

Section 7

ZR320 Selective Calling Interconnect Controller

Overview

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

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

Physical Description

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

Located on the front panel are:

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

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

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

Standard Features

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

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

Access/Deaccess to the ZR320

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

Access Sequence

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

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

System Configurations

IMPORTANT

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

The following instructions explain the use of the access sequence:

Standard Users

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

Supervisor or Administrator

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

Deaccess Sequence—All Users

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

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

IMPORTANT

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

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

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

System Configurations

Through programming, the ZR320 may be configured to support many system requirements from simple dispatch systems to complicated PBX styled systems. The ZR320 supports up to 100 different users which are defined by the equipment type (i.e. non-digital pager, Quik-Call II mobile radio, TPL portable radio, etc.) A

more detailed discussion of the users and equipment types appears in the GR Series Programming Guide (6880903Z43).

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

The main configuration categories described in the following paragraphs are:

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

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

Dispatch**Carrier Repeat**

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

Single User TPL/DPL Repeat

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

Interconnect**Manual Access**

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

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

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

Automatic Single User (Industrial Strength Cordless Phone)

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

Automatic Multi-User

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

Automatic Multi-User/Untrained Callers (Autocall User)

In the automatic multi-user mode for untrained callers, everything functions as described in "Automatic Multi-User", with one exception. The telephone caller must know to enter the user number after the prompt. This works well if every caller has been trained to use

the interconnect, but it could be a problem for those who have not been trained. Allowing the autocall user function to take over allows calls to be placed by untrained callers to a designated user (a dispatcher or secretary).

Combined Dispatch/Interconnect

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

Phone Link

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

Dial-Up

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

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

Basic Operation

Basic Operation

The ZR320 has four basic modes of operation:

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

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

Single User Interconnect Mode

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

Outbound Calls

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

Channel Busy

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

Autocall User

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

Answer Time

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

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

How a Mobile Answers a Call

A mobile answers a call by sending the access code followed by the correct user number. Note that the user

must enter both digits of the user number in order to answer the call. For example, if the access code is '*' and the user number required to answer the call is 1, '*01' must be sent to answer the call.

How a Call is Terminated

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

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

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

Inbound Calls**How a Mobile Initiates a Call**

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

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

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

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

How the Call is Terminated

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

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

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

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

Half-/Full-Duplex Operation

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

- **Tone-only Pagers** - The Quik-Call II page is sent over the air, the caller will hear five pager beeps and the call is terminated.
- **Tone+voice Pagers** - The Quik-Call II page is sent over the air, the caller hears a talk "beep" and his audio is live on the air until either the Pager Talk Time expires or the ZR320 detects a two second gap in the voice. When the page is finished, the ZR320 sends two beeps to the caller indicating that the talk time is up and the call is terminated.
- **Talkback Pagers** - The TPL/DPL or QCII tone set is encoded and two talk "beeps" are sent to the

caller. The caller can then voice hail the talkback pager which has the mobile Answer Time to answer. Once the talkback pager answers, the call proceeds just like a mobile call. When the talkback pager does not answer, the call is terminated.

- **Direct Air** - The caller hears two talk "beeps," is dropped on the air immediately and is allowed to voice hail the mobile for up to the mobile answer time. The mobile must answer within the mobile Answer Time for the call to take place, otherwise it is terminated.

Simplex Operation

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

Conversation Mode

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

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

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

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

Basic Operation

transmitter is unkeyed and the ZR320 goes back to waiting.

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

Multi-User Interconnect Mode

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

NOTE

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

Mobile to Mobile

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

NOTE

The steering digit allows a mobile user to choose between two modes:

- telephone interconnect (steering digit 9 or *)
- selective calling / revertive paging

(steering digit 7).

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

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

TPL/DPL/Quik-Call II Mobile

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

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

Tone Only Pager

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

Tone + Voice Pager

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

Talkback Pagers

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

Direct Air

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

ZR330

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

Single-User Telephone Line Extender

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

NOTE

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

Outbound Calls

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

Inbound Calls

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

Conversation Mode

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

Multi-User Telephone Line Extender

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

telephone "extension" number). Up to 100 ZR330s can be called through the ZR320.

Equipment Required For Installation

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

- a communications service analyzer

and ONE of the following

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

Theory of Operation

ZR320/ZR330 Control Card

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

Power Supply/Conditioning

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

Reset Circuit

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

Theory of Operation

Microprocessor/EPROM/EEPROM

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

Tone Generation

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

VOX Circuit

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

DTMF Decoder Circuit

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

ZR320 Trunk Card**Audio Limiter**

The audio limiter consists of C32, RP2C, RP2D, CR11, RP3D, R35, U5C, R35, C33, RP2A, RP3A, U5B, RP2B,

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

Dial Click Decoder

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

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

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

Compander

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

Ring Detect

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

Jumper Configurations

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

NOTE

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

Adjustments

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

NOTE

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

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

power is on when the red portion of the switch is visible.

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

Receive Audio Level

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

TPL/DPL Encode Level

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

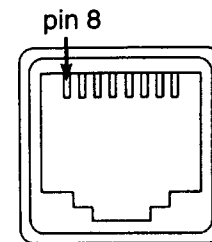


Figure 7-1. J2 Programming Connector, Front View

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

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

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

* either A or B

Table 7-2. Jumper Settings for ZR320 Controller Board

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

Preventive Maintenance

3. Adjust the **PL/DPL** control for 15% of maximum rated system deviation.
4. Press any DTMF digit to end the test.

Hybrid Adjustment

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

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

NOTE

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

2. Once in the programming mode, enter command 95#. The ZR320 will generate two tones that are sent to the telephone. Audio coming from the telephone is then presented to the transmit radio so that any hybrid imbalance will appear as transmitted audio.
3. Alternately adjust the **R** and **C** controls for minimum transmitted audio.
4. Repeat Step 3 until no further minimizing of the transmitted audio can be attained. The hybrid is now balanced.
5. Press any DTMF digit to terminate the test.

Dial Click Decode Level

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

1. Enter command 96# to enable the dial click decode test.
2. For each rotary digit you enter, the ZR320 will send "beeps" back.

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

Preventive Maintenance

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

Visual Inspection

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

Cleaning

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

Tests

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

Transmit Level Test

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

TPL/DPL Level Test

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

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