

***Repeater Link Controller 1***  
***Copyright Link Communications 1993***

***Link Communications, Inc.***  
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**Introduction:**

Congratulations, you have purchased a very powerful tool for your group's repeater. The RLC-1 may seem complicated and intimidating at first, but don't worry. Setting it up and programming it are easy and straightforward, once you have read the manual. Please take the time to read it before you try to start programming. This will save you a lot of confusion and frustration, as it should answer most of your questions.

The RLC-1 repeater controller consists of one repeater port, one linking port, four analog voltage inputs, four logical (dry contact) inputs, and five MOSFET output drivers. The repeater and linking ports can be configured to require combinations of COR and PL inputs for access. The RLC-1 has a single DTMF decoder that scans between the two receiver ports, thereby supporting DTMF control from all ports of the controller. Speed selectable Morse Code prompts the users in the programming of the controller's variables.

This manual consists of three main sections: setup and interfacing, programming and commands, and the appendices with commonly referenced tables and charts. A glossary has also been included at the end to explain some of the terms and abbreviations that are used throughout the manual.

We have attempted to explain everything in a way that is easy to understand, but some questions are inevitable. If you have carefully read the manual and still have questions, call or fax us at (406) 482-7515 or write to us at

Link Communications, Inc  
P.O. Box 1071  
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## **Limited Warranty**

### **COVERAGE:**

Link Communications warrants that its products will be free from defects in materials and workmanship for a period of one year from the date of shipment. During this time, Link Communications will cover parts, labor and return shipping. If failure is caused by instances other than manufacturing defects, Link Communications will repair the product and bill the customer for parts and labor. Contact Link Communications for more information.

### **What Link Communications will not cover:**

1. Too much voltage to the controller. The RLC-1 operates at +11V to +15V, negative ground.
2. Damage to the controller by lightning, accident, or incorrect power hook-up.
3. Incorrect unit installation.
4. Damage caused by shipment (damage claims are handled by the carrier).
6. Repairs by other than Link Communications.

### **THIS WARRANTY HOLDS ONLY TO THE ORIGINAL PURCHASER**

### **HOW TO GET SERVICE**

Please contact Link Communications for servicing information and authorization.

### **SOFTWARE**

Link Communications holds the copyright on the RLC-1's software and hardware. Changes to the software and copying of the software is prohibited without the written consent of Link Communications.

**User Survey (Optional)**

A knowledge of the user base will allow us to better serve you in the future by helping us develop more specialized software and hardware. Please take a few minutes and fill out this questionnaire.

**RLC-1 Serial Number** ..... \_\_\_\_\_

**RLC-1 Purchase Date** ..... \_\_\_\_\_

**Application:** (Circle All That Apply)

**Ownership:**

- 1 - Privately Owned Repeater
- 2 - Club Owned Repeater
- 3 - Group Owned Repeater
- 4 - Commercial Business Repeater
- 5 - Other \_\_\_\_\_

**Installation:**

- 1 - Wide Coverage Repeater with Chain Links
  - Port to Port Linking
- 2 - Full Duplex Links
- 3 - Half Duplex Links
- 4 - VHF Repeater: Power \_\_\_\_\_ Make \_\_\_\_\_
- 5 - UHF Repeater: Power \_\_\_\_\_ Make \_\_\_\_\_
- 6 - Link Ports Used as Repeater Ports: Yes No
- 7 - Serial Data Used to Control Repeater: Yes No
- 8 - Other Amateur Repeaters At the Site: Yes No
- 9 - Other Link Communication Products Used: Yes No

**Misc:**

- 1 - User Base: Technical Rag Chew Personal
- 2 - Autopatch used on the System: Yes No
- 3 - Frequency Adjustable Remote: Yes No
- 4 - Linking to Other Repeaters: Yes No
- 5 - Linking Closed Access: Yes No
- 6 - PL Required on Main Repeater: Yes No Varies
- 7 - PL Required on Linking System: Yes No Varies

**Please Return to: Link Communications, Inc.**

**P.O. Box 1071  
Sidney, MT. 59270**

**Comments:**

## Setup and Interfacing

This section of the manual contains everything you should need to know to get your repeater controller up and running. The numbered steps cover the basics, through connecting your radios and adjusting the RLC-1. After that there is information concerning the other input and output features of the RLC-1: the serial interface, the logical output and input lines, and the analog input lines.

### Step #1: Check the Packing List

Your package should contain the following items:

- (1) RLC-1 Repeater Controller
- (1) 2.50mm Power Connector
- (3) DB-9 Male Solder Connectors
- (1) DB-25 Male Solder Connector
- (1) RLC-1 Manual

If any of these parts are missing, contact Link Communications.

### Step #2: Connect Power

- The RLC-1 was designed to run off of 12V DC. 11V to 14V should work fine.
- Locate the 2.50mm power connector included in your parts bag.
- Unscrew the plastic outer shield and thread your power and ground wires through it (20 gauge suggested).
- Solder the +12V wire to the center pin of the 2.50mm connector.
- Solder the ground wire to the shield of the 2.50mm power connector.
- Screw on the plastic outer shield.
- When power is applied to the RLC-1 controller, the DTMF Valid LED will flicker, and the Repeater port transmitter will send out a CW message 'RESET ?'



## Step #4: Connecting Your Receivers to the RLC-1

The main repeater and the link port connect to the RLC-1 using male DB-9 connectors (included).

### Main Port and Link Port

- 1 - Ground Reference
- 2 - PL Input (Active Low)
- 3 - PTT Out (Active Low)
- 4 - Audio Out (10K OHM)
- 5 - Audio In (10K OHM)
- 6 - Ground Reference
- 7 - COR Input (Selectable Polarity)
- 8 - Ground Reference
- 9 - Ground Reference

### Connecting the Receiver COR:

- The first step in connecting your receiver is to locate a COR signal. This signal indicates if the receiver is active or inactive. The RLC-1 will accept either an Active high COR (Goes from ground to above 4 volts, or open), or an Active low COR (Goes from a voltage greater than 4 volts, to a ground, or goes from an open to a ground). The input impedance of the RLC-1 COR input is 10K $\Omega$  and it is diode clamped with internal pull-up resistors. This allows it to handle input voltages of up to 40 volts without damage to the controller. **The COR input must not go below 0V (ground); this would damage the Micro-Processor.**

### Selecting COR Polarity Jumpers:

Once you have determined the polarity of your COR signal, you need to tell the RLC-1 what the polarity is. This is accomplished using jumpers J4 for the Main Receiver COR, and J5 for the Link Receiver COR. When the jumper is connected across the 2 pins, the COR is expected to be Active Low. When the jumper is not connected across the 2 pins, the COR is expected to be Active High. The RLC-1 comes shipped with the COR's selected to be Active Low (Jumper Connected)

Using one of the supplied DB-9 Male connectors, connect your COR signal to pin #7

### Connecting a PL Input (optional):

- If you wish to use a PL (CTCSS) decoder on any of the receivers, it can be connected to pin #2 of the appropriate connector in the same fashion as the COR input. See Commands C005..C006 for information on using the PL input.

**Connecting the Receiver Audio:**

- 2 types of audio can be used on the RLC-1 controller:

Type 1: Deemphasized audio (Speaker Audio)

Type 2: Discriminator audio (Raw Unscelched Audio)

- If type 1 audio is used, remove the appropriate jumper on the controller. This removes the deemphasis filter from the circuit. As the controller comes shipped, all ports are set up for type 1 audio.

J1 - Main Receiver Deemphasis Jumper

J2 - Link 1 Receiver Deemphasis Jumper

- If type 2 audio is used, place the appropriate jumper in circuit (over both pins). This will place a - 6dB/octave deemphasis filter into the circuit. Some discriminators can not directly drive the 10K $\Omega$  input impedance. If this is the case, a pre-driver or different audio access point will be required.

- The audio input is connected to pin #5 of the male DB-9 connector

- The audio adjustments will be described in Step #5.

**How the DTMF Decoder Works:**

The RLC-1's DTMF decoding circuit uses a scanner that enables the controller to receive tones from all the ports, without mixing the two receiver's audio together. This allows the receivers to have total control of the DTMF decoder when its Receiver is active. Once the decoder has detected a tone on one of the ports, it stops scanning and waits up to four seconds for the next digit. It is reset at the beginning of each DTMF digit. If any of the DTMF digits are held for longer than 4 seconds or there is a pause of 4 seconds between digits, the DTMF scanner will resume scanning and all digits entered up to that point will be lost.

**Step #5: Connecting Your Transmitters to the RLC-1****Transmitter PTT:**

- The RLC-1 produces an active low PTT signal (ground when PTT is active). This output is buffered with an open drain type driver capable of sinking 150mA. There is a built in 30V zener clamping diode to protect the PTT MOSFET from the high voltage spikes that can be caused by interfacing to a PTT relay coil. Your transmitter PTT input should be connected to pin #3 of the DB-9 connector.

**Transmitter Audio:**

- The RLC-1 provides a 10K $\Omega$  output impedance to your transmitter audio input.
- The transmitter audio is connected to pin #4 of the DB-9 connector.
- The audio levels will be adjusted in Step #5.
- If it is not already, the DB-9 plug can now be plugged into the appropriate jack on the main board. The link port is located to the left of the main port connector.

**Step #5: Adjusting the RLC-1 Controller**

Locate connector J10 on the RLC-1 (it is above the 2 voltage regulators). This test bus will provide the signals that we need to adjust the inputs on the RLC-1. In order to maintain audio deviation during channel switching, all of the receiver inputs must be set to the same level. These signals can be measured with an oscilloscope or an AC voltmeter. If you are using a meter, you will need to adjust to 1.4 volts RMS, which is equivalent to 2.0 volts peak-to-peak measured with an oscilloscope. In order to obtain an audio signal on J10, a valid COR or PL must be received (See Access Modes for the proper signal style).

**Main Receiver: Transmitter Port Adjustment:**

- Present a stable DTMF tone to the Main RX.
- Adjust the Main RX pot on pin 1 of J10 (Labeled MI) to 2 volts peak-to-peak.
- This pot is Labeled MAIN REC. R11
- Adjust the Main TX pot to obtain the desired deviation.

**Link Receiver Port Adjustment:**

- Present a stable DTMF tone to the Link RX.
- Adjust the Link RX pot on pin 2 of J10 (Labeled LI) to 2 volts peak-to-peak.
- This pot is Labeled LINK REC. R15
- Adjust the Main TX pot to obtain the desired deviation.

**Main Transmitter Adjustment:**

- Present the Main RX with the same DTMF tone used earlier.
- Adjust R19 (MAIN TRANS.) Pot to the desired deviation.
- Access to the Main TX Audio is available at J10, Pin 5 (Labeled MO)

**Link Transmitter Adjustment:**

- Present the Main RX with the same DTMF tone used earlier.
- Command Main-Link Connection using Command C000
- Adjust R25 (LINK TRANS.) Pot to the desired deviation.
- Access to the Link TX Audio is available at J10, Pin 6 (Labeled LO)

**Beep Adjustment:**

- Adjust R4, MAIN TONE until it "sounds" good, or about 1.5 Khz. Deviation
- Adjust R5, LINK TONE until it "sounds" good, or about 1.5 Khz. Deviation

### **Serial Port Interfacing**

The RLC-1 has a serial terminal port for interfacing to any serial device, i.e. packet and serial terminal. This allows the user to monitor, control, and program all facets of the controller. The serial terminal carries highest priority for access and programming of the RLC-1. There is an 8 digit password needed to log on to the serial port of the controller, ensuring the security of the system. The format for the input password is simply "[\$\$\$\$\$\$\$]" , where "\$" is any ASCII character. The serial system can not be accessed from the DTMF port decoder, only via a serial system. The RLC-1 output is the RS-232 standard,  $\pm 12V$ .

### **Pin-Out Serial P1 Connector**

- 1 - No Connection
- 2 - RS-232 Data Output (To Your Terminal)
- 3 - RS-232 Data Input (From your Terminal)
- 4 - No Connection
- 5 - Ground Reference
- 6 - No Connection
- 7 - No Connection
- 8 - No Connection
- 9 - Ground Reference

### **Local Terminal Interfacing**

When using a local ASCII terminal at the RLC-1's location, an ASCII terminal can be used to communicate with the programming features of the RLC-1. The terminal's communication parameters must be set to:

```
Baud ..... 2400
Start Bits..... 1
Stop Bits ..... 1
Parity ..... N
Word Length ..... 8
```

These parameters will allow communication with the RLC-1. For system operations, see the next section "Operation and Programming Over the Serial Port".

## Operation and Programming Over the Serial Port

The RLC-1's serial port gives the controller the ability to communicate with the world over a digital radio link. The RLC-1 has a security key of 10 characters that must be entered properly in order to have the RLC-1 communicate with your computer terminal. The syntax of the initial password is as follows:

[\$\$\$\$\$\$\$\$]



"[" is the first character entered

"]" is the last character entered

"\$" is any ASCII character except the "[" or "]"

The default password is: [ABCDEFGH]

Once the proper password has been entered, the RLC-1 will respond with the message

**"RLC-1: LOG ON"**



If you did not receive this message after you logged on, then check:

- Are you already logged on?
- Do you have the correct password, including CAPS LOCK?
- Is your serial port connected and configured correctly?

Once on the serial system, you have access to all features of the RLC-1, and several special commands only for the serial user. **A very important note, all commands entered over the serial port must begin with a "[" and end with a "]" in order to be accepted.**

### Serial Command Structures:

- Upper Case Letters must be used
- You must log on before any control can take place
- Lack of activity on the serial port will cause an automatic log off after 1 minute

### RLC-1 Command Entry:

- *All command names must be 4 characters long*
- Command name "12" must be entered as "0012"
- *No <EOF> key is needed in the data string*
- To do a keypad test, the normal DTMF tones are: C041\*123456789\*
- Over the serial port the data string is: [C041123456789]
- *Commands are entered exactly like over the air, except for the above "Rules"*
- *CW response will be over the Main Repeater port, unless the Command states Different*
- *Characters entered for RLC-1 Commands must be limited to the DTMF Tones*
- 0 1 2 3 4 5 6 7 8 9 A B C D \* #
- Do not use you <EOF> key in the string, it will cause incorrect execution of the command

### Serial Commands Entry Format:

- All Serial Commands begin with the Letter "S"
- The Commands number from 00 .. 05

#### Serial Commands:



##### *S00 - Dump of Command Names*

C000 : C001 : C002 : .. C042:

##### *S01 - Formatted Dump of the Output Lines, Input Lines, and Analog Lines*

###### Outputs:

- 1 - N or F
- 2 - N or F
- 3 - N or F
- 4 - N or F
- 5 - N or F

###### Inputs:

- 1 - H or L
- 2 - H or L
- 3 - H or L
- 4 - H or L

###### Analog:

- 1 - Actual Dump of programmed Value
- 2 - Actual Dump of programmed Value
- 3 - Actual Dump of programmed Value
- 4 - Actual Dump of programmed Value

##### *S02 - Dump of Selected Macro Position*

Example: Two output lines turned on with one command

[

Macro 1:

C017 Plus 01:01  
C017 Plus 02:00

]

***S03 - Change the Serial Systems Log-On Password Name***

This command allows the user to change the serial log-on password (Default ABCDEFGH) from its current name, to a new name. It is very important not to forget your serial log-on. If you forget your log-on name, controller re-initialization will be needed.

Format for programming:

```
[S03 ##### $$$$$$]
```

##### is the Current Serial Password, 8 Characters in Length  
 \$\$\$\$\$\$ is the New Serial Password, 8 Characters in Length

The Serial Output :

```
[  
Old:  
#####  
New:  
$$$$$$$  
]
```

***S04 - System Configuration View Screen***

This command allows the user to view the system configuration for each port. The screen will show each ports access type, either COR or COR and PL. This command also allows the port configurations, either repeater port or a link port.

Configuration:

Access:

Main: COR (or) COR and PL (or) RX/TX Off

Link: COR (or) COR and PL (or) RX/TX Off

Connect Type:

Main: Repeater Port (or) Link Port -----, <-----, <----> Link: Repeater Port (or) Link Port

----- Indicates No Communication Between Ports

<----- Indicates Communication only 1 Direction

<----> Indicates Communication both Directions

***S05 - Serial System Log OFF***

This command logs the serial server off the RLC-1 Controller. The Serial Port Log-Off Message will appear when you Log-Off. If you do not Log-Off, the RLC-1 will automatically Log-Off after 1 Minute of Non-Activity.

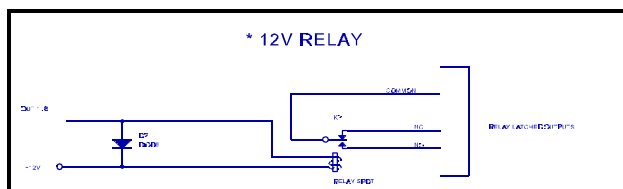
**"RLC-1: LOG OFF"**

## Logical Latched Output Lines

The RLC-1 offers 5 logical control lines for site control. These 5 latched control lines are power MOSFETs in "open drain" configuration. Because the output lines are open drain, the user will not measure any voltage on the output lines, only an open or a ground. In order to check the condition of the control lines, a meter set to resistance will be needed. The meter will read an open when the control line is off and closed (connected to ground) when the control line is on. When using a semiconductor device as a latch, certain current limitations are imposed. The MOSFET used can sink (apply a ground), of 150mA. If this current is exceeded, the MOSFET will short and destroy the device. The RLC-II has a 30V zener clamping diode on each output line to protect the MOSFET from damage when using a relay on the output line. Figure #2 shows how to connect a relay to one of the output lines. (See Command Listing for output control line commands).

### Pin-Out Logical Latched Outputs P5 Connector

- 01 - Output #1
- 14 - Output #2
- 02 - Output #3
- 15 - Output #4
- 03 - Output #5
- 12 - Ground
- 13 - Ground
- 16 - Ground
- 25 - Ground



**Figure #2 Relay Interfacing to a Control Line**

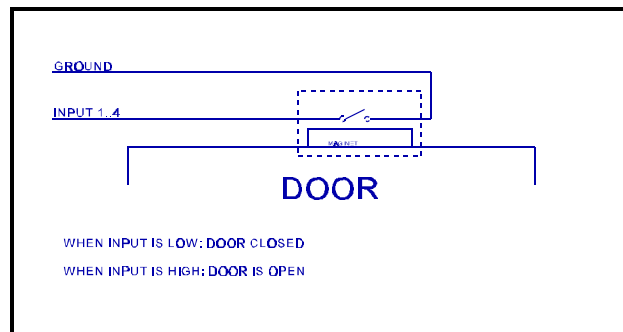


## Logical Input Line

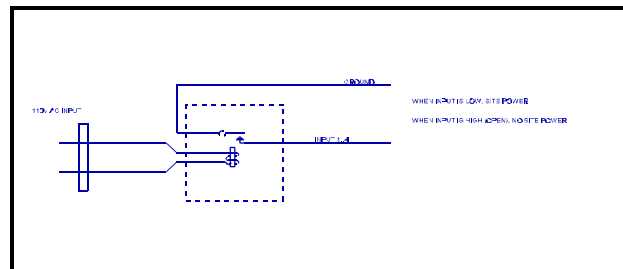
The RLC-1 offers the user 4 logical input lines. These lines recognize an open/ground input change. These lines are internally pulled up to +5 Volts and zener diode clamped to 5 Volts. This allows direct interface to higher voltage inputs that do not exceed +40 Volts. The application to site users is great: door open/closed magnetic contacts (See Figure #3a), local site controlled switches, and site power monitoring relays (See Figure #3b). These are just a few of the applications that the logical input lines can be used for.

### Pin-Out Logical Inputs P5 Connector

- 17 - Input #1
- 18 - Input #2
- 19 - Input #3
- 20 - Input #4
- 04 - Ground
- 05 - Ground
- 06 - Ground
- 07 - Ground



**Figure #3a Magnetic Door Alarm Interface**



**Figure #3b Local House Power Failure Alarm**

## Analog Input Telemetry Lines

The RLC-1 offers what most other controllers charge thousands for, 4 analog monitoring input lines. This is a nice feature that allows the site owner to monitor analog conditions like temperature, site voltages (See Figure #4a and following page), forward and reflected power, heat sink temperature, and much more. The RLC-1 comes set up to measure 0-4 Volts with 20mV resolution. Several voltage conversion faceplates are provided to convert an input voltage to another function. Included faceplates:

- 1 - Voltage 0.00 - 4.00 Volts
- 2 - Voltage 00.0 - 25.0 Volts \*
- 3 - Celsius Temperature †
- 4 - Fahrenheit Temperature †

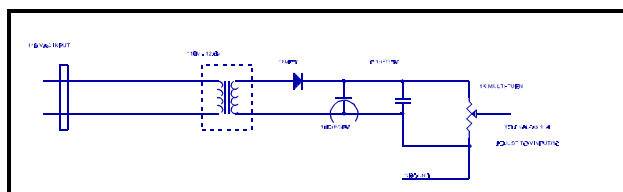
It is important not to apply over 10 volts to the RLC-1 analog inputs\*. If this voltage level is exceeded, damage to the analog opamp will occur.

### Pin-Out Analog Inputs P5 Connector

- 21 - Analog Input #1
- 08 - Ground Reference
- 22 - Analog Input #2
- 09 - Ground Reference
- 23 - Analog Input #3
- 10 - Ground Reference
- 24 - Analog Input #4
- 11 - Ground Reference

\* To read voltages greater than 4.00 volts, you must use the voltage divider circuit shown on the next page. Please note that this circuit drops the voltage that actually reaches the input of the RLC-1 to 4 volts or less when the input to the divider is 25 volts or less.

† To read temperatures with the LMx35 temperature sensors, you should install the appropriate jumper: J6..J9. This provides power to the sensor. The jumpers should be removed for all other applications.



**Figure #4a Site AC House Power Monitor**

## **Other Analog Input Examples**

## **Programming and Commands**

This section of the manual first discusses some of the things you need to know that are common to all of the commands. It then has a list of the commands sorted according to their function, a list sorted according to the command name, and lastly a detailed description of what each command does and how it is used.

### **Command Names**

The default command names all begin with the letter 'C'. This 'C' is part of the command name, not just an indication that it is a command. For example, to connect the link to the main port, you would enter the DTMF tones 'C', '0', '0', '0', '\*'. This assumes that your DTMF pad has 16 keys (0-9, \*, #, A-D); the letters corresponding to the numbered keys on a telephone (2=A,B,C) will not work. The command names can be changed with Command C038.

### **The <EOF> Key**

The <EOF> key refers to the key that is used to tell the controller that the command has been entered (with the DTMF pad) and that it is time to act on it. It is also used to separate the command name from any parameters (extra data) it might have. The <EOF> key is '\*' by default, but this can be changed with Command C039.

### **Programming Messages**

Link, and ID messages in the RLC-1 can be changed to a message more specific to your controller. This is done with command C036, "Message Program Utility." These messages are composed of CW characters, the codes for which are found in the CW Table (Appendix A). Each character is identified by a two digit code (leading 0s are necessary for short codes). Each message has a specific maximum length, although not all messages have the same maximum. See Commands C036, and C037 for more information on message programming, and C014, C015 and C016 for CW frequency and speed.

## Command Listing (by function)

### Receiver Access Commands

#### Main Port:

- Selects Access Modes for Main Receiver
- COMMAND C005
- Selects COR and PL Access for Main Receiver
- COMMAND C005\*2
- Selects COR Access for Main Receiver
- COMMAND C005\*1
- Selects NO Access for Main Receiver
- COMMAND C005\*0

#### Link Port:

- Selects Access Modes for Link Receiver
- COMMAND C006
- Selects COR and PL Access for Link Receiver
- COMMAND C006\*2
- Selects COR Access for Link Receiver
- COMMAND C006\*1
- Selects NO Access for Link Receiver
- COMMAND C006\*0

### Main Port - Link System Variables

#### Main - Link Only:

- Selects Main Port ON Link Port, TX and RX
- COMMAND C000
- Removes Main Port OFF Link Port, TX and RX
- COMMAND C002
- Allows Main Port to MONITOR Link Port RX, no TX
- COMMAND C001

#### Main and Link Port Timers:

- Programs Main and Link Port Timers:
- COMMAND C010\* ### \$\$\$ (in 10mS Steps)
  
- Programs Main and Link Port Time-Out Timers:
- COMMAND C011\* ## \$\$ (in 1 Minute Steps)
  
- Programs Main and Link Port ID Timer (When Port is in Loop Back)
- COMMAND C013\* ## \$\$ (in 1 Minute Steps)

**Main and Link Port Beeps:**

- Programs Main Port Courtesy Beep
- COMMAND C007\* ##...## (Courtesy Beep Data)
  
- Programs Link Port Courtesy Beep
- COMMAND C008\* ##...## (Courtesy Beep Data)
  
- Programs Main and Link Port Courtesy Timers:
- COMMAND C013\* ## \$\$ (in 10mS Steps)
  
- Programs Main - Link Port 'ON' Message
- COMMAND C036\*3 ##...## (CW Code Data)
  
- Programs Main - Link Port 'MONITOR' Message
- COMMAND C036\*5 ##...## (CW Code Data)
  
- Programs Main - Link Port 'OFF' Message
- COMMAND C036\*4 ##...## (CW Code Data)
  
- Programs Main Port 'ID' Message
- COMMAND C036\*1 ##...## (CW Code Data)
  
- Programs Link Port 'ID' Message
- COMMAND C036\*2 ##...## (CW Code Data)
  
- Programs Main Port into Loop Back Mode (Repeater Mode)
- COMMAND C003\*1
- Programs Link Port into Loop Back Mode (Repeater Mode)
- COMMAND C004\*1
  
- Programs Main Port into Normal Linking Mode
- COMMAND C003\*0
- Programs Link Port into Normal Linking Mode
- COMMAND C004\*0

**Command Name and Enter Key Name Change:**

- Changes the Current Command Name to a New Command Name
- COMMAND C038\*##### \$\$\$\$ (#-Old, #-New)
- Changes the Current <EOF> Digit to a New Name
- COMMAND C039\*# (\*-Old, #-New)

**Analog Lines Reading****Analog Input #1:**

- Read Analog Input #1
- COMMAND C019
- Programs Analog Input #1 Voltage/Temperature Faceplate
- COMMAND C024\*1 \$ (1-Line, \$-Faceplate)
- Programs Analog Input #1 Offset Value
- COMMAND C023\*1 \$\$ (\$\$-00..19 Offset Value, 10=No Offset)

**Analog Input #2:**

- Read Analog Input #2
- COMMAND C020
- Programs Analog Input #2 Voltage/Temperature Faceplate
- COMMAND C024\*2 \$ (2-Line, \$-Faceplate)
- Programs Analog Input #2 Offset Value
- COMMAND C023\*2 \$\$ (\$\$-00..19 Offset Value, 10=No Offset)

**Analog Input #3:**

- Read Analog Input #3
- COMMAND C021
- Programs Analog Input #3 Voltage/Temperature Faceplate
- COMMAND C024\*3 \$ (3-Line, \$-Faceplate)
- Programs Analog Input #3 Offset Value
- COMMAND C023\*3 \$\$ (\$\$-00..19 Offset Value, 10=No Offset)

**Analog Input #4:**

- Read Analog Input #4
- COMMAND C022
- Programs Analog Input #4 Voltage/Temperature Faceplate
- COMMAND C024\*4 \$ (4-Line, \$-Faceplate)
- Programs Analog Input #4 Offset Value
- COMMAND C023\*4 \$\$ (\$\$-00..19 Offset Value, 10=No Offset)

**Keypad Test:**

- Allows the User to Key in up to 20 DTMF Pad Tones
- COMMAND C041\* ###...### (DTMF Keys)

## Input Lines Reading

### Input Line #1:

- Read Input Line #1
- COMMAND C018\*1 ('H' if High, 'L' if Low)

### Input Line #2:

- Read Input Line #2
- COMMAND C018\*2 ('H' if High, 'L' if Low)

### Input Line #3:

- Read Input Line #3
- COMMAND C018\*3 ('H' if High, 'L' if Low)

### Input Line #4:

- Read Input Line #4
- COMMAND C018\*4 ('H' if High, 'L' if Low)



## Output Lines Control, and Reading

### Output Line Control:

- Output Line #1 'ON' (LOW)
- COMMAND C017\*1 1
- Output Line #1 'OFF' (OPEN)
- COMMAND C017\*1 0
- Output Line #1 Interrogate
- COMMAND C017\*1

- Output Line #2 'ON' (LOW)
- COMMAND C017\*2 1
- Output Line #2 'OFF' (OPEN)
- COMMAND C017\*2 0
- Output Line #2 Interrogate
- COMMAND C017\*2

- Output Line #3 'ON' (LOW)
- COMMAND C017\*3 1
- Output Line #3 'OFF' (OPEN)
- COMMAND C017\*3 0
- Output Line #3 Interrogate
- COMMAND C017\*3

- Output Line #4 'ON' (LOW)
- COMMAND C017\*4 1
- Output Line #4 'OFF' (OPEN)
- COMMAND C017\*4 0
- Output Line #4 Interrogate
- COMMAND C017\*4

- Output Line #5 'ON' (LOW)
- COMMAND C017\*5 1
- Output Line #5 'OFF' (OPEN)
- COMMAND C017\*5 0
- Output Line #5 Interrogate
- COMMAND C017\*5

## Command Listing (by function)

### Macros

- Programs 1 of the 7 multiple command Macros
- COMMAND C037\*1-7
  
- Recalls Macro #1 COMMAND C025
- Recalls Macro #2 COMMAND C026
- Recalls Macro #3 COMMAND C027
- Recalls Macro #4 COMMAND C028
- Recalls Macro #5 COMMAND C029
- Recalls Macro #6 COMMAND C030
- Recalls Macro #7 COMMAND C031

Macros 1 .. 7 are 30 Keystroke Sequences

(See Command C032 for more Information)

### DTMF Tone Muting

#### Mutes DTMF Transmitters:

- Toggles Mute Function for Main and Link Port Transmitters
- COMMAND C009\* # \$ (#-1/0 Main, \$-1/0 Link)

### Command Listing (by name)

<b>Name:</b>	<b>Brief Functional Description</b>
<b>C000</b>	Link Port RX/TX Enabled <b>ON</b> Main Port System
<b>C001</b>	Link Port RX Enabled Monitor <b>ON</b> Main Port System
<b>C002</b>	Link Port Disabled <b>OFF</b> Main Port System
<b>C003</b>	Main Port Loop Back <b>ON/OFF</b>
<b>C004</b>	Link Port Loop Back <b>ON/OFF</b>
<b>C005</b>	Main Port Access Mode #0,1,2
<b>C006</b>	Link Port Access Mode #0,1,2
<b>C007</b>	Main Port Courtesy Beep Message Type #0,1,2
<b>C008</b>	Link Port Courtesy Beep Message Type #0,1,2
<b>C009</b>	DTMF Mute <b>ON/OFF</b> Main and Link Port
<b>C010</b>	Hang Timer Main and Link Port
<b>C011</b>	Time-Out Timer Main and Link Port
<b>C012</b>	Courtesy Timer Main and Link
<b>C013</b>	ID Timer Main and Link
<b>C014</b>	Main Port CW Frequency
<b>C015</b>	Link Port CW Frequency
<b>C016</b>	CW ID Speed
<b>C017</b>	Output Line 1-5 Interrogate, and Control
<b>C018</b>	Input Line 1-4 Interrogate
<b>C019</b>	Read Analog Input #1
<b>C020</b>	Read Analog Input #2
<b>C021</b>	Read Analog Input #3
<b>C022</b>	Read Analog Input #4
<b>C023</b>	Analog Input 1-4 Offset Adjust
<b>C024</b>	Analog Input 1-4 Faceplate Select
<b>C025</b>	Macro #1 Recall
<b>C026</b>	Macro #2 Recall
<b>C027</b>	Macro #3 Recall
<b>C028</b>	Macro #4 Recall
<b>C029</b>	Macro #5 Recall
<b>C030</b>	Macro #6 Recall
<b>C031</b>	Macro #7 Recall
<b>C032</b>	Macro 1-7 Keystroke Program
<b>C033</b>	Doug Hall RBI-1 Parameter Program
<b>C034</b>	Disable Input #4 Auto-Command Execution
<b>C035</b>	Send Port ID (Port Dependent)
<b>C036</b>	Program CW Message Utility
<b>C037</b>	Recall CW Message Utility
<b>C038</b>	Command Name Change Utility
<b>C039</b>	<EOF> Key Rename Utility
<b>C040</b>	Interrogate Main and Link System
<b>C041</b>	DTMF Keypad Test
<b>C042</b>	RLC-1 Remote Reset Utility

## In Depth Command Description: C000..C002

### Link Port RX / TX Control on Main Port

These commands allow the user to connect the link to or disconnect the link from the Main Port. This connection can be two-way or receive only. Receive only mode allows the Main Port to be used to monitor the link port without any traffic from the main port going out over the link port. The CW responses can be changed with Command C036.

Description		Command	CW Response
Link	RX & TX	C000*	LINK ON
	RX Only	C001*	LINK M O N
	Off	C002*	LINK OFF

Parameters: None

Defaults:

- Link Port Off of Main Port

No Error Messages:

## In Depth Command Description: C003 and C004 Main and Link Port Loop-Back Enable/Disable

These commands allow the Main and Link ports to be converted to repeater ports or link ports. When the Main port is converted to a link port, the COR-PTT loop-back from the Main receiver to the Main transmitter is disconnected. When the Link port is converted to a repeater port, the COR-PTT loop-back from the Link receiver to the Link transmitter is connected. Both ports on the RLC-1 can be converted to links or repeaters, or any combination between the two systems.

Description	Command	CW Response
Main Loop Back	C003*\$*	Main Port ID
Link Loop Back	C004*\$*	Link Port ID

### Parameters:

- \$ - 1 Enables Main / Link Port Loop Back
- 0 Disables Main / Link Port Loop Back

### Defaults:

- Main Port Loop Back Enabled
- Link Port Loop Back Disabled

### Error Message:

If the format is not correct, the RLC-1 will send a "E" error code.


- ER1 - Too Many Digits Entered
- ER2 - Invalid Mode Selected

## In Depth Command Description: C005 and C006 Main and Link Access Mode

The RLC-1 offers the user the ability to select from three modes. These conditions are based on the state of the COR and PL (CTCSS) inputs. The RLC-1 will accept either an Active High COR (COR goes from ground, or 0 Volts to a point above 4 Volts), or an Active Low COR (COR goes from a voltage above 4 Volts, to ground, or 0 Volts). The COR polarity is selected using the 2 COR jumpers: J4 for Main port, and J5 for Link port. If the jumper is connected across the 2 pins, then the COR must be Active Low. If the jumper is not connected, then the COR is Active High.

PL (CTCSS) inputs must be Active Low in order for the RLC-1 to recognize activity. They can be inverted with a transistor if necessary. Either just COR or both COR and PL inputs must be active, depending on the access mode, in order for the RLC-1 to recognize the receiver.

Mode	Description	Comments
0	NO ACCESS	No transmit or receive allowed
1	COR ACCESS	COR activity trigger repeater
2	COR and PL ACCESS	COR/PL activity trigger repeater



This selection of modes allows the RLC-1 user to remotely control access to the controller during high traffic times.

Description	Command	CW Response	
Main	Mode 0	C005*0*	
	Mode 1	C005*1*	CW BEEP RSP
	Mode 2	C005*2*	
Link	Mode 0	C006*0*	
	Mode 1	C006*1*	CW BEEP RSP
	Mode 2	C006*2*	

### Parameters:

All parameters are incorporated into the chart above

### Defaults:

- COR Access (Mode 1) for both ports

### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Not a Valid Mode, Must be 0..2

ER2 - Digit Counter Error, Too Many digits Entered

## In Depth Command Description: C007 and C008

### Set Main and Link Courtesy Beep Type

The RLC-1 offers the user the ability to program a specialized courtesy beep for the link. The link beep will go out the main port when the link is enabled (C000 and C001) and the main port is in loop-back mode (C003\*1). The main beep will go out the link port when the main-link port is enabled (C000) and the link port is in loop-back mode (C004\*1). In order to send a courtesy beep out any port, the port must be configured as a repeater port. The courtesy beep generator can handle 2 types of beeps:

- Single tone with programmed duration and frequency
- Two tones sequential with programmed duration and tones

This allows nice tones to be generated when receiver activity disappears.

Description		Command	CW Response
Main	Single	C007*1 &&&& %%*	CW BEEP RSP
	Dual	C007*2 &&&& %% \$\$\$\$ ## @@*	
	No Beep	C007*0*	
Link	Single	C008*1 &&&& %%*	CW BEEP RSP
	Dual	C008*2 &&&& %% \$\$\$\$ ## @@*	
	No Beep	C008*0*	

#### Parameters:

&&&& determines the frequency for Tone #1: &&&& Counts

\$\$\$\$ determines the frequency for Tone #2: \$\$\$\$ Counts

%% is the length of Tone 1 in increments of 10mS

## is the length of Tone 2 in increments of 10mS

@@ is the length of Tone 1-Tone 2 Delay in increments of 10mS

#### Notes:

The Tone Table (Section 6) provides an equation and chart to aid in finding the number of counts necessary to generate a desired frequency.

Setting a mode 1 courtesy beep with a length of 0 will make a long test tone. It can be reset by simply changing the courtesy beep to the desired setting.



#### Defaults:

- Dual Tone Courtesy Beeps for both Main and Link

#### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Not a Valid Mode, Must be 0, 1 or 2

ER2 - Digit Counter Error, Check the number of digits entered

## In Depth Command Description: C009

### Main and Link Port Transmitter DTMF Mute Enable/Disable

The RLC-1 has the ability to mute the audio when DTMF digits are being entered. When muting is enabled, the RLC-1 will begin muting as soon as a valid DTMF digit is detected (a short "bleep" is inevitable) and continue muting as long as at least one digit is entered each second. This allows multiple tones to be muted without each one causing a "bleep." One second after the last tone ends, the audio is returned to normal. This command controls the muting audio routed to the Main and Link Transmitter.

Description	Command	CW Response
Main and Link Mute	C009* % \$ *	CW BEEP RSP

#### Parameters:

- % - Controls Muting for the Main Port Transmitter
- \$ - Controls the Muting for the Link Port Transmitter

- 1 - Muting Enabled
- 0 - Muting Disabled

#### Defaults:

- DTMF Muting is Disabled

#### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

- ER1 - Too Many digits entered
- ER2 - Number too Large



## In Depth Command Description: C010 Main and Link Port Hang Timer

These commands allow for keeping each port's transmitter on for a specified time after the input signal disappears. The hang timers can vary from no hang time up to 9.99 seconds of transmitter delay. This feature can be used on full duplex links and with caution on half duplex links. When using this feature on half duplex links, the link transmitter will remain keyed while the hang timer is running, thereby disabling the link receiver. On full duplex links, the receiver is available for reception even while the transmitter is keyed.

Description	Command	CW Response
Main and Link	C010*### &&& * ###-Main Port 10mS Step &&&-Link Port 10mS Step	CW BEEP RSP

### Parameters:

- The hang time in increments of 0.01 seconds
- The value entered **must not be 000**

### Defaults:

- Both Hang Timers: 2.00 Seconds

### Error Message:

If the format is not correct, the RLC-1 will send an "E" error code.

ER1 - Too Few or too Many Digits Entered

ER2 - Entered Number is too Large

## In Depth Command Description: C011 Main and Link Port Time Out Timer Values

The RLC-II offers time-out timers for both ports. They can be set for 01 to 99 minutes. The timers will keep track of a port's receiver traffic. After a specified time of being continuously active, the RLC-1 will disable the port's PTT circuit, turning the transmitter off. Using this feature is only needed with full duplex links and is rarely used. When using the port as a repeater port the user should conform to FCC regulations concerning timing for "automated control" of your transmitter.

The time-out features for the Main Port pertain only to Main's traffic. If, for example, Main's transmitter is consistently keyed by Link's receiver, Main will not time-out. If Main's transmitter is consistently keyed by Main's receiver, then after \$\$ minutes, the transmitter will be unkeyed until the carrier drops to reset that timer. This feature is also available on the Link port's transmitter.

Description	Command	CW Response
Main and Link	C011*\$\$ ##*	CW BEEP RSP

### Parameters:

\$\$ is the timer value in minutes for the Main port  
## is the timer value in minutes for the Link port

### Defaults:

- Time-Out Timers set to 3 Minutes
- The value entered **must not be 00**



### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

- ER1 - Too Many Digits Entered
- ER2 - Entered Number is larger than 99

## In Depth Command Description: C012

### Main and Link Courtesy Beep Delay Timer

This command allows the user to set the Courtesy Beep Delay Timer. This timer is used to determine how long the delay will be between the times the receiver becomes inactive and the courtesy beep is sent. The use of the timer is to keep the courtesy beep from being sent every time the receiver becomes inactive. Since a courtesy beep will not be sent while the receiver is active, a courtesy beep will only be sent during periods of receiver inactivity longer than this timer. Normally it is set for 1 second.

Description	Command	CW Response
Main and Link	C012*\$\$ %%*	CW BEEP RSP

#### Parameters:

\$\$ is the main port timer value in increments of 0.1 second (0.0 to 9.9 seconds)

%% is the link port timer value in increments of 0.1 second (0.0 to 9.9 seconds)

#### Defaults:

- 1.0 Second Courtesy Timer
- The value entered **must not be 00**

#### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too Many Digits Entered

ER2 - Number larger than 99

## In Depth Command Description: C013 Main and Link Port ID Timer

This command allows the user to vary the ID Timer. This timer is used to determine when to send the ID message. The timer is started when activity on the port begins. Normally this timer is set for 5-7 minutes; it can range from 01 to 99 minutes.

Description	Command	CW Response
Main and Link	C013*\$\$ ##*	CW BEEP RSP

### Parameters:

\$\$ is the timer value in minutes for the Main port

## is the timer value in minutes for the Link port

### Defaults:

- 10 Minute ID Timer

- The value entered **must not be 00**

### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too Many Digits Entered

ER2 - Number larger than 99

## In Depth Command Description: C014 and C015 Main and Link Port CW Frequency

This command allows the user to vary each port's CW frequency. This frequency is separate for each port because the RLC-1 has separate tone generators for each port. The frequency will not effect courtesy beep frequency, but will effect the CW ID's, CW BEEP RSP response, and ERROR messages. The number of counts necessary to get a desired frequency can be found using the Tone Look-up table at the end of the manual.

Description	Command	CW Response
Main CW Freq.	C014*\$\$\$\$*	CW BEEP RSP
Link CW Freq.	C015*\$\$\$\$*	CW BEEP RSP

### Parameters:

\$\$\$\$ is the frequency counts

### Defaults:

- Main Port 1000 Hz.
- Link Port 1333 Hz.

### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too Many Digits Entered

ER2 - Number larger than 99

## In Depth Command Description: C016 Program CW Sending Speeds

This command allows the user to select the CW (Morse code) sending speed. The speed can vary from 5 WPM to 25 WPM. Speeds can be chosen from 5,10,13,15,20,25 WPM.

Description	Command	CW Response
Set CW Speed	C016*\$*	CW BEEP RSP

### Parameter:

\$ is the CW Sending Speed Code (1..6)

Code	Speed
1	5 WPM
2	10 WPM
3	13 WPM
4	15 WPM
5	20 WPM
6	25 WPM

### Defaults:

- 20 WPM

### Error Message:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Not a Valid CW Speed Code 1..6 Only

## In Depth Command Description: C017 Interrogate and Control Latched Outputs On/Off

This command allow the user to turn each of the logical output lines on or off or check the current state the line is in. Note that the outputs are buffered with open drain drivers; therefore on means that the line is pulled to ground (will sink current) and off means that the output is in a high impedance state and will not sink any current. Interrogation is accomplished by entering only the line requested. The RLC-1 will return either a 'F' if the line is off, or 'N' if the line is on.

Description	Command	CW Response
Out #1 On/Off	C017*1 \$*	CW BEEP RSP
#2 "	C017*2 \$*	
#3 "	C017*3 \$*	
#4 "	C017*4 \$*	
#5 "	C017*5 \$*	
Out #1 Check	C017*1*	'F' if Line is OFF
#2 "	C017*2*	'N' if Line is ON
#3 "	C017*3*	
#4 "	C017*4*	
#5 "	C017*5*	

### Parameters:

- \$ - 1 To turn line ON
- \$ - 0 To turn line OFF

### Error Message:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Not a Valid Output Line

ER2 - Not a Valid Output Condition, Must be a 0 or 1

## In Depth Command Description: C018 Interrogate the Logical Input Lines

This commands allow the user to interrogate Logical Input Lines 1..4. When executed, the RLC-1 will check the status of the selected line and respond with the selected line's "H" if the line is High or Open, or "L" if the line is Low or Grounded.

Description	Command	CW Response
Read Logical #1	C018*1*	'H' if High
#2	C018*2*	
#3	C018*3*	'L' if Low
#4	C018*4*	

Parameters: None

### Error Message:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Not a Valid Input Line



## In Depth Command Description: C019..C022

### Read the Analog Input Lines

These commands allow the user to read the Analog Input lines. To control the analog lines calibration (Offset), see Command C023. To set the scale each input is interpreted on, see Command C024.

Description	Command	CW Response
Read Analog #1	C019*	#.## V Faceplate 1
#2	C020*	##.# V Faceplate 2
#3	C021*	### C Faceplate 3
#4	C022*	### F Faceplate 4

Parameters: None

Default:

- All Voltage Faceplates: 0.00V Faceplate #1
- All Offsets set to '10', No Offset

No Error Messages:

## In Depth Command Description: C023 Analog Offset Adjust

This command allows for offset adjustment of the analog lines. This command is used to calibrate the information read in by the RLC-1. If a known voltage or current is not read correctly by the RLC-1 (is off by a few degrees or volts), that input can be calibrated by changing the offset associated with that analog line.

Description	Command	CW Response
Offset Adjust	C023*\$ ##*	CW BEEP RSP

### Parameters:

\$ Analog 1..4 Selected  
## Offset Number, 00..19

- An offset value of 10 is equal to an offset of 0.
- An offset value of 19 is an offset of +9 counts
- An offset value of 01 is an offset of -1 counts
- An offset value of 09 is an offset of -9 counts

Example: You want to calibrate the reading of the battery voltage

- Read the voltage with a calibrated meter
- Read the voltage with the RLC-1
- Increase or decrease the Offset until the Voltage reading is correct

Example: You want to calibrate your LM135, LM235, LM335 temperature sensor

- With a voltage meter read the voltage at the analog input
- This voltage corresponds to Kelvin/100
- To convert Kelvin to Celcius, you subtract 273 from the number
- 2.85 Volts is actually 285K which is 12°C
- To Convert Celcius to Farenheit: Farenheit=(Celcius \* 1.80) + 32
- Read the Temperature with the RLC-1
- Add or Subtract the Offset until the Temperature reading is correct

### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

- ER1 - Too many digits Entered
- ER2 - Invalid Analog Line Selected
- ER3 - Number too Large Entered

## In Depth Command Description: C024

### Select Analog Input Scale

The RLC-1 has the ability to interpret the readings from the Analog Input Lines on several different scales with a variety of resolutions and ranges. This command allows the user to select which of several preprogrammed scales is attached to each of the analog input lines. Please note that this command selects only the way the input is interpreted; see Page 14 on the Analog Input Lines to select whether the actual input voltage is to be dealt with the 0..4V or 0..25V range. Command C023 allows the user to assign and adjust offsets for the analog input lines. Because the input circuits are not exactly alike, this offset adjustment may be needed to calibrate the lines.

Description	Command	CW Response
Select Scale	C024*& \$*	CW BEEP RSP

#### Parameters:

& is the Analog Input Line Selected (1..4)

\$ is the Analog Input Scale Code (1..4)

#### Analog Input Scales:

Code	Description	Range	Read Response
1	Voltage	0...4V $\pm 0.01$	#.## V
2	Voltage	0..25V $\pm 0.1$	##.# V
3	Celsius	-152...152 $^{\circ}\pm 2$	### C 'M' if Minus
4	Fahrenheit	-152...146 $^{\circ}\pm 2$	### F 'M' if Minus

Note:  $\pm 2$  is only meant to indicate the resolution of the measurement, not its accuracy; that is dependent on the temperature sensing device and how well the system is calibrated.

#### Defaults:

- Voltage Template (0..4V, Code 1)

#### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Not Valid Analog Line

ER2 - Invalid Analog Faceplate

ER3 - Not Enough Digits

## In Depth Command Description: C025-C031 Recall Macro

This command allows the recall of a Macro position. Use of the command will allow the control operator to find what is located inside of the Macro position

Description	Command	CW Response
Macro Recall	C025* - C031*	CW BEEP RSP

See Serial Command S02 for Macro Sequence Recall

See Command C032 for Macro Sequence Program

See Appendix #D for Macro Recording Sheets

No Error Messages:

## In Depth Command Description: C032 Program Selected Macro Position

This command allows the programming of a selected macro position. (See Attached Macro Programming Sheets). The concept of macro programming is that the user can chain several command sequences together to form one new command, the macro.

Example: You want to set the repeater access mode to COR and PL, change the courtesy beep to a single short beep, and lengthen the ID timer to 10 Minutes. All commands will be executed by the Macro.

Solution: Use a Macro Cell to Accomplish the Task

Actual Commands that need to be executed:

- C005\* 2 \* ; Force COR and PL Access
- C007\*1 1000 05 \* ; Change the Courtesy Beep to Mode 1:1000HZ at 50mS
- C013\* 10 01\* ; Change Repeater's ID Timer to 10 Minutes, Link to 1 Minute

For this Example we will use Macro #1

C032\* 1 C0052 A C0071100005 A C0131001 \* CW Response CW BEEP RSP

Some Items to Note:

- 1) The commands are entered in 1 set of keystrokes
- 2) There are no <EOF> keys used within the Macro
- 3) Commands are entered with the additional data in each group
- 4) Command sequences are separated by the DTMF Digit 'A'
- 5) The CW Response "CW BEEP RSP" indicates Macro Sequence stored

### Macro #1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C	0	0	5	2	A	C	0	0	7	1	1	0	0	0
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0	5	A	C	0	1	3	1	0	0	1				

## Macro Specifics:

Macro Positions 1 - 7 are 30 Keystroke Macros

Command Names that do not have additional Data are separated with an 'A' if additional commands are to follow, otherwise <EOF> to end the sequence.

Command Names that have additional data are entered in the order:

- Command Name (4 Digits)
- Then Additional Data
- Finally an 'A' if more commands are to follow, otherwise an <EOF> to end the sequence.

## Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too Many Digits Entered

ER2 - No Such Macro Position

## In Depth Command Description: C033

### Doug Hall RBI-1 Parameter Program

This command allows the user to control an external Doug Hall RBI-1 interface. The RBI-1 will allow control of several Kenwood type mobile radios. This includes the single band, and dual band radios. Refer to the RBI-1 manual for more information.

For easy access to the radio's features by the end user, the keystrokes used to control the RBI-1 can be stored in one of the 7 Macros. (See Command C032 for Macro programming information). In order for the RLC-1 to send information out to the RBI-1, 3 of the RLC-1's output lines are needed. These three lines shift out the data to the interface, which in turn controls the remote radio. The lines user are:

Output #3 ..... RBI-1 Remote Reset  
 Output #4 ..... Data to RBI-1  
 Output #5 ..... Clock to RBI-1

When using the RBI-1 features, the RLC-1 will change the way these lines are set. All data must be entered correctly in order to control the RBI-1. The RLC-1 will respond only after data has been shifted out correctly. The beep response is intended to verify that the keystrokes have been entered correctly.

Description	Command	CW Response
Write RBI-1 Inf	C033*! @ ##### \$ %% ^ &*	CW BEEP RSP

#### Parameters:

! is the Band Unit Selected

- 0 = 1240 MHZ (Port 3)
- 1 = 1250 MHZ (Port 3)
- 2 = 140 MHZ (Port 0)
- 3 = 220 MHZ (Port 0 or Port 1) Port 0 for Dual Band Radios
- 4 = 440 MHZ (Port 0 or Port 2) Port 0 for Dual Band Radios
- 5 = 1270 MHZ (Port 3)
- 6 = 1280 MHZ (Port 3)
- 7 = 1290 MHZ (Port 3)
- 8 = 1260 MHZ (Port 3)
- 9 = 430 MHZ (Port 0 or Port 2) Port 0 for Dual Band Radios
- A = 28 MHZ (Port Not Yet Defined)
- B = 52 MHZ (Port Not Yet Defined)
- C = 900 MHZ (Port not Yet Defined)

@ is the Power Level Selected, Does not work on all radios

- 0 Low Power Mode
- 1 High Power Mode
- 2 Medium Power Mode
- 3 Do Not Change the Power Setting

#### is the Frequency Requested, 1Mhz, 100Khz, 10Khz, 5Khz

\$ is the Radio Offset

- 0 Minus Offset
- 1 Plus Offset
- 2 Simplex
- 3 Minus 20 (1200 Only)

%% is the PL Tone Requested (Refer to the RBI-1 Manual for Frequency)

^ is the Access Mode Requested, Does not work on all radios

- 0 COR Access, PL Decoder OFF
- 1 PL Access, PL Decoder ON

& is the Encode Mode Requested, Does not work on all radios

- 0 PL Encoder Disabled
- 1 PL Encoder Enabled

Once all the variables are entered, the RLC-1 will send them to the RBI-1 using Out#4, and Out #5. When programming in the parameters, the RLC-1 will send a BEEP response.

Example:

Program the 147.380 + Repeater, COR access, PL Encode, TX PL 100 Hz, High Power

C033\* 2 1 7380 1 12 0 1 \*

- (2) Band 2 (140-150 Mhz)
- (1) High Power
- (7380) Frequency
- (1) Plus Offset
- (12) 100 Hz. PL Frequency
- (0) COR Access
- (1) PL Encoder ON

Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too Many Digits Entered

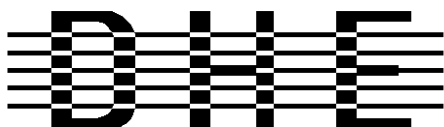
ER2 - Number too Large



## **Resetting the RBI-1 Interface**

An RBI-1 Reset might be needed if the interface does not respond to commands sent to it. If this occurs, the user may choose to reset it remotely. Any output line may be used, but for discussion we will use output line #3. To remotely reset the RBI-1, using either a macro, or individual keystrokes, turn output line #3 on, and then off. This will cause a reset of the interface. If you still can not control it, contact Link Communications.

No Error Messages:



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## **Doug Hall RBI-1 Information INTRODUCTION**

The DHE Remote Base Interface (RBI-1) Adapts the Kenwood series TM-X21 and TM-X31 mobile radios to several brands of Repeater Controllers. The RBI model 1 converts the serial data stream from the Controller and Directly controls the Kenwood Mobile radio. All connections to the Kenwood radio are made thru the microphone jack. In the maximum configuration using a Kenwood TM-701 Dual Band Mobile you can control Frequency, CTCSS encode On/Off, RF power level, Offset, Power On/Off, and Band. This is all still accomplished thru the microphone jack.

The RLC-1 Format supports the following functions:  
Full frequency control, 4 ports/radios, and 4 bands.  
Transmitter power HI/MED/LOW  
CTCSS Frequency select, Encode on/off, Decode on/off.  
-20 and -12 Mhz offsets on 1200.

The Supported Kenwood Mobile Radios are as follows:

<u>140</u>	<u>220</u>	<u>440</u>	<u>1200</u>	<u>DUAL</u>	
TM-221	TM-321	TM-421	TM-521	TM-621+	TM-721+
TM-231	TM-331	TM-431	TM-531	TM-631+	TM-731+
TM-241		TM-441	TM-541		TM-701+
+ Dual Banders					

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## SPECIFICATIONS

Microprocessor:	INTEL 87C51 Series 12MHz
Connections:	
Power:	RCA Phono + center pin.
Controller:	9 Pin female "D" Connector
Expansion:	9 Pin male "D" connector.
Radios:	4 8 Pin Modular Compatible with Kenwood PG-4H cable. 1 PG-4H provided. Additional cables available from Kenwood or DHE.
Adjustments:	"T" (VR1) Radio transmit audio level adjust. "R" (VR2) Radio receive audio level adjust.
Audio:	Radio Transmit 0.050V to 2.5V Input. (response controlled by capacitor removal) Impedance 15K. Radio Receive 0.020V to 2.5V Output. (response controlled by capacitor removal) Impedance 5K.
"S" Meter output:	0 to +5V 0V = no signal, 5V = > "S" 9. Output impedance approx 5K.
Expansion output:	8 outputs, ground active, Sink 500mA each, 1A maximum total.
Power Requirements:	+10 to +14 Vdc @ 23mA.
Size:	1.5" X 5.1" X 5.5"

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## INSTALLATION

Place or mount the RBI in close proximity to the Kenwood mobile radio to be used. Connect the RBI with the provided PG-4H Cable from the 8 pin modular jack marked "RADIO" to the Kenwood Microphone jack. Only Port 1 (140/DUAL) will support a Dual Band radio. Port 1 is the only Port the 140 Mhz radio can be connected.

The RBI will support all 4 bands (140/220/440/1200) as follows:

If Port one is filled, Port 2 is for 220 only, Port 3 is for 440 only, Port 4 is for 1200 only. Basically, if the selected band is unavailable on Port 1 it will go to the port hard assigned to that band.

J2	Line Name	RLC-1 Connections
1	RBI-1 RESET	2 RLC-1 Output #3, P5
2	"S" Meter output	..
3	Data	15 RLC-1 Output #4, P5
4	Clock/Strobe	3 RLC-1 Output #5, P5
5	Kenwood TX Audio (T Pot)	4 RLC-1 Link Connector Port
6	Kenwood RX Audio (R Pot)	5 RLC-1 Link Connector Port
7	COS from Kenwood RX	7 RLC-1 COR Input (Must be Inverted to Active Low)
8	PTT to Kenwood TX	3 RLC-1 PTT Output Link Connector Port
9	Ground	1 RLC-1 Ground Connection

Audio receive level from the Kenwood to the Controller is controlled by VR2 (R). The audio level from the Controller to the Kenwood is adjusted by VR1 (T). Refer to your manuals for additional adjustments in your controller.

## RADIO SETUP

The Kenwood radio's need certain parameters setup before they can operate from the RBI. Things such as STEP, etc. Since the memory channels in the radio aren't used we will reset the radio to default on all setup options. This can be found in your Kenwood operating guide.

TM-701	Hold the MR key down during power on to reset.
TM-X21	Hold the VFO/M and M.IN keys down during power on to reset.
TM-621/721	Hold the F key down during power on to reset.
TM-631/731	Hold the MR key down during power on to reset.
TM-X31	Hold the MR key down during power on to reset.
TM-X41	Hold the VFO key down during power on to reset.

**Capacitor C5 (10uF) Inside the RBI-1 Interface, must be removed, and replaced with a 1uF/25V Tant. Capacitor for the Audio to sound correct.**

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## RADIO SETUP CONT...

Set the step size to 5KHz. (25Khz on 1200 Mhz units)

Set dual band radio's to single band.

Set power to desired setting. Remember, remote base transmitters can have a high duty cycle because it will be transmitting during all activity on the Repeater side. The mobile radio's used in a remote base configuration should be set to low power in most cases.

Set VFO/MEM to VFO for external frequency input.

Set CTCSS for desired frequencies. When using TM-X31/X41 series it will be set by the controller and will override your initial setting.

Set CTCSS Decode to off.

Set ABC and AL to off on models that support it.

Turn off Repeat functions.

Once these have been set, connect the Mike jack to the RBI. Reset the RBI to initialize the radio to the controller and get them in sync.

Any time there is manual changes from the radio front panel, the RBI and the Radio can get out of sync. This will require a RBI reset to correct. We recommend hooking the reset line from the RBI to a toggled User function output. Initialize the User function to "1" on and save those in all your Macro's or the reset line will be held low and disabled. To reset just interrogate the user function, this will toggle the reset line and reset the RBI.

## SUPPORT CROSS REFERENCE

FUNCTION	CTCSS ENCODE	CTCSS SELECT	CTCSS DECODE	MULTI BAND	RF PWR POWER
GENERIC	Y	Y	Y	Y	Y
<u>KENWOOD</u>					
TM-X21	Y	N	N		N
TM-X31	Y	Y	Y		Y
TM-X41	Y	Y	Y		Y
TM-621/721	Y	N	N	Y	N
TM-631/731	Y	N	N	Y	N
TM-701	Y	Y	Y	Y	Y

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## In Depth Command Description: C034

### Clear Input #4 Auto-Command Execution Name

This command allows the user to clear Input #4 High-Low and Low-High command names. These commands are called when Input #4 goes from one state to another. The RLC-1 will recognize the change once every 30 Seconds. This time will filter out contact bounce. Programming of these commands is accomplished using C036 and C037. This command has the same effect as using C036 to program messages 7 and 8 to nothing.

Description	Command	CW Response
Clear Input #4	C034*	CW BEEP RSP

Parameters: None

No Error Messages:

## In Depth Command Description: C035

### Send Port's CW ID Message

This command allows recall of the calling port's "ID" message. This lets the user recall the ID that is programmed to the port. Operation of this command is similar to the Message recall command (C037\*1 or C037\*2). The RLC-1 looks where the DTMF tones came from and then routes the appropriate message to the port.

Description	Command	CW Response
Send ID Message	C035*	Calling Port's ID

Parameters: None

No Error Messages:

## In Depth Command Description: C036 Message Program Utility

This command allows programming of the many messages on the RLC-1. Messages 1..6 are be CW (Morse Code), 7..8 execute the specified command. Refer C037 for the message numbers and maximum lengths.

Description	Command	CW Response
Program Message	C036*\$ %% .. %%*	See Below

### Parameters:

\$ is a one-digit code (0..8) representing the number of the message you wish to program.

%% - This data must be 2 digits long per CW Character, up to the maximum message length (see C037), or 4 digits long if it is a command name (messages 7 and 8 only). See CW Tables for Character list.

Example: To Program 'KF7FW / R' for the Main Port ID

```
C036*1 20 15 07 15 32 36 27 *
      K F 7 F W / R
```

Example: To change the Main CW Beep Frequency when Input #4 goes from Low-High. Also we will change the frequency back when Input #4 goes from High-Low. This could be used as an open door alarm.



- 1) Use Macro #1 to change the frequency on a Low-High condition
- 2) Use Macro #2 to change the frequency on a High-Low condition
- 3) Macro #1 Program: C032 \* 1 C014 0500 \*
- 4) Macro #2 Program: C032 \* 2 C014 1000 \*
- 5) Low-High Command Name Call: C036\* 8 C025 \*
- 6) High-Low Command Name Call: C036\* 7 C026 \*

### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - No Such Message

ER2 - Too Many Digits Entered for Selected Message



## In Depth Command Description: C037

### Message Read Back Utility

This command reads back the preprogrammed CW (Morse Code) messages. This helps in determining what messages are programmed in without having to re-program them.

Description	Command	CW Response
Read Message	C037*\$*	See Below

#### Parameters:

\$ is a one-digit code representing the number of the message you wish to recall.

Message Number	Description	Maximum Length
0	RLC-1 Version	20 CW Characters
1	Main Port ID	20 CW Characters
2	Link Port ID	20 CW Characters
3	Link ON	20 CW Characters
4	Link OFF	20 CW Characters
5	Link MON	20 CW Characters
6	CW Response Message	5 CW Characters
7	Input #4 High-Low Command	1 Four Digit Command
8	Input #4 Low-High Message	1 Four Digit Command



#### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - No Such Message

## In Depth Command Description: C038 Re-Program Command Name

This command allows the user to change any of the four digit preprogrammed command names to any combination of DTMF digits (excluding the <EOF> key) four digits or less in length. All command names that are less than four digits must be padded with leading zeros to four digits when using this command. Command name "12" would be entered as "0012". Command Name "1200" would be entered as "1200". Afterward, when executing those commands, any leading zeros can be omitted. This command is capable of changing its own name. Care should be taken to keep track of what name each command is changed to. Appendix C contains charts to assist you in this. It is highly recommended that you use them. It is possible to "lose" a command; if you don't know its name, you can't rename it. If this happens, you can either live without that command or re initialize the whole controller. The only exception to this is if you have a serial terminal and do a command dump with Serial Command [S00].

If two commands are given the same name, the one that has the lowest number in the manual will always be the one referenced. It can then be renamed, separating the two commands.

Description	Command	CW Response
Change Name	C038*&&&& \$\$\$\$ *	CW BEEP RSP



### Parameters:

&&&& is the Command's Current Name

\$\$\$ is the Command's New Name

### Example:

You want to rename the command to enable Link Port on the Main Port. This command is "C000." You want to rename it to "150".



C038 \* C000 0150 \*

### CW Response:

CW BEEP RSP

### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too Many Digits Entered

ER2 - Number too Large

## In Depth Command Description: C039

### Set <EOF> Key

This command allows the user to change the <EOF> key. This key has two uses. First, if a command has parameters (additional information after the command name), the <EOF> key is used to separate the command name from that additional information (except when programming a macro). Second, it can be used to tell the RLC-1 to execute a command that has been entered into the controller, as an alternative to letting the COR drop. The <EOF> key can not be used in any command names.

Description	Command	CW Response
Set <EOF> Key	C039*&*	CW BEEP RSP

#### Parameters:

\* is the current <EOF> key

& is the new <EOF> key

#### Default:

'\*' <EOF> Key

#### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too Many Digits Entered

## In Depth Command Description: C040 Interrogate Main and Link Systems

This command allows the user to check the configuration of the "other port". When using this command, the RLC-1 will indicate what the port communication condition is in.

Description	Command	CW Response
Interrogate Ports	C040*	See Below

When the DTMF command is entered from the Main Port:

- If the Link Port is connected to the Main Port (C000), the CW Response is "M N," Main is ON
- If the Link Port is Disconnected from the Main Port (C002), the CW Response is "M F," Main is OFF
- If the Link Port is being Monitored by the Main Port (C001), the CW Response is "M M," Main is Monitoring

When the DTMF command is entered from the Link Port:

- If the Main Port is Connected to the Link Port (C000 and C001), the CW Response is "L N," Link is ON Main
- If the Link Port is Disconnected from the Main Port (C002), the CW Response is "L F," Link is OFF

No Error Messages:

## In Depth Command Description: C041 DTMF Tone Pad Test

This command allows the user to test their DTMF tone pad. It allows up to 20 digits to be entered. After the command is executed, digits entered will be sent by CW.

Description	Command	CW Response
DTMF Tone Test	C041*\$\$\$\$....\$\$\$\$*	Keys Entered

### Parameters:

\$ is any key on the DTMF Tone Pad

### Error Message:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too Many Digits Entered

## In Depth Command Description: C042

### Remote Controller Reset

This command allows the user to remotely reset the RLC-1 Controller. This command acts like pushing the external reset switch or turning the power off and back on. It will not erase any of the messages you have programmed, etc. **NO REMOTE INITIALIZATION IS POSSIBLE, ONLY REMOTE RESETTING.**

Description	Command	CW Response
Remote Reset	C042*	RESET ?

No Error Messages:

## Appendix A - CW (Morse Code) Table

00 - 0	13 - D	26 - Q	39 - AR
01 - 1	14 - E	27 - R	40 - SPACE
02 - 2	15 - F	28 - S	41 - PAUSE
03 - 3	16 - G	29 - T	
04 - 4	17 - H	30 - U	
05 - 5	18 - I	31 - V	
06 - 6	19 - J	32 - W	
07 - 7	20 - K	33 - X	
08 - 8	21 - L	34 - Y	
09 - 9	22 - M	35 - Z	
10 - A	23 - N	36 - /	
11 - B	24 - O	37 - .	
12 - C	25 - P	38 - ?	

See Commands C036, and C037 for more information on message programming, and C014, C015 and C016 for CW frequency and speed.

## Appendix B - Tone Look-Up Table

The frequency of the RLC-1 tone generator can be determined by applying the following formula or the table.

$$\text{Counts} = \left( \frac{1,000,000}{\text{Frequency}} \right) - 1$$

**Tone Table, (100Hz to 2900Hz in 5Hz Steps)**

FREQ	COUNTS	FREQ	COUNTS	FREQ	COUNTS	FREQ	COUNTS
100	9999	295	3388	490	2039	685	1458
105	9522	300	3332	495	2019	690	1448
110	9089	305	3277	500	1999	695	1437
115	8694	310	3224	505	1979	700	1427
120	8332	315	3173	510	1959	705	1417
125	7999	320	3124	515	1940	710	1407
130	7691	325	3075	520	1922	715	1397
135	7406	330	3029	525	1903	720	1387
140	7141	335	2984	530	1885	725	1378
145	6895	340	2940	535	1868	730	1368
150	6665	345	2897	540	1850	735	1359
155	6450	350	2856	545	1833	740	1350
160	6249	355	2815	550	1817	745	1341
165	6059	360	2776	555	1800	750	1332
170	5881	365	2738	560	1784	755	1323
175	5713	370	2701	565	1768	760	1314
180	5554	375	2665	570	1753	765	1306
185	5404	380	2630	575	1738	770	1297
190	5262	385	2596	580	1723	775	1289
195	5127	390	2563	585	1708	780	1281
200	4999	395	2530	590	1693	785	1272
205	4877	400	2499	595	1679	790	1264
210	4760	405	2468	600	1665	795	1256
215	4650	410	2438	605	1651	800	1249
220	4544	415	2408	610	1638	805	1241
225	4443	420	2379	615	1625	810	1233
230	4346	425	2351	620	1611	815	1225
235	4254	430	2324	625	1599	820	1218
240	4165	435	2297	630	1586	825	1211
245	4080	440	2271	635	1573	830	1203
250	3999	445	2246	640	1561	835	1196
255	3920	450	2221	645	1549	840	1189
260	3845	455	2196	650	1537	845	1182
265	3772	460	2172	655	1525	850	1175
270	3702	465	2149	660	1514	855	1168
275	3635	470	2126	665	1502	860	1161
280	3570	475	2104	670	1491	865	1155
285	3507	480	2082	675	1480	870	1148
290	3447	485	2060	680	1469	875	1141



FREQ	COUNTS	FREQ	COUNTS	FREQ	COUNTS	FREQ	COUNTS
880	1135	1135	880	1390	718	1645	606
885	1128	1140	876	1395	715	1650	605
890	1122	1145	872	1400	713	1655	603
895	1116	1150	868	1405	710	1660	601
900	1110	1155	864	1410	708	1665	599
905	1103	1160	861	1415	705	1670	597
910	1097	1165	857	1420	703	1675	596
915	1091	1170	853	1425	700	1680	594
920	1085	1175	850	1430	698	1685	592
925	1080	1180	846	1435	695	1690	590
930	1074	1185	842	1440	693	1695	588
935	1068	1190	839	1445	691	1700	587
940	1062	1195	835	1450	688	1705	585
945	1057	1200	832	1455	686	1710	583
950	1051	1205	828	1460	683	1715	582
955	1046	1210	825	1465	681	1720	580
960	1040	1215	822	1470	679	1725	578
965	1035	1220	818	1475	676	1730	577
970	1029	1225	815	1480	674	1735	575
975	1024	1230	812	1485	672	1740	573
980	1019	1235	808	1490	670	1745	572
985	1014	1240	805	1495	667	1750	570
990	1009	1245	802	1500	665	1755	568
995	1004	1250	799	1505	663	1760	567
1000	999	1255	795	1510	661	1765	565
1005	994	1260	792	1515	659	1770	563
1010	989	1265	789	1520	656	1775	562
1015	984	1270	786	1525	654	1780	560
1020	979	1275	783	1530	652	1785	559
1025	974	1280	780	1535	650	1790	557
1030	969	1285	777	1540	648	1795	556
1035	965	1290	774	1545	646	1800	554
1040	960	1295	771	1550	644	1805	553
1045	955	1300	768	1555	642	1810	551
1050	951	1305	765	1560	640	1815	549
1055	946	1310	762	1565	637	1820	548
1060	942	1315	759	1570	635	1825	546
1065	937	1320	756	1575	633	1830	545
1070	933	1325	753	1580	631	1835	543
1075	929	1330	750	1585	629	1840	542
1080	924	1335	748	1590	627	1845	541
1085	920	1340	745	1595	625	1850	539
1090	916	1345	742	1600	624	1855	538
1095	912	1350	739	1605	622	1860	536
1100	908	1355	737	1610	620	1865	535
1105	903	1360	734	1615	618	1870	533
1110	899	1365	731	1620	616	1875	532
1115	895	1370	728	1625	614	1880	530
1120	891	1375	726	1630	612	1885	529
1125	887	1380	723	1635	610	1890	528
1130	883	1385	721	1640	608	1895	526

FREQ	COUNTS	FREQ	COUNTS	FREQ	COUNTS	FREQ	COUNTS
1900	525	2155	463	2410	413	2665	374
1905	523	2160	461	2415	413	2670	373
1910	522	2165	460	2420	412	2675	372
1915	521	2170	459	2425	411	2680	372
1920	519	2175	458	2430	410	2685	371
1925	518	2180	457	2435	409	2690	370
1930	517	2185	456	2440	408	2695	370
1935	515	2190	455	2445	407	2700	369
1940	514	2195	454	2450	407	2705	368
1945	513	2200	453	2455	406	2710	368
1950	511	2205	452	2460	405	2715	367
1955	510	2210	451	2465	404	2720	366
1960	509	2215	450	2470	403	2725	365
1965	507	2220	449	2475	403	2730	365
1970	506	2225	448	2480	402	2735	364
1975	505	2230	447	2485	401	2740	363
1980	504	2235	446	2490	400	2745	363
1985	502	2240	445	2495	399	2750	362
1990	501	2245	444	2500	399	2755	361
1995	500	2250	443	2505	398	2760	361
2000	499	2255	442	2510	397	2765	360
2005	497	2260	441	2515	396	2770	360
2010	496	2265	440	2520	395	2775	359
2015	495	2270	439	2525	395	2780	358
2020	494	2275	438	2530	394	2785	358
2025	492	2280	437	2535	393	2790	357
2030	491	2285	436	2540	392	2795	356
2035	490	2290	435	2545	391	2800	356
2040	489	2295	434	2550	391	2805	355
2045	487	2300	433	2555	390	2810	354
2050	486	2305	432	2560	389	2815	354
2055	485	2310	431	2565	388	2820	353
2060	484	2315	430	2570	388	2825	352
2065	483	2320	430	2575	387	2830	352
2070	482	2325	429	2580	386	2835	351
2075	480	2330	428	2585	385	2840	351
2080	479	2335	427	2590	385	2845	350
2085	478	2340	426	2595	384	2850	349
2090	477	2345	425	2600	383	2855	349
2095	476	2350	424	2605	382	2860	348
2100	475	2355	423	2610	382	2865	348
2105	474	2360	422	2615	381	2870	347
2110	472	2365	421	2620	380	2875	346
2115	471	2370	420	2625	379	2880	346
2120	470	2375	420	2630	379	2885	345
2125	469	2380	419	2635	378	2890	345
2130	468	2385	418	2640	377	2895	344
2135	467	2390	417	2645	377	2900	343
2140	466	2395	416	2650	376		
2145	465	2400	415	2655	375	END OF TABLE	
2150	464	2405	414	2660	374		

### Appendix C - Command Name Change Chart

Name	New Name		Comments
C000			
C001			
C002			
C003			
C004			
C005			
C006			
C007			
C008			
C009			
C010			
C011			
C012			
C013			
C014			
C015			
C016			
C017			
C018			
C019			
C020			
C021			
C022			
C023			
C024			
C025			
C026			
C027			
C028			
C029			
C030			
C031			
C032			
C033			
C034			
C035			
C036			
C037			
C038			
C039			
C040			
C041			
C042			

### Appendix D - Macro Recording Sheets

#### Macro #1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

#### Macro #2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

#### Macro #3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

#### Macro #4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

**Appendix D - Macro Recording Sheets****Macro #5**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

**Macro #6**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

**Macro #7**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

## Appendix D - Additional Macro Recording Sheets

### Macro #1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

### Macro #2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

### Macro #3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

### Macro #4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

**Appendix D - Additional Macro Recording Sheets****Macro #5**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

**Macro #6**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

**Macro #7**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

## **Appendix E - Initializing and Resetting the RLC-1**

When the RLC-1 powers up or the reset button is pressed, a warm reset is processed. This reset will load the most recently programmed variables into the controller. The variables are stored in the nonvolatile EEPROM cell located inside the microprocessor. If the variables in the EEPROM get scrambled somehow, a cold boot will be needed. This cold boot resets all of the RLC-1's variables to the factory settings - anything you have programmed will be lost. This cold boot is accomplished by pressing and holding the initialize switch and pushing the reset switch. You must hold the initialize switch down for at least 5 seconds when resetting. Once the controller has been initialized, the reset switch must be pushed and released. The RLC-1 takes about 15 seconds to re-initialize the EEPROM. The initialization process will be complete when the RLC-1 sends out the reset message "RESET ?". At this point you must press and release the reset switch.



## Appendix F - Troubleshooting

### *No Audio at Test Bus:*

- Check for main system power (+12 Volts plugged in).
  - Is there a valid COR signal present?
    - Check the COR polarity jumper.
- Is the Access mode COR and PL? If so are both signals active?

### *Have audio at the test bus, but not on the transmitter:*

- Are the output audio pots turned up (clockwise)?
- Is the transmitter connected to the audio output (high)?

### *The CW Volume seems Low:*

- Turn up the pot marked "Main Tone" or "Link Tone."

### *When I connect my COR, the RLC-1 will not accept it:*

- Does the COR go to ground when active?
  - If so is the COR polarity jumper connected?
- Does the COR go above 4 volts when active?
  - If so is the COR polarity jumper disconnected?
    - Can the COR sink 2mA when active?
- Does the 5V pull-up resistor conflict with your radio?
  - Motorola R-100 Repeaters are susceptible to this
- Solution: open collector the driver on R-100 repeaters

### *When I connect my serial terminal, I do not get any data:*

- Is your terminal set to 2400,N,8,1?
- Is your serial terminal plugged into P1 serial connector?
- Are all the RS-232 TX and RX and ground wires connected?
- You should use a straight-through (not null-modem) cable in most cases.

### *DTMF Valid LED flashes, but nothing happens*

- Is there a valid COR present?
- Is the transmitter hooked up?
- Is the RLC-1 in the Proper Access Mode (COR or COR and PL)?

## Glossary:

**Dry Contact Input** - A input that is commonly used with a typical on/off switch for detecting such things as open doors.

**<EOF>** - The DTMF key that tells the controller that the command has been entered. It is also used to separate command names from the parameters.

**Kerchunk** - Quickly keying up and unkeying a receiver.

**Macro** - The RLC-1 supports macros that consist of a string of commands that can be repeated by executing the macro command.

**RX** - Receiver

**TX** - Transmitter

**WPM** - Words Per Minute. Rate at which CW (Morse Code) is sent.

## **Schematic Diagrams:**





## Board Layout

**Bill of Materials****Link Communications RLC-1 Revision: A**

Item	Quantity	Reference	Part
1	18	C1,C2,C3,C5,C6,C7,C15,C16,C26,C27,C28 C29,C30,C31,C32,C33,C34,C35	0.01uF
2	7	C4,C8,C9,C10,C11,C12,C17	0.1uF
3	2	C13,C14	4.7uF
4	2	C19,C18	33pF
5	2	C21,C20	22pF
6	2	C24,C22	10uF
7	1	C23	1uF
7a	1	C25	100uF
8	8	D3,D4,D5,D6,D15,D16,D17,D18	1N750A
9	7	D8,D9,D10,D11,D12,D13,D14	1N4754
10	1	D19	1N4000
11	1	D20	LED Red
12	8	J1,J2,J4,J5,J6,J7,J8,J9	Header 2 Pin
13	8	J1,J2,J4,J5,J6,J7,J8,J9	Jumper 2 Pin
14	1	J3	2.50 mm Power
15	1	J10	Header F/6 Pos.
16	3	P1,P3,P4	DB9 RA/F

**Bill of Materials Cont...Link Communications RLC-1 Revision: A**

Item	Quantity	Reference	Part
17	1	P5	DB25 RA/F
18	8	Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q9	2N7000
19	1	RG1	LM7805T
20	1	RG2	LM317T
21	1	R1	22K DIP Res.
22	4	R21,R22,R27,R28	47K,.25W,1%
22a	2	R39,R43	47K SIP Res.
23	1	R2	10K DIP Res.
23a	3	R23,R31,R61	10K,.25W,1%
24	4	R11,R15,R19,R25	200K Variable
25	6	R12,R13,R16,R17,R33,R34	5.1K,.25W,1%
26	12	R14,R18,R20,R26,R35,R36,R37,R38,R44 R45,R46,R47	1K,.25W,1%
27	2	R4,R9	50K Variable
28	3	R24,R30,R42	680,.25W,1%
29	2	R41,R40	10M,.25W,1%
30	1	R48	237,.25W,1%
31	1	R49	1.69K,.25W,1%



**Bill of Materials Cont...Link Communications RLC-1 Revision: A**

Item	Quantity	Reference	Part
32	4	R50,R51,R52,R53	2.5K,.25W,1%
33	1	R60	15K,.25W,1%
34	1	S1,S2	Key Switch
35	2	U1,U3	Nat. LMC660
36	1	U2	Moto CD4066
37	1	U4, 8 Pin Socket	Dallas DS1275
38	1	U6, 8 Pin Socket	Dallas DS1232
39	1	U7, 52 Pin Socket	MC68HC711E9
40	1	U8, 18 Pin Socket	SSI75T-202IP
41	1	U9	Nat. 74C906
42	1	U10	Moto CD4053
43	1	Y1	8.0 Mhz
44	1	Y2	3.579545 Mhz
45	2	RG1,RG2	6-32" Screw/Nut
46	1	J3/Plug	2.50mm Power
47	3	P1,P3,P4 DB9 Connectors	Male S. Cup
48	1	P5 DB25 Connector	Male S. Cup
49	1	RLC-1 Operations Manual	RLC-1 Manual

## Condor Software Differences:

- 1) All commands entered from the Main port, for use on the Main port must begin with a '\*' followed by the normal command name.
- 2) All commands entered from the Link port must begin with the link pre-access name. This name defaults to '99'. The command prefix for the link port is a '#'. In order to execute a command the complete word '#99' must be entered. The link prefix name can be changed using Command C033.
- 3) <EOF> or enter key defaults to a 'D', not a '\*' as discussed in the manual
- 4) DTMF muting is controlled using Command C009. The muting function controls both the audio and the TX PTT. The PTT is controlled when the port is configured as a link only; otherwise only the audio is effected.
- 5) When entering data from the Main port, and the controller detects a '\*' prefix, and the link port RX/TX is connected to the main port, then the TX PTT for the link port is broken. The PTT is enabled again when either the Main port receiver goes inactive, or a command is executed by entering the 'D' key.
- 6) When the DTMF mute function is enabled (See Command C009) and a '#' is entered, the DTMF mute function will be disabled only on the link port, for that sequence of tones. When a COR drop occurs, the mute function will be re-enabled.
- 7) Doug Hall RBI-1 support is disabled when using the Condor Software.

## In Depth Command Description: C033 Link Pre-Access Name Program

This command allows the user to change the pre-access name for the link port. The name allows the users on the link system to access the controller when the correct name has been entered. The pre-access name must be entered for each command executed, and if the receiver access has been dropped since the last entry.

Description	Command	CW Response
Change Pre-Acc.	C033*##*	CW BEEP RSP

### Parameters:

## is the New Pre-Access Name

Default: 99

### Error Messages:

If the format is not correct, the RLC-1 will send a "E" error code.

ER1 - Too many or too few Digits Entered