Model 72 Serial Number _____

NOTE: This manual covers software versions 1.0 through 1.6.

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

Z E T R O N

Model 72 Extend-a-Line
INSTRUCTION MANUAL

#025-9189G

QUICK! --- GET ME ON THE AIR!

If this is your first Model 72 Extend-a-Line, your first question is probably "What do I have to do to get it working?" Here is the answer:

The Model 72s must be installed properly. Since you have purchased Model 72s, it is assumed that the radio sites are not easily reached; therefore, we suggest that you *set up the Model 72s on a bench first!* Because of the complexity of setting up two separate transceivers, it helps to set up the Model 72s and transceivers at the same place the first time. Along with the ability to adjust the system in the comfort of your workshop, you will be able to verify the operation of the entire system and become familiar with its operation. Follow the "Installation Procedure" in Section 6.

Once the Model 72 and transceiver packages are installed on a bench, try placing and receiving telephone calls. This is the best time to test the effects of the installation programming and to make any adjustments.

After everything is working, re-install the Model 72 and transceiver packages at the radio sites. The same installation procedure should be repeated at the site, and only a few final adjustments should be required. Once the Model 72 and transceiver packages are installed, test the telephone service.

The Model 72s MUST be installed by a qualified radio service technician.

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WARRANTY STATEMENT

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

FEDERAL COMMUNICATIONS COMMISSION (FCC) REGULATIONS

The following criteria must be met to comply with FCC rules:

1. The FCC registration number of this device (EYBUSA-74165-OT-E) and ringer equivalence number (0.4B) must be reported to the telephone company if so requested.

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

   a. This device may not cause harmful interference.

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

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

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

5. The total of all ringer equivalence numbers connected to the Model 72 remote should not exceed 3.0 for best performance.

6. 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 may notify the user as soon as they are able.

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

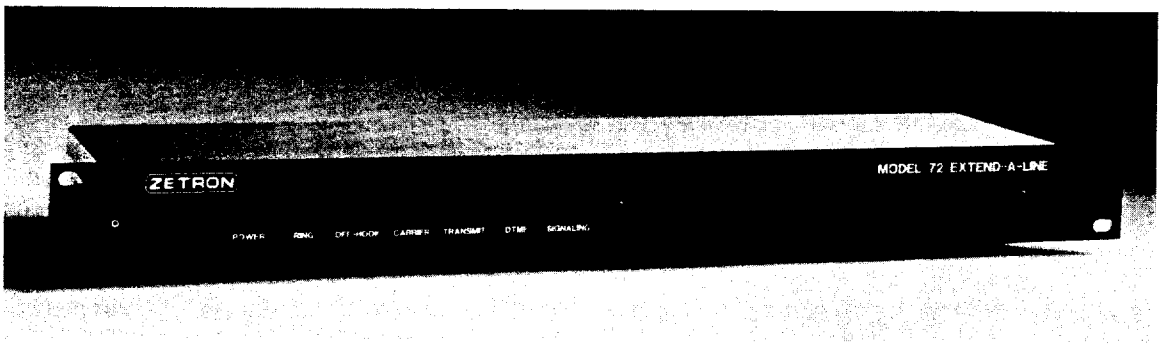
TRADEMARKS

Touch-Tone is a registered trademark of AT&T.

Zetron is a registered trademark of Zetron, Inc.

All other product names in this document are trademarks or registered trademarks of their respective owners.

1. INTRODUCTION



1. INTRODUCTION

In remote or isolated locations, telephone service may be either nonexistent or not economically feasible. A pair of Zetron Model 72 Extend-a-Lines and two full-duplex radios (or repeaters turned into full-duplex base stations) can be used in place of telephone lines to provide service to these areas. The Model 72 provides all the necessary audio processing and control to create a wireless telephone system.

The Model 72 provides telephone line extension compatible with Touch-Tone and pulse dial phones, modems, FAX machines and answering machines. Installation programmable items are easily configured using a standard Touch-Tone telephone.

There are two types of Model 72s: the "remote" and the "base". The Model 72 remote is the device located in the isolated area where telephone service is being extended to. The Model 72 remote provides the normal phone line functions to the remote telephone equipment connected to it, such as 48 volt battery feed and ringing. The other end of the Model 72 system is the Model 72 base which connects to the line from the telephone company Central Office. The Model 72 base emulates a telephone connected to the telephone company's central office.

TYPES OF SYSTEMS

At least one of each type of Model 72 is required to make a system. You may think of the Model 72 system simply as a "wireless" cable in place of the telephone line. Model 72s can be used to construct three different types of systems:

1. Point to point (one CO line to a base and one remote phone location)
2. Single base to multiple remote phone locations
3. Multiple bases to one remote phone location

Point to Point
For systems where a single telephone line needs to be extended, a pair of Model 72s may be used to provide the link between the telephone and the central office telephone line. In this mode of operation, the Model 72 system is transparent to the users, whether they are receiving or placing calls.

Single Base to Multiple Remotes
In cases where a single telephone line from the central office is to provide telephone service for several telephone users, a single Model 72 base may provide service for up to 10 Model 72 remotes, allowing them to share a single line.

When a telephone system caller wants to call one of the Model 72 remotes, he or she dials the Model 72 base phone number, the Model 72 base will answer, then generate a second dial tone to the calling person. The calling person then dials a single digit to specify which Model 72 remote to ring; this is referred to as "overdialing". The Model 72 base will signal the selected Model 72 remote to ring its telephone, and all other Model 72 remotes are denied access to the system until the call in progress has been completed.

NOTE: If rotary dial telephones will be used to call the Model 72 base, the dial click decoder option must be installed in the Model 72 base unit.

This type of system is transparent to the remote telephone users placing outgoing calls.

If other users try to place calls during a conversation, a busy tone will be heard when they lift their handsets off-hook.

Multiple Bases to a Single Remote
In some cases, point to point operation doesn't provide a wide enough dialing area. To overcome limited dialing areas, additional Model 72 bases may be added to different geographical areas to extend the "local" dialing area. This type of system requires users making outgoing calls from the Model 72 remote to specify which Model 72 base to use by overdialing a single digit "line select" number.

FEATURES

* Supports up to 10 CO phone lines or 10 remote sites (depending on the system configuration)

* Optional Dial Click decoder available in the Model 72 base unit for multiple-remote systems that must support rotary overdial

* Each remote may ring up to three standard telephones

* Compatible with data modems and FAX machines

* Model 72 remotes are compatible with DTMF, rotary, or dial pulse phones

* A programmable Morse code station ID is standard in both units

* Programmable setup via Touch-Tone telephone

* Programmable Call Limit timer in the Model 72 remotes

* Internal squelch circuit for simple installation

* Compandor for high quality audio

2. SPECIFICATIONS

2. SPECIFICATIONS

GENERAL SPECIFICATIONS

Power	11-16 VDC
Current	
M72 base:	750 mA
M72 remote:	750 mA idle, 1500 mA during ringing
Temperature	0 to 65 degrees Celsius
Size	19" W x 6.25" D x 1.75" H
Weight	2.0 pounds

TELEPHONE INTERFACE SPECIFICATIONS

Line type	End-to-end phone line
Connector	RJ11 modular jack
FCC Registration	EYBUSA-74165-OT-E
Incoming call	Ring detection on tip-ring pair Programmable number of rings to answer
Call answer	Off-hook, tip-ring current draw
Call disconnect	Call Limit or Base Knock-down timeouts

RADIO INTERFACE SPECIFICATIONS

PTT	Relay with normally open, and normally closed contacts
COR	Discriminator noise detector
Tx audio	-40 to +6 dBm. Hi/Lo selector. 1K ohm output
Rx audio	-40 to +10 dBm. Hi/Lo selector. 50K ohm input. 25 mV to 6 Vpp

ADDITIONAL SPECIFICATIONS

Indicators	Power, Ring, Off-Hook, Carrier, Transmit, DTMF decode, Signaling decode
Station ID	Morse code, fixed 1200 Hz frequency with selectable call sign
Prompt tones	Progress tones, error tones and warning tones to signal errors, including radio circuit (or path) failure
Programming	Programmable via Touch-Tone telephone
Signaling	Multiple frequency in-band audio tones
Data retention	EEPROM - data retention for more than 10 years without power
Protection	Telco high voltage clamps with protective fusing elements

3. OPERATION

3. OPERATION

OVERVIEW

This section gives a general description of how the Model 72 units operate in various types of systems to provide phone service. It is divided into three parts in order to focus on the three different types of systems that can be built using Model 72s. The last part of this section discusses the operation of various features that can be used in any one of the three system types.

POINT-TO-POINT SYSTEMS

A point-to-point system consists of a Model 72 remote located at the remote site which has a DTMF or rotary telephone plugged into it. At the telephone line end is a Model 72 base which is plugged into the telephone line supplied by the telephone company (see Figure 3-1). All the Model 72 pair does is to replace the wireline with a full-duplex RF link. In point-to-point systems, a call is placed on the system by simply lifting the handset on one of the telephones plugged into the Model 72 remote. The remote will sense that the phone is off hook and signal to the base unit to go off hook on the phone line. The user waits for dial tone from the telephone line and begins to dial. The conversation takes place just as if there were a telephone line connected to the telephone. If the radio channel is busy when the phone is picked up, then the Model 72 remote will send a busy tone to the user indicating that the call cannot be processed at that time and that the user should hang up and try again later. Any time during the busy tone, the user may press a DTMF '*'and hang up. This instructs the Model 72 remote to signal the user with a triple ring when the channel does become free.

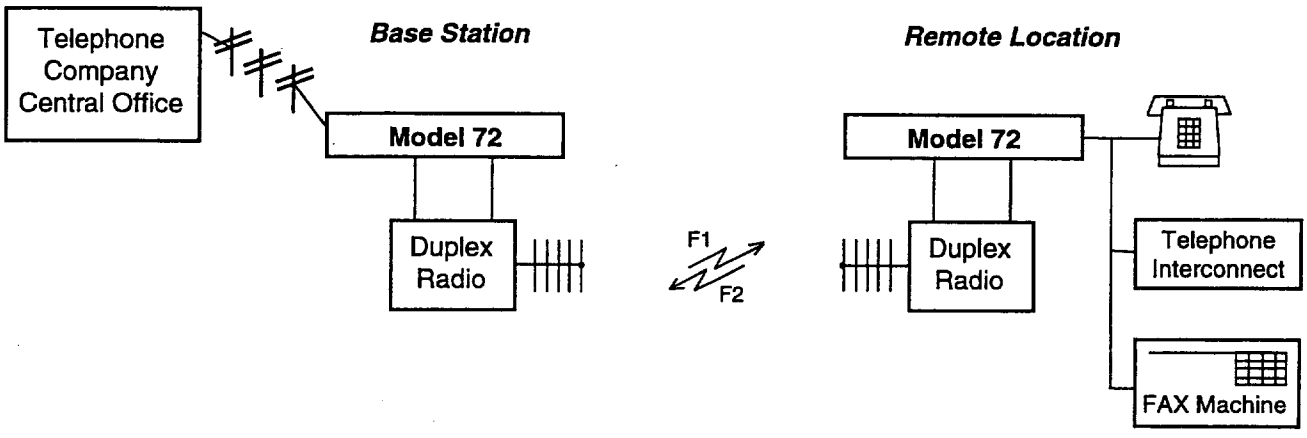


Figure 3-1. Point-to-Point System

When a call comes into the system (when someone wants to talk to the remote site), the Model 72 base detects the ringing on the line and signals the Model 72 remote to tell it to ring the remote telephone. The telephone at the remote site rings in conjunction with the ringing at the Model 72 base. When the Model 72 remote detects that the phone is off hook (someone answered it), then it signals the Model 72 base to answer the line. In both cases, whether the user is dialing out or answering an incoming call, there will be a slightly longer delay between picking up the remote phone and when he or she first hears anything than would be normal on a real phone. This is due to the signaling that must go on between the base and remote units. However, once the call is in progress, it will be hard to tell any difference between the link and a real phone line.

If the call comes into the base and, while the base is waiting for the remote to answer, the phone caller hangs up, then the base unit will stop sending the ringing signal to the remote and return to the idle state as soon as it misses the next ring it expects from the telephone line.

There are two primary ways in which a call in progress can be terminated. The call is terminated whenever the remote telephone is hung up for 2 seconds or more, anything less is considered a hook flash. The other way a call may be terminated is to allow the Call Limit timer to expire. The Call Limit timer is a programmable feature in the Model 72 remote that restricts the length of the telephone call. The Call Limit timer can be programmed to several different lengths or disabled. Before the call is terminated by this timer, the users will hear warning beeps indicating that the call is about to be terminated by the Model 72. There is a third way for the call to be terminated that is not normally used. The Model 72 base has a programmable Base Knock Down Timer, which is provided to disconnect the call at the base end after a certain period of time even if no disconnect command has been received from the remote unit. This feature is not used unless the path between the two Model 72 sites is poor enough that there is a chance the remote phone could be hung up and the base might not receive the command to hang the phone line up.

Even if the user didn't answer the remote telephone, after a programmable number of rings, the Model 72 base will answer the telephone and the base will send error tones to the caller. Once the error tones have finished, the caller has 6 seconds to enter the program mode access code in order to remotely program the Model 72 base.

SINGLE-BASE-TO-MULTIPLE-REMOTES SYSTEMS

A single-base-to-multiple-remotes system consists of a Model 72 base connected to the telephone line provided by the telephone company, and up to 10 Model 72 remotes, one located at each site that requires telephone service. The best comparison would be a party line in a traditional telephone system. In a multiple remote system, an outbound call is placed on the system by simply lifting the handset on one of the telephones plugged into one of the Model 72 remotes. The user waits for dial tone and begins to dial. The conversation takes place just as if there were a telephone line connected to the telephone. If the radio channel is busy when the user picks up his/her handset, the Model 72 remote will send a busy tone to the user indicating that the call cannot be processed at that

time and that he/she should hang up and try again later. Any time during the busy tone, the user may press a DTMF '*' and hang up. This instructs the Model 72 to signal the user with a triple ring when the channel has become free.

When a call comes into the system (when someone wants to talk to one of the remote sites), the telephone line rings into the Model 72 base. The Model 72 base answers the telephone call on the first ring and sends another dial tone prompt to the caller. The caller should then enter a single DTMF (or rotary dial if the Dial Click Decode option is installed) digit to select the specific Model 72 remote he/she wishes to talk to. If the channel is busy, the caller will get busy tone from the Model 72 base and will have to hang up and try the call again later. Once the Model 72 base has the single digit, it signals the appropriate remote unit to start ringing its phone line. The other remotes can no longer key up once this happens. When the user at the site called answers his/her phone, then that remote signals the base to connect the call.

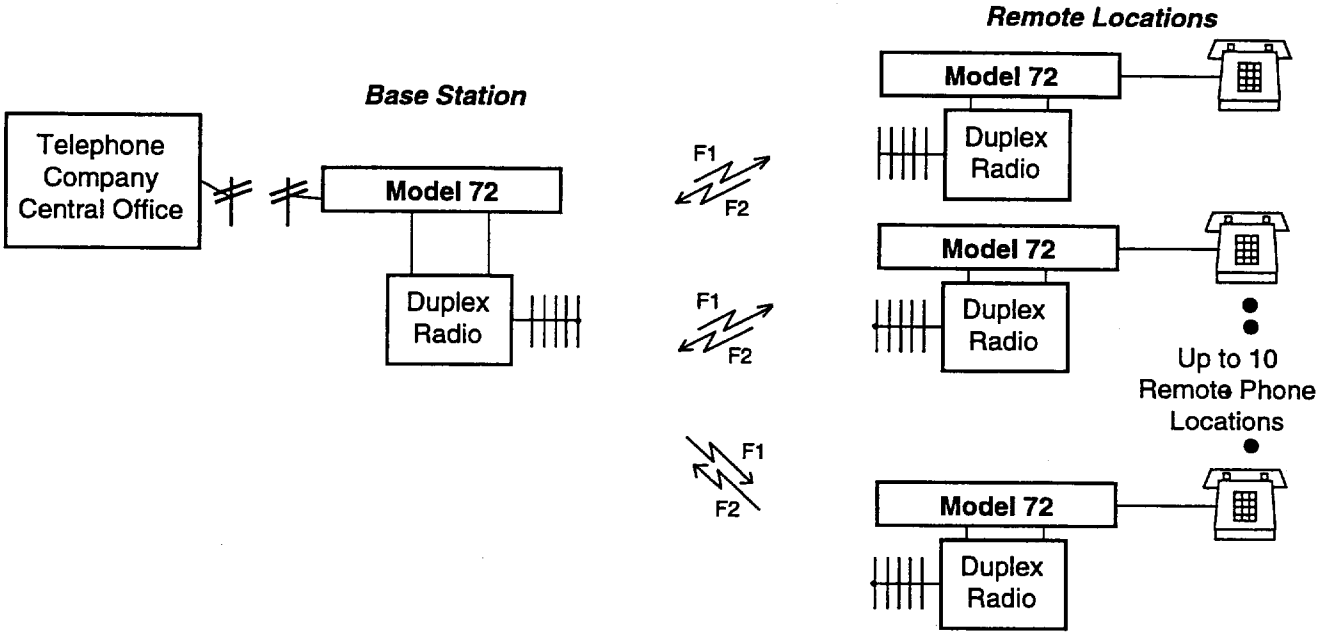


Figure 3-2. A Single Base to Multiple Remotes

The Model 72 base unit does not know how many remotes there are in the system or what their user numbers might be. The base only knows that there must be more than one because the base was programmed in the Multiple Unit mode and so it answers the phone line and trusts that the caller will give it the correct unit number for the remote to be signaled to ring. If the caller gives the base a number that does not match any active remote in the system, then the base will go ahead and signal out to the non-existent remote and the call will never get answered. It is therefore very important that persons who will be calling into this system understand about the overdialing and know what numbers represent valid remote units.

There are two primary ways in which a call can be terminated. The call is terminated whenever the remote telephone is hung up for 2 seconds or more, anything less is considered a hook flash. The other way a call may be

terminated is to allow the Call Limit timer to expire. The Call Limit timer is a programmable feature in the Model 72 remote that restricts the length of the telephone call. The Call Limit timer can be programmed to several different lengths or disabled. Before the call is terminated by this timer, the users will hear warning beeps indicating that the call is about to be terminated by the Model 72 remote. It is most likely that if the Call Limit timer gets used, it will be in this type of system which is essentially a party line. There is a third way for the call to be terminated that is not normally used. The Model 72 base has a programmable Base Knock Down Timer, which is provided to disconnect the call at the base end after a certain period of time even if no disconnect command has been received from the remote unit. This feature is not used unless the path between the two Model 72 sites is poor enough that there is a chance the remote phone could be hung up and the base might not receive the command to hang the phone line up.

If, after a programmable number of rings, the remote user called still has not answered his/her phone, the Model 72 base will send error tones to the caller. Once the error tones have finished, the caller has 6 seconds to enter the program mode access code to remotely program the Model 72 base. Since, in this type of system, the Model 72 base has no way to determine if the phone caller has hung up, once the base starts sending the ringing signal to the remote that was called, the base will continue to send the ringing until the remote either answers or the base reaches the Rings-to-Answer limit. If the Rings-to-Answer number programmed into the base is too high, then you will get complaints from remote users that they are always answering the phone only to find that the caller has already hung up. Experience indicates that six to ten rings is probably about right for a system of this type.

MULTIPLE-BASES-TO-SINGLE-REMOTE SYSTEMS

A multiple-bases-to-single-remote system consists of a single Model 72 remote located at the site where telephone service is required. Up to 10 Model 72 bases may be placed at various geographic locations, each with its own telephone line and number. This service allows the remote user to have a wider "local" dialing area than would otherwise be attained with only a single Model 72 base. For the remote user to make an outbound phone call, he/she lifts the handset of the telephone attached to the Model 72 remote. The user will immediately get a dial tone prompt from the remote itself. At this point, the user must select a Model 72 base to call out on, which he/she does by entering a single digit on phone. Once the selection has been made, the Model 72 remote signals the appropriate base unit to take its phone line off hook. The user will then hear dial tone again from the telephone company and the call proceeds just as if he/she were using a standard telephone. If the radio channel is busy when the remote user picks up his/her phone, the Model 72 remote will send a busy tone to the user indicating that the call cannot be processed at that time and that he/she should hang up and try again later. Any time during the busy tone, the user may press a DTMF '*' and hang up. This instructs the Model 72 remote to signal the user with a triple-ring when the channel has become free.

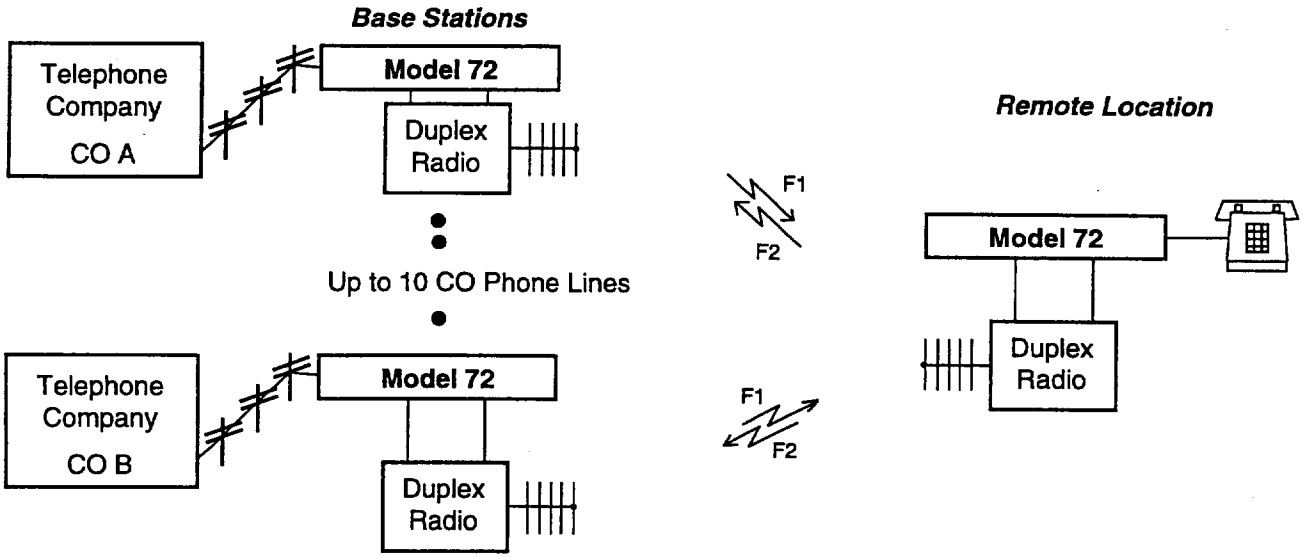


Figure 3-3. Multiple Bases to a Single Remote

When a call comes into the system (when someone wants to talk to the remote site), the Model 72 base receiving the call signals the Model 72 remote to tell it to ring the telephone. The telephone at the remote site rings in conjunction with the ringing at the Model 72 base. When the Model 72 remote detects that the phone is off hook (someone answered it), it then signals the Model 72 base that received the call to answer the line. From this point on the call proceeds as it would on a normal phone line.

There are two primary ways in which a call can be terminated. The call is terminated whenever the remote telephone is hung up for 2 seconds or more, anything less is considered a hook flash. The other way a call may be terminated is to allow the Call Limit timer to expire. The Call Limit timer is a programmable feature in the Model 72 remote that restricts the length of the telephone call. The Call Limit timer can be programmed to several different lengths or disabled. Before the call is terminated by this timer, the users will hear warning beeps indicating that the call is about to be terminated by the Model 72. There is a third way for the call to be terminated that is not normally used. The Model 72 base has a programmable Base Knock Down Timer, which is provided to disconnect the call at the base end after a certain period of time even if no disconnect command has been received from the remote unit. This feature is not used unless the path between the two Model 72 sites is poor enough that there is a chance the remote phone could be hung up and the base might not receive the command to hang the phone line up.

If the user at the remote sight has not answered the call before the base reaches the number of Rings-to-Answer, then the base will answer the line and send error tones to the caller. Once the error tones have finished, the caller has 6 seconds to enter the program mode access code to remotely program the Model 72 base.

MODEL 72 FEATURES

Call Limit Timer

The Call Limit Timer is feature of the remote units which determines the maximum time that a call may last before automatic termination by the Model 72 remote. The remote warns the users of the coming forced disconnect by sending double warning beeps to the users every 3 seconds starting 15 seconds before termination. The Call Limit can be set to be 3, 15, or 30 minutes long, or disabled. The default condition is disabled. This feature is especially useful in controlling the use of a single base to multiple remote system.

Number of Rings to Answer

If the Model 72 remote doesn't answer an incoming call, the Model 72 base will answer the telephone after a programmable number of rings. The Model 72 base will then send error tones for four seconds followed by a six second period of silence. The six second window of silence after the error tone stops is to allow the caller to enter the Program Mode Access Code so they can remotely program the Model 72 base. In multiple remote systems, the phone is immediately answered by the Model 72 base to obtain the overdial digit. If a digit is not entered within 10 seconds, the Model 72 base will send error tones for four seconds followed by the same six second period of silence. If a remote's unit number is entered during the ten seconds, then the base will use the Rings-to-Answer value to determine how many times it should ring the remote before abandoning the call. When the base reaches the maximum number of rings, it will return an error tone to the phone caller and give them their chance to get into program mode. The Program Mode Access Code is a five digit DTMF number used to control access to the program mode of the Model 72 base. The default code is 12172, however, this may be changed in the field to increase the security of the system. Note that Model 72s may NOT be programmed using rotary telephones.

Key Up over Busy Channel

In Point-to-Point systems, it is sometimes useful to allow telephone conversations even when activity can be detected on the radio channel. This feature is necessary when a distant station's carrier can be detected and would inhibit normal operation, but the station is so distant that transmission by the Model 72 system wouldn't cause any interference with the co-channel user.

In Single Base-to-Multiple Remote, or Multiple Base-to-Single Remote systems, transmitting over a busy channel isn't advised because it could disrupt other calls within the system. CTCSS encode/decode may be added to the radios used in a system with multiple bases or remotes so that the Model 72's can distinguish local carrier from distant carrier and communications within the system are not disrupted.

Morse Code Station ID

To identify the transmitting stations, the Model 72 base and remote are both capable of transmitting Morse code station ID. The ID may be sent every 15 or 30 minutes during continuous conversation or only at the end of each call. If the ID timer expires during a call, the Model 72 will ID at a low enough level to keep from disturbing the conversation in progress. The pitch of the Morse code tone is a fixed 1200 Hz.

Transmitter Key Up Delay
The base and remote units in a Model 72 system signal each other by sending frequency shifted DTMF packets back and forth between themselves. It is very important that the transmitter be fully up and stabilized and the receiver on the other end unsquelched before these packets are sent so that no digits will be missed. This command allows the system installer to control the length of the delay between first keying the transmitter and sending the first signal to the other end of the system. The delay can be programmed for a duration of anywhere from 0 to 2.5 seconds, in one-tenth of a second increments. The default value for this feature is 0.5 seconds.

Base Knock Down Timer
The Model 72 system, regardless of which type of system is built, is designed to terminate phone calls and hang up the phone line at the base end when the remote phone is hung up and the remote signals to the base to hang up the line. If the system is put into service in an area with very marginal signal path conditions, the possibility exits that the base might not receive the disconnect signal from the remote when the call has ended and just sit there with the line off hook and its transmitter keyed.

The Base Knock Down timer is designed to provide some relief in these situations. While it defaults to being disabled, this timer can be programmed in the field to any time between 1 and 60, in 1-minute increments. When it is enabled, this timer makes the base hang up the line and drop its transmitter, whether or not it has seen any signals from the remote end of the system. Unlike the Call Limit timer in the remote unit, this Base Knock Down timer does not provide any warning tones to alert the users that the call is about to end. When the Base Knock Down timer reaches zero, the call in progress just ends.

Dial Click Overdial (option)
When building a Single Base-to-Multiple Remote system, the Model 72 base units need to answer the phone line on incoming calls and get a single digit from the phone caller to indicate to which remote unit to route the call. In order to support calls made from rotary or pulse telephones, there is an optional Dial Click decoder board which can be purchased and installed in the Model 72 base. If this option is already installed, the installer can also program the base unit to convert dial clicks received from the phone line into DTMF to send to the remote at any time during the call. This feature is provided to support dialing into other DTMF controlled equipment at the remote site, such as telephone interconnects. Once the base unit detects dial clicks coming to it from the phone line, it will continue to convert the incoming digits to DTMF until there is a pause of more than ten seconds between digits or the maximum limit of 16 digits is reached.

Remote Programming via the Base
This feature allows the system operator to change the programming of the remote unit without making a trip out to the remote site, just as he/she can do with the Model 72 base unit. Basically this feature operates as a special command that is used from within the programming mode on the Model 72 base unit.

4. MODEL 72 BASE PROGRAMMING

4. MODEL 72 BASE PROGRAMMING

RESETTING THE MODEL 72 BASE TO FACTORY DEFAULTS

If for any reason the Model 72 base needs to have its memory reset to factory defaults, you have two methods available to accomplish this:

1. If you are still able to get into the programming mode, you can use the DTMF command "91#" to reset all the programmable values.

2. If you cannot get into the programming mode, then you must use the hardware method. You remove power from the unit and remove its top cover. Press and hold the test button down and apply power to the unit. Hold the test button down until the RING LED comes on solidly (this will take about 4 seconds). You may then release the button. All the programmable settings have now been reset to factory defaults. Remove power from the unit, replace the cover, and re-apply power.

REMEMBER: Using either method resets ALL programmable memory settings back to the factory default values, and there is no way to retain or recover ANY of the prior programming once you have used either method. Before using either one of them, be sure that you really want to or need to, and that you are prepared to restore all necessary programming from your written notes of previous programming.

PROGRAM MODE ACCESS

Even if the dial click option has been installed, Model 72 bases cannot be programmed with rotary telephones. DTMF (Touch-tone) equipped telephones MUST be used.

The programming mode of the Model 72 base can be accessed by calling the unit and waiting for it to reach "Rings-to-Answer". The base will answer the phone and issue an error tone. After the error tone ends, you have 6 seconds to enter the program mode access code. The base unit is not listening for the program mode access code until error tone stops, so you must wait for the error tone to end before you start entering the code. The remote user must NOT answer the telephone, otherwise the Model 72 base will not allow the caller to enter the program mode access code. The default value for the program mode access code is "12172", but can be changed in programming to any other five digit number.

ENTERING A PROGRAM COMMAND

To execute a program command, a two digit DTMF number is entered followed by the '#' key. Once the '#' key has been entered, the Model 72 will respond with the five beep go-ahead sequence, indicating that the command was accepted, or a high-low error tone sequence indicating that an invalid command was received. If the command used requires additional information, the Model 72 will respond with two short beeps and wait for the additional information to be entered followed by a '#'. Wait until the go-ahead or error tones are sent before entering the next command. Do not try to "string" commands together. While in the program mode, a command must be entered at least every 60 seconds, or the Model 72 will automatically exit the program mode and return to normal operation. The following is a summary of prompt and response tones:

DTMF "#"	Enter key, accept data or command.
5 Beeps	Ready for next command.
2 Beeps	Need more information to complete command.
"DEE-DOO, ..."	Error Tone, invalid data or command entered.

Since the Model 72 base offers no method of viewing programmed settings, it is important to be careful during programming and to keep track of all programmed settings. If the Model 72 base is ever in an unknown programming state, ALL settings may be reset to the factory default values by entering the command "91#".

A tried and proven technique is to go through the programming command list ahead of time, figure out what you want to change and to what new values, and then write all the commands and entries down in a list. After you have the list ready and checked, you get into the program mode on the Model 72 base and just punch in the data from the list. This is the easiest way to get the programming done correctly and you can fill out your programming records on the unit from your list.

PROGRAMMABLE ITEMS

Operating Mode

A Model 72 base may operate in either the single unit mode or the multiple unit mode. The operating mode used tells the Model 72 base whether or not it needs to answer the phone and get an overdial digit to select the proper talk path. If the Model 72 base needs to communicate with more than one Model 72 remote at the other end, then it needs to be programmed to operate in the multiple unit mode. For example, a Model 72 base that provides service to three Model 72 remotes needs to operate in the multiple unit mode since the caller must tell the base which remote he/she wants to talk to. Similarly, since each Model 72 remote only has to communicate with a single Model 72 base, they need to be programmed to operate in the single-unit mode. To sum up, in a Point-to-Point or a Multiple Base-to-Single Remote system the base will be set to the "Single Unit" mode. In a Single Base-to-Multiple Remote system the base should be set to the "Multiple Unit" mode.

01# - Single Unit Mode (Default)
02# - Multiple Unit Mode

See Table 4-1 for examples of programming operating modes.

Unit Address

Each Model 72 has a specific unit number (or address) which is equivalent to the unit's overdial digit. If the unit is the only one of its type (Model 72 base or Model 72 remote) in the system, then the unit's address needs to be "0" so that it may be called by all the other units in the system. If the system design is Multiple Bases-to-Single Remote, then each of the base units must have a unique unit number assigned to it so the user at the remote end of the system can select which base to call out on. The valid range for this command is any single digit 0 through 9.

03# __# - Unit Address (Default = 0) [range 0 - 9]

See Table 4-1 for examples that demonstrate the relationship of operating mode and unit address when programming the bases and remotes in a system.

Table 4-1. Operating Mode and Unit Address Examples

Type of System	Remote#	Base#	Mode	Address#
Point-to-Point				
1 M72 remote	1		single	0
1 M72 base		1	single	0
Single Base-to-Multiple Remotes				
3 M72 remotes	1		single	1
	2		single	2
	3		single	3
1 M72 base		1	multi	0
Multiple Bases-to-Single Remote				
1 M72 remote	1		multi	0
3 M72 bases		1	single	1
		2	single	2
		3	single	3

Morse Code Station Identification
If enabled, the Model 72 base will transmit the Morse code station ID programmed whenever the Morse Code Identification Period ends (even during a call in progress if that is when the timer runs out). Alternatively, the base can be programmed to send the ID at the end of every phone call before it drops the transmitter. If set to ID at the end of calls, the ID will be sent even if the other unit does not answer the call. The ID is sent at 30% of full channel deviation and 25 words per minute. The ID tone frequency is 1200 Hz. This command is used to enter the station ID characters. The range for this command is from one to ten characters, in any combination of letters and numbers.

04# _ _ _ _ _ _ _ _ _ _ **#** - **CW ID Call Sign** (default is blank)

The characters are entered from the DTMF keypad on the phone, and, in order to provide unique entries for all 26 letters and ten numerals, all characters of the ID will be represented by two digit entries.

To enter a letter, the first digit you press (1, 2, or 3) will designate if the letter you want to enter is the first, second, or third letter on the next key you will press. The second digit will be that key on the DTMF keypad that has the letter you need written above its number. For example,

if you want to enter "W", notice that "W" is the first letter on the "9" key (see Figure 4-1). So you press the "1" key and then the "9" key to enter a "W" in the ID code. To enter a number, press the "0" key first, followed by the number you need. For example, to enter a "2", press "0" and then "2". Enter all the digits and letters of the station ID and end with a '#' key.

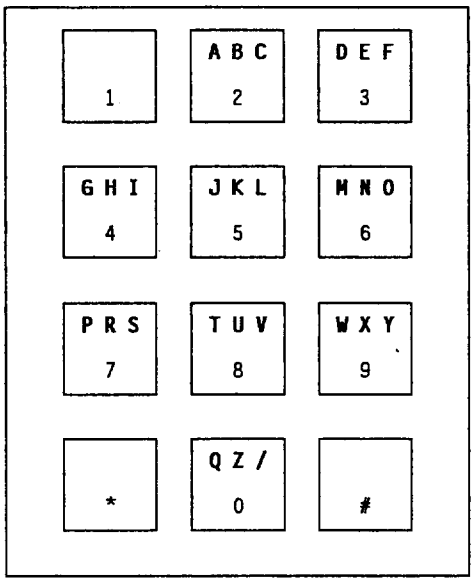


Figure 4-1. DTMF Keypad with Letters Shown

For example, to enter the station ID "WNCR-414" you would enter:

Enter DTMF --> 04# 19 26 32 27 04 01 04 #

Comments --> ID = W N C R 4 1 4 done

Table 4-2 shows the DTMF digits to enter for the letters or numbers in the station ID. It also shows the Morse code equivalent.

Table 4-2. Morse Code Station ID and DTMF Entry Cross-Reference

Digits	Letter	Code	Digits	Letter	Code	Digits	Letter	Code
00	0	_ _ _ _ _	12	A	. _	26	N	_ .
01	1	. _ _ _ _	22	B	_ . . .	36	O	_ _ _
02	2	. . _ _ _	32	C	_ . _ .	17	P	. _ _ .
03	3	. . . _ _	13	D	_ . .	10	Q	_ _ . _
04	4	. . . . _	23	E	.	27	R	. _ .
05	5	. . . . .	33	F	. . _ .	37	S	. . .
06	6	_	14	G	_ _ .	18	T	_
07	7	_ _ . . .	24	H	. . . .	28	U	. . _
08	8	_ _ _ . .	34	I	. .	38	V	. . . _
09	9	_ _ _ _ .	15	J	. _ _ _	19	W	. _ _
			25	K	_ . _	29	X	_ . . _
			35	L	. _ . .	39	Y	_ . _ _
			16	M	_ _	20	Z	_ _ . .
						#	(done)	

Enable/Disable Morse Code ID
The station ID can be enabled and disabled using the following commands without changing any of the other ID programming.

05# - Disable Morse Code Station ID (default)
06# - Enable Morse Code Station ID

ID at End of Conversation
This command instructs the Model 72 base to transmit the station ID only at the end of each call, regardless of length. This avoids any disruptions in the conversation due to the station ID being transmitted.

07# - ID at End of Conversation (default is periodic ID)

Morse Code Identification Period
The station identification can be transmitted every 15 or 30 minutes during the conversation. The Model 72 base will send the station ID at least once within the period selected.

08# - ID every 15 minutes (Default)
09# - ID every 30 minutes

Transmitter Key Up Delay
The Model 72 will wait for the transmitter to stabilize and the receiver on the other end to unsquelch before transmitting any signaling tones. The key up delay can be programmed from 0 seconds to 2.5 seconds in 0.1 second increments. Having a long enough key up delay to ensure that no signaling tones are transmitted before the other end is ready to receive them is critical for correct operation of the system. The Model 72 defaults to 0.5 seconds of key up delay. Any value from 0 to 25 is acceptable for this command.

10# - __ __# Transmitter Key Up Delay (Default = 0.5 seconds)

Transmit on Busy Channel
The Model 72 base may be programmed to ignore the presence of carrier on the channel. This feature can be used in Point-to-Point systems when the Model 72 base's location allows it to detect signals from a distant radio system, yet when keyed, the transmissions of the base won't interfere with the distant system. This feature should not be used in systems using one of the multiple unit modes since it would allow one base to key up on top of other units in the system. Systems using one of the multiple unit modes must have CTCSS decoders connected to the AUX input to distinguish between local transmissions, and a distant carrier.

11# - Disable Transmit on Busy Channel (Default)
12# - Enable Transmit on Busy Channel

Number of Rings to Answer
In systems that only have a single remote unit, the Model 72 base needs to know how many times it should let the telephone line ring before answering the phone and allowing the caller an opportunity to enter the Program Mode Access Code. In multiple remote systems, the Model 72 base will use this value as the number of times to ring the remote telephone before it abandons the call if the remote doesn't answer. In the second case, since the Model 72 base cannot detect if the phone caller has disconnected, it will keep ringing the remote until it reaches the Rings-to-Answer value, even if the phone caller has disconnected. The longer the Model 72 base rings the remote telephone, the greater the chance that the remote user will answer after the calling party has given up.

If the number of rings is too small, the Model 72 base will stop ringing the Model 72 remote and answer the call before the remote telephone can answer. A value of 6 to 10 rings is usually adequate for multiple remote systems. The Model 72 base defaults to 10 rings before allowing the caller a chance to enter the Program Mode Access Code. The maximum number of rings allowed is 25.

Note: This command may only be executed on the Model 72 bases!

13# - __ __# - RINGS-to-ANSWER (Default = 10 rings)

Base Knock Down Timer
This command allows you to program up to a 60-minute timeout timer in the Model 72 base. Whenever a call is started this timer starts counting down, and when it times out the base will hang itself up whether or not it has received a disconnect signal from the remote. The range for this timer is "00" to "60" in whole minutes. Entering a value of "00" will disable this timer.

Note: This command may only be executed on the Model 72 bases!

18# - __ __# - Base Knock Down Timer (Default = 00)

Dial Click Overdial
When dial click overdial is enabled, the phone caller will be allowed to enter up to 16 digits with a maximum pause of 10 seconds between digits. If less than 16 digits are entered, the dial click decoder will be active for 10 seconds or will be disabled immediately if a DTMF digit is decoded. In some cases voice may false the dial click decoder during the first few seconds of the call, causing DTMF to be generated and heard by the remote user during the conversation.

Note: This command is valid only in the Model 72 bases, and only when the Dial Click Overdial option (950-9357) is purchased.

32# - Enable Dial Click Overdial
33# - Disable Dial Click Overdial (Default)

Program Mode Access Code
The DTMF access code required to put the Model 72 base into the program mode can be changed by the user for added security. The number must be five digits long, and defaults to "12172". To change the access code, enter "90#", and, after the double beep is sent, enter a five digit number followed by a "#". Example: to change the access code to 12345, enter "90#", wait for double beep, then enter "12345 #".

Note: This command may only be executed on Model 72 bases!

90# - __ __ __ __ __# Program Mode Access Code (Default = 12172)

Reset ALL Programmable Settings to Factory Defaults
This command will erase ALL previous settings in the unit and return them to the Zetron factory defaults. THERE IS ABSOLUTELY NO WAY OF RESTORING PREVIOUSLY PROGRAMMED SETTINGS ONCE THIS COMMAND HAS BEEN USED. When this DTMF command is used in the Program Mode, there will a somewhat longer wait for the go-ahead beeps than you are used to. This is normal while the base is busy clearing its memory. If the Program Mode Access Code in the Model 72 base has been forgotten, the Model 72 may be reset to factory defaults by using the hardware method described at the beginning of this section.

91# - Reset ALL Programmable Settings to Factory Defaults

Dial Click Calibration Test
When used, this test will indicate the dialed number by returning a series of slow beeps to the phone. The number of beeps sent will equal the pulse dialed number that the base thought it heard. The test is terminated by entering a DTMF "#" from the phone.

Note: This command may only be executed on Model 72 bases that have the Dial Click Decoder option (950-9357) installed!

96# - Dial Click Calibration Test

Remote Programming
This command allows you to program the Model 72 remotes over the telephone line via the Model 72 base. To enter this mode, enter the programming mode in the Model 72 base first and then enter the command "97#" followed by the unit number of the Model 72 remote you wish to program. Unlike other commands, in this one particular case, you will enter the digit after the "#" (for the remote unit number) without waiting for a prompt to do so, and you will <u>not</u> put any "#" after the unit number. After this mode is entered, you may use the DTMF commands for the remote just as you would when programming the remote from its own phone. To exit this mode, enter 99# which returns you to the normal programming mode in the Model 72 base. The valid range for the unit number is any single digit "0" through "9".

Note: This command may only be executed on Model 72 bases!

97# <u>n</u> - Remote Programming (where "n" = remote's unit number)

Exit the Program Mode
This command makes the Model 72 base hang up the phone and return to its normal operational mode.

99# - Exit the Program Mode

5. MODEL 72 REMOTE PROGRAMMING

5. MODEL 72 REMOTE PROGRAMMING

RESETTING THE MODEL 72 REMOTE TO FACTORY DEFAULTS

If for any reason the Model 72 remote needs to have its memory reset to factory defaults, you have two methods available to accomplish this:

1. If you are at the remote, remove power from the unit and remove its top cover. Press and hold the test button down and apply power to the unit. Hold the test button down until the RING LED blinks rapidly. You may then release the button. The defaults have now been reset to factory defaults. Remove power from the unit, replace the cover, and re-apply power.

2. Since the remote can also be programmed over the telephone line via the Model 72 base, resetting the Model 72 remote to factory defaults may also be done by entering the program mode and entering the DTMF command "91#".

REMEMBER: Using either method resets ALL programmable memory settings back to the factory default values, and that there is no way to retain or recover ANY of the prior programming once you have used either method. Before using either one of them, be sure that you really want to or need to, and that you are prepared to restore all necessary programming from your written notes of previous programming.

PROGRAM MODE ACCESS

Even though the Model 72 remotes can process pulse or rotary dialing for normal calls without any trouble, Model 72 remotes cannot be programmed with pulse or rotary telephones. DTMF (Touch-tone) equipped telephones MUST be used for all programming. This is also true when programming the remote via the Model 72 base, even if the base has the Dial Click Decoder option installed.

The programming mode can be accessed in the Model 72 remote by pressing and holding the TEST button and taking the telephone off hook. Also note that during programming, the Model 72 being programmed is out of service until the "EXIT PROGRAMMING" command (99#) has been entered.

The remote can also be programmed over the telephone line by first calling the Model 72 base and entering into the program mode on the base. Once into programming on the base you send the DTMF command "97#n" (where "n" = the unit number of the remote to be programmed), and the base will signal the remote and start passing all audio back and forth between the telephone line and the remote. To exit from this mode of programming you first enter "99#" to terminate the programming session with the remote, and then enter "99#" again to terminate the programming mode in the base.

ENTERING A PROGRAM COMMAND

To execute a program command, a two digit DTMF number is entered followed by the '#' key. Once the '#' key has been entered, the Model 72 will respond with the five beep go-ahead sequence, indicating that the command was accepted, or a high-low error tone sequence indicating that an invalid command was received. If the command requires additional information, the Model 72 will respond with two short beeps and wait for the additional information to be entered followed by a '#'. Wait until the go-ahead or error tones are sent before entering the next command. Do not try to "string" commands together. While in the program mode, a command must be entered at least every 60 seconds, or the Model 72 will automatically exit the program mode and return to normal operation. The following is a summary of prompt and response tones:

DTMF "#"	Enter key, accept data or command.
5 Beeps	Ready for next command.
2 Beeps	Need more information to complete command.
"DEE-DOO, ..."	Error Tone, invalid data or command entered.

Since the Model 72 remote offers no method of viewing programmed settings, it is important to be careful during programming and to keep track of all programmed settings. If the Model 72 remote is in an unknown programming state, ALL settings may be reset to the factory default values by entering the command "91#".

A tried and proven technique is to go through the programming command list ahead of time, figure out what you want to change and to what new values, and then write all the commands and entries down in a list. After you have the list ready and checked, you get into the program mode on the Model 72 remote and just punch in the data from the list. This is the easiest way to get the programming done correctly and you can fill out your programming records from the list.

PROGRAMMABLE ITEMS

Operating Mode

A Model 72 remote may operate in either the Single Unit mode or the Multiple Unit mode. The operating mode tells the Model 72 remote whether or not it needs to get an overdial digit from the user of the remote phone to select the proper talk path. If the Model 72 remote needs to communicate with more than one Model 72 base at the other end of the system, then the remote needs to be programmed to operate in the Multiple Unit mode. For example, a Model 72 remote that provides service to 3 Model 72 bases needs to operate in the Multiple Unit mode since the user must tell it which Model 72 base he/she wants to talk to. Similarly, since each Model 72 base only has to communicate with a single Model 72 remote, they need to be programmed to operate in the Single Unit mode. Overdial digits are not required to access the single Model 72 remote from the bases. To sum up, in a Point-to-Point or Single Base-to-Multiple Remote system the remote(s) will be set to the Single Unit mode. In a Multiple Bases-to-Single Remote system the remote will be set to the Multiple Unit mode.

01# - Single Unit Mode (Default)
02# - Multiple Unit Mode

See Table 5-1 for examples of programming operating modes.

Unit Address

Each Model 72 has a specific unit number (or address) which is equivalent to the unit's overdial digit. If the unit is the only one of its type (Model 72 remote or Model 72 base) in the system, then the unit's address needs to be "0" so that it may be called by all the other units in the system. If the system design is Single Base-to-Multiple Remotes, then each of the remote units must have a unique unit number assigned to it so that the phone caller can select it by overdialing that number into the base when the base answers a call. The valid range for this command is any single digit 0 through 9.

03# __# - Unit Address (Default = 0) [range 0 - 9]

See Table 5-1 for examples that demonstrate the relationship of operating mode and unit address when programming the bases and remotes in a system.

Table 5-1. Operating Mode and Unit Address Examples

Type of System	Remote#	Base#	Mode	Address#
Point-to-Point				
1 M72 remote	1		single	0
1 M72 base		1	single	0
Single Base-to-Multiple Remotes				
3 M72 remotes	1		single	1
	2		single	2
	3		single	3
1 M72 base		1	multi	0
Multiple Bases-to-Single Remote				
1 M72 remote	1		multi	0
3 M72 bases		1	single	1
		2	single	2
		3	single	3

Morse Code Station Identification
If enabled, the Model 72 remote will transmit the Morse code station ID programmed whenever the Morse Code Identification Period ends (even during a call in progress if that is when the timer runs out). Alternatively, the remote can be programmed to send the ID at the end of every phone call before it drops the transmitter. The ID is sent at 30% of full channel deviation and at 25 words per minute. The ID tone frequency is 1200 Hz. This command is used to enter the station ID characters (call sign). The range for this command is from one to ten characters, in any combination of letters and numbers.

04# _ _ _ _ _ _ _ _ _ _ **# - CW ID Call Sign** (default is blank)

For instructions on entering a station ID with a DTMF keypad, see "Morse Code Station Identification" in Section 4.

Enable/Disable Morse Code ID
The station ID can be enabled and disabled using the following commands without changing any of the other ID programming.

05# - Disable Morse Code Station ID (Default)
06# - Enable Morse Code Station ID
ID at End of Conversation
This command instructs the Model 72 remote to transmit the station ID only at the end of each call, regardless of length. This avoids any disruptions in the conversation due to the station ID being transmitted.

07# - ID at End of Conversation (default is periodic ID)

Morse Code Identification Period
The station identification can be transmitted every 15 or 30 minutes during the conversation. The Model 72 remote will send the station ID at least once within the period selected.

08# - ID every 15 minutes (Default)
09# - ID every 30 minutes

Transmitter Key Up Delay
The Model 72 will wait for the transmitter to stabilize and the receiver on the other end to unsquelch before transmitting any signaling tones. The key up delay can be from 0 seconds to 2.5 seconds in 0.1 second increments. Having a long enough key up delay to ensure that no signaling tones are transmitted before the other end is ready to receive them is critical for correct operation of the system. The Model 72 defaults to 0.5 seconds of key up delay. Any value from 0 to 25 is acceptable for this command.

10# __ __# - Transmitter Key Up Delay (Default = 0.5 seconds)

Transmit on Busy Channel
The Model 72 remote may be programmed to ignore the presence of carrier on the channel. This feature can be used in Point-to-Point systems when the Model 72 remote's location allows it to detect signals from a distant radio system, and yet, when keyed, the transmissions of the remote won't interfere with the distant system. This feature should not be used in systems using one of the multiple unit modes since it would allow the remote to key up on top of other units in the system. Systems using one of the multiple unit modes must have CTCSS decoders connected to the AUX inputs on the Model 72's to distinguish between local transmissions, and a distant carrier.

11# - Disable Transmit on Busy Channel (Default)
12# - Enable Transmit on Busy Channel

Call Limit Timer
Telephone calls on the system can be limited in length to meet either federal regulations or system requirements. When the Call Limit timer is approaching its limit, the remote will transmit double beeps over the channel at 3 second intervals, starting 15 seconds before terminating the call. When the timer reaches its limit the remote will send a disconnect signal to the base and then drop its own transmitter until it senses that the remote phone has been placed back on hook and then picked up again. The default condition for this feature is disabled.

Note: This command may only be executed on Model 72 Remotes!

14# - Disable Call Limit Timer (Default)
15# - 3 Minute Call Limit Timer
16# - 15 Minute Call Limit Timer
17# - 30 Minute Call Limit Timer

Reset All Programmable Settings to Factory Defaults
This command will erase ALL previous settings in the unit and return them to the Zetron factory defaults. THERE IS ABSOLUTELY NO WAY OF RESTORING PREVIOUSLY PROGRAMMED SETTINGS ONCE THIS COMMAND HAS BEEN USED. When this DTMF command is used in the Program Mode, there will be a somewhat longer than normal delay before you hear the go-ahead beeps. This is normal while the remote is busy clearing its memory.

91# - Reset ALL Programmable Settings to Factory Defaults

Test Tone
This command can only be used when accessing the program mode in the remote unit via the Model 72 base. If you try to use it from the remote phone, then the Model 72 remote will return an error tone. When this command is used it causes the Model 72 remote to generate a 1-KHz test tone for 30 seconds or until a DTMF digit is entered from the telephone.

REMEMBER: This command may only be executed on Model 72 remotes, and even then, only when programming the remote via the Model 72 base!

95# - Generate 1-KHz Test Tone

Exit the Program Mode
This command returns the Model 72 remote to its normal operational mode. After using this command, you must hang up to remote phone and come off hook again in order to make a call.

99# - Exit the Program Mode

6. INSTALLATION

6. INSTALLATION

GENERAL INFORMATION

Installation Warning

This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with this instruction manual, it may cause interference to radio communications. Installation of the Model 72 Extend-a-Line should only be attempted by qualified radio service personnel.

* * * * * * * * * * * * * * * W A R N I N G * * * * * * * * * * * * * * *

HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE MODEL 72 REMOTE UNIT. TO AVOID ELECTRIC SHOCK, USE INSULATED TOOLS FOR MAKING ADJUSTMENTS. AVOID MAKING BODILY CONTACT WITH INTERNAL COMPONENTS. ALWAYS REPLACE THE COVER BEFORE PUTTING THE UNIT INTO SERVICE.

* *

Overview

This section of the manual covers the interfacing of the base and remote units to their radios and the level adjustments necessary to ensure proper operation and optimum performance of the system.

Connections to the transmitter, receiver, and power are all grouped on a single detachable terminal strip on the rear of the Model 72, designated J2. The connections to this terminal will be the same for the base and the remote units.

The level adjustments are required to ensure proper operation of the system and should be done before you start into the final programming of the two units. Experience indicates that you should (if you can) set up both ends of the system while still in your shop and adjust the levels and test the system's operation there. This will greatly enhance the probability that once you transport the two ends of the system out to their separate sites, the system will at least come up working, and hopefully need only minor on site adjustments to reach optimum performance.

The last part of this section contains some information on how you can hook up the base and remote units back-to-back on the bench (without using radios) so that you can work with the units and get comfortable with how they operate before you start installing them on their radio gear. If you have never worked with a telephone line extender before, and you have the time, this is a great way to remove some of the mystery before you get involved with interfacing the Model 72 units to other equipment. This section also has some suggestions for how to use an external carrier detect signal (COR) with the Model 72 units. This is not the preferred mode of operation for these units; however, it is provided to aid those technicians whose situation in the field make it necessary to use an external carrier detect.

Equipment Required for Installation
The following equipment is required for installation of the Model 72:

1. Communications service monitor
2. Shielded cable
3. Touch-Tone telephone
4. Hand tools

The following additional equipment is recommended:

1. Volt Ohm Meter
2. Oscilloscope

System Considerations
There are several items concerning the physical design of a system that need to be considered in order to ensure that the finished system will provide an acceptable level of service to the end users.

To reduce the chance of interfering with co-channel users, it is recommended that the unit with the greatest RF coverage have its receive/transmit channel offset configured like a repeater. For example, in the United States, the convention for a UHF band repeater frequency offset is to set the receive frequency 5 MHz higher than the transmit frequency. Therefore, it is said that the repeater "transmits low" and "receives high". In a Model 72 system, the unit that will have the greatest coverage (based on geography) should be set up to operate like a repeater so that other co-channel repeaters don't get interfered with when it is keyed. Typically, the Model 72 bases would be installed with their frequency offset matching a repeater, and the Model 72 remotes installed with offsets matching mobile units.

To provide telephone service equivalent to that of the telephone company requires a few simple but important things:

- Good equipment must be used to provide high-quality telephone service. Repeaters (or full duplex base stations) should be used for the RF links since they typically are capable of continuous duty operation and are already set for full-duplex operation. We usually recommend against using a pair of mobiles or portable radios to work as a full-duplex station. A full-duplex station will usually cost more, but for good reason.

- Since this system is full-duplex by nature, the use of duplexers or tuned cavity filters is highly recommended. Using vertically isolated antennas without combiners or bandpass filters is not a good choice when attempting to provide a similar grade of service to that of the telephone company.

- Care should be taken when installing the equipment. Shielded cable MUST be used for all audio leads and the shields MUST be grounded. RF routing is important also. Double shield cabling should be used for all RF paths. Always use good grounding practices.

- For both ends of the system, place the RF equipment in locations such that the path between the Model 72 base and Model 72 remote is as clean and strong as possible. The RF path should have as little interference from co-channel stations as it is practical to arrange, and both receivers should go "full-quieting" when the transmitter is keyed at the opposite end of the system.

INSTALLATION PROCEDURE

All of the following instructions refer to the 15 pin rear panel detachable screw terminal connector labeled "J2".

1. **POWER SUPPLY:** Locate a 12 VDC power source for the Model 72. The voltage should be between 11.0 VDC and 15.0 VDC, and the source should be rated for at least one ampere continuous output. If a suitable DC supply cannot be found, the optional 12 VAC wall transformer may be used. For DC operation, connect the power supply ground lead to pin 3 ("GND") of J2, and the positive supply lead to pin 1 ("AC/DC") of J2. For AC operation, connect the wall transformer leads to pins 1 ("AC/DC") and 2 ("AC") of J2.

2. **GROUND CONNECTION:** Connect a chassis ground wire from pin 3 ("GND") of J2 to the chassis ground of the transmitter/receiver.

3. **TRANSMITTER PTT:** A relay is used to control the transmitter. Most transmitters require a contact closure to ground for PTT. If this is the case, connect pin 6 ("PTT COM") of J2 to pin 4 ("GND") of J2, and pin 7 ("PTT NO") of J2 to the transmitter's PTT input. If a pull up is required to key the transmitter, connect pin 7 ("PTT NO") of J2 to the transmitter's PTT input, and pin 6 ("PTT COM") of J2 to the pull up power source (usually found in the transmitter). In most cases, the relay may simply be wired in place of the PTT button.

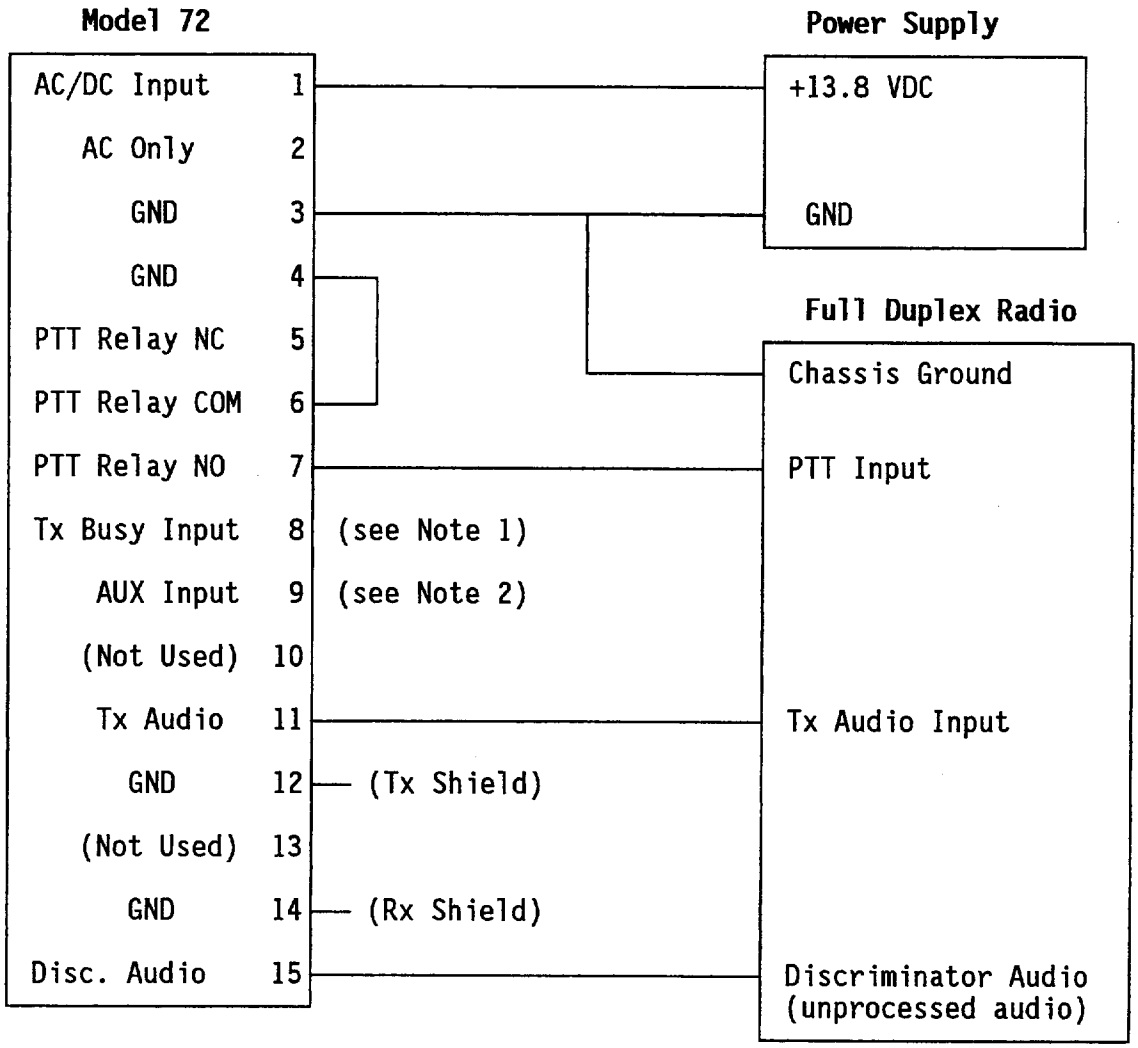
4. **TRANSMITTER AUDIO OUTPUT:** Connect pin 11 ("TX AUD") of J2 to the microphone input of the transmitter. Shielded cable must be used for this connection. Connect the shield braid of the cable to pin 12 ("GND") of J2. Do not connect the braid to anything on the radio end.

5. **DISCRIMINATOR INPUT:** Connect pin 15 ("DISC") of J2 to the receiver discriminator output. Shielded cable must be used for this connection. Connect the shield braid of the cable to pin 14 ("GND") of J2. Do not connect the braid to anything on the radio end. **NOTE:** Unfiltered, unsquelched, raw discriminator audio MUST be used for proper operation of the squelch and receive audio circuits in the Model 72. Speaker audio may NOT be used. The carrier detection circuitry depends on high frequency noise to operate properly. Speaker audio is band limited and squelched, and therefore will not allow the noise through to the Model 72's carrier detect circuitry.

6. **TRANSMITTER BUSY INPUT:** Pin 8 ("TX BUSY") of J2 may be connected to the COR output on an auxiliary receiver on the transmit channel, permitting monitoring of the transmit channel for activity. The "TX BUSY" input must be pulled low when carrier is detected, and high when carrier is absent. This input has an internal pull-up resistor which guarantees the correct logic input level when the "TX BUSY" input is left unconnected.

7. **AUXILIARY INPUT:** Pin 9 ("AUX IN") of J2 may be connected to a CTCSS decoder output. This feature adds the ability to distinguish between a co-channel user, and a distant Model 72 station in multiple unit systems. JP20 is used to set the CTCSS decode polarity. If the CTCSS decoder output goes low when it decodes a valid tone, set JP20 to the "B" position, otherwise, set it to the "A" position.

Generic Wiring Diagram
Figure 6-1 illustrates the generic wiring for the Model 72 J2 15-pin connector.



Notes:

1. The Tx Busy input is for use with a monitoring receiver on the transmit frequency of the full duplex base in question. This provides a way to prevent the Model 72 unit from keying its transmitter on top of another co-channel transmitter that is close enough to be interfered with by the Model 72.

2. The AUX input is for use with the logic output of a CTCSS/DCS decoder in the receiver section of the radio. This input can be used to help the Model 72 units ignore long distance co-channel skip without making them ignore local channel activity in systems using multiple bases or remotes. The jumper JP20 in the Model 72 is used to set the valid decode polarity for this input.

Figure 6-1. Generic Wiring Diagram

TESTS AND ADJUSTMENTS

These tests and adjustments should be done twice. The first time will be done on the bench in the shop in order to prove that the interfacing of the base and remote units to their radios was done correctly. The second time is when the units are finally installed at their respective sites, in order to confirm that everything is correctly adjusted for best operation under the conditions in which the units will actually serve.

Radio Adjustments

The radio level adjustments will be the same for both the base and remote versions of the Model 72.

1. Unplug J2, remove the screw in the Model 72's top cover, and remove the cover from the Model 72.

2. **RESETTING THE PROGRAMMABLE SETTINGS:** If this is the first time that the tests and adjustments are being done and the units have not yet been programmed for installation, then you may reset the programmable settings before proceeding. If the unit was already installed and is being tested at the site, then simply turn on the power, and continue.

   TO RESET THE MODEL 72 BASE: Locate the TEST switch (SW1). While power is off, press and hold this switch and while holding it down apply power to the unit. Continue to hold the switch until the RING LED comes on solid (about four seconds) and then release the switch and the LED should remain lit. Remove power from the unit for a few seconds and then reapply power to the unit and continue with the tests.

   TO RESET THE MODEL 72 REMOTE: Locate the TEST switch (SW1). While power is off, press and hold this switch and while holding it down apply power to the unit. Continue to hold the switch until the RING LED begins to blink rapidly (a few seconds). Release the switch and the LED should go dark. Remove power from the unit for a few seconds and then reapply power to the unit and continue with the tests.

3. **TRANSMIT AUDIO GAIN:**
   a. If you have not already done so, apply power to the Model 72. Set your service monitor to receive on the radio's transmit frequency and configure it to give you a deviation reading on the received signal.
   b. Verify that JP17 in the Model 72 is in the "A" position to start this test, if not, move the jumper to position "A".
   c. Press and hold the "TEST" switch. The Model 72 will key the transmitter and send a 1KHz test tone out the transmitter. The Model 72 will stop the signal and unkey the transmitter as soon as you release the TEST switch.
   d. Adjust the "TX" gain pot (R68) for a deviation of ±3.0 KHz on the channel. If a ±3.0 KHz deviation cannot be achieved, then move JP17 to the "B" position and readjust the "TX" gain pot.

NOTE: If subaudible tone (CTCSS of DCS) is generated by the transmitter, set the Tx Audio deviation to 3.0 KHz plus the subaudible deviation. For example, for CTCSS encode of 100.0 Hz at ±700 Hz deviation, set the total deviation to ±3.700 KHz.

NOTE: If you are monitoring the TX channel during normal operation, the signal will appear to be distorted. Remember that this is a companded signal you are observing, and it will be expanded again by the Model 72 at the other end of the system.

4. **RECEIVE AUDIO GAIN:**
   a. Verify that JP6 in the Model 72 is in the "A" position to start this test. If it is not, move JP6 to the "A" position.
   b. Set the service monitor to generate a 1 KHz tone at ±3.0 KHz deviation on the radio's receive channel without any CTCSS or DCS encode.
   c. Monitor the AC voltage on the test point TP1 (labeled "RX AUD" next to JP6 and behind pin 14 of J2).
   d. Adjust R39 until 1.7 Vpp (0.6 Vrms) is present at the test point. If necessary to reach the required level, move the "RX gain" jumper, JP6, to the "B" or "C" position and readjust R39.
   e. When you have finished the adjustment, unkey the service monitor.

5. **CARRIER:**
   a. Attach a test lead to the radio's local speaker and configure the service monitor's meter to measure SINAD (or use an external SINAD meter).
   b. Generate the 1 KHz tone/ 3KHz deviation test signal into the receiver again, and then reduce the signal strength until you are measuring a 6 dB SINAD signal to the receiver.
   c. Adjust the Model 72's "CARRIER" pot, R40, so that the "CARRIER" LED just lights.
   d. Remove test signal and verify that the "CARRIER" LED goes out.

   NOTE: The CARRIER LED must correctly reflect the state of carrier. Adjust the CARRIER pot (R40) until it does.

This completes the adjustments associated with the Model 72's interface to the radio. If you are working on the bench in the shop, you can try the telephone adjustments now to familiarize yourself, or you can leave them until you get to the sites, where they should always be done.

Telephone Adjustments

Unlike the radio adjustments, the telephone adjustments will be different between the Model 72 base and remote units. The hybrid adjustments are important to the final satisfaction of the end users since a misadjustment with the hybrid will result in a reverberation or echo distortion that the users can hear when they talk.

1. **TELEPHONE HYBRID ADJUSTMENT:** The Model 72 Remote must be connected to a telephone and the Model 72 Base connected to a central office phone line. The hybrids must both be adjusted correctly for optimum audio quality and system performance. During the test, the Model 72 will send a test tone to the telephone and open the audio path to the transmitter. The better the match between the hybrid and the phone line, the less reflected audio energy will be sent to the transmitter. You will monitor your progress in adjusting the hybrids by measuring the transmit deviation coming out of the Model 72 under test.

   BALANCING THE MODEL 72 REMOTE:
   a. Set the service monitor to receive on the transmit frequency of the Model 72 remote under test, and to display the deviation. Remove the top cover of the remote.
   b. Plug in the telephone that will be used into the Model 72 remote.
   c. Install a jumper at JP8 (TEST 2) to begin the hybrid balance test. The remote will key its transmitter and send a test tone to the phone.
   d. Lift the handset off the telephone and leave it off until the balancing is complete.
   e. Adjust the hybrid balancing controls R124 ("C"), R125 ("L"), and R126 ("R"), for minimum deviation on the transmit channel. Repeat adjusting these three controls until no additional reduction in deviation can be achieved.
   f. Place the handset on the telephone, remove the jumper at JP8 (TEST 2) and replace the cover of the Model 72.

   BALANCING THE MODEL 72 BASE:
   a. Set the service monitor to receive on the transmit frequency the Model 72 base under test, and to display the deviation. Remove the top cover of the base.
   b. Plug the telephone line that will be used into the Model 72 base.
   c. Either call or have an assistant call the Model 72's phone number and remain quietly on the line until the base hangs up at the end of the test.
   d. When the line into the Model 72 begins to ring, install a jumper at JP8 (TEST 2) to begin the hybrid balance test. The base will answer the line and send a test tone to the phone while it also keys the transmitter and opens the audio path from the phone to the transmitter.
   e. Adjust the hybrid balance controls R124 ("C"), R125 ("L"), and R126 ("R"), for minimum deviation on the transmit channel. Repeat adjusting these controls until no additional reduction in deviation can be achieved.
   f. Remove the jumper at JP8 (TEST 2) and note that the Model 72 hangs up the line, person at the other end of the phone line can hang up now too. If you are not doing the Dial Click calibration on this base unit then replace the top cover of the Model 72. If your are going to do the Dial Click then proceed to the next step.

2. **DIAL CLICK CALIBRATION:** This test only needs to be performed on Model 72 base units that have the Dial Click Decoder option (950-9357) installed. When executed, this test will indicate the dialed number by returning a series of slow beeps to the phone. The number of beeps sent indicates the number that the base thought it decoded.

   To calibrate the dial click board you must first enter the programming mode on the base and initiate the DIAL CLICK DECODE TEST (96#). For this reason it will be necessary for the technician to have both a DTMF and a rotary telephone connected in parallel on the phone line that the base is called from (or a phone that can be switched from DTMF to Pulse mode).

   a. Connect the Model 72 base unit to its incoming phone line.
   b. Connect a rotary and a DTMF phone in parallel on any outgoing phone line. (This phone line should be near enough to the Model 72 base to allow the caller to speak with whoever is adjusting the dial click)
   c. Call the Model 72 base and let it ring until the base answers, and then enter programming mode. (Enter 12172 from the DTMF telephone after error tones)
   d. After the Model 72 beeps to indicate it is in the programming mode enter 96# from the DTMF phone to initiate the DIAL CLICK DECODE TEST.
   e. Start entering in digits from the rotary phone. You have 10 seconds to enter another digit before the Model 72 times out and exits the program mode.
   f. After the phone finishes sending the number you dialed, the Model 72 should return a slow string of beeps to indicate the number it decoded from the phone.

      1 = 1 Beep 9 = 9 Beeps 0 = 10 Beeps

      Be sure to wait for a second or so after the beeping stops before you dial the next number so that you can be sure that the base is finished and ready for another entry.
   g. If the base does not decode all ten numbers correctly, then adjust R6 up or down until the Model 72 does decode all the digits (0-9) correctly.
   h. Switch back to the DTMF phone and enter a "#" to exit the DIAL CLICK DECODE TEST.
   i. Enter 99# to exit programming mode on the base.

ADDITIONAL INFORMATION

This portion of the installation section is provided to give field technicians some additional tools to use in solving the problems that may arise when the installation situation turns out to be somewhat abnormal.

The back-to-back wiring scheme is useful for two things. First, you can set up a pair of Model 72s on the bench and experiment with them and their programming until you are comfortable with how they operate, all without tying up a pair of expensive radios. Secondly, you can use this approach with equipment from existing systems whenever there is a question as to whether it is the Model 72s or the radios that are causing the problem.

The Model 72 units were not designed to be installed using an external carrier detect signal from the radio receiver; however, cases have arisen where obtaining a source of discriminator audio from the receiver that contained enough high frequency audio energy to make the squelch circuit in the Model 72 operate correctly was not feasible. The notes in "External COR Input" give the technician a couple of alternatives to try if he or she is fighting such a situation.

The last portion of this section is a listing of all the test points, controls (potentiometers), and jumpers found in the Model 72 units. These lists can be helpful when reviewing the installation and test procedures or the schematics.

Back-to-Back Bench Testing

A pair of Model 72 units can be set up back-to-back simply by making up a special wiring harness using the connector plugs supplied with each unit. There are three considerations that must be covered in this application that differ from the normal installation of these units on radios.

- **POWER SUPPLY** Normally you would power the two Model 72 units off of the power supplies of their respective radios. In this situation, however, you will probably want to power them both off of a single bench supply. The supply will need to be rated for at least three amperes in order to supply all the current need by both units at one time. In the diagram that follows, the units are shown wired for a DC supply. You can use an AC source, such as a 12 VAC/3 Amp transformer, if you wish. Just be sure to wire the AC leads into the proper pins on the connectors.

- **TX/RX AUDIO** The transmit audio out of both units will need to be wired into the receive input of the opposite unit. The jumpers JP6 and JP17 are both set such that the only level setting you should need to do is to set the transmit level out of each unit to get the correct receive level in the opposite unit.

- **CARRIER DETECT** The Model 72 units normally determine the receiver's condition by looking for the presence of high level high frequency noise when there is no signal being received. In this set up there is no source of noise available so the Model 72s will have to be "faked out". This can be done by connecting the PTT output of each unit to the TX Busy input on its opposite unit. Grounding this input will be the same as supplying a carrier detect signal. The output of the noise

detector must still be taken care of. This is done by attaching a jumper lead to the junction of R63 (100K) and the anode of CR16 (unbanded end), and the attaching the other end of the jumper to ground.

Figure 6-2 shows how to make up a harness for back-to-back operation.

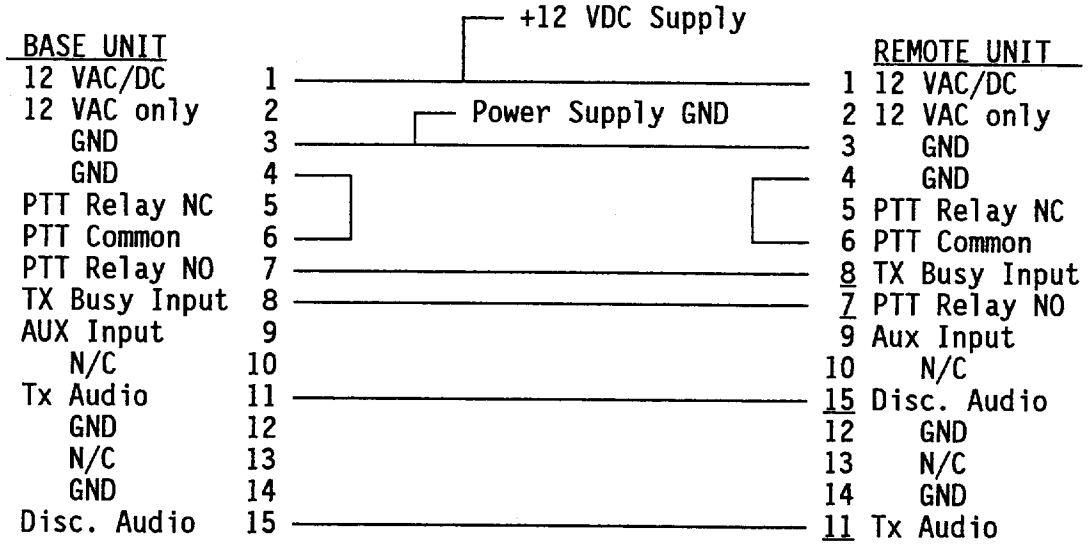


Figure 6-2. Back-to-Back Model 72s Wiring Diagram

The following steps guide you through setting up the units after you have connected them with the above harness.

1. Make up the harness shown. Remove the top covers on both Model 72 units and connect them to each other with the harness.

2. In each unit, connect a jumper lead to the junction of R63 (100K) and the anode of CR16 (the unbanded end), and connect the other end to ground at TP2. This satisfies the noise detector output.

3. In each unit, set or verify the positions of jumpers JP6 and JP17. The Rx Gain jumper JP6 needs to be in the "A" position, and the Tx Gain jumper JP17 needs to be in the "B" position.

4. Apply power to the two units. The POWER LED should be lit and the rest of the LED's should be off.

5. Connect an AC Voltmeter or an oscilloscope to TP1 in the base unit and configure the instrument to measure an AC signal. Locate the control R68 in the base unit. Press and hold the TEST switch (SW1) in the remote unit and adjust R68 in the base unit until you get a reading of 0.6 Vrms (1.7 Vpp) at TP1 in the base. Then release the TEST switch in the remote.

6. Connect the AC Voltmeter or oscilloscope to TP1 in the remote unit. Press and hold the TEST switch (SW1) in the base unit and adjust R68 in the remote unit until you get a reading of 0.6 Vrms (1.7 Vpp) at TP1 in the remote. Then release the TEST switch in the base.

7. This completes the general set up of two units for back-to-back operation. Connect a phone line to the base and a phone instrument to the remote and you are ready to start working with your simulated system. If any telephone adjustments are necessary, just follow the instructions found in the normal installation procedure.

External COR Input

The Model 72 units are designed to detect the condition of the receiver by detecting the presence or absence high level, high frequency discriminator noise at the receive audio input. Some receivers do not provide a convenient source of this unprocessed audio. For this reason (and other possible situations) the technician may want to try using an external carrier detect logic signal from the squelch circuitry in the receiver. The following notes are the suggested ways for bringing an external carrier detect signal into a Model 72. The modifications will all use pin 10 of connector J2 for the external carrier input. PLEASE NOTE: These modifications will not provide any means of adjusting the carrier threshold level in the Model 72. The signal must change states between ground (or very near ground) and greater than +4 DC in order to make these carrier modifications work. You will need to measure the voltages provided by the signal you intend to use from the radio receiver while the radio is both squelched and unsquelched in order to determine the polarity of the signal and that it has a sufficient voltage swing.

METHOD #1 - *Active Low Carrier Detect / No Tx Busy Used*

If the carrier signal from the receiver pulls to ground when the receiver unsquelches and returns high again when it squelches, and you are not going to use a monitoring receiver on the Tx Busy input, then you can connect the signal from the receiver to pin 8 of J2. In order to disable the noise detector circuit in the Model 72, unsolder the cathode lead of CR16 (the banded end) and lift it clear of the board. Then connect a jumper wire between the anode of CR16 (the unbanded end) and ground at TP2.

METHOD #2 - *Active Low Carrier Detect / Tx Busy Used For Monitoring*

If the carrier signal from the receiver pulls to ground when the receiver unsquelches and returns high again when it squelches, and you also intend to use the Tx Busy input for its original purpose, then do the following. Unsolder the cathode end of CR16 (the banded end) and lift it clear of the board. Solder a 10K 1/4 watt resistor to the cathode lead (banded end) of a signal diode (1N4148 or equivalent), and connect the anode lead (unbanded) of the diode to the junction of R65 (100K) and the anode lead of CR17 on the board. Connect one end of a jumper wire to the free end of the 10K resistor and connect the other end of the wire to pin 10 of J2. You can take the board out of the chassis and solder the wire to the pin under the connector, or just bring the wire out under the cover and inserting it into the connector plug at the pin 10 position along with the wire coming from the radio receiver, whichever you think is best.

METHOD #3 - *Active High Carrier Detect*

If the carrier signal from the receiver pulls high to some value above +4 VDC when the receiver unsquelches, and then pulls low to ground again when the receiver squelches, then do the following. Unsolder the cathode lead of CR16 (the banded end) and pull it clear of the board. Solder a 10K 1/4 watt resistor to the cathode lead of CR16, the one that you just pulled up. Connect one end of a jumper wire to the free end of the 10K resistor connected to CR16. Connect the other end of the jumper wire to pin 10 of J2, either by soldering it to pin 10 on the bottom of the board, or by bringing the wire out under the cover and inserting it into the pin 10 position along with wire coming from the receiver, whichever you think is best.

Test Points

TP1 = Rx Audio = This test point is used to monitor the receive audio levels from the radio while adjusting the receive levels during installation and set up. This test point is located near the inside end of the radio interface connector (J2), near the ferrite bead marked "E1".

TP2 = GND = This is a point at which you can pick up a reference ground for instrument probes. It is located on the right side of the unit (viewed from the front), next to the fuse labeled "F1".

TP3 = Hybrid = This provides a point from which to monitor audio coming from the phone line as it come out of the Hybrid. This point is right after the first gain stage, U23B. It is located near the Dial Click Decoder card connector (J3).

Controls

R39 = Rx Level = This control is used to make final adjustment of the receive audio level coming into the Model 72 from the radio. It is located at the rear of the unit, near pin 15 of the radio connector (J2).

R40 = Carrier = This control is used to set the Squelch threshold in the Busy (Carrier Detect) circuit. It is located at the rear of the unit, next to the control R39.

R68 = Tx Level = This control is used to adjust the final level of transmit audio going to the radio. It is located in the middle of the right end of the unit (when facing it from the front).

R124 = Hybrid C = This control is used to adjust the capacitive component of the hybrid balance when nulling the unit's hybrid to its telephone line or attached equipment. It is located at the center, front of the unit.

R125 = Hybrid L = This control is used to adjust the inductive component of the hybrid balance when nulling the unit's hybrid to its telephone line or attached equipment. It is located at the center, front of the unit.

R126 = Hybrid R = This control is used to adjust the resistive component of the hybrid balance when nulling the unit's hybrid to its telephone line or attached equipment. It is located at the center, front of the unit.

SW1 = Test Switch = This switch is used during the installation procedure to make the Model 72 key its transmitter and put out a test tone so that the transmitter deviation can be set. SW1 is located near the middle of the unit, near the microprocessor. This switch can also be used in both the Model 72 base and the Model 72 remote to force a hardware reset of all field programmable settings to default values. See "Resetting the Model 72 Remote to Factory Defaults" in Section 5 to find out how to use SW1 for this purpose.

Jumpers

JP1 = RING DET 1 = This jumper is used in selecting whether or not the Ring voltage is detected by measuring across the TIP & RING phone line pair or in reference to ground. The normal position for this jumper is "LL" so that the voltage is measured across TIP & RING. It is located at the rear of the unit, near the telephone jack, J1.

JP2 = RING DET 2 = This jumper is not normally used. It could be used to configure the unit detect ring voltage on the line by using ground as a reference rather than by measuring across TIP & RING. Its position is at the rear of the unit, near the telephone jack, J1.

JP3, JP4, JP5 = These jumpers are used to configure the phone input jack to support line type other than the standard End-to-End subscriber line. These jumpers are not used in this application. Their position is located at the center rear of the unit near the phone jack, J1.

JP6 = Rx Gain = This jumper is used to make large, step changes in the gain level of the first receive audio gain stage in the Model 72. In position "A" it provides unity gain, in position "B" it provides a X20 gain, and in position "C" it provides a X40 gain. It is located in the rear corner of the unit near the radio interface connector (J2) and the Rx Audio test point TP1.

JP7 = "SER" = This set of jumper pins allows access to the serial port on the microprocessor. It is only used during production testing. It is located next to the microprocessor.

JP8 = TEST 2 = This jumper is used during the installation testing and adjustments to null the hybrid. Installing JP8 will make the Model 72 latch the phone line and send a test tone down the line, and at the same time it will key the transmitter and open the audio path from the phone to the transmitter. The test is terminated as soon as JP8 is removed and the unit returns to idle. This jumper is located in the middle of the unit near the microprocessor and SW1.

JP9 = Wink/Immediate Start = This jumper is not used in this application. It is used for selecting the type of call origination used in a DID Model 72 base.

JP10, JP11 = Digits of Feed = These two jumpers are not used in this application. They are used in a DID unit to select the number of feed digits that the unit should expect to get from the DID Model 72 base.

JP12, JP13, JP14, JP15, JP16 = 4-Wire/Hybrid = These five jumpers are not used in this application. They intended for possible future implementations of the Model 72 hardware that interface to the phone line or telephone equipment at a 4-wire rather than a 2-wire level. They are located near the middle of the unit next to T3.

JP17 = Tx Hi/Lo = This jumper is used to make large, step changes in the level of the transmitted audio. Position "A" provides the low level output and position "B" provides a high level output. It is located next to U16.

JP18 = Rx Audio Expander = This jumper is not normally used. It could be used to disable the Companded Audio feature and allow the Rx audio to be used exactly as it received from the radio. If this jumper is ever used, then jumper JP19 must also be in the same position, as well as both jumpers in the unit at the other end of the link. It is located towards the right side of the unit (faced from the front), near U16 and in between JP17 and JP19.

JP19 = Tx Audio Compressor = This jumper is not normally used. It could be used to disable the Companded Audio feature and allow the Tx audio to go out without being compressed first. If this jumper is ever used, then jumper JP18 must also be in the same position, as well as both jumpers in the unit at the other end of the system. It is located on the right side of the unit near U24 and next to JP18 and JP17.

JP20 = Aux Polarity = This jumper is used to select which condition of the Auxiliary Input is considered to represent a valid CTCSS decode condition. The "A" position is active HI, and the "B" position is for active LOW. The default condition of this jumper is position "A", which will be read as valid even if the input is not connected to anything. It is located at the front of the unit next to U21 and DS7 ("SIG VALID" LED).

JP21, JP22, JP23 = H1, H2, H3 = These three jumpers are used to reconfigure the hybrid circuit based on whether the Model 72 in question is a base or remote unit. These jumpers are placed in the proper position at the factory and should not be moved in the field. These jumpers are located at the center, front of the unit.

7. REPAIR

7. REPAIR

CIRCUIT DESCRIPTION

The major circuits in the Model 72 units can be collected into four main groups based on their functions. The four functions are: Telephone Interface, Radio Interface, Signaling Generator/Detector, and Logic/Control. The largest functional group of circuits is the Telephone Interface. The Radio Interface group's function is obvious. The Signaling section controls all the generation and detection of all in-band signaling that passes between the base and remote units. This section also includes the audio compandor circuitry. The Logic/Control group organizes the overall operation of the rest of the functional groups in the unit.

Telephone Interface

The contents of the Telephone Interface group will depend on whether the unit is a base or a remote unit. In a base unit this group would include: the ring detector, the answer relay, the telephone hybrid, and an optional dial click detector. In a remote unit this group would include: the telephone hybrid, ring generator, -48 volt isolated supply, and loop current detector.

Radio Interface

The radio interface group includes: PTT control, carrier detection, receive audio amplifier, and a transmit audio output buffer.

Signaling Processing

The signaling generator transmits various progress tones to the user, as well as the in-band signaling tones. This section also includes a DTMF tone decoder for the telephone interface. Finally, the signal processor compresses and expands the telephone audio on the radio channel to greatly improve the signal to noise ratio and to increase the dynamic range of the system.

Logic/Control Unit

The microprocessor based control unit controls all of the relays, LEDs, audio paths and tone generation circuitry. All of the programming for the unit is contained in the microprocessor. Changing the microprocessor can change the operation of the whole product.

CIRCUIT THEORY AND REPAIR

Microprocessor Operation

To ensure an orderly microprocessor power up sequence, the POWER UP RESET circuitry holds the microprocessor in reset until the 12 volt supply has stabilized. Once the microprocessor has completed its power up initialization routine, it checks to see if the Test Switch is being held down. If the switch is down, then the processor will reset all of the programmable values it is holding in EEPROM to the factory default values, and then enter into the normal operating mode. If the switch is up, then the unit just enters directly into the normal operating mode.

Power Supply
Full wave bridge rectification and filtering is used to smooth the 9-12 VAC from the wall transformer, or supply additional filtering to 12 Volt DC input. The +12 VDC is available as an unregulated supply for the relays, and LEDs. The +12 VDC is also supplied to the primary of transformer T1 to drive the isolated power supply and the -48 VDC supply in the remotes. The main +5 VDC supply (VR1) is regulated and filtered to provide power for all the digital circuitry. The bias supplies for the analog circuits (+A5 and +2V) are both supplied from the +5 VDC bus.

DTMF Encoding/Decoding
The telephone audio is passed through the telephone hybrid, amplified, filtered, and presented to the DTMF decoder, U6. The microprocessor reads the output pins of U6 (D1, D2, D4, D8) whenever the Digit Valid line (DV) goes high. The 3.58 MHz oscillator for this IC also provides the CLOCK signal for the microprocessor. The task of DTMF encoding is accomplished directly by the microprocessor and some external D/A convertor circuitry (RP2).

Signal Encode/Decode
The multi-frequency in-band signaling used between the Model 72 base and remote units is generated by the microprocessor in the same way that the DTMF tones are generated. The decoding of these signals is performed by the SIGNAL DECODER circuitry, U2. This IC is the same as the one used for the DTMF Decoder, however, a nonstandard oscillator crystal has been used with the IC in order to shift the signaling tones away from the frequencies normally used with DTMF. The receive audio signal from the radio is low pass filtered to remove audio above the signaling tone frequencies before being input to U2.

Compandor
The compressing and expanding of the audio passing between the base and remote is performed by the COMPANDOR circuitry, U17. The purpose of "companding" the audio is to provide audio with a better dynamic range to both the phone parties without exceeding the deviation limitations on the radios' RF carriers. Although it is not recommended, the audio can be bypassed around the compandor, if so desired, by using JP18 and JP19. If you do decide to bypass the compandor, you must move both jumpers, and do so in both the base and the remote, otherwise distortion of the audio will result.

Busy Detector
The Model 72 detects the presence carrier internally using the Busy Detector circuit. The discriminator input from the radio includes high level, high-frequency energy whenever the carrier is not present. When carrier is present, the high-frequency energy disappears. The circuitry high-pass filters (U11/A), detects (CR16), and integrates (U11/B) the high frequency energy of the discriminator input, and then supplies a logic level output to the microprocessor. Just before the logic signal goes off to the processor, the circuit combines the Carrier detect signal with the Tx Busy input signal from pin 8 of the J2 connector on the rear of the unit (to pin 1 of U3 via CR17 and R75). The Tx Busy input is for an external carrier detect signal from an external monitoring receiver.

Aux Input Buffer
The Model 72 will accept a decode input from an external CTCSS decoder. This is supplied via pin 9 of J2. The input signal is buffered and the valid polarity selected by U21 and JP20. This input is used to discriminate between the signals of another local Model 72, and the carrier skip signal of a distant co-channel radio.

De-Emphasis
The de-emphasis circuit (U13/A) de-emphasizes the audio from the discriminator buffer. De-emphasis is the process by which receive audio is attenuated based on it's frequency. The de-emphasis is 6 dB/octave; the higher the frequency, the higher the attenuation. The transmit audio can either be pre-emphasized in the Model 72 or sent out into the transmitter "flat" and pre-emphasized there. This can be selected by moving JP17 (along with changing the range over which the Tx gain can be adjusted). By pre-emphasizing (amplifying based on frequency -- opposite of de-emphasizing) transmit audio and de-emphasizing receive audio, the signal to noise ratio is greatly increased since any noise introduced into the signal during its transmission is attenuated by the de-emphasis stage while the transmitted audio is fully recovered.

300 Hz High-Pass Filter
This high-pass filter (U13/B) removes any CTCSS tones that may accompany audio on the channel prior to expanding the receive audio.

Isolated Power Supply and -48V Battery Feed
The telephone company normally supplies -48 VDC to telephone equipment from a power supply at the Central Office. The Model 72 remote unit uses a switching power supply circuit to supply the telephone it services with the required voltage to operate. The +12 VDC supply is gated into the primary of T1 and then rectified off one of the secondary windings to generate the -48 VDC needed. The other secondary winding is rectified for use by the isolated supply, which is required to operate the balance circuitry of the telephone hybrid.

Ring Generator
When a remote unit needs to ring the telephone, the microprocessor switches the output of the ringer onto the phone line, and pulses +12 VDC through the primary of the ring transformer, T2. The transformer secondary provides the AC voltage necessary to ring the telephone. When the ringing is done, the Model 72 stops pulsing the primary of T2 and switches the hybrid circuit back onto the phone line.

Ring Detector
The ring detector circuit in the Model 72 base units provide a logic signal to an input of the microprocessor when a high voltage signal is detected on the telephone line from the C.O. The ringing will normally be measured between the two telephone lines, Tip and Ring. The jumpers JP1 and JP2 can be used to configure this circuit to measure between one line and ground.

Loop Current Detector
The loop current detector circuit in the remote units determines when the telephone is off hook. The output of this circuit signals the microprocessor whenever it detects loop current being drawn from the -48 VDC supply.

Answer Relay
The Model 72 base uses a relay to take the telephone off hook. When the base comes off hook, the Model 72 hybrid is connected to the phone line and loop current is drawn from the C.O.

Audio Limiter
The audio levels transmitted over the telephone must be limited to meet US federal regulations (FCC Part 68). The audio limiter circuit (U25/A,B,&C plus Q7) measures the audio level going to the hybrid. If it exceeds the acceptable limits, the limiter reduces the audio level.

IN CASE OF DIFFICULTY...

In case of installation difficulty, call Zetron Model 72 Applications Department at (206) 820-6363. Please have the serial numbers of the units you are working with and/or the Zetron Order number if possible. If the call is made from the installation site by the installer or radio technician, the problem can usually be solved over the phone.

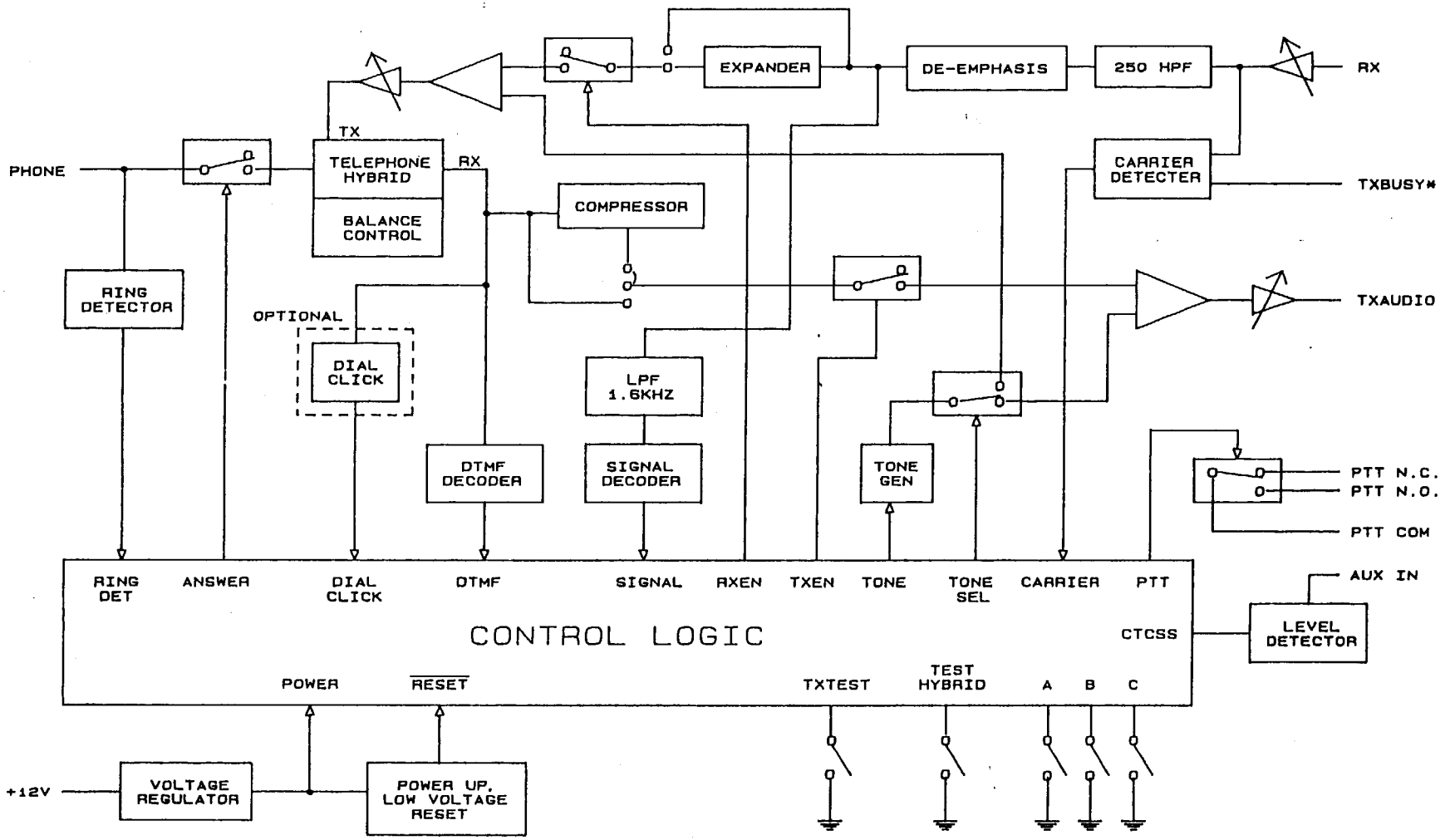
If a problem develops after a unit has been in service for some time, call the Zetron Model 72 Service Department at (206) 820-6363. If the call is made from the installation site by a radio tech, the problem can usually be solved over the phone.

The parts lists for the Model 72 are included in this section to aid installation or repair of the unit.

A NOTE ABOUT READING THE SCHEMATICS

The Model 72 base and remote units both use the same printed circuit board. The majority of the circuits are used in both units and so those parts will be present on the board. There some circuits that are only used in one unit or the other and will only be present as required. The schematics for the base and the remote will show all the components for both units, however, the parts that would not be present in the particular unit you are looking at will have a "#" printed next to the part designator number to indicate that the part is not there. Because of the great similarity between the two schematics, always take time to make sure that you are looking at the proper schematic for the unit you are working on.

LTR	DESCRIPTION	DR	APPRD	DATE
A	RELEASE	KN		



ZETRON INCORPORATED 12335 134TH COURT NORTHEAST REDMOND, WASHINGTON 98052-2433		
Title MODEL 72 E/E BASE BLOCK DIAGRAM		
Size A	Document Number 006-0064	REV A
Date: May 21, 1992	Sheet 1 of 1	

MODEL 72 BASE CONTROLLER (702-9366G)
Parts List

LEGEND:
= NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY
+ = OPTION (INSTALLED PER CUSTOMER ORDER)

Item	Quantity	Reference	Part	Description	Mfg.Part No.
1	5	R4,R53,R54,R55,R56,R57#, R58#,R59#,R60#	101-0010	1 OHM 1/4W 5% CARBON FILM	
2	1	R113	101-0025	10 OHM 1/4W 5% CARBON FILM	
3	2	R5,R1	101-0030	16 OHM 1/4W 5% CARBON FILM	
4	4	R37,R50,R51,R76	101-0047	47 OHM 1/4W 5% CARBON FILM	
5	2	R52#,R127,R128	101-0049	100 OHM 1/4W 5% CARBON FILM	
6	2	R26,R111	101-0057	220 OHM 1/4W 5% CARBON FILM	
7	1	R34	101-0059	270 OHM 1/4W 5% CARBON FILM	
8	2	R12,R112	101-0061	330 OHM 1/4W 5% CARBON FILM	
9	3	R36,R102,R123	101-0065	470 OHM 1/4W 5% CARBON FILM	
10	1	R93	101-0066	510 OHM 1/4W 5% CARBON FILM	
11	2	R88,R89	101-0068	620 OHM 1/4W 5% CARBON FILM	
12	12	R2,R3,R18#,R96,R103,R118, R129,R130,R131,R132,R133, R134,R135	101-0073	1K 1/4W 5% CARBON FILM	
13	2	R81,R109	101-0075	1.5K 1/4W 5% CARBON FILM	
14	1	R22,R23#	101-0081	2.2K 1/4W 5% CARBON FILM	
15	1	R48	101-0085	3.3K 1/4W 5% CARBON FILM	
16	4	RX1 NOTE 4,R106,R107,R108	101-0087	3.9K 1/4W 5% CARBON FILM	
17	2	R28,R42	101-0089	4.7K 1/4W 5% CARBON FILM	
18	3	R6,R7,R43	101-0090	5.1K 1/4W 5% CARBON FILM	
19	1	R35	101-0093	6.8K 1/4W 5%	
20	1	R90	101-0095	8.2K 1/4W 5% CARBON FILM	
21	14	R10,R13,R14,R15,R41,R66, R70#,R75,R83,R84,R97, R101,R104,R117,R119	101-0097	10K 1/4W 5% CARBON FILM	
22	1	R62	101-0100	13K 1/4W 5% CARBON FILM	
23	1	R80	101-0101	15K 1/4W 5% CARBON FILM	
24	1	R100	101-0103	18K 1/4W 5% CARBON FILM	
25	6	R24#,R30,R33,R38,R78,R87, R98	101-0105	22K 1/4W 5% CARBON FILM	
26	1	R79	101-0108	30K 1/4W 5% CARBON FILM	
27	3	R77,R85,R86	101-0109	33K 1/4W 5% CARBON FILM	
28	2	R61,R105	101-0111	39K 1/4W 5% CARBON FILM	
29	2	R45,R72	101-0114	51K 1/4W 5% CARBON FILM	
30	1	R136	101-0117	68K 1/4W 5% CARBON FILM	
31	12	R27,R46,R47,R49,R63,R65, R67,R82,R94,R95,R99,R120	101-0121	100K 1/4W 5% CARBON FILM	
32	1	R91	101-0125	150K 1/4W 5% CARBON FILM	
33	1	R92	101-0126	180K 1/4W 5% CARBON FILM	
34	2	R110,R114	101-0129	220K 1/4W 5% CARBON FILM	
35	1	R44	101-0131	270K 1/4W 5% CARBON FILM	

MODEL 72 BASE CONTROLLER (702-9366G)
Parts List (Continued)

Item	Quantity	Reference	Part	Description	Mfg.Part No.
36	2	R69,R74	101-0139	560K 1/4W 5% CARBON FILM	
37	6	R8,R9,R25,R64,R71♯,R73♯, R121,R122	101-0145	1M 1/4W 5% CARBON FILM	
38	1	R11	101-0149	1.5M 1/4W 5% CARBON FILM	
39	0	R115♯	103-2200	2.2K 3W 5% WIREWOUND	
40	0	R116♯	103-3075	RES, 7.5 OHM 5W 5% WIREWOUND	
41	1	R29	103-3300	3.3K 1W 5% CARBON FILM	
42	0	R17♯,R16♯	104-0360	360 OHM 2W 0.1% ULTRA-STABLE	
43	2	RV2,RV1	105-0001	VARISTOR 250V AC	
44	2	R32,R31	106-0047	4.7 OHM 1/2W 5% FUSIBLE	
45	1	R19,R20♯,R21♯	106-1175	75 OHM 1W 5% FUSIBLE	
46	2	R40,R68	107-0202	2K POT 1 TURN	
47	1	R126	107-0501	5K POT 1 TURN	
48	2	R124,R39	107-0502	50K POT 1 TURN	
49	1	R125	107-0504	200K POT 1 TURN	
50	1	RP1	119-0006	10K x 9 BUSSED 10-PIN SIP	
51	1	RP2	119-0021	R/2R 100K/200K 10 PIN SIP	
52	1	RP3	119-0025	10K X 4 ISOLATED 8-PIN SIP	
53	1	RP4	119-0026	2K X 4 ISOLATED 8-PIN SIP	
54	2	C31,C28	150-0096	1000 PF 1KV +-20% CERAMIC DISC	
55	2	C26,C74,C80♯	151-0047	470PF 100V/200V +-10%/5% CERAMIC NPO	
56	1	C2,C43♯,C44♯,C48♯,C49♯	151-0120	.01UF 50V/100V +-10% CERAMIC X7R	
57	17	C6,C7,C8,C11,C16,C19,C34, C35,C36,C38,C39,C51♯,C52, C53,C54,C60♯,C79,C85,C87	151-0180	.1UF 50V +-20% CERAMIC Z5U	
58	1	CX1 NOTE 5	151-0199	.47UF 50V +-5%, POLYESTER	
59	10	C27,C29,C30,C59,C68,C70, C72,C73,C78,C88	152-0012	.1 UF 50V +-5% POLYESTER	
60	0	C5♯	152-0020	.47 UF 630V +-10% POLYESTER	
61	1	C14♯,C20	152-0021	.47 UF 250V +-10% POLYESTER	
62	1	C58,C12♯	152-0030	2.2 UF 250V +-10% POLYESTER	
63	3	C13,C64,C93	152-0050	10 UF 100V 20% NON-POLAR ELECTROLYTIC, RADIAL	
64	3	C63,C82,C83	152-0080	.22 UF 50V +-5%	
65	6	C32,C33,C61,C62,C90,C91	152-0085	.01 UF 50V +- 5% POLYESTER	
66	2	C3,C4	152-0088	.0047UF 50V +-5% POLYESTER	
67	4	C22,C24,C57,C81,C89♯	152-0089	.001 UF 50V +-5% POLYESTER	
68	2	C55,C56	152-0090	.001uF 50V +-2% POLYPROPYLENE	
69	4	CX2 NOTE 6, CX3 NOTE 7, C21,C92	152-0250	.047 UF 50V 5% POLYESTER	
70	2	C23,C65	154-0025	1 UF 35V TANTALUM +- 10%	
71	7	C9,C10,C25,C37,C66,C75, C94	154-0100	10 UF 16V TANTALUM +-10%	
72	3	C15,C42♯,C45♯,C46♯,C47♯, C69,C77	155-0012	2.2 UF 100V +-20% RADIAL ALUMINUM ELECTROLYTIC	

MODEL 72 BASE CONTROLLER (702-9366G)
Parts List (Continued)

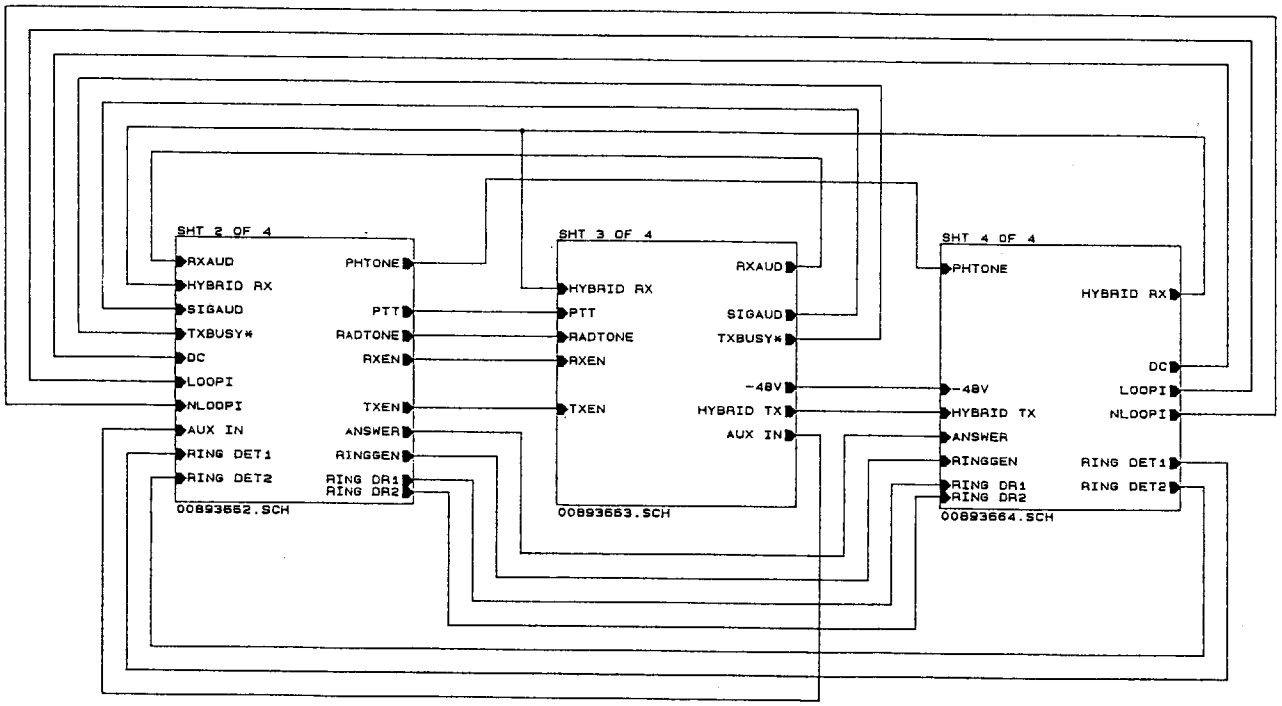
Item	Quantity	Reference	Part	Description	Mfg.Part No.
73	1	C76	155-0013	4.7 UF 100 VOLT RADIAL ALUMINUM ELECTROLYTIC	
74	5	C1,C17,C18,C40,C41	155-0052	10 UF 35V +-20% RADIAL ALUMINUM ELECTROLYTIC	
75	1	C67	155-0077	100UF 25V +-20% RADIAL ALUMINUM ELECTROLYTIC	
76	0	C50#	155-0082	470 UF 16V +-20% AXIAL ALUMINUM ELECTROLYTIC	
77	2	C86,C84	155-0083	470 UF 10 VOLT RADIAL ALUMINUM ELECTROLYTIC	
78	1	C71	155-0140	3300 UF 25V +50%-10% AXIAL ALUMINUM ELECTROLYTIC	
79	2	E1,E2	305-0001	FERRITE BEADS W/ LEADS	
80	2	T3,T4	305-1540	TELCO HYBRID XFMR, SMALL SIZE	
81	0	T2#	305-1635	16V 6VA SPLIT BOBBIN XFMR	
82	1	T1	305-4812	12V TO 12V AND 48V TRANSFORMER	
83	0	U9#,U10#	311-0008	OPTO ISOLATOR	4N26
84	6	DS2,DS3,DS4,DS5,DS6,DS7	311-0011	LED RED FLUSH	
85	1	DS1	311-0012	LED GREEN FLUSH	
86	1	U5,U4#	311-1001	OPTO ISOLATOR, BI-POLAR	H11AA1
87	1	U25	316-0324	OP-AMP, QUAD BIPOLAR, 358 EQUIVALENT	324
88	4	U11,U15,U23,U24	316-0358	OP-AMP, DUAL BIPOLAR	358
89	1	U17	316-0575	COMPANDOR	575
90	0	U8#	316-1011	BATTERY FEED	LB1011
91	1	U22 NOTE 9	316-3072	DUAL OP-AMP, HIGH BIAS CURRENT	34072T
92	2	U13,U12 NOTE 8	316-3307	DUAL OPAMP, LOW BIAS CURRENT	34072M
93	1	VR1	316-7805	REGULATOR, +5V 1.5A	7805
94	0	VR3#	316-7824	+24V 1.5A REGULATOR	7824
95	0	VR2#	316-7924	-24V 1.5A REGULATOR	7924
96	2	U2,U6	321-0204	DTMF RECEIVER	75T204
97	1	U14 NOTE 3	321-6806	8 BIT CMOS OTP 40 PIN DIP (68HC05)	ASIC 009
98	1	U7	322-9346	1024 BIT SERIAL EEPROM	93C46N
99	1	U1	323-4049	HEX INVERTER, UNBUFFER GATES	4049
100	1	U16	323-4053	3PDT SWITCH	4053
101	2	U19,U18	324-4373	OCTAL LATCH	74HC373
102	2	U3,U21	324-7414	HEX SCHMIDT	74HC14
103	1	U20	340-2003	RELAY DRIVER 50V/.5A	2003
104	2	Q1,Q2,Q5#,Q6#	340-3055	12A 60V N FET	3055
105	2	Q3,Q4	340-3904	NPN 40V/200MA	2N3904
106	1	Q7	340-7000	XTR, MOSFET, N-CHANNEL TO-92 60V/0.2A	2N7000
107	1	CR15#,CR22,CR23	342-0103	SCHOTTKY, 0.37V @ 1MA TYP	SD103A
108	5	CR9,CR11,CR12,CR16,CR17	342-3009	SILICON .50 SP	1N4148
109	4	CR1,CR2,CR3,CR4,CR5#, CR6#,CR7#,CR8#	342-4935	SIL FAST 200V .50 SP	1N4935
110	4	CR18,CR19,CR20,CR21	342-5400	SIL 3A 50V .50 SP	1N5400
111	1	CR10	343-3100	1W 8.2V +-5%	1N4738A
112	2	CR14,CR13	343-3110	1W 20V +-5%	1N4747A
113	1	SW1	371-0009	PWB MNT MOM KEY	
114	1	Y2 NOTE 1	376-0358	XTAL, 3.579545 HC-49 CL=18PF	3.58MHz
115	1	Y1 NOTE 1	376-3276	3.2768MHz HC49 CASE	3.2768MHz
116	3	K1#,K2#,K3,K4,K5	380-0030	DPDT 12V COIL MINI RELAY 360 OHM	

MODEL 72 BASE CONTROLLER (702-9366G)
Parts List (Continued)

Item	Quantity	Reference	Part	Description	Mfg.Part No.
117	1	J2	401-0059	15 POS R/A HEADER	
118	1	J1	401-0080	6-PIN LO PRO R/A TELCO	
119	1	J3	401-6005	6-POS FEMALE	
120	3	TP1,TP2,TP3,JP4#,JP5#	403-0001	1 OF 401-0052	
121	1	JP8	403-0002	2 OF 401-0052	
122	9	JP1,JP2#,JP9,JP10,JP11, JP12#,JP13#,JP15#,JP16#, JP17,JP18#,JP19#,JP20, JP21,JP22,JP23	403-0003	3 OF 401-0052	
123	1	JP7	403-0004	4 OF 401-0052	
124	0	JP3#	403-0009	9 OF 401-0052	
125	0	JP14#	403-0202	4 OF 401-0052 [2X2]	
126	1	JP6	403-0203	6 OF 401-0052 [2x3]	
127	1	F1	416-1202	FUSE AGC 2A FAST-BLOW	2A
128	4	XR31,XR32	251-9000	1/4" RESISTOR LEAD SPACER IN-.047 OD-.125	
129	7	XJP6,XJP17,XJP20,XJP21, XJP22,XJP23(POS A) XJP1 (POS B)	402-3040	MINI JUMPER	
130	1	XU5	407-0006	SKT, 06 PIN DIP	
131	8	XU7,XU11,XU12,XU13,XU15, XU22,XU23,XU24	407-0008	SKT, 08 PIN DIP	
132	5	XU2,XU3,XU6,XU21,XU25	407-0014	SKT, 14 PIN DIP	
133	3	XU1,XU16,XU20	407-0016	SKT, 16 PIN DIP	
134	3	XU17,XU18,XU19	407-0020	SKT, 20 PIN DIP	
135	1	XU14	407-0040	SKT, 40 PIN DIP	
136	1	PCB	410-9365A	M72 CONTROLLER PCB	
137	2	XF1	416-3040	FUSE CLIP	
138	7	XDS1,XDS2,XDS3,XDS4,XDS5, XDS6,XDS7	417-0010	LED MOUNT RA	

NOTES: NOTES ARE FOR PRODUCTION USE ONLY.

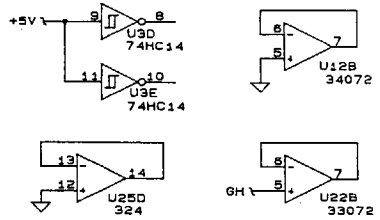
REV	DESCRIPTION	DRN	APD	DATE
A	RELEASE	KM		
B	ECN 1808	GH		
C	HCN 2035	KN		
D	HCN 2059	DW		
E	HCN 2281	DW	KW	5-93
F	HCN 2314	KM	QCV	10-29-93
G	HCN 2652	DW	KH	10-11-94



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.

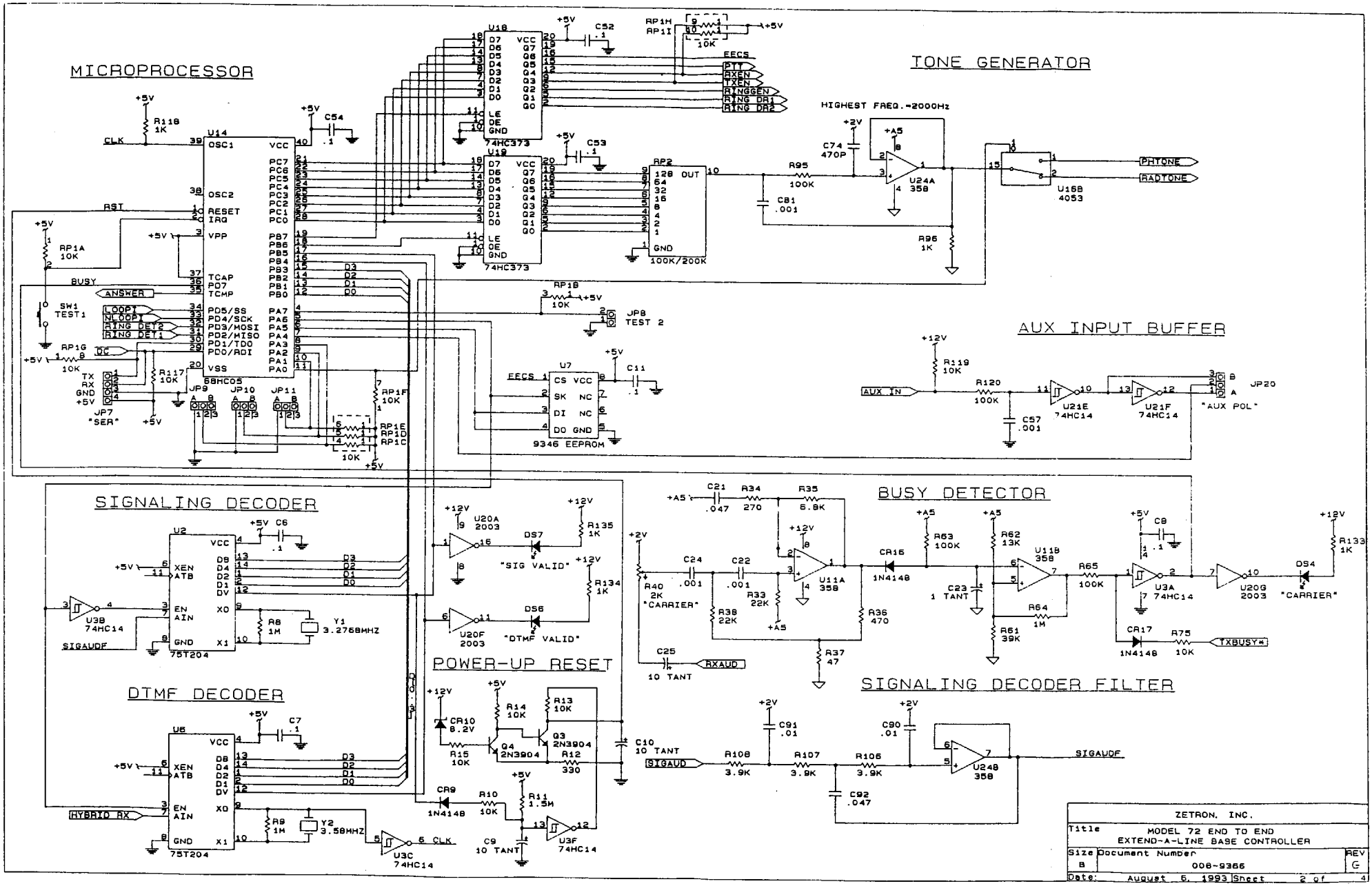
ZETRON, INC.

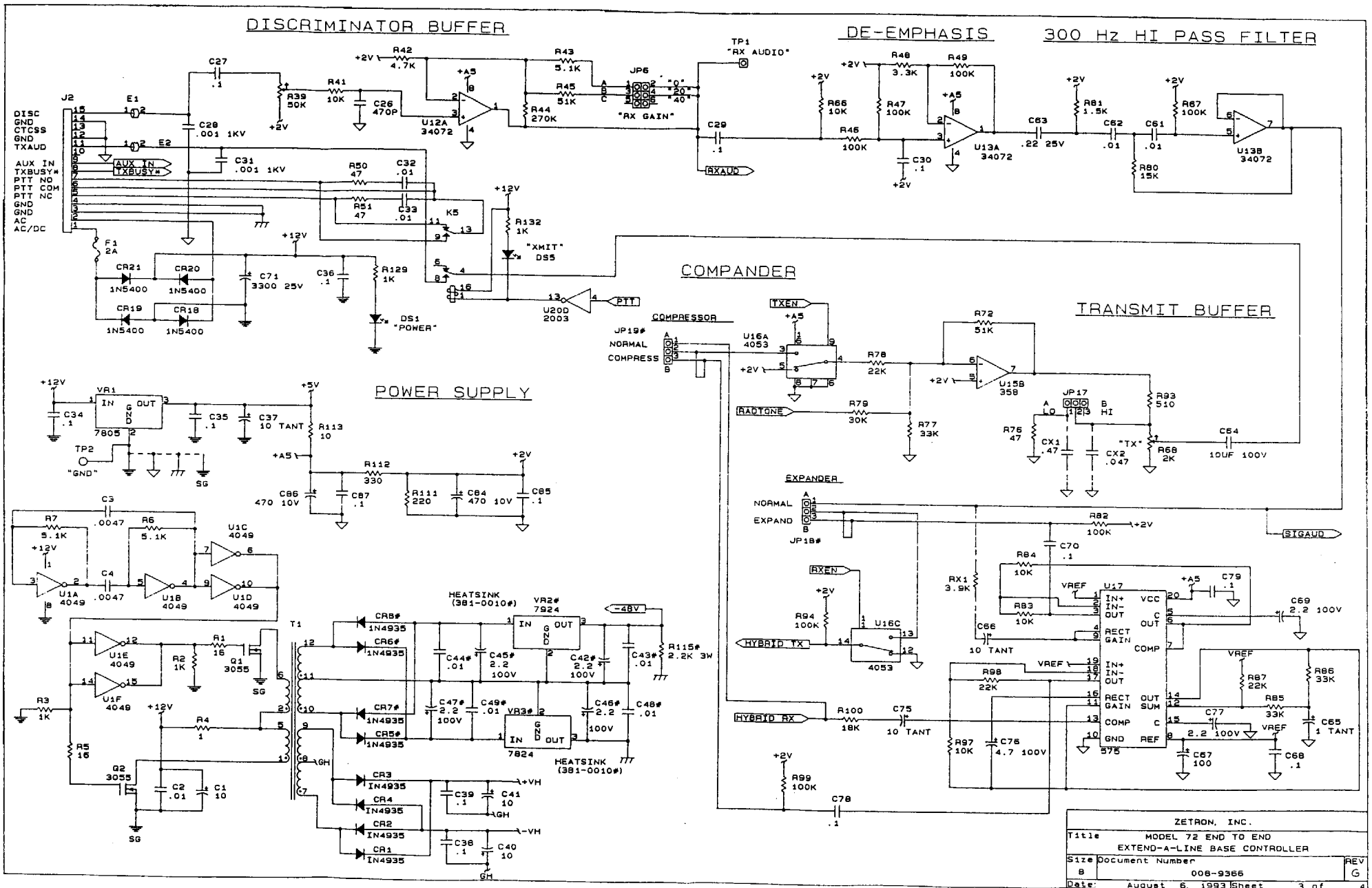
12335 134TH COURT N.E.
REDMOND, WASHINGTON, 98052-2433

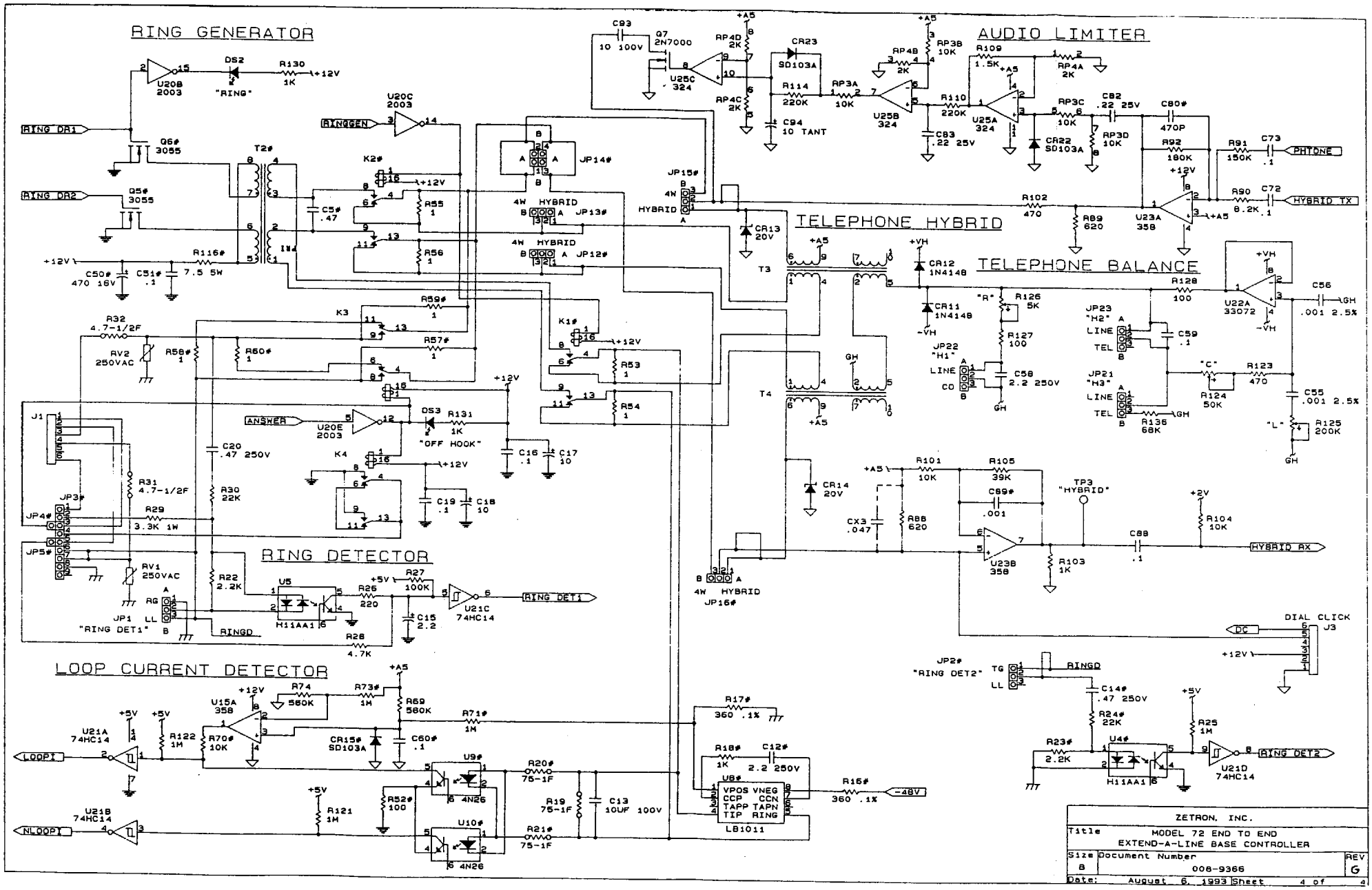
Title: MODEL 72 END TO END EXTEND-A-LINE BASE CONTROLLER

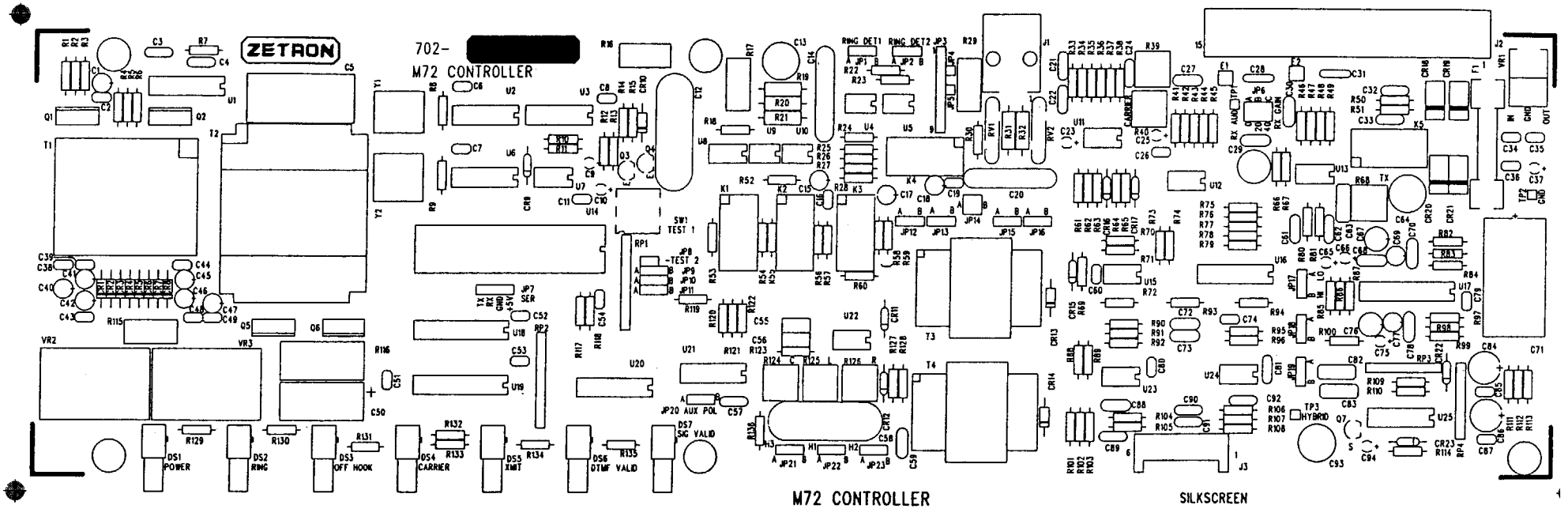
Size	Document Number	REV
B	008-9366	G

Date: August 6, 1993 Sheet 1 of 4

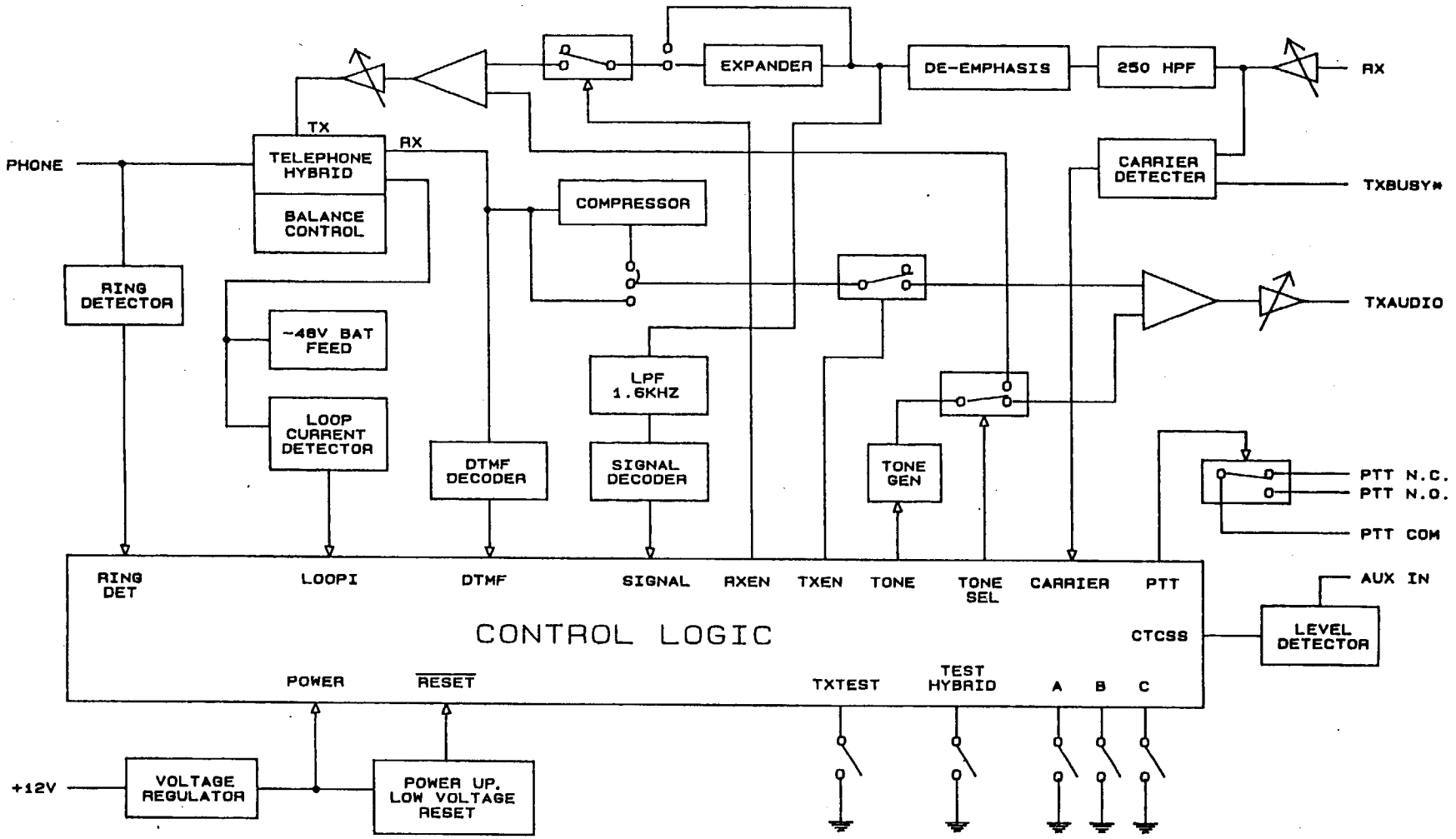

MICROPROCESSOR
TONE GENERATOR
AUX INPUT BUFFER
SIGNALING DECODER
BUSY DETECTOR
DTMF DECODER
POWER-UP RESET
SIGNALING DECODER FILTER
9346 EEPROM
68HC05
75T204
74HC373
HIGHEST FREQ.=2000Hz
ZETRON, INC.
Title MODEL 72 END TO END EXTEND-A-LINE BASE CONTROLLER
Size B
Document Number 006-9366
REV G
Date: August 6, 1993 Sheet 2 of 4


DISCRIMINATOR BUFFER
DE-EMPHASIS
300 Hz HI PASS FILTER
COMPANDER
TRANSMIT BUFFER
POWER SUPPLY
COMPRESSOR
EXPANDER
"RX AUDIO"
"RX GAIN"
"XMIT"
"POWER"
"GND"
"TX"
DISC
GND
CTCSS
GND
TXAUD
AUX IN
TXBUSY*
PTT NO
PTT COM
PTT NC
GND
GND
AC
AC/DC
RXAUD
PTT
TXEN
RXEN
RADTONE
HYBRID TX
HYBRID RX
SIGAUD
NORMAL
COMPRESS
EXPAND
HEATSINK (381-0010#)
ZETRON, INC.
MODEL 72 END TO END
EXTEND-A-LINE BASE CONTROLLER
Size B
Document Number 008-9366
REV G
Date: August 6, 1993
Sheet 3 of 4


RING GENERATOR
AUDIO LIMITER
TELEPHONE HYBRID
TELEPHONE BALANCE
RING DETECTOR
LOOP CURRENT DETECTOR
RING DR1
RING DR2
RINGGEN
ANSWER
"RING"
"OFF HOOK"
"RING DET1"
"RING DET2"
PHTONE
HYBRID TX
HYBRID RX
DIAL CLICK
LOOPI
NLOOPI
-48V
LB1011
ZETRON, INC.
MODEL 72 END TO END
EXTEND-A-LINE BASE CONTROLLER
Size B
Document Number 008-9366
REV G
Date: August 6, 1993
Sheet 4 of 4


ZETRON
702-
M72 CONTROLLER
DS1 POWER
DS2 RING
DS3 OFF HOOK
DS4 CARRIER
DS5 XMIT
DS6 DTMF VALID
DS7 SIG VALID
JP20 AUX POL
SW1 TEST 1
JP8 TEST 2
JP7 SER
RING DET1
RING DET2
CARRIER
TX
RX
AUX
RX CARR
HYBRID
M72 CONTROLLER
SILKSCREEN

LTR	DESCRIPTION	DR	APPRD	DATE
A	RELEASE	KN	[illegible]	5-27-92



ZETRON INCORPORATED 12335 134TH COURT NORTHEAST REDMOND, WASHINGTON 98052-2433		
Title: MODEL 72 E/E REMOTE BLOCK DIAGRAM		
Size: A	Document Number: 006-0065	REV: A
Date: May 21, 1992	Sheet 1 of 1	

MODEL 72 REMOTE CONTROLLER (702-9367H)
Parts List

LEGEND:
♯ = NOT INSTALLED
^ = INSTALLED ON HIGHER ASSY
+ = OPTION (INSTALLED PER CUSTOMER ORDER)

Item	Quantity	Reference	Part	Description	Mfg.Part No.
1	3	R4,R53♯,R54♯,R55♯,R56♯, R57,R58♯,R59,R60♯	101-0010	1 OHM 1/4W 5% CARBON FILM	
2	1	R113	101-0025	10 OHM 1/4W 5% CARBON FILM	
3	2	R5,R1	101-0030	16 OHM 1/4W 5% CARBON FILM	
4	4	R37,R50,R51,R76	101-0047	47 OHM 1/4W 5% CARBON FILM	
5	2	R52♯,R127,R128	101-0049	100 OHM 1/4W 5% CARBON FILM	
6	1	R26♯,R111	101-0057	220 OHM 1/4W 5% CARBON FILM	
7	1	R34	101-0059	270 OHM 1/4W 5% CARBON FILM	
8	2	R12,R112	101-0061	330 OHM 1/4W 5% CARBON FILM	
9	3	R36,R102,R123	101-0065	470 OHM 1/4W 5% CARBON FILM	
10	1	R93	101-0066	510 OHM 1/4W 5% CARBON FILM	
11	2	R89,R88	101-0068	620 OHM 1/4W 5% CARBON FILM	
12	13	R2,R3,R18,R96,R103,R118, R129,R130,R131,R132,R133, R134,R135	101-0073	1K 1/4W 5% CARBON FILM	
13	1	R81,R109♯	101-0075	1.5K 1/4W 5% CARBON FILM	
14	0	R23♯,R22♯	101-0081	2.2K 1/4W 5% CARBON FILM	
15	1	R48	101-0085	3.3K 1/4W 5% CARBON FILM	
16	4	RX1 NOTE 5,R106,R107,R108	101-0087	3.9K 1/4W 5% CARBON FILM	
17	1	R28♯,R42	101-0089	4.7K 1/4W 5% CARBON FILM	
18	3	R6,R7,R43	101-0090	5.1K 1/4W 5% CARBON FILM	
19	1	R35	101-0093	6.8K 1/4W 5%	
20	15	R10,R13,R14,R15,R41,R66, R70,R75,R83,R84,R97,R101, R104,R117,R119	101-0097	10K 1/4W 5% CARBON FILM	
21	2	R105,R62	101-0100	13K 1/4W 5% CARBON FILM	
22	2	R90,R80	101-0101	15K 1/4W 5% CARBON FILM	
23	1	R100	101-0103	18K 1/4W 5% CARBON FILM	
24	4	R24♯,R30♯,R33,R38,R78, R87	101-0105	22K 1/4W 5% CARBON FILM	
25	1	R79	101-0108	30K 1/4W 5% CARBON FILM	
26	4	R77,R85,R86,R98	101-0109	33K 1/4W 5% CARBON FILM	
27	1	R61	101-0111	39K 1/4W 5% CARBON FILM	
28	2	R45,R72	101-0114	51K 1/4W 5% CARBON FILM	
29	1	R136	101-0117	68K 1/4W 5% CARBON FILM	
30	12	R27,R46,R47,R49,R63,R65, R67,R82,R94,R95,R99,R120	101-0121	100K 1/4W 5% CARBON FILM	
31	1	R92,R110♯,R114♯	101-0129	220K 1/4W 5% CARBON FILM	
32	1	R44	101-0131	270K 1/4W 5% CARBON FILM	

MODEL 72 REMOTE CONTROLLER (702-9367H)
Parts List (Continued)

Item	Quantity	Reference	Part	Description	Mfg.Part No.
33	1	R91	101-0133	330K 1/4W 5% CARBON FILM	
34	2	R74,R69	101-0139	560K 1/4W 5% CARBON FILM	
35	8	R8,R9,R25,R64,R71,R73, R121,R122	101-0145	1M 1/4W 5% CARBON FILM	
36	1	R11	101-0149	1.5M 1/4W 5% CARBON FILM	
37	1	R115	103-2200	2.2K 3W 5% WIREWOUND	
38	1	R116	103-3075	RES, 7.5 OHM 5W 5% WIREWOUND	
39	0	R29#	103-3300	3.3K 1W 5% CARBON FILM	
40	2	R16,R17	104-0360	360 OHM 2W 0.1% ULTRA-STABLE	
41	2	RV2,RV1	105-0001	VARISTOR 250V AC	
42	2	R32,R31	106-0047	4.7 OHM 1/2W 5% FUSIBLE	
43	0	R19#,R20#,R21#	106-1175	75 OHM 1W 5% FUSIBLE	
44	2	R40,R68	107-0202	2K POT 1 TURN	
45	1	R126	107-0501	5K POT 1 TURN	
46	2	R124,R39	107-0502	50K POT 1 TURN	
47	1	R125	107-0504	200K POT 1 TURN	
48	1	RP1	119-0006	10K x 9 BUSSED 10-PIN SIP	
49	1	RP2	119-0021	R/2R 100K/200K 10 PIN SIP	
50	0	RP3#	119-0025	10K X 4 ISOLATED 8-PIN SIP	
51	0	RP4#	119-0026	2K X 4 ISOLATED 8-PIN SIP	
52	2	C31,C28	150-0096	1000 PF 1KV +-20% CERAMIC DISC	
53	2	C26,C74,C80#	151-0047	470PF 100V/200V +-10%/5% CERAMIC NPO	
54	5	C2,C43,C44,C48,C49	151-0120	.01UF 50V/100V +-10% CERAMIC X7R	
55	18	C6,C7,C8,C11,C16,C19,C34, C35,C36,C38,C39,C51,C52, C53,C54,C79,C85,C87	151-0180	.1UF 50V +-20% CERAMIC Z5U	
56	1	CX1 NOTE 6	151-0199	.47UF 50V +-5%, POLYESTER	
57	10	C27,C29,C30,C59,C68,C70, C72,C73,C78,C88	152-0012	.1 UF 50V +-5% POLYESTER	
58	1	C5	152-0020	.47 UF 630V +-10% POLYESTER	
59	0	C14#,C20#	152-0021	.47 UF 250V +-10% POLYESTER	
60	2	C58,C12	152-0030	2.2 UF 250V +-10% POLYESTER	
61	2	C13,C64,C93#	152-0050	10 UF 100V 20% NON-POLAR ELECTROLYTIC, RADIAL	
62	1	C63,C82#,C83#	152-0080	.22 UF 50V +-5%	
63	7	C32,C33,C60,C61,C62,C90, C91	152-0085	.01 UF 50V +- 5% POLYESTER	
64	2	C3,C4	152-0088	.0047UF 50V +-5% POLYESTER	
65	4	C22,C24,C57,C81,C89#	152-0089	.001 UF 50V +-5% POLYESTER	
66	2	C55,C56	152-0090	.001uF 50V +-2% POLYPROPYLENE	
67	4	CX2 NOTE 7, CX3 NOTE 8, C21,C92	152-0250	.047 UF 50V 5% POLYESTER	
68	2	C23,C65	154-0025	1 UF 35V TANTALUM +- 10%	
69	6	C9,C10,C25,C37,C66,C75, C94#	154-0100	10 UF 16V TANTALUM +-10%	

MODEL 72 REMOTE CONTROLLER (702-9367H)
Parts List (Continued)

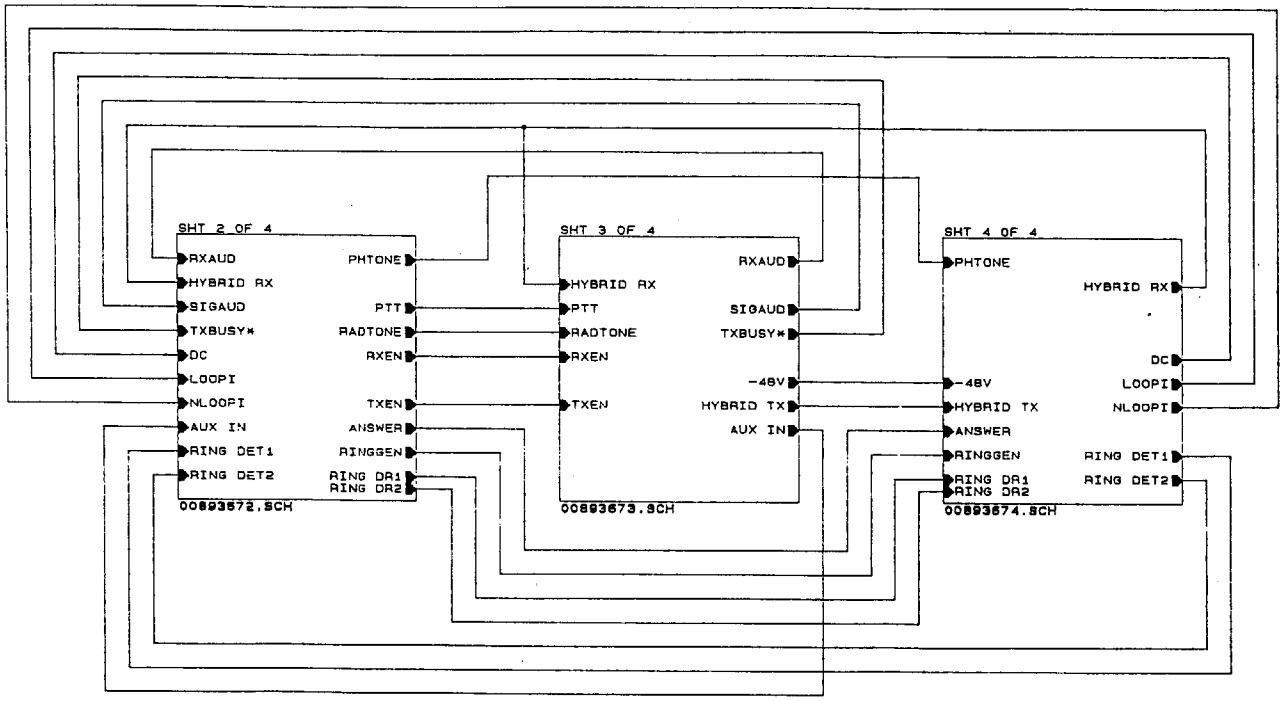
Item	Quantity	Reference	Part	Description	Mfg.Part No.
70	6	C15♯,C42,C45,C46,C47,C69, C77	155-0012	2.2 UF 100V +-20% RADIAL ALUMINUM ELECTROLYTIC	
71	1	C76	155-0013	4.7 UF 100 VOLT RADIAL ALUMINUM ELECTROLYTIC	
72	5	C1,C17,C18,C40,C41	155-0052	10 UF 35V +-20% RADIAL ALUMINUM ELECTROLYTIC	
73	1	C67	155-0077	100UF 25V +-20% RADIAL ALUMINUM ELECTROLYTIC	
74	1	C50	155-0082	470 UF 16V +-20% AXIAL ALUMINUM ELECTROLYTIC	
75	2	C86,C84	155-0083	470 UF 10 VOLT RADIAL ALUMINUM ELECTROLYTIC	
76	1	C71	155-0140	3300 UF 25V +50%-10% AXIAL ALUMINUM ELECTROLYTIC	
77	2	E1,E2	305-0001	FERRITE BEADS W/ LEADS	
78	2	T4,T3	305-1540	TELCO HYBRID XFMR, SMALL SIZE	
79	1	T2	305-1635	16V 6VA SPLIT BOBBIN XFMR	
80	1	T1	305-4812	12V TO 12V AND 48V TRANSFORMER	
81	0	U9♯,U10♯	311-0008	OPTO ISOLATOR	4N26
82	6	DS2,DS3,DS4,DS5,DS6,DS7	311-0011	LED RED FLUSH	
83	1	DS1	311-0012	LED GREEN FLUSH	
84	0	U4♯,U5♯	311-1001	OPTO ISOLATOR, BI-POLAR	H11AA1
85	0	U25♯	316-0324	OP-AMP, QUAD BIPOLAR, 358 EQUIVALENT	324
86	4	U11,U15,U23,U24	316-0358	OP-AMP, DUAL BIPOLAR	358
87	1	U17	316-0575	COMPANDOR	575
88	1	U8	316-1011	BATTERY FEED	LB1011
89	1	U22 NOTE 15	316-3072	DUAL OP-AMP, HIGH BIAS CURRENT	34072T
90	2	U13,U12 NOTE 14	316-3307	DUAL OPAMP, LOW BIAS CURRENT	34072M
91	1	VR1	316-7805	REGULATOR, +5V 1.5A	7805
92	1	VR3	316-7824	+24V 1.5A REGULATOR	7824
93	1	VR2	316-7924	-24V 1.5A REGULATOR	7924
94	2	U2,U6	321-0204	DTMF RECEIVER	75T204
95	1	U14 NOTE 4	321-6806	8 BIT CMOS OTP 40 PIN DIP (68HC05)	ASIC 009
96	1	U7	322-9346	1024 BIT SERIAL EEPROM	93C46N
97	1	U1	323-4049	HEX INVERTER, UNBUFFER GATES	4049
98	1	U16	323-4053	3PDT SWITCH	4053
99	2	U19,U18	324-4373	OCTAL LATCH	74HC373
100	2	U3,U21	324-7414	HEX SCHMIDT	74HC14
101	1	U20	340-2003	RELAY DRIVER 50V/.5A	2003
102	4	Q1,Q2,Q5,Q6	340-3055	12A 60V N FET	3055
103	2	Q3,Q4	340-3904	NPN 40V/200MA	2N3904
104	0	Q7♯	340-7000	XTR, MOSFET, N-CHANNEL TO-92 60V/0.2A	2N7000
105	1	CR15,CR22♯,CR23♯	342-0103	SCHOTTKY, 0.37V @ 1MA TYP	SD103A
106	5	CR9,CR11,CR12,CR16,CR17	342-3009	SILICON .50 SP	1N4148
107	8	CR1,CR2,CR3,CR4,CR5,CR6, CR7,CR8	342-4935	SIL FAST 200V .50 SP	1N4935
108	4	CR18,CR19,CR20,CR21	342-5400	SIL 3A 50V .50 SP	1N5400
109	1	CR10	343-3100	1W 8.2V +-5%	1N4738A
110	2	CR14,CR13	343-3110	1W 20V +-5%	1N4747A

MODEL 72 REMOTE CONTROLLER (702-9367H)
Parts List (Continued)

Item	Quantity	Reference	Part	Description	Mfg.Part No.
111	1	SW1	371-0009	PWB MNT MOM KEY	
112	1	Y2 NOTE 1	376-0358	XTAL, 3.579545 HC-49 CL=18PF	3.58MHz
113	1	Y1 NOTE 1	376-3276	3.2768MHz HC49 CASE	3.2768MHz
114	4	K1,K2,K3♯,K4,K5	380-0030	DPDT 12V COIL MINI RELAY 360 OHM	
115	1	J2	401-0059	15 POS R/A HEADER	
116	1	J1	401-0080	6-PIN LO PRO R/A TELCO	
117	1	J3	401-6005	6-POS FEMALE	
118	3	TP1,TP2,TP3,JP4♯,JP5♯	403-0001	1 OF 401-0052	
119	1	JP8	403-0002	2 OF 401-0052	
120	8	JP1♯,JP2♯,JP9,JP10,JP11, JP12♯,JP13♯,JP15♯,JP16♯, JP17,JP18♯,JP19♯,JP20, JP21,JP22,JP23	403-0003	3 OF 401-0052	
121	1	JP7	403-0004	4 OF 401-0052	
122	0	JP3♯	403-0009	9 OF 401-0052	
123	0	JP14♯	403-0202	4 OF 401-0052 [2X2]	
124	1	JP6	403-0203	6 OF 401-0052 [2x3]	
125	1	F1	416-1202	FUSE AGC 2A FAST-BLOW	2A
126	2	XVR2,XVR3	210-0001	440 KEPT NUT PLATED	
127	6	XR31,XR32,XR116	251-9000	1/4" RESISTOR LEAD SPACER ID-.047 OD-.125	
128	2	XVR2,XVR3	220-0108	440x1/4 PAN PHILLIPS	
129	2	XVR2,XVR3 NOTE 2	381-0010	HEATSINK TO-220 BLACK	
130	6	XJP6,XJP17,XJP20,XJP21, XJP22,XJP23 (POS A)	402-3040	MINI JUMPER	
131	9	XU7,XU8,XU11,XU12,XU13, XU15,XU22,XU23,XU24	407-0008	SKT, 08 PIN DIP	
132	4	XU2,XU3,XU6,XU21	407-0014	SKT, 14 PIN DIP	
133	3	XU1,XU16,XU20	407-0016	SKT, 16 PIN DIP	
134	3	XU17,XU18,XU19	407-0020	SKT, 20 PIN DIP	
135	1	XU14	407-0040	SKT, 40 PIN DIP	
136	1	PCB	410-9365A	M72 CONTROLLER PCB	
137	2	XF1	416-3040	FUSE CLIP	
138	7	XDS1,XDS2,XDS3,XDS4,XDS5, XDS6,XDS7	417-0010	LED MOUNT RA	

NOTES: NOTES ARE FOR PRODUCTION USE ONLY.

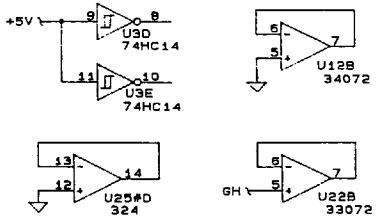
REV	DESCRIPTION	DRN	APD	DATE
A	RELEASE	KM		
B	ECN 1810	GH		
C	HCN 1885	DW		
D	HCN 2036	KN		
E	HCN 2039A	DW		
F	HCN 2282	DW		
G	HCN 2314	KM		
H	HCN 2653	DW		



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:

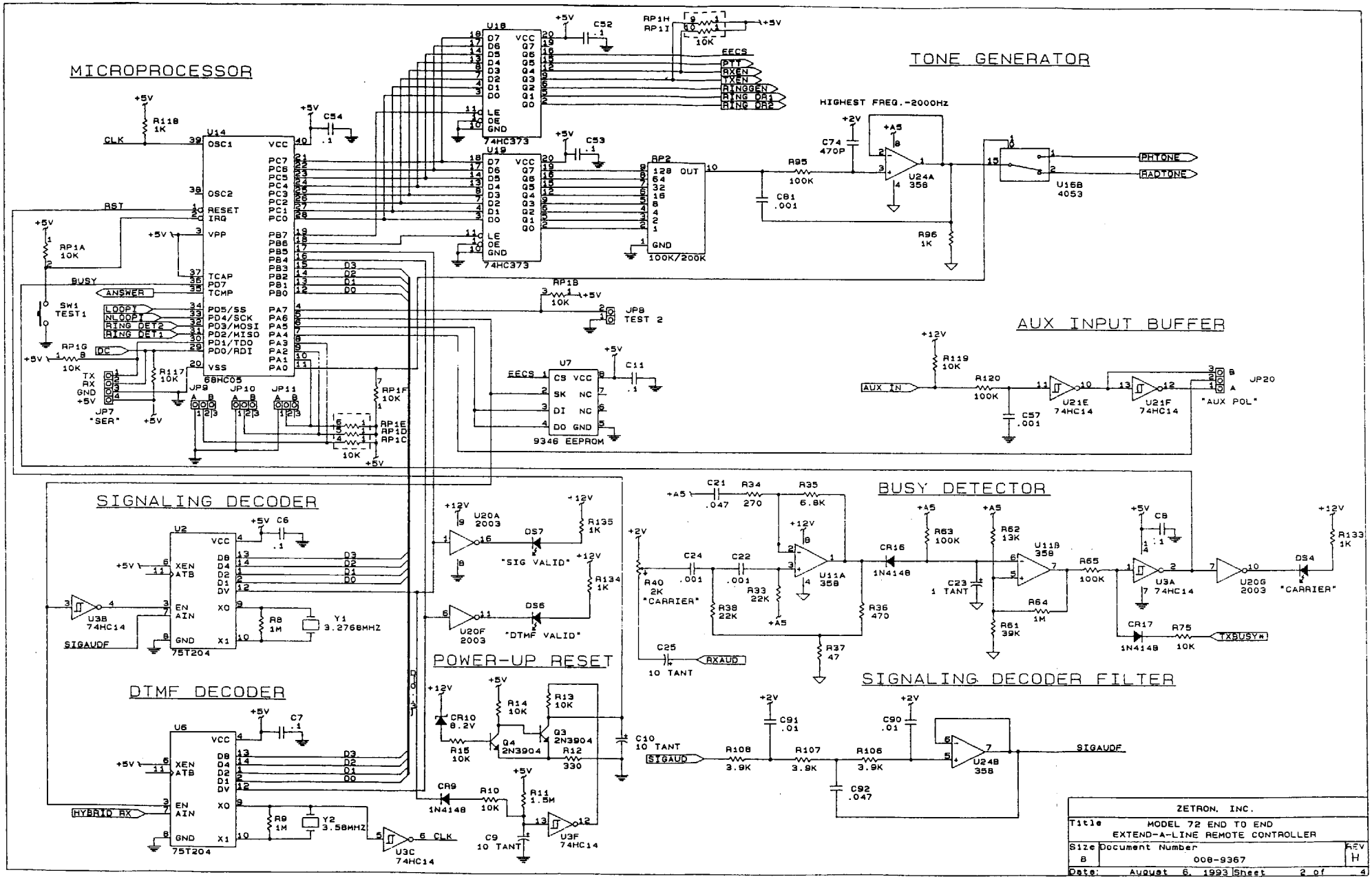
+	OPTION, INSTALL PER CUSTOMER ORDER.
-	INSTALLED ON HIGHER ASSEMBLY.
#	NOT INSTALLED.
——X——	CUT TRACE.
- - - - - - - - - -	JUMPER WIRE.

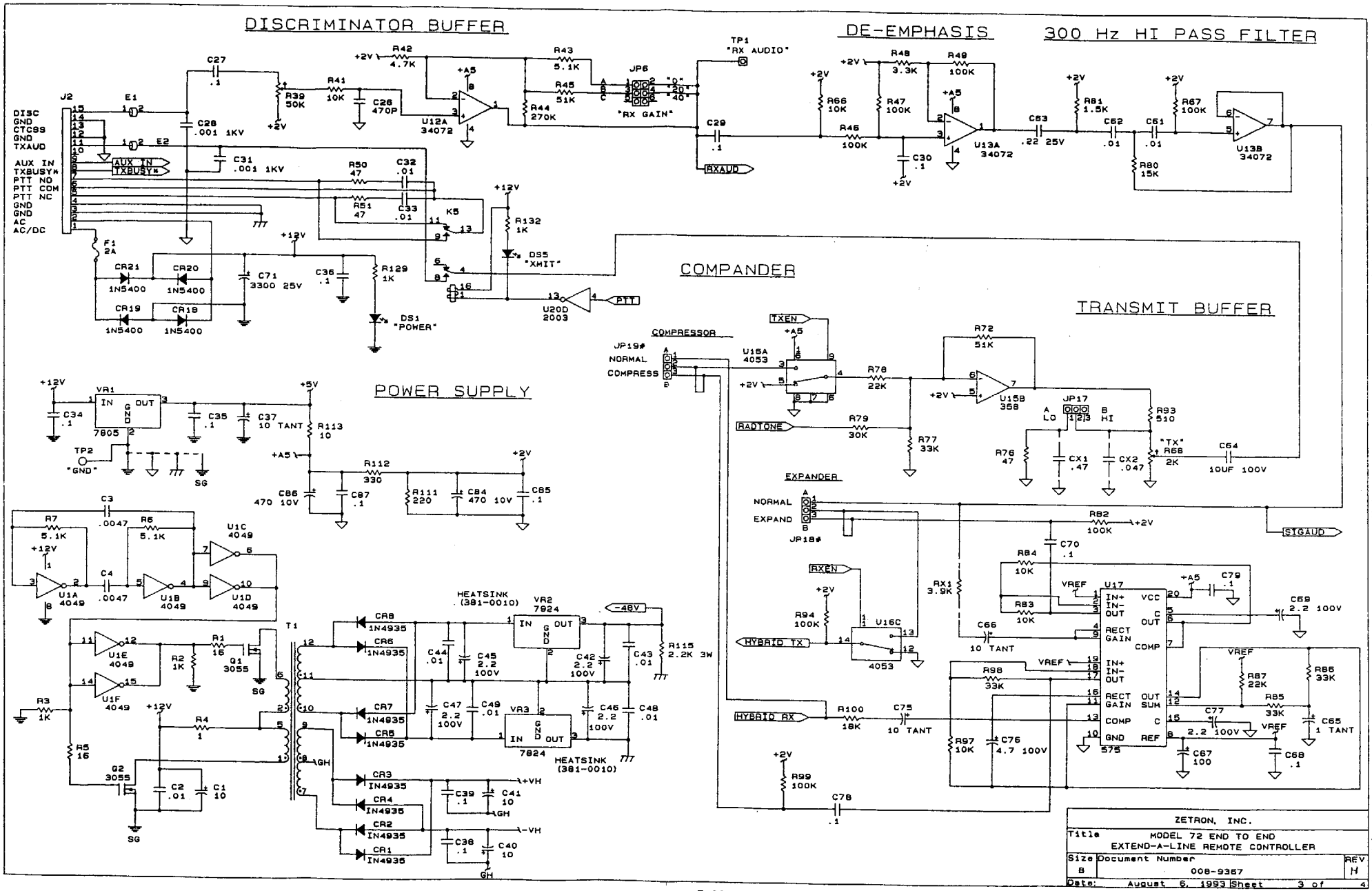
ZETRON, INC.
12335 134TH COURT N.E.
REDMOND, WASHINGTON, 98052-2433

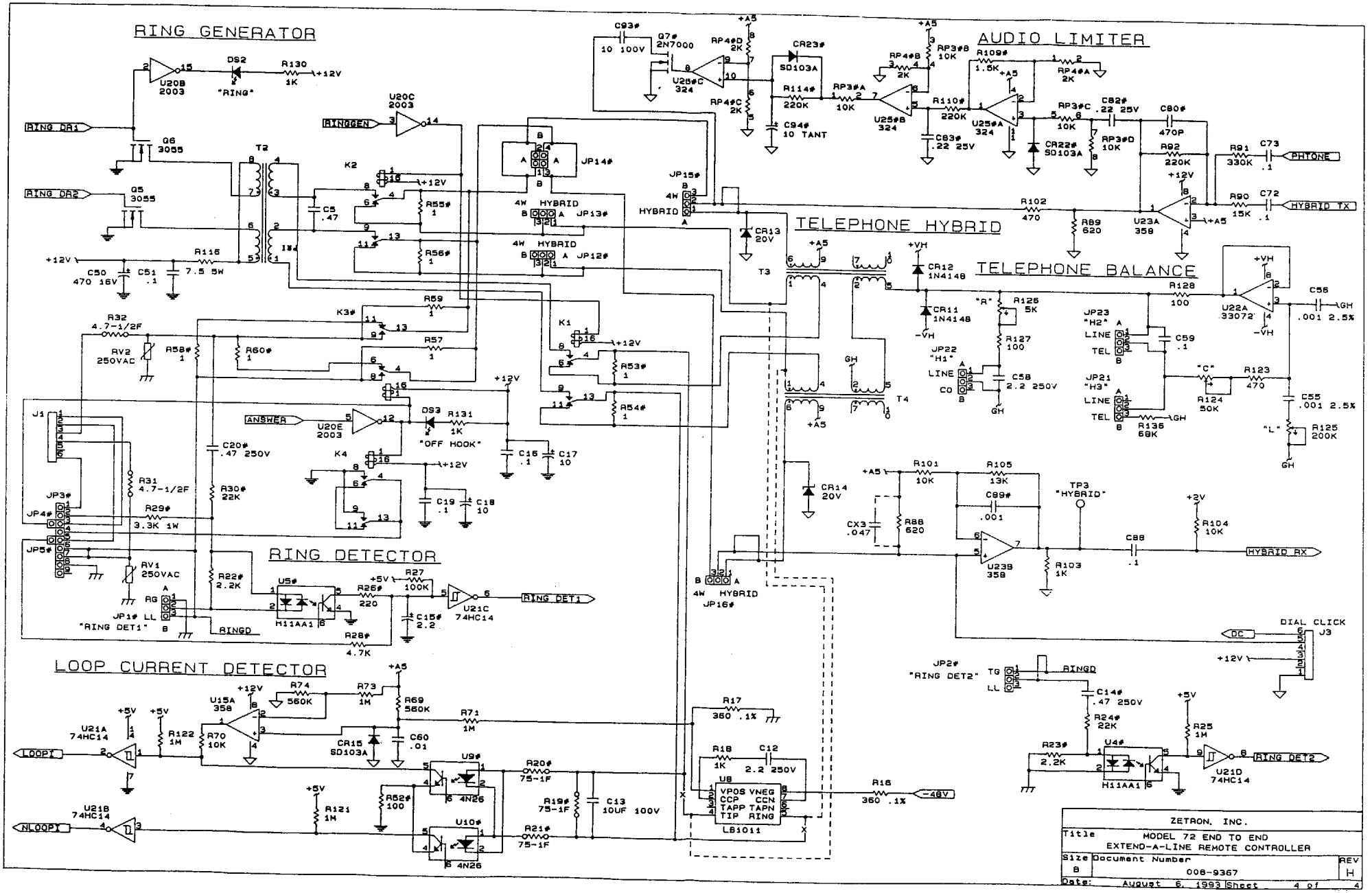
Title: MODEL 72 END TO END EXTEND-A-LINE REMOTE CONTROLLER

Size: B | Document Number: 008-9367 | REV: H

Date: August 6, 1993 | Sheet 1 of 4


MICROPROCESSOR
TONE GENERATOR
AUX INPUT BUFFER
SIGNALING DECODER
BUSY DETECTOR
DTMF DECODER
POWER-UP RESET
SIGNALING DECODER FILTER
HIGHEST FREQ.-2000Hz
U14
68HC05
U18
U19
74HC373
RP2
128 OUT
100K/200K
U24A 358
U16B 4053
PHTONE
RADTONE
U7
9346 EEPROM
JP8 TEST 2
JP7 "SER"
JP9
JP10
JP11
JP20 "AUX POL"
U2
75T204
U6
75T204
U20A 2003
U20F 2003
U20G 2003
"SIG VALID"
"DTMF VALID"
"CARRIER"
U11A 358
U11B 358
U21E 74HC14
U21F 74HC14
U3A 74HC14
U3B 74HC14
U3C 74HC14
U3F 74HC14
U24B 358
Y1 3.2768MHZ
Y2 3.58MHZ
Q3 2N3904
Q4 2N3904
CR10 8.2V
CR9 1N4148
CR16 1N4148
CR17 1N4148
SIGAUDF
SIGAUD
RXAUD
TXBUSY*
HYBRID RX
ANSWER
BUSY
RST
CLK
ZETRON, INC.
Title MODEL 72 END TO END
EXTEND-A-LINE REMOTE CONTROLLER
Size B
Document Number 008-9367
REV H
Date: August 6, 1993 Sheet 2 of 4


DISCRIMINATOR BUFFER
DE-EMPHASIS
300 Hz HI PASS FILTER
COMPANDER
TRANSMIT BUFFER
POWER SUPPLY
COMPRESSOR
EXPANDER
TP1 "RX AUDIO"
"RX GAIN"
RXAUD
TXEN
RADTONE
HYBRID TX
HYBRID RX
RXEN
STGAUD
PTT
DS1 "POWER"
DS5 "XMIT"
HEATSINK (381-0010)
+VH
-VH
-48V
ZETRON, INC.
MODEL 72 END TO END
EXTEND-A-LINE REMOTE CONTROLLER
008-9367
August 6, 1993 Sheet 3 of 4


RING GENERATOR
AUDIO LIMITER
TELEPHONE HYBRID
TELEPHONE BALANCE
RING DETECTOR
LOOP CURRENT DETECTOR
RING DR1
RING DR2
RINGGEN
ANSWER
"OFF HOOK"
"RING"
"RING DET1"
"RING DET2"
HYBRID
HYBRID TX
HYBRID RX
PHTONE
DIAL CLICK
LOOPI
NLOOPI
RINGD
-48V
LB1011
ZETRON, INC.
Title MODEL 72 END TO END
EXTEND-A-LINE REMOTE CONTROLLER
Size B
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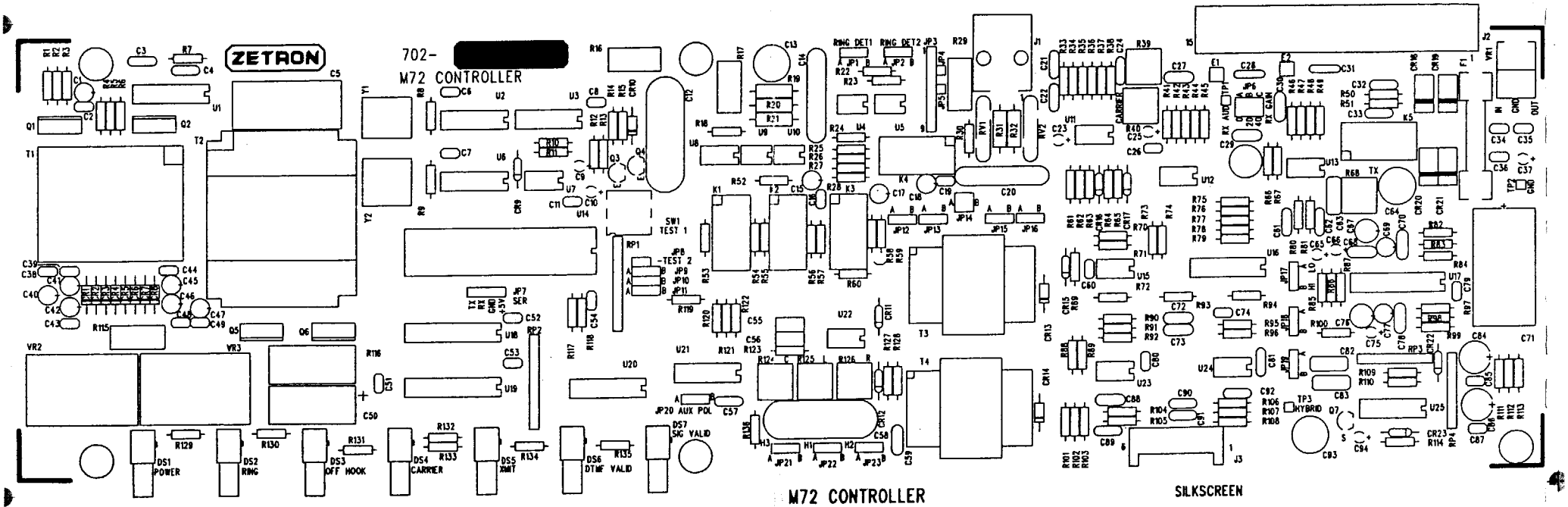
REV H
Date: August 6, 1993 Sheet 4 of 4


ZETRON
702-
M72 CONTROLLER
DS1 POWER
DS2 RING
DS3 OFF HOOK
DS4 CARRIER
DS5 XMIT
DS6 DTMF VALID
DS7 SIG VALID
M72 CONTROLLER
SILKSCREEN

8. PROGRAMMING LOG AND QUICK REFERENCE

8. PROGRAMMING LOG AND QUICK REFERENCE

MODEL 72 BASE

Use this page to log all programmed settings for future use. Be sure to log all commands entered into the Model 72 base!

01# [ ] - Single Unit Mode **(Default)**
02# [ ] - Multiple Unit Mode
03# ___ - Unit Address **(Default = 0)** [Range 0 - 9]

04# __ __ __ __ __ __ __ __ __ __ # - CW ID Call Sign **(Default = blank)**
05# [ ] - Disable Morse Code Station ID **(Default)**
06# [ ] - Enable Morse Code Station ID
07# [ ] - ID at End of Conversation
08# [ ] - ID every 15 minutes **(Default)**
09# [ ] - ID every 30 minutes

10# __ __ - Transmitter Keyup Delay **(Default = 0.5 sec)** [Range 0 - 2.5]

11# [ ] - Disable Transmit on Busy Channel **(Default)**
12# [ ] - Enable Transmit on Busy Channel

13# __ __ - Rings-to-Answer **(Default = 10)** [Range 1 - 25]

18# __ __ - Base Knock Down Timer **(Default = 00)**
[Range 1 - 60 in minutes, 00 = Disabled]

32# [ ] - Enable Dial Click Overdial (only when overdial option installed)
33# [ ] - Disable Dial Click Overdial **(Default)**

90# __ __ __ __ __ # - Program Access Code **(Default = 12172)**

91# - Reset ALL Programmable Values to Factory Defaults

96# [ ] - Dial Click Calibration Test

97# __ - Remotely Program a Model 72 Remote

99# - EXIT the Program Mode

MODEL 72 REMOTE

Use this page to log all programmed settings for future use. Be sure to log all commands entered into the Model 72 remote!

01# [ ] - Single Unit Mode **(Default)**
02# [ ] - Multiple Unit Mode
03# ___ - Unit Address **(Default = 0)** [Range 0 - 9]

04# __ __ __ __ __ __ __ __ __ __ # - CW ID Call Sign **(Default = blank)**
05# [ ] - Disable Morse Code Station ID **(Default)**
06# [ ] - Enable Morse Code Station ID
07# [ ] - ID at End of Conversation
08# [ ] - ID every 15 minutes **(Default)**
09# [ ] - ID every 30 minutes

10# __ __ - Transmitter Keyup Delay **(Default = 0.5 sec)** [Range 0 - 2.5]

11# [ ] - Disable Transmit on Busy Channel **(Default)**
12# [ ] - Enable Transmit on Busy Channel

14# [ ] - Disable Call Limit Timer **(Default)**
15# [ ] - 3 Minute Call Limit
16# [ ] - 15 Minute Call Limit
17# [ ] - 30 Minute Call Limit

91# - Reset ALL Programmable Values to Factory Defaults

95# [ ] - Generate 1-kHz Test Tone for 30 Seconds or Until a Digit is entered from the phone (This command only works when programming the remote unit via the base unit.)

99# - EXIT Program Mode

PRODUCT QUALITY CUSTOMER FEEDBACK FORM

Please fill out and return this form after you have had a chance to install and operate your Zetron device.

Product:_____ Today's Date:_____

How long did it take to install?_____

How long did it take to program?_____

Did you have to call Zetron for technical assistance? y n

If yes, why?_____

Which brand radio/repeater is it interfaced to?_____

How many products of this type do you purchase in a year?_____

Reason for choosing Zetron:_____

RATING OF PRODUCT	Excellent	Good	Average	Below Avg.	Poor
Ease of Install	1	2	3	4	5
Ease of Programming	1	2	3	4	5
Number of Features	1	2	3	4	5
Reliability of Operation	1	2	3	4	5
Price for Performance	1	2	3	4	5
Met your Expectations	1	2	3	4	5
Confidence in Product	1	2	3	4	5
Call-In Technical Support	1	2	3	4	5

Suggestions (use second sheet if necessary):_____

_____

New Product Ideas:_____

_____

How many Zetron products have you purchased: 1 2-5 6-10 10-20 20-more

FAX TO: (206) 820-7031

MAIL TO: B&I Marketing
Zetron, Inc.
12034 134th Court N.E.
P.O. Box 97004
Redmond, WA 98073-9704

OPTIONAL

Name/Title:_____

Company:_____

Address:_____

City:_____

State/Zip:_____

Phone/FAX:_____

Thank you for your help.

PRODUCT MANUAL CUSTOMER FEEDBACK FORM

Please provide us with suggestions on how we can improve this manual. Your opinions are important to us.

Product:_____ Manual No.: #025-_____ Date:_____

RATING OF MANUAL	Excellent	Good	Average	Below Avg.	Poor
Understandability	1	2	3	4	5
Technical Completeness	1	2	3	4	5
Explanation of Operation	1	2	3	4	5
Installation Instructions	1	2	3	4	5
Programming Instructions	1	2	3	4	5
Schematics/Diagrams	1	2	3	4	5
Overall Ease of Use	1	2	3	4	5
As a Quick-Reference Tool	1	2	3	4	5

Suggestions (use second sheet if necessary):_____

_____

_____

_____

Specific Edits/Changes (include page no.):_____

_____

_____

_____

_____

FAX TO: (206) 820-7031

MAIL TO: B&I Marketing
Zetron, Inc.
12034 134th Court N.E.
P.O. Box 97004
Redmond, WA 98073-9704

OPTIONAL

Name/Title:_____

Company:_____

Address:_____

City:_____

State/Zip:_____

Phone/FAX:_____

Thank you for your help.

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.