Section 8
ZR330 Remote Telephone Interface

Overview

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

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

Physical Description

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

Located on the front panel are:

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

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

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

Standard Features

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

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

Basic Operation

The ZR330 may be programmed to operate in two ways:

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

ZR330 Telephone Link

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

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

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

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

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

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

ZR330 Mobile Type Device

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

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

Mobile Calls (Steering Digit =7)

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

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

Telephone Calls (Steering Digit = 9)

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

Busy Channel

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

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

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

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

Equipment Required For Installation

The following equipment is required for installation of the ZR330:

- a communications service analyzer

and **ONE** of the following

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

Theory of Operation

Circuit Description for ZR320/ZR330 Control Card

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

Circuit Description for ZR330 Trunk Card

Compander

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

48 V Supply

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

Ring Generator

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

Jumper Configurations

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

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

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

* either A or B

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

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

Table 8-3. Jumper Settings for ZR330 Trunk Card

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

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

Adjustments

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

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

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

Receive Audio Level

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

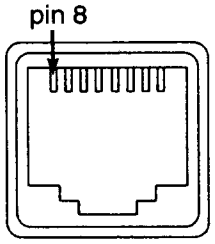

Figure 8-1. J2 Programming Connector, Front View

TPL/DPL Encode Level

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

Hybrid Adjustment

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

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

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

Preventive Maintenance

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

Visual Inspection

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

Cleaning

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

Tests

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

Transmit Level Test

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

TPL/DPL Level Test

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

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

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