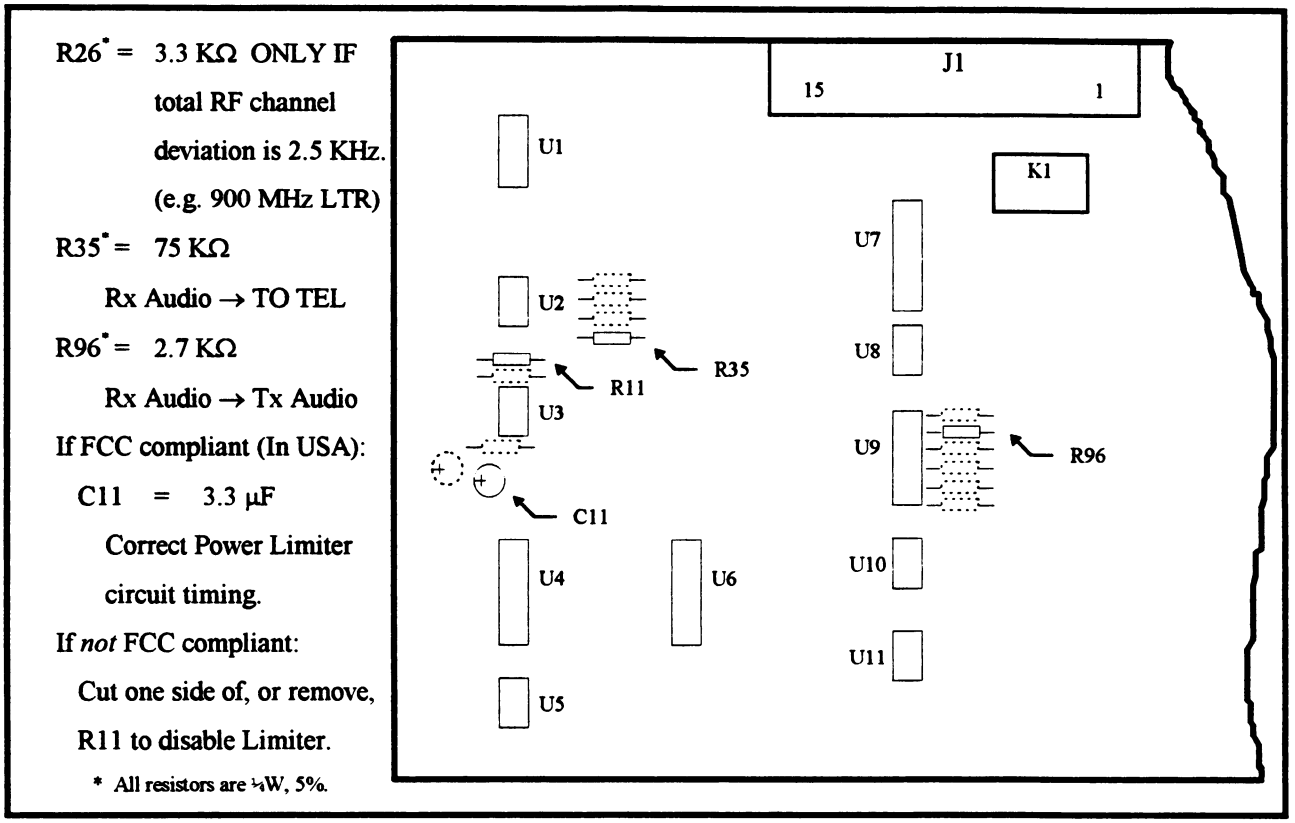

Figure 8-2: Model 49 Rev S-X Resistor Locations

MRS804ZX Repeaters
These changes apply to all MRS804ZX Repeater ARX800B Control Boards, Rev.A-E.5. The units will function without these changes in 800 MHz operation, but will yield improved audio performance with these minor changes.

On the ARX800BZ Main Board, R18 ensures Rx/Tx repeat audio levels are 1:1. R66 corrects compandored audio levels vs non-compandored levels to be equal. These modifications are shown in Figure 8-3.

ARX790 Interconnect Boards require R91 be replaced to correct prompt tone and DTMF levels relative to voice levels for TO TEL signaling. This may have been performed previously. The location and value for R91 are indicated in Figure 8-4.

MRS804ZX operators subject to FCC (USA) control must use the telco power limiter circuitry on the ARX790 Card to comply with Part 68 of the FCC regulations. This circuit allows for occasional audio peaks above 0 dBm to be transmitted down phone lines, but sustained high level signals must be decreased (≈10 dBm) by the power limiter. MRS804ZX operators having Rev A-F ARX790 cards should correct the power limiter operation by replacing R105 and rewiring as noted in Figure 8-4. The board revision is the letter following the 702-9398 part number written along the left rear edge of the card, visible with the repeater drawer pulled out.

MRS804ZX operators outside of the jurisdiction of the FCC (USA) may not need to utilize the telco power limiter circuitry (TO TEL). This circuit can be defeated by jumpering R108 of the ARX790 card with a wire (power off), as noted in the text of Figure 8-4.

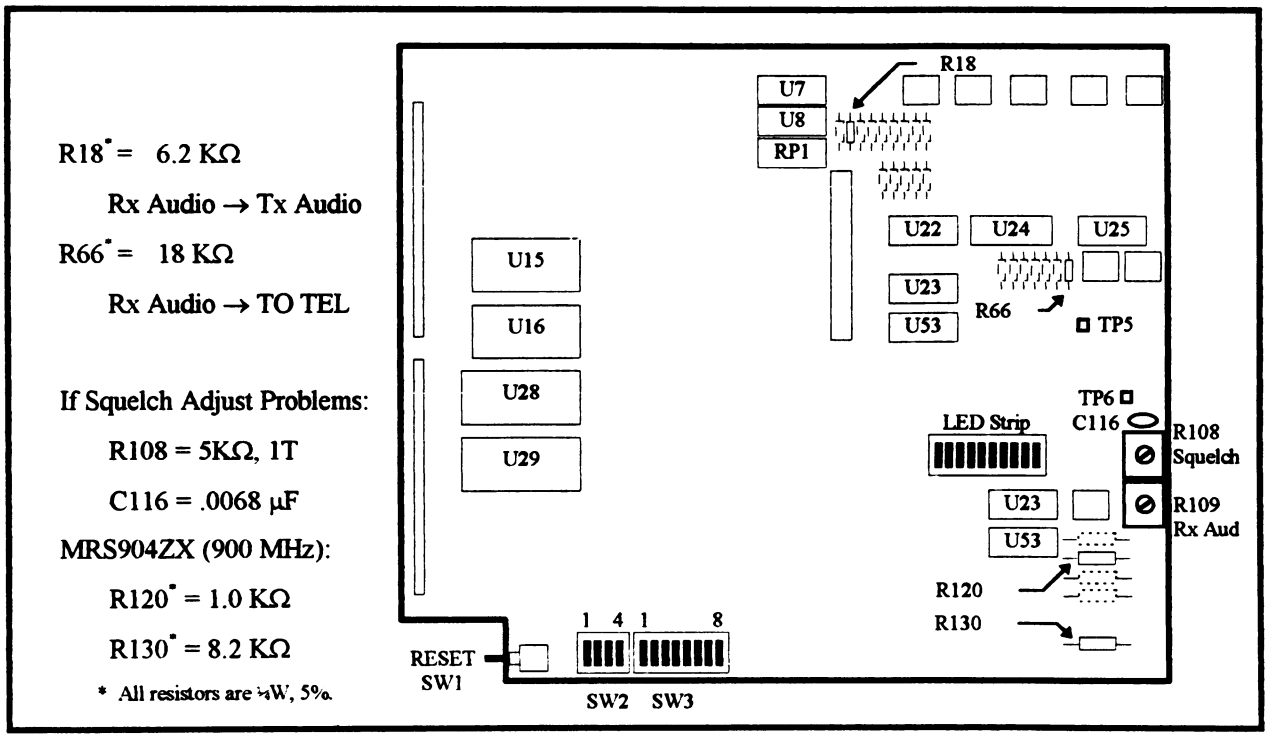

Figure 8-3: MRS804ZX Repeater, ARX800BZ Main Board

Rev A-F ARX790 Boards

R91* = 75 KΩ

Remove U12 and bend pin 13 so that it won't plug into the IC socket. Solder a 1" length of 26-30 AWG wire onto pin 13. Strip the other end of the wire.

Solder a second 1" length of wire high onto the shoulder of pin 1, being careful not to overheat the IC chip (Pin 1 *must* be able to plug into the IC socket).

Re-install U12. Solder the wire from pin 13 to the right-hand side of R45.

Cut the left side of R45, lift, and solder the wire from pin 1 to the lifted end of R45.

All ARX790 Boards

If FCC compliant:

R105* = 470 KΩ

If *not* FCC compliant:

Bypass R108 with a wire.

* All resistors are ¼W, 5%.

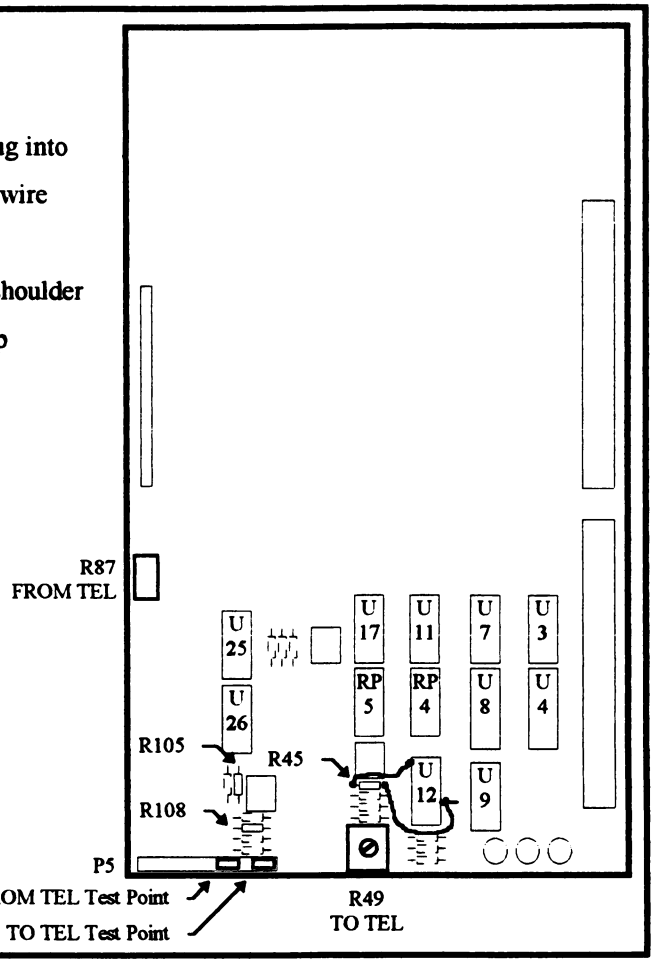

Figure 8-4: MRS804ZX Repeater, ARX790 Interconnect Board

MRS904ZX Repeaters

For 900 MHz applications, the ratio of *audio : data* is lower, requiring the receive audio squelch circuitry to be modified slightly, as noted in Figure 8-3. Replacing R108 and C116 will increase the squelch sensitivity, while replacing R120 and R130 will increase the Receive Audio sensitivity.

Transmit signal level changes for 900 MHz signalling are handled adequately by the Transmit Exciter Module adjustments.

CHANGE INFORMATION

At Zetron, we continually strive to improve our products by updating hardware components and software as soon as they are developed and tested.

Due to printing and shipping requirements, this manual may include information about the latest changes on the following pages.