Pacific Research
RI-100
REPEATER CONTROLLER
USER MANUAL

Revised 10.25.96 - RI-100 User Manual Version 1.10

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INTRODUCTION

Your controller represents the latest technological advances in repeater control systems. The RI-100 utilizes a microprocessor design providing all control functions for a single repeater on a main printed circuit board 3 by 6½ inches and a display board, ¾ by 3 inches. The RI-100 does not require memory backup batteries, all program configurations are stored in a NON-VOLATILE EEPROM (Electrically Erasable Programmable Read Only Memory), which maintains its data even with the power disconnected. This EEPROM may be re-programmed by the user in order to change the system characteristics. The microprocessor and power supply are constantly monitored by a "WATCHDOG TIMER" and "POWER SUPPLY SUPERVISORY CIRCUITS" that maintain the operational integrity of the system. The RI-100 is easy to set up and use, only five interconnect wires are required to interface to your repeater. With three simple audio level adjustments, your repeater will be operational with the default user command functions.

Once you are familiar with the macro command system you can customize your user functions, messages, and schedulers. We recommend that you read sections 1 and 2 of this manual first, to get familiar with the system and its basic operation. The other sections of this manual provide a more thorough explanation of the RI-100's many Features.

The RI-100 repeater interface has the following features which together are not available in any other repeater controller in the industry:

- Transmit audio level, squelch level, CTCSS level and receiver level potentiometer adjustments are radio remotely adjustable.
- On board squelch circuit. You do not have to add in someone else's circuit. It's SmartSquelch™, An intelligent microprocessor controlled squelch and it's fast.
- On board CTCSS decoder and encoder. You do not have to add in an external decoder. It's clean and cost effective. The CTCSS encode maybe remotely controlled. Multiple CTCSS decoded tones and tone panel features are provided.
- A selectable sub audio reject filter is provided, to remove the received CTCSS sub-audio tone from being repeated.
- DTMF tones maybe passed, muted, or regenerated.
- User programmable inputs and outputs.
- User programmable event scheduler. Command can be programmed to execute automatically.
- NON-VOLATILE EEPROM data storage. You never have to be concerned with replace a memory backup battery.
- User command macro editor. All user commands are completely programmable.
- All the repeater owner has to do is interface the repeater audio and remotely program the functions and feature desired.

The RI-100 provides excellent audio quality. With proper consideration when interfacing the controller to the receiver and transmitter, your repeater will provide excellent audio to the users. Interfacing information is provided in numerous sections of this manual and information support is available from the factory. The receiver discriminator output must be connected to the RI-100 audio input in order for the squelch circuit to function properly and to provide the excellent audio. **Do not connect the RI-100 audio input to the receiver speaker connections or the squelch will not operate properly.**

The RI-100 provides easy programming of customize user features or command functions by the ability to write and name simple macros. All messages and telemetry are also programmable.

GETTING STARTED

1.0   QUICK START

This section will cover the basics of installation and programming of your RI-100. You may also need to review section 2 for more details on connecting your RI-100 to your repeater. Once you have covered the basics, we recommend that you thoroughly review the complete manual in order to get the most out of your controller.

1.1   UNPACKING THE RI-100

Inspect the carton for the following contents and if any of the items that you have ordered are missing or damaged, notify your RI-100 dealer or the factory that shipped the unit to you.

1. RI-100 Repeater controller board with mating DB15S connector.
2. RI-100 User manual.
3. IC-100 Optional interconnect cable for connecting to another RI-200 or RI-100.

1.2   MOUNTING THE RI-100 REPEATER CONTROLLER

1. The repeater builder can mount the RI-100 repeater controller in any enclosure of his choice. The enclosure that you selected should be strong enough to mechanically protect the contents. The enclosure should be made of metal with good shielding properties. We do not recommend the use of a plastic enclosure in a RF environment. Mounting the RI-200 is accomplished by drilling four holes and mounting the unit with #4-40 standoffs.
2. Avoid installing the RI-100 in the following places.

    • Directly above a transmitter or power amplifier because of heat and RF considerations.
    • Directly above any power supplies because of heat and 60 Hz coupling into the audio circuits.

1.2.1   INTERFACE YOUR RECEIVER AND TRANSMITTER

The RI-100 repeater controller is very easy to interface with your repeater. Before you continue, you need to make the following connections. All connections are covered with greater detail in section 2 of this manual. Once you have finished connecting your RI-100 to your repeater, you can continue with section 1.4 of this manual.

1. +12 Volts DC power source, J1 Pin 1.
2. DC ground, J1 Pin 9
3. Receiver Discriminator, J1 Pin 2.
4. Discriminator return, J1 Pin 10.
5. Transmitter audio, J1 Pin16
6. Transmitter return, J1 Pin 15.
7. Transmitter keying circuit (PTT), J1 Pin 4.
8. System ground, J1 Pin 5.

See section 2 for more complete details on proper interfacing to your repeater transmitter and receiver.

1.3   SETTING UP YOUR REPEATER CONTROLLER

This section will cover some items that you will need to modify before you put your repeater on the air. But first confirm the following items to make sure that your controller is operational.

1. Turn on power to the repeater. You will first hear a CW "OK" and then the default ID "HELLO". The system LED should be the only LED on.
2. Apply a carrier without a CTCSS tone on the input of the repeater. The COS LED should come on.
3. Apply a carrier with a 100 Hz CTCSS tone on the input of the repeater. The COS and the CTCSS LED should come on.
4. Apply a carrier with a DTMF tone on the input of the repeater. The DTMF LED should come on.

1.3.1   DEFAULT USER COMMANDS

The controller comes programmed with some default commands. See section 5 for details on changing the command names or the commands themselves. You can send these commands when the controller is locked.

*1	Repeater (system) ON.
#1	Repeater (system) OFF.
*2	Full duplex link ON, used if you have 2 repeaters tied together.
#2	Link OFF
*3	Repeater CTCSS tone decode ON.
#3	Repeater CTCSS tone decode OFF.
*4	Repeater CTCSS tone encode ON.
#4	Repeater CTCSS tone encode OFF.
*5	DTMF mute ON.
#5	DTMF mute OFF.
*6	Repeater Squelch ON.
#6	Repeater Squelch OFF.
*7	Carrier delay ON.
#7	Carrier delay OFF.
*8	Telephone off hook, simplex. You can include the telephone number with this command.
#8	Telephone on hook.
*9	Telephone off hook, duplex. You must include the telephone number with this command.
#9	Telephone on hook
A	Trigger a CW message. You must include the message buffer number 1 through 16 with this command.
B	Lock on the PTT for X time. You must include the time in seconds 0 through 3600 with this command.

1.3.2   DEFAULT CTCSS OPERATION

Your repeater controller is shipped with CTCSS disabled for all functions (S-Command ??). The CTCSS LED will show when the controller is decoding CTCSS, even though this **current** decode is not **being** used in the controller operation. CTCSS is also not required for DTMF controlling. If you need to change this operation, use S-Command ??.

1.4.3   SETTING UP YOUR ID

You are now ready to change the **ID message**. Your can review section 5.4 for more details on programming messages. You will be changing message 06, the default ID. This message is your normal ID. The current default ID is "HELLO" which you will want to change to your call sign. We will first show how "HELLO" is done and then we will do your ID. You can also use this same technique to modify all other message buffers.

Each character of the ID has a 3 digit command number. See the CW data table in this manual for a list of all CW commands.

Character 1 = 017   697 Hz tone
Character 2 = 036   CW speed, 16 WPM
Character 3 = 082   CW Space
Character 4 = 063   CW "H"
Character 5 = 060   CW "E"
Character 6 = 067   CW "L"
Character 7 = 067   CW "L"
Character 8 = 070   CW "O"

Review the procedure to enter this ID into the controller.

1. Unlock the controller, send "123456" and un-key, you will hear a function complete "OK".
2. **Send the edit message buffer S-Command**, buffer number and message data (see above) "30 06 017 036 082 063 060 067 067 070" and un-key. You should hear a function complete "OK". If you hear an error message "ERROR", a mistake was made and you will need to re enter the message
3. Test your message, send "32 06". You should hear this message.
4. You are done, send "69" to lock the controller.

Now you are ready to enter your ID message. The table below shows the default ID, use this table to fill in your ID.

MESSAGE TABLE																
Msg #	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	NOTE
06	017	036	082	063	060	067	067	070									Default ID
06																	Your new ID

1. In D1, enter the tone number you want to use, CW command 001 through 024.
2. In D2, enter the CW code speed you want to use, CW command 025 through 045.
3. In D3, enter CW command "082" a space.
4. In D4 through D16, enter your repeater ID, CW command 046 through 081.
5. Unlock the controller, send "123456" and un-key, you will hear a function complete "OK".
6. Send the system command, buffer number and message data "30 06 (your ID message)" and un-key. You should hear a function complete "OK". If you hear an error message "ERROR", a mistake was made and you will need to re enter the message
7. Test your message, send "32 06". You should hear your message.
8. You are done, send "69" to lock the controller.

You can also use tones of various lengths and pauses in any of your messages, CW commands 101 through 164.

1.3.4   SETUP CTCSS TONE DECODE

The controller comes programmed with 100 Hz CTCSS tone enabled. You can enable or disable any of the CTCSS tones. See section 4.5.19 through 4.5.25 for more details. The following example assumes that you want to disable 100.0 Hz and enable 127.2 Hz for the repeater, telephone and control. See the CTCSS tone table in section 4.5.24 for your specific tone number.

1. Unlock the controller, send "123456" and un-key, you will hear a function complete "OK".
2. Disable the repeater 100.0 Hz tone, send "20 13 0" and un-key, you will hear a function complete "OK".
3. Enable the repeater 127.2 Hz tone, send "20 20 1" and un-key, you will hear a function complete "OK".
4. Disable the DTMF control 100.0 Hz tone, send "21 13 0" and un-key, you will hear a function complete "OK".
5. Enable the DTMF control 127.3 Hz tone, send "21 20 1" and un-key, you will hear a function complete "OK".
6. Disable the telephone 100.0 Hz tone, send "23 13 0" and un-key, you will hear a function complete "OK".
7. Enable the telephone 127.3 Hz tone, send "23 20 1" and un-key, you will hear a function complete "OK".
8. Now that you have setup the decode tables, you will need to turn on each of the tables for use. Before you continue, make sure that you are transmitting the new tone and the CTCSS LED goes on.
9. Turn on the repeater tone table, send "19 1 1" and un-key, you will hear a function complete "OK". You can also do this by sending the user command "*3" when the repeater controller is locked.
10. Turn on the DTMF control tone table, send "19 2 1" and un-key, you will hear a function complete "OK".
11. Turn on the telephone tone table, send "19 3 1" and un-key, you will hear a function complete "OK".
12. You are done, send "69" to lock the controller.

1.4.5   POWER ON RESET COURTESY MESSAGE

On software versions 1.14 and older, when you first turn on the controller, the default courtesy message is CW "RST". On version 1.15 and newer, the power on reset message is disabled by default. To change the courtesy message so that you will have a normal courtesy message, you must set the time clock. The clock is only used to automatically schedule events. If you do not plan to automatically schedule events, you may want to permanently disable the power on reset message. Use one of the following procedures.

RESETTING THE TIME CLOCK:

1. Unlock the controller, send "123456" and un-key, you will hear a function complete "OK".
2. Set the current time in 24 hour mode, if the time is 1:30 PM send "43 1330" and un-key, you will hear a function complete "OK". If the time was 3:00 AM, you would have sent "43 0300" and un-key
3. You are done, send "69" to lock the controller.
4. You will now notice a new courtesy message.

PERMANENTLY DISABLE THE POWER ON RESET MESSAGE:

1. Unlock the controller, send "123456" and un-key, you will hear a function complete "OK".
2. Change the power on reset message to the standard courtesy message, send "31 08 1" and un-key, you will hear a function complete "OK".
3. You are done, send "69" to lock the controller.
4. You will now notice a new courtesy message.

1.4.6   CHANGING YOUR PASSWORD

The controller comes pre-programmed with "123456" as the password to access the system command mode. You can select up to a new 6 digit password. Do not use a "C" in your password. To reduce additional problems, check your new password with the system commands to make sure it does not look like a system command. Example, do not use "010" as the password. If you are in the system command mode and accidentally send this password, you will turn off the system instead.

1. Pick your password, 1 to 6 digits. The default is 123456.
2. Unlock the controller, send "123456" and un-key, you will hear a function complete "OK".
3. Enter your new password, send "66 (Your password)" and un-key, you will hear a function complete "OK".
4. If you make any mistakes, re-enter your new password. If you lock the controller with a mistake in the password, you will have to reset all the factory defaults to return to the default password.
5. You are done, send "69" to lock the controller.
6. Check your new password, send "(Your password)" and un-key, you will hear a function complete "OK".
7. Re-lock the controller, send "69"

1.5   AUXILIARY INPUT AND OUTPUT

The RI-200 has auxiliary input and output capability for connecting to another RI-200 or RI-100 repeater controller, or connecting to a single control receiver. By interfacing a second RI-200, two repeaters, two links or one repeater and one link maybe interconnected. Audio paths and a digital serial data path provide all the communication required when connect the two controllers together. This allows the two repeaters or links to operate separately or cross connected. Digital serial data link is selected by S-Command 37 1. For added protection, the serial data link protocol contains an error check routine and if a unit does not receive valid data for four seconds, that RI-200 will return to a normal operating mode. This is to prevent a transmitter from staying keyed-down because of a serial data failure.

REPEATER INTERFACE

2.0   REPEATER INTERFACE

The RI-200 is equipped with the latest technological advancements. It is also a simplest controller to interface to your repeater. Just follow these few simple steps. Review this section to the end and plan you repeater interface before the start making connections. Enjoy setting audio remotely from your radio. See section 3.4 of this manual for more details on making level adjustments.

This section will cover in detail, connecting your RI-200 to your repeater. The diagram on the right is an end view of the radio interface connector on your RI-100. Use the supplied DB-15 male connector for making all connections to the controller.

RADIO INTERFACE CONNECTOR
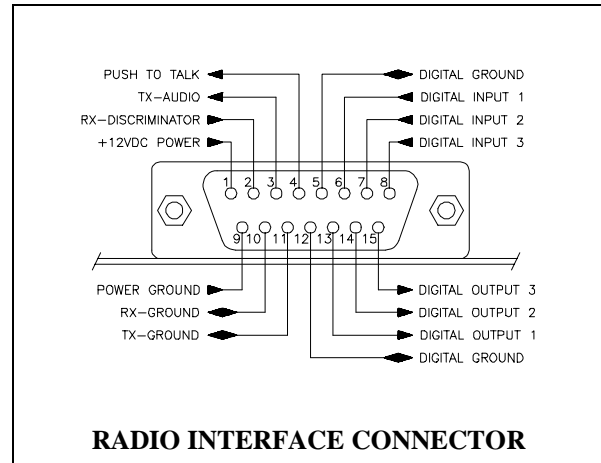
2.1   PROPER TECHNIQUES FOR QUALITY REPEATER AUDIO

Obtaining good audio in any repeater is based on understanding the design of the equipment. The audio in all frequency modulation (FM) transmitters or phase modulation (PM) transmitters have what is known as audio pre-emphasis. Pre-emphasis means that with increasing audio frequency the amount of the modulation will increase. The reverse is performed in all FM receivers and is called de-emphasis. The RI-100 was designed to operate with flat audio response from the repeater receiver and transmitter. This means that no de-emphasis and pre-emphasis of the audio is performed on the repeater or controller. This leaves all of the emphasis filtering to the user's radio. The RI-100 controller does include a low pass filter that rolls off the very high audio frequency content to prevent adjacent channel splatter. The ideal interface to the RI-100 and FM modulator is when a varactor diode is directly driven. However the RI-100 does have a de-emphasis filter that can be turned on for those applications where you may need to interface to a modulator with pre-emphasis. The input to he RI-100 still requires you to connect directly to the receiver's discriminator for the squelch to work properly. It is not advisable to drive the microphone input on the transmitters. Most transmitters have significant audio shaping, compensating for the microphone response and other characteristics.

Besides audio frequency response, you should consider the audio amplitude levels to and from the controller. If the levels to and for the repeater are small, it may be valuable to use shielded cable. We recommend shielded cables at all times. Use large signal levels whenever possible. On the other hand do not let the audio signal get large enough where clipping occurs in any stage of the controller, the receiver or the transmitter. In the RI-100 repeater controller has a built in audio level meter. See section 3.4 for more details on adjusting the audio levels in the controller. Consider and practice the above and you will have repeater audio you and your repeater users will be proud of.

2.2   POWER SUPPLY CONNECTIONS

The RI-200 operates on 12 volts DC nominal. The DC source voltage must be between 8 and 15 VDC. The controller typically draws 50 ma without the status LED's turned on. Connect the +12v to J1 pin 1. Connect J1 pin 9 to ground or the 12 V return side of the power supply. The repeater builder may elect to incorporate an on/off power switch on the +DC side. Most repeater owners switch the AC primary side of the power supply. **The RI-100 repeater controller connection to the power supply must be over current protected**. Use of a one ampere fuse should be the largest capacity considered in your system. A 250 ma fuse is best. When connected properly, the green LED on the status LED display will light when the power is applied and the system enable command is on.

2.3   REPEATER RECEIVER AUDIO CONNECTION

Since the RI-100 controller has the squelch or COR/COS circuits incorporated on board, the audio input MUST BE connected to the receiver discriminator output. Connect the receiver discriminator audio to the RI-100 J1 pin 2 and the receiver ground or audio return to J1 pin 10. **Do not connect to the speaker leads**. If you are not familiar with the repeater receiver get assistance from someone knowledgeable on the subject or contact our factory for support. If your discriminator does not have adequate filtering for 455 KHz, you will have to provide for this filtering between the radio and controller. A 10mH inductor in line with a 1000pF capacitor to ground should work. You may need to adjust these values according to the output impedance of your discriminator. For best performance all audio connections should be made with shielded cable. The controllers audio path has a flat frequency response from 30 Hz through 4500 Hz except for the CTCSS high pass filter that cuts off at 300 Hz. When interfaced properly to the repeater receiver and transmitter the controller will provide superb audio characteristics.

2.4   REPEATER TRANSMITTER AUDIO CONNECTIONS

Whenever possible, use a direct FM type modulator. However the RI-100 does have a de-emphasis filter that can be turned on for those applications where you may need to interface to a modulator with pre-emphasis. It is not advisable to drive the microphone input on the transmitters. Most transmitters have significant audio shaping, compensating for the microphone response and other characteristics. Always use shielded cable. Connect the controller transmit audio output J1 pin 3 to the input of the modulator. Connect the modulator ground or audio return to J1 pin 11. If an FM modulator without pre-emphasis is not available, the RI-100 can be jumped to drive a phase modulator or modulator with pre-emphasis. This is done by selecting the de-emphasis mode, S-Command 10 3 and changing the position of the on board jumper. The on board jumper should be set with the shunt on the side closest to U10. The side with the shunt closest to J3 is for driving a non de-emphasis modulator.

2.5   REPEATER TRANSMITTER PTT OR TRANSMIT KEYING CONNECTION

The RI-100 repeater controller keys the transmitter at the required times. WARNING - As with all repeater controllers, the controller will key the transmitter at times you may not think of, such as when the ID is executed. It never fails when you disconnect the antenna to connect an in-line watt meter that the ID goes off or a repeater user arrives on the receiver input. The controller PTT keying transistor sinks current, that is, the transistor pulls to ground the relay or keying stage in the repeater transmitter. This is by far the most common interface. Should you need to source a voltage to PTT then contact Pacific Research for application design notes. The keying transistor can sink or pull down (active low) a maximum of 60 ma of current. Connect J1 pin 4 to the repeater transmitter PTT.

2.6   DIGITAL INPUTS

The RI-100 has three digital inputs that can be used to trigger macros. These are CMS gates with a voltage swing of 0 to 5 VDC, TTL level. All digital inputs have pull up resistors. Your application must "pull down" or sink current with either a transistor or TTL gate or equivalent. Upon detecting either a rising or falling edge or change of state of an input the controller automatically executes a macro. See Section 4.5.45 and 4.5.46 for additional information on programming these inputs. These inputs are located on J1 pins 6, 7 and 8. See the connector diagram on the previous page.

2.7   DIGITAL OUTPUTS

The RI-100 has three digital outputs who's states can be modified by S-commands. Each of the three outputs can individually be commanded or forced into the high or low logic state or pulsed high for a desired duration of time. These are CMOS gates with a voltage swing of 0 to 5, VDC TTL levels. Using S-commands (or macros that are composed of S-commands), each output maybe turned on or off or pulsed with the desired S-commands. See Sections 4.5.47 and 4.5.48 for additional information on programming these outputs. These outputs are located on J1 pins 13, 14 and 15. See the connector diagram above.

2.8   CONNECTING TWO RI-100 REPEATER CONTROLLERS TOGETHER

You can connect two RI-100 or a RI-100 and RI-200 Repeater controllers together using the auxiliary interface connector. Over this port, the two radios will exchange audio, PTT and command information. The PTT and S-command information is sent between the two controllers as serial data. A fixed data time-out timer is included in this protocol to protect accidentally keying a transmitter. If data is not received for four seconds the controllers will return to a normal operating mode. The two radios maybe a repeater and a link, two links, two repeaters or a remote base.

Connect the two controllers together with the optional IC-100 interconnect cable. If you prefer to make your own cable the connectors at each end of the 16 conductor flat ribbon cable is "pin flipped" with respect to each other.

AUXILIARY INTERFACE CONNECTOR
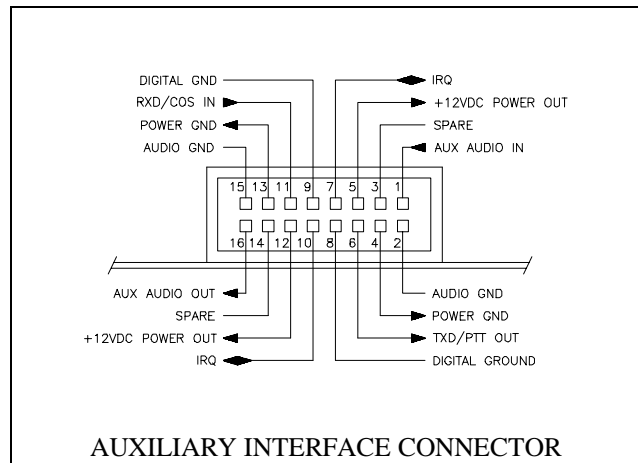
Reference Macro Programming Section 5.0. Command information is sent from one controller to another by writing macro table data telling the controller to send the S-command information to another controller and not to perform that S-command within itself. Each receiver in your radio system has one DTMF decoder and one control processor connected to it. To execute a macro (or user command) within a controller follow all the normal procedures in this manual and in the programming macro's section 5.0. User function that needs to be operated on by another RI-100 controller, you simply insert a "A1" before the S-command and it's data into the macro. All data from the "A1" through the "C" or "D" S-command terminator, will be sent to the second controller. Each controller in the system will have a controller number. When sending a command to another controller , all controller with the same controller number as the "A" number, will execute that S-command. All "A1" controllers will respond to "A1" prefix macro data. All "A3" assigned controllers will respond to the "A3" prefixed macro table data.

Note: The "controller unit address" is set with S-Command 38 and can be any address 1 through 9. The default address is 1 which can be used by both controllers, when only two controllers are connected together.

To transfer serial data between multiple controllers S-Command 37 must be in the default state or 27 1 or mode 1 serial port data transfer mode.

The RI-100 repeater controller and intelligent interface uses the same interfacing connectors and signals as the RI-100. If you require a telephone interface or CTCSS tone panel simply unplug your RI-100 and plug in the RI-200.

The RI-100 also has a digit data mode (S-Command ??) Mode 0 used when connecting to someone else's controller. In this mode the auxiliary interface TTL level input and output digital signals are LOW TRUE or LOW ACTIVE. The COS input is the same as the RXD input and the PTT output is the same as TXD output.

OPERATING AND ADJUSTING THE CONTROLLER

3.0   OPERATING

There are two types of control operations, user macro or user commands and system commands. The system commands or (S-commands) are the principle means for the repeater owner to configure and control the RI-100's basic operations. These commands typically change the characteristics of the system or turn on/off functions of the system. The macros are commands that the repeater owner builds to customize the repeater for the users.

3.1   SYSTEM STATUS INDICATORS

The system status LED indicators will display the current status of the controller. S-Command 11 is provided to enable or disable (turn on or off) all status LED's. This will lower the current drain of the controller and may be important in a solar or portable repeater configuration. With the status LED's turned off, the controller will draw less than 60 ma. During the controller power on self test, the RI-100 will turn on all of the status LED's for 1 second. The following is a list of status LED's and their function.

RI-200 TELEPHONE INTERCONNECT, STATUS LED's

INDICATOR	DESCRIPTION
SYSTEM	Shows when power is connected and the system is enable or turned on (S-Command ??).
COS	Carrier Operated Switch, indicates when a signal is present at the receiver.
CTCSS	Continuous Tone Controlled Squelch System, indicates when a sub-audio tone that has been enabled in the repeater CTCSS tone table is present at the receiver (S-Command ??).
AUX	Shows when there is activity coming from the AUX link port.
PTT	Push To Talk, indicates when the controller is keying the repeater transmitter.
DTMF	Dual Tone Multi Frequency, indicates when the controller is decoding DTMF (Touch Tones).

3.2   DTMF COMMAND INPUT

Dual Tone Multi Frequency or DTMF is typically used in telephone system for dialing. The RI-100 uses DTMF as the primary means for the owner and users to control and communicate with the repeater. DTMF is made up of eight tones with two of the eight turned on in each of the sixteen keystrokes. DTMF is used because of the reliability and ease of use in the audio transmission range.

3.3   TELEMETRY MESSAGES

Telemetry or messages are sent from the controller to you in response to repeater status or function. Any of the messages may be modified (S-Command ??). The controller comes pre-programmed with default messages in response to one of the following events:

EVENT	DESCRIPTION
Courtesy tone	Courtesy message is sent after **each user speaks to let other** users know when the time-out timer has been reset and it is OK to continue talking.
Weak Signal	Replaces the courtesy message when the received signal is weak or noisy.
Power on reset	Replaces the courtesy message after power has been restored to the controller. This message is reset by setting the clock.
Post time-out	Generated when the time-out offender releases his PTT to inform the user of this condition.
Pre time-out	Generated just before the controller chops off the transmission of the user that timed out.
ID	This is the system identification, usually in CW. The factory default is "HELLO". The ID sent periodically as required by the FCC.
Function Error	Generated in response to an S-Command that the controller did not understand.
Function Complete	Generated in response to an S-Command the controller understood and executed.

It should be noted that when the controller is executing a macro, the function complete or function error is in response to the S-Commands within the macro. If you get a function error when controlling your system with a macro, you have an S-Command with an error in the macro.

3.4   SETTING AUDIO LEVELS

Warning: Refer to section 3.8, Initialization procedure. When a full controller initialization is performed all digital pot settings are returned to their default settings, position 31. **Do not perform the initialization procedure at this time**. During full controller initialization all macros, messages, and digital pot settings will be returned to there defaults. While holding down the initialization button, apply 12 VDC power. After all the LED's are turned on, you can release the initialization button and only the system data will be modified. If you continue holding the initialization button for more than five seconds, a full controller initialization will occur resetting the digital pots will be reset.

Note: If you are having startup problems, check the following items.

1.   When entering your password the first time, make sure the COS, CTCSS and DTMF status LED's are operating properly. Most of the startup problems will relate to discriminator audio level too low, too high, too much DTMF twist and/or audio distortion (or CTCSS too high or low). If your discriminator does not have adequate filtering for 455 KHz, you will have to provide for this filtering between the radio and controller. The RI-200 design has a wide dynamic range for all of the decoders and should work in most conditions.

2.   The un-key of your radio when sending a command is a normal command termination. If you are experiencing a problem when getting started or the COS is always on, you can use the "C" DTMF character for the command termination. This should only be necessary until you get the receiver and squelch properly set.

3.   If you experience some problems decoding DTMF, the likely problem is that the tone levels are out of range. The DTMF decoder has 30+ dB dynamic range and decoding DTMF should not be a problem with a reasonable discriminator input level. The DTMF status LED lights when a tone is first decoded and remains lit until after either a function complete or a DTMF Inter-digit time-out. We have seen problems where one row or column did not decode properly. To test this, send one by one digit, all DTMF tone digits, letting the LED light drop off then test the next tone, confirming that all YOUR tones are being properly decoded.

4.   If you send your password multiple times and receive an "ERROR" telemetry message, the controller may already be unlocked.

3.4.1   SETTING RECEIVER INPUT GAIN (S-COMMAND ??)

1. Apply the 12 VDC power source. Confirm the green system LED is on.
2. If the system LED is not on, see the section on troubleshooting.
3. Transmit a carrier on the repeater's input channel. Did the yellow COS light come on? Do not be surprised if the COS LED did not come on or is already on, as we have two adjustments to make before the squelch will work correctly.
4. Generate about a 1000 Hz tone at 3.5 or 5.0 KHz deviation on the repeater input. You can generate a single tone on your DTMF keypad by holding down two buttons in the same row or in the same column. A good test tone is 941 Hz, the bottom row, you can do this by pressing the * and # or * and 0 at the same time.
5. Adjust the receiver audio pot ?? for a level of 2.8 Vp-p or 1 Vrms for a 5 KHz deviation input signal at U1 pin 8. 3.5 KHz deviation is more typical for touch-tones on a typical radio. Then the level should be set for 0.75 Vrms or 2.0 Vp-p at U1 pin 8.

3.4.2   SETTING SQUELCH STAGE GAIN (S-COMMAND ??)

There are two ways to change the gain on any of the digital audio level pots. **Both adjust in a simi**lar manner. The digital pots have electrical shaft positions called steps. Each pot has 64 step, ranging from 0 to 63. There are S-commands to set the pots to specific steps or allow up control by pushing the * key and down control by pressing the # key. All pots in the RI-100 are default set at midrange or 31. Lets set the correct squelch level as we have described.

1. Correctly entered the password.
2. Enter the pot step value with the S-command ?? [level], where the level is a pot step value between 00 and 63. The factory default is 31. If you COS is on all the time, you can try sending ?? 45 or smaller steps to see which way you have to go.
3. If your squelch is too tight, you can try sending a ?? 20 or smaller steps to see which way you have to go.
4. If the squelch is open (COS LED on all the time), it may be necessary to use the "C" command terminator to the end of the command.

For best performance, set the squelch pot 2 or 3 steps above the open squelch threshold. We have now set the squelch level pots. The next is the transmitter audio output.

3.4.3   ADJUSTING THE REPEATER TRANSMITTER (S-COMMAND ??)

After hooking up the repeater transmitter audio and the repeater PTT keying circuit per Section 2, you will need to adjust the through repeat audio. The best way is with a service monitor to look at the transmitter deviation. If a service monitor is not available, use any receiver that is easy to flip back and forth from the repeater input to output channel and listening to the levels. Ideally you will have the same transmit deviation going out the repeater transmitter as coming in the receiver. Transmit a 3 to 4 KHz deviation tone on the repeater input channel. As you flip back and forth between the repeater input and output frequencies listening, adjust the repeater transmitter audio level or deviation. This level is remotely adjusted with a digital pot in the same manner as the previous paragraph but with S-Command ??. When you have finished this adjustment, you have a working repeater with all audio levels correctly adjusted.

3.5   SMARTSQUELCH™ AND NORMAL SQUELCH OPERATION

One of the most powerful features of the RI-100 controller is its built-in squelch (COS). The RI-100 squelch circuit uses a discriminator noise band-pass filter, an adjustable amplifier (adjustable gain), an AC to DC conversion stage, into an ADC (Analog to Digital Converter) and then into the micro-controller. By using the micro, all the significant parameters of a squelch circuit maybe implemented and remotely configurable. In the normal mode the squelch will operate similar to that of a standard radio. You can change the squelch level, upper and lower squelch threshold. In the SmartSquelch mode, micro-controller performs math functions that are operated by an algorithm resulting in a high performance squelch system. Many parameters of the SmartSquelch are remotely adjustable. The squelch starts with a fast 10 ms decay delay and extends this delay depending on the quality of the signal on the repeater input. SmartSquelch also has another useful feature the "weak signal message". The amount of noise is measured and after which if a signal becomes noisier the "weak signal message" replaces the normal courtesy message.

3.6   CTCSS DECODE AND ENCODE OPERATION

CTCSS (Continuous Tone Controlled Squelch System) decode and encode is provided as a standard feature on the RI-100 using state of the art devices. All standard EIA CTCSS tones can be decoded or encoded. The controller has divided CTCSS decode into three independent tone panels. These panels include the repeater, auxiliary interface and DTMF control. The decode tones are selected with S-Commands ?? through ??. The factory default tone for repeater, auxiliary link and control is 100.0 Hz. Default tones maybe changed or additional tones added. Once you have selected the tones that you want to decode, you will need to enable each of the decode tables for decoding of the tone (S-Command ??).

3.8   INITIALIZATION PROCEDURE

There are two distinctive methods of re-initializing and returning to factory default data. Default data for each of the S-Commands are listed in section 4 and the System Command Table at the end of this manual. To initialize the RI-100 data, use the following procedure:

1. Turn power to the RI-100 off.
2. While depressing the initialization button, turn power back on.
3. Wait until all the status LED's turn on and release the initialization button.
4. During this initialization procedure all default data except the audio level digital pot positions were loaded into the repeater controller's "EEPROM" non-volatile memory. During the writing process to the EEPROM, all status LED's will remain on (approximately 3 to 5 seconds).
5. If you need to initialize the digital pot audio levels, during power on initialization continue holding the initialization button for more than five seconds. Then release the button. This initialization loads all default data including the audio level digital pot positions.

Pressing the initialization button while power is applied after the five second initialization time-out will not change any data or be detrimental. After the power has been on for five seconds, the initialization button can be pressed to turn the LED display into a re**ceiver** audio level meter.

3.9   EVENT SCHEDULER

The RI-200 has an event scheduler which can be used to automatically execute commands at programmed times of the day. For the scheduler to work, the system time clock must be set. The system time clock, using S-Command ??. See the programming section for more details. The scheduler uses the system clock to determine when to execute a command. Because the system clock does not have battery backup, it must be reset each time the power is restored to the repeater controller. You can also enable a courtesy message trigger that will let you know when the time clock needs to be reset.

ENABLE THE POWER ON RESET MESSAGE:

1. Unlock the controller, send the password and un-key, you will hear a function complete.
2. Change the power on reset trigger from the standard courtesy message to the CW "RST" message, send "?? 08 3" and un-key, you will hear a function complete.
3. You are done, send "69" to lock the controller.
4. You will now notice a new courtesy message.

Once the system time clock has been set and the schedulers have been setup, command will automatically execute. Three individual schedulers are available. To setup the scheduler, use S-Command ??. See the programming section for more details.

PROGRAMMING

4.0   PROGRAMMING

Creating macros "user commands or functions" are the means by which the repeater owner customizes the repeater. Macro's themselves are a string of S-Commands that are executed just as if you entered them directly. A macro will have its own name, making it a custom user command. Customizing or writing Macros and Messages is as easy as filling in tables and entering data into the controller via any DTMF equipped radio.

IMPORTANT NOTE: At all times the controller is in one of two command modes:

1. **Normal operating mode** where macros or "user commands" are functional.
2. **Programming mode** where S-Commands are entered by the repeater owner.

The controller is always in one of the two modes and never in both. To enter the programming mode the correct password (section 4.2) must be executed. To exit the programming mode and return back to the "Macro mode" or "Normal operating mode" the S-Command 69 is executed. Programming mode is often referred to as the controller "unlocked mode" and the Macro mode as the controller "locked mode".

4.1   PROGRAMMING COMMAND FORMAT

Syntax is a common computer term which means the format of a statement, command, or data that must be organized and entered such that the computer can recognize or understand what you are telling the computer. The syntax of an S-Command consist of a two digit number ranging from 00 to 99 which identifies the S-Command itself. The S-Command is followed by data of various types and amounts. Each of the S-Commands listed in this section will detail its own syntax.

4.2   PASSWORD ACCESS

Prior to the access of any system command or S-commands the repeater owner must enter the valid password. Upon receipt of the valid password the RI-100 controller will return an acknowledgment message (default is an "OK"). At that time any system or S-command may be issued. Any valid S-command will also return the acknowledgment message or sometimes call a "function complete" telemetry. If the controller did not understand the S-Command you will get a CW error message (default is "ERROR").

The controller comes programmed with "123456" as the password to access the system command mode. You can change the password within the range of 1 to 6 digits. Do not use a "C" in your password. To reduce additional problems, check your new password with the system commands to make sure it does not look like a system command. Example, do not use "010" as the password. If you are in the system command mode and accidentally send the password "010", you will turn off the system.

1. Pick your password, 1 to 6 digits. The default is 123456.
2. Unlock the controller, send "123456" and un-key, you will hear a function complete "OK".
3. Enter your new password, send "?? (Your password)" and un-key, you will hear a function complete "OK".
4. If you make any mistakes, re-enter the new password. If you lock the controller with a mistake in the password, you will have to reset all the factory defaults to return to the default password.
5. You are done, send "69" to lock the controller.
6. Check your new password, send "(Your password)" and un-key, you will hear a function complete "OK".
7. Re-lock the controller, send "69"

Should you forget your password, you will have to turn off power to the RI-200 controller, while simultaneously holding down the initialize switch on the controller apply power to the controller. Now the controller will restore all the factory default data. The password will again be the default 123456 and you will have to change it to a new secure password. You will also have to change all the default data to the desired data again. Keep good notes on all data that is changed and all macros written. Space is provided at the end of the manual.

Some controller owners have experience the following problems.

When sending a valid password you may have to terminate the command with a "C" terminator and NOT "letting the COS drop" terminator. This can occur when the squelch is not properly adjusted.

The second problem is when you enter the correct password you will receive an "OK" message or "your acknowledgment message". You continue to enter your correct password and on all following attempts, you receive an "ERROR" message or "your error message". What happened? When the first password was executed and you received an "OK" message you are then in the S-command entry mode. In the S-command mode and if your password does not look like an S-command you will get an "ERROR" message. If your password looks like a valid S-command to the controller, you will have executed that S-command and then receive an "OK" message. Example the default password is 123456. The first time you will get a valid password decoded and an "OK". If you send a 123456 again the controller will think you are trying to send a "12 3456" which try's to set the repeater time out timer to an invalid time.

Always re-lock your controller by sending the S-command 69 when you have finished. Also, there is a time-out timer on the controller. When the controller is un-locked, it will re-lock the controller 5 minutes after the last valid S-command. If you hear an "OK" and you did not expect it (as you did not enter a command function) then the controller has automatically executed the lock command.

4.2.1   AUXILIARY CONTROLLER PASSWORD ACCESS

When you have two RI-100's connected together, you can un-lock and control the auxiliary controller. Un-locking another controller is done by adding an A1 to the end of the local controller's password. Once the auxiliary controller is un-locked you can send S-Commands as usual. Use the following example.

1. Assume the local controller password is 123456 and the auxiliary controller password is 987654.
2. Assume the local and auxiliary controller unit address is 1.
3. From the local controller, send "123456A1" and un-key. You should hear a function complete, CW "OK".
4. The auxiliary controller is now un-locked and you can send S-Commands in the normal format.
5. When your are done, send S-Command 69 to lock the auxiliary controller.

4.3   VALID S-COMMAND AND MACRO DATA

All DTMF digits are valid as data in an S-command or as macro data. The DTMF character "C" is the only digit not valid as data, this character is used as a command terminator, instead of un-keying your radio. When building a macro, the DTMF character "D" is used as the "End of Macro character".

4.4   LEADING ZEROS RULES FOR S-COMMAND DATA

Leading zeros means that if a command requires a 3 digit value, whether the value is 001 or 100, a total of 3 digits must be used. All S-command codes are two digits long. If the first digit is a zero it must always be entered. For most S-command data, use the following rule. If the data is a single parameter, then leading zero's are not required. All commands looking for multiple parameters, required leading zero's for each parameter except the last parameter. Use of the specified number of digits as listed in the syntax of each S-Command later in this section. Anytime an S-command requires two data parameters such as S-Command 30 the first data parameter must have leading zeros and the second data parameter does not require leading zeros. If you are not sure, always use leading zeros especially when you are not yet familiar with the controller.

4.5   S-COMMANDS

IMPORTANT NOTE: At all times the controller is in one of two command modes:

1. **Normal operating mode,** where macros or "user commands" are functional.
2. **Programming mode,** where S-Commands are entered by the repeater owner.

The controller is always in one of the two modes and never in both. To enter the programming mode the correct password (section 4.2) must be executed. To exit the programming mode and return back to the "Macro mode" or "Normal operating mode" the S-Command 69 is executed. Programming mode is often referred to as the controller "unlocked mode" and the Macro mode as the controller "locked mode".

The following sections will detail each of the S-Command codes showing syntax, examples, and the default data values. Remember there are two methods of executing DTMF command sequences over the air. One of the two methods is to directly execute S-Commands. The other method is designed for user function. User function command, macros, are S-Command sequences that are custom defined for your repeater application. To execute an S-Command you must first "unlock" the controller with the current password. When "unlocked" the user commands or macros will not decode. When you "lock" the controller with S-Command 69 you exit the S-Command mode and are again in the user mode of executing macros.

4.5.00   NO OPERATION

Modify or executes nothing. Primarily a NOP will be used to write over portions of a Macro table no longer desired.

        SYNTAX: 00
      DEFAULT: N/A
      EXAMPLE: 00

4.5.01   SYSTEM ENABLE

System enable turns on or off the Repeater PTT, Auxiliary PTT, and all telephone features. The repeater would appear dead to the users when system enable is turned off. When the system is off, the "SYSTEM" status LED will also be off. All other LED's will still show there associated status. This command is set to on when power is applied to controller.

        SYNTAX: 01 [on/off]
      MINIMUM: 0
    MAXIMUM: 1
          UNITS: 1 = On and 0 = Off
      DEFAULT: 1 = On, Set to default when power is turned on.
      EXAMPLE: 01 0   Turns off or disables the Repeater PTT, Auxiliary PTT, and all telephone features.

4.5.02   REPEATER ACCESS MODE

Repeater access mode determines what conditions are required to key the repeater and pass audio from the repeater receiver to the repeater transmitter. This condition is based on carrier detection and or CTCSS requirements.

        SYNTAX: 02 [Mode]
      MINIMUM: 0
    MAXIMUM: 4
          UNITS: Mode 0 = PTT off   Mode 3 = COS and Repeater CTCSS are both required.
                          Mode 1 = COS or carrier detect only.   Mode 4 = Open squelch, the repeater will blow squelch.
                          Mode 2 = Repeater CTCSS only.   Mode 5 = No repeat audio
      DEFAULT: Mode 1 = Repeater COS only.
      EXAMPLE: 02 3   Mode 3, Set repeater to require COS and CTCSS for access

4.5.03   REPEATER CARRIER DELAY ENABLE

This command is used to turn on or off the repeater carrier delay or "hang time". When the carrier delay is off, the courtesy and telemetry carrier delays will also be turned off.

        SYNTAX: 03[on/off]
      MINIMUM: 0
      MAXIMUM: 1
            UNITS: 1 = On and 0 = Off
       DEFAULT: 1 = On, Set to default when power is turned on.
      EXAMPLE: 03 0   Turn Repeater carrier delay off.
                         03 1   Turn Repeater carrier delay on.

4.5.04   REPEATER CARRIER DELAY TIMER

This is the time that the repeater transmitter stays keyed after the receiver input has dropped. The repeater carrier delay is set in tenths of seconds (100 ms) increments.

        SYNTAX: 04 [Time]
      MINIMUM: 0
      MAXIMUM: 255 (25.5 Seconds)
            UNITS: Tenths of Seconds (1/10 Seconds or 100 mili-seconds)
       DEFAULT: 30 (3.0 Seconds)
      EXAMPLE: 04 055   Set carrier delay to 5.5 seconds
                         04 10   Set carrier delay to 1.0 second

4.5.05   FORCE PTT ON

Keys up or "locks on" the repeater transmitter for the selected number of seconds. This provides a constant repeater transmitter signal for running test, measuring power output, or check signal coverage as you drive around. Once the timer has expired, it will not reset itself. You can clear this timer by entering a zero value for the time.

        SYNTAX: 05 [Seconds]
      MINIMUM: 0
      MAXIMUM: 3600 Seconds (equals one hour max.)
            UNITS: Seconds
       DEFAULT: 0
      EXAMPLE: 05 120   Lock on the repeater transmitter for 120 seconds (2 minutes).
                         05 300   Lock on the repeater transmitter for 300 seconds (5 minutes)

4.5.06   REPEATER TELEMETRY MODE

Set the CW telemetry responses to one of three modes. Off, ID only and all on. This can be used to turn off the function complete and error messages while keeping the ID function. If you omit the mode data, the controller will temporarily suspend the function complete or error message. This suspended message is one time only, not effecting the previously selected mode. This feature can be used keep a function complete message from occurring during a macro or user command. More commonly used during a automatic command or scheduled command.

        SYNTAX: 06 [Mode]
      MINIMUM: (No Data)
      MAXIMUM: 2
            UNITS: 0 = Off, 1 = ID only, 2 = All On, No data = Temporarly suspend function complete or function error.
       DEFAULT: 2 = All On
      EXAMPLE: 06 0   Turns off telemetry responses
                         06 1   Turns ID message on only

4.5.07   CARRIER DELAY TIME AFTER A MESSAGE IS SENT

This is the time that the repeater transmitter stays keyed after the courtesy message is finished. Set this timer in tenths of seconds for the carrier delay AFTER any CW, DTMF, or SINGLE TONE MESSAGE.

SYNTAX:	07 [Time]	
MINIMUM:	0	
MAXIMUM:	99 (9.9 Seconds)	
UNITS:	Tenths of seconds (1/10 Seconds or 100 ms)	
DEFAULT:	20 (2.0 Seconds)	
EXAMPLE:	07 10	Set a 1.0 second carrier delay after CW message
	07 99	Set a 9.9 seconds carrier delay after CW message

4.5.08   ID TIMER

Select the time interval for the CW ID or identification. The ID will try to be courteous in that it will wait for someone to un-key before the controller sends the ID. A cleanup ID will also occur after the repeater activity has stopped and the timer has elapsed.

SYNTAX:	08 [Time]	
MINIMUM:	0 (Disable ID)	
MAXIMUM:	255 (25.5 Minutes)	
UNITS:	Tenths of Minutes	
DEFAULT:	100 (10.0 Minutes)	
EXAMPLE:	08 55	5.5 Minutes between IDs

4.5.09   COURTESY MESSAGE TIMER

The courtesy message timer is the selected time from COS carrier dropping, to the start of a courtesy message. This applies to ALL types of courtesy messages. If the carrier is picked up prior to the courtesy timing out, the courtesy message will be skipped. When the courtesy message is started, the repeater time out timer is also reset.

SYNTAX:	09 [Time]	
MINIMUM:	0 (Disable Courtesy)	
MAXIMUM:	99 (9.9 Seconds)	
UNITS:	Tenths of seconds (1/10 Seconds or 100 ms)	
DEFAULT:	20 (2.0 Seconds)	
EXAMPLE:	09 35	3.5 Seconds

4.5.10   RECEIVER AUDIO SOURCE MODE

Select the receiver audio source for the transmitter. The HPF reduces the CTCSS tone passed to the repeater output. The LPF reduces noise bandwidth above 4.5 KHz. Use the de-emphasis if you plan to drive a transmitter with PM or pre-emphasis modulation.

SYNTAX:	10 [Mode]
MINIMUM:	1
MAXIMUM:	4
UNITS:	Mode 1 = Includes a low pass filter (LPF) and a high pass filter (HPF), reject CTCSS tones.
	Mode 2 = Include the low pass filter (LPF) reduces noise above 4.5 KHz, pass CTCSS tones.
	Mode 3 = Select the de-emphasis output for driving pre-emphasis modulation and reject CTCSS tones.
	Mode 4 = Select the de-emphasis output for driving pre-emphasis modulation and pass CTCSS tones.
DEFAULT:	Mode 1, Includes a low pass filter (LPF) and a high pass filter (HPF), rejects CTCSS tones.
EXAMPLE:	10 2 LPF, Low Pass Filter only, pass CTCSS on the repeater output.

4.5.11   LED STATUS DISPLAY ON/OFF

This command turns the LED status display on or off to reduce controller current drain. The display serves no purpose when someone is not present at the repeater. In low power or solar powered systems, this function can be useful to reduce the controller power consumption.

        SYNTAX: 11 [on/off]
     MINIMUM: 0
    MAXIMUM: 1
          UNITS: 1 = On and 0 = Off
      DEFAULT: 1, On
     EXAMPLE: 11 0   Turns Status LED display off (reduce system current drain)

4.5.12   REPEATER TIME-OUT TIMER

The time-out timer sets the maximum length of a single transmission for a user. When the user's transmission time has been exceeded the repeater transmitter PTT is turned off, un-keyed. The COS must drop and the courtesy message started for a normal reset or S-Command 13 can be executed to reset the timer. See the section on messages for more information on the pre and post time-out messages.

        SYNTAX: 12 [Time]
     MINIMUM: 0 (Disable time-out)
    MAXIMUM: 255
          UNITS: Tenths of minutes or 6 second increments
      DEFAULT: 30 (3.0 Minutes)
     EXAMPLE: 12 10   The user will time out the repeater in 1 minute.

4.5.13   REPEATER TIME-OUT TIMER RESET

This command simply resets the repeater time-out timer for S-Command 12. If a user talks to long the timer cuts off the repeater or the repeater timed out from noise on the input. The timer can be reset by capturing the signal on the repeater input and issue the time-out reset S-Command and terminated with a "C". This command could be sent over the Auxiliary Link or telephone.

        SYNTAX: 13
      DEFAULT: N/A
     EXAMPLE: 13   Resets time-out timer.
                         13C   Resets time-out timer.

4.5.14   ADJUST REPEATER TRANSMITTER AUDIO INPUT LEVEL

Also see setup instructions in section 3. This command is used to set the transmitter output audio level. This digital pot has 64 positions (0 to 63) that can set the actual pot position. The command will also accept * up and # down adjustment for one step of the transmitter output audio level. Each up or down command increments or decrement the pot position one number. If you want to move the pot, say five counts each time, you can write a macro to do so.

        SYNTAX: 14 [Level]
     MINIMUM: 0 or # DOWN
    MAXIMUM: 63 or * UP
          UNITS: 1 numeric pot positions.
      DEFAULT: 31
     EXAMPLE: 14*   Raises pot setting by one steps
                         14#   Lowers pot setting by one steps
                         14 15   Moves digital pot to position 15

4.5.15   MACRO COMMAND DECODE ENABLE

This command turns on or off the Macro Command decode, i.e. turning on and off the "user commands". The controller will still listen for the password and S-Commands.

        SYNTAX: 15 [on/off]
     MINIMUM: 0
     MAXIMUM: 1
          UNITS: 0 = Off and 1 = On
       DEFAULT: 1 (On)
      EXAMPLE: 15 0   Disable "user commands" or macros

4.5.16   DTMF INTER-DIGIT TIME

Set the maximum time allowed between DTMF digits in a valid command sequence. If the Inter-digit timer, times out, the command will be terminated without excitation.

        SYNTAX: 16 [Data]
     MINIMUM: 1 (0.1 Seconds)
     MAXIMUM: 99 (9.9 Seconds)
          UNITS: Tenths of seconds (1/10 Seconds or 100 ms)
       DEFAULT: 20 (2.0 Seconds)
      EXAMPLE: 16 50   Sets Inter-digit time to 5.0 Seconds
                           16 35   Sets Inter-digit time to 3.5 Seconds

4.5.17   DTMF MUTE DELAY TIME

Set the time that the receiver audio is muted to the repeater transmitter starting with a valid DTMF tone until desired time expired.

        SYNTAX: 17 [Time]
     MINIMUM: 0 (Disable DTMF mute)
     MAXIMUM: 99 (9.9 Seconds)
          UNITS: 1/10 Seconds
       DEFAULT: Tenths of seconds (1/10 Seconds or 100 ms)
      EXAMPLE: 17 50   Sets Mute time to 5.0 Seconds

4.5.18   SEND DTMF TONES ON REPEATER TRANSMITTER

This command is used to re-send or regenerate a DTMF string on the repeater transmitter, the DTMF tones decoded on the repeater input. The controller regenerates 150 ms long DTMF tones with 80 ms spacing when the USER UN-KEYS. Valid DTMF digits are 0 through 9, A, B, D, *, #. (C is the only non-valid digit). The DTMF regenerate buffer has a maximum length of 48 DTMF digits. This command can also be used in a macro to generate a DTMF string upon a user command.

        SYNTAX: 18 [Data]
     MINIMUM: 0 DTMF digits
     MAXIMUM: 48 DTMF digits
          UNITS: DTMF characters 0 through 9, A, B, D, *, #. (C is the only non-valid digit).
       DEFAULT: N/A
      EXAMPLE: 18 1234567890*#   Resends DTMF characters 1234567890*# on transmitter

4.5.19   CTCSS TONE and DCS DECODE TABLE ENABLE

This command is used to enable or disable each of the CTCSS / DCS decode tables If a decode table is disabled, the CTCSS tone or DCS code will not be required for that function. A table can be disabled without forgetting any of the settings that are enabled in the table. DCS is only available if you ordered your controller with the DCS option installed.

        SYNTAX: 19 [Table] [on/off]
      MINIMUM: 0
     MAXIMUM: 4
           UNITS: 0 = All tables, 1 = Repeater CTCSS / DCS decode table, 2 = DTMF CTCSS / DCS decode table.
                       3 = AUX CTCSS / DCS decode table, 4 = Telephone CTCSS / DCS decode table.
                       0 = Off and 1 = On
       DEFAULT: All tables off
     EXAMPLE: 19 1 1   Enable the repeater decode table.

4.5.20   REPEATER CTCSS TONE and DCS CODE DECODE ENABLE

Each repeater CTCSS tone and DCS code may be independently enabled or disabled for decode. Enabled tones and codes that are active at the receiver, depending on this tone table being enable (S-Command 19) and depending on the repeater access mode (S-Command 02), will allow access of the repeater and pass repeat audio. All, none, or any combination of tones and codes maybe enabled. See table in section 4.5.24 for the individual tone and code numbers. On software version 1.14 and older, only two digit tone numbers are required. DCS is only available if you ordered your controller with the DCS option installed. If you plan **to use** the DCS repeater decode function, avoid using CTCSS tone frequencies 131.8 Hz, 136.5 Hz and greaterthan 210.7 Hz. The DCS protocol uses a tone near this frequency to terminate the DCS data.

        SYNTAX: 20 [Tone Number] [on/off]
      MINIMUM: 000 (All tones and codes)
     MAXIMUM: 144
           UNITS: Tone / Code number 000 through 144 and 1 = On, 0 = Off
       DEFAULT: 013 = 100.0 Hz tone enabled
     EXAMPLE: 20 000 0   Turns off all tones
     EXAMPLE: 20 000 1   Turns on all tones
     EXAMPLE: 20 025 1   Turns on tone number 25 which is 151.4 Hz
     EXAMPLE: 20 020 0   Turns off tone number 20 which is 127.3 Hz

4.5.21   DTMF (CONTROL FUNCTION) CTCSS TONE and DCS CODE DECODE ENABLE

This command is used to enable CTCSS tones and DCS code to be used for DTMF Control. Each DTMF control CTCSS tone and DCS code may be independently enabled or disabled for decode. Enabled tones and codes that are active at the receiver and depending on this tone table being enable (S-Command 19), will allow DTMF control of the repeater in either the macro mode or S-Command modes. If all tones and DCS codes are disabled, a tone or code is not required to control the repeater. All, none, or any combination of tones and codes maybe enabled. See table in section 4.5.24 for individual tone and code numbers. On software version 1.14 and older, only two digit tone numbers are required. DCS is only available if you ordered your controller with the DCS option installed.

        SYNTAX: 21 [Tone Number] [on/off]
      MINIMUM: 000 (All tones and codes)
     MAXIMUM: 144
           UNITS: Tone / Code number 000 through 144 and 1 = On, 0 = Off
       DEFAULT: 013 = 100.0 Hz tone enabled
     EXAMPLE: 21 00 0   Turns off all tones, COS only required for DTMF control
     EXAMPLE: 21 00 1   Turns on all tones
     EXAMPLE: 21 25 1   Turns on tone number 25 which is 151.4 Hz
     EXAMPLE: 21 20 0   Turns off tone number 20 which is 127.3 Hz

4.5.22   AUXILIARY LINK CTCSS TONE and DCS CODE DECODE ENABLE

Each Auxiliary Link CTCSS tone and DCS code may be independently enabled or disabled for decode. Enabled tones or codes that are active at the receiver and depending on this tone table being enable (S-Command 19), will allow the controller to send an auxiliary PTT output data to another controller and depending on the auxiliary access mode of (S-Command 33) and this decode table enable (S-Command 19). All, none, or any combination of tones and codes maybe enabled. See table in section 4.5.24 for individual tone numbers. On software version 1.14 and older, only two digit tone numbers are required. DCS is only available if you ordered your controller with the DCS option installed.

SYNTAX:	22 [Tone Number] [on/off]	
MINIMUM:	000 (All tones and codes)	
MAXIMUM:	144	
UNITS:	Tone / Code number 000 through 144 and 1 = On, 0 = Off	
DEFAULT:	013 = 100.0 Hz tone enabled	
EXAMPLE:	21 00 0	Turns off all tones
EXAMPLE:	21 00 1	Turns on all tones
EXAMPLE:	21 25 1	Turns on tone number 25 which is 151.4 Hz
EXAMPLE:	21 20 0	Turns off tone number 20 which is 127.3 Hz

4.5.23   TELEPHONE ACCESS CTCSS TONE and DCS CODES DECODE ENABLE

Each Telephone CTCSS tone and DCS code may be independently enabled or disabled for decode. Enabled tones and codes that are active at the receiver and depending on this tone table being enable (S-Command 19), will allow the controller to route audio to the telephone. All, none, or any combination of tones and codes maybe enabled. See table in section 4.5.24 for individual tone numbers. On software version 1.14 and older, only two digit tone numbers are required. DCS is only available if you ordered your controller with the DCS option installed.

SYNTAX:	23[Tone Number] [on/off]	
MINIMUM:	000 (All tones and codes)	
MAXIMUM:	144	
UNITS:	Tone / Code number 000 through 144 and 1 = On, 0 = Off	
DEFAULT:	013 = 100.0 Hz tone enabled	
EXAMPLE:	21 00 0	Turns off all tones
EXAMPLE:	21 00 1	Turns on all tones
EXAMPLE:	21 25 1	Turns on tone number 25 which is 151.4 Hz
EXAMPLE:	21 20 0	Turns off tone number 20 which is 127.3 Hz

4.5.24   SET ENCODE CTCSS TONE or DCS CODE for REPEATER TRANSMITTER

This command is used to set the desired CTCSS tone or DCS code to be transmitted on the repeater output. S-Command 25 is then used to determine when this tone or code is transmitted. Each tone or code has a number assigned to it as listed in the following table. DCS is only available if you ordered your controller with the DCS option installed. Cross tone encoding is also available. This is when a different tone is encoded for each decoded tone. For an example, the controller can be set up so that when 100.0 Hz is decoded, tone 127.3 Hz is encoded. Or when DCS code 023 is decoded, tone 151.4 Hz is encoded. Each decode can be assigned one of two types of encode. The use of a master or main encode tone and an individual encode tone. The master or main encode tone is the normal operation of the controller and is selected by omitting the decode tone number. The individual encode tone is optional data in the command and a value of 0 will force the controller to use the master or main encode tone number. To use this cross tone encoding mode, S-Command 25 must be set to mode 3.

```
     SYNTAX:  24 [Encode Tone Number] <Decode Tone Number>
    MINIMUM:  0 (No tone or off)
    MAXIMUM:  144
      UNITS:  Tone Number 0 through 144, Decode tone number is optional
    DEFAULT:  Master or main = 13 (100.0 Hz tone), Indivigal = 0 (Select master tone)
    EXAMPLE:  24 20           Sets master tone encode to 127.3 Hz
    EXAMPLE:  24 0            Sets tone encode to off
    EXAMPLE:  24 013 020      Encode 100.0 Hz when 127.3 Hz is decoded
    EXAMPLE:  24 025 041      Encode 151.4 Hz when DCS code 023 is decoded
```

CTCSS DECODE AND ENCODE TONE (Hz)									
NUMBER	FREQ.	NUMBER	FREQ.	NUMBER	FREQ.	NUMBER	FREQ.	NUMBER	FREQ.
000	ALL	008	85.4	016	110.9	024	146.2	032	192.8
001	67.0	009	88.5	017	114.8	025	151.4	033	203.5
002	69.3	010	91.5	018	118.8	026	156.7	034	210.7
003	71.9	011	94.8	019	123.0	027	162.2	035	218.1
004	74.4	012	97.4	020	127.3	028	167.9	036	225.7
005	77.0	013	100.0	021	131.8	029	173.8	037	233.6
006	79.7	014	103.5	022	136.5	030	179.9	038	241.8
007	82.5	015	107.2	023	141.3	031	186.2	039	250.3
								040	254.1

DCS DECODE AND ENCODE CODES									
NUMBER	CODE	NUMBER	CODE	NUMBER	CODE	NUMBER	CODE	NUMBER	CODE
041	023	062	131	083	251	104	371	125	532
042	025	063	132	084	252	105	411	126	546
043	026	064	134	085	255	106	412	127	565
044	031	065	143	086	261	107	413	128	606
045	032	066	145	087	263	108	423	129	612
046	036	067	152	088	265	109	431	130	624
047	043	068	155	089	266	110	432	131	627
048	047	069	156	090	271	111	445	132	631
049	051	070	162	091	274	112	446	133	632
050	053	071	165	092	306	113	452	134	654
051	054	072	172	093	311	114	454	135	662
052	065	073	174	094	315	115	455	136	664
053	071	074	205	095	325	116	462	137	703
054	072	075	212	096	331	117	464	138	712
055	073	076	223	097	332	118	465	139	723
056	074	077	225	098	343	119	466	140	731
057	114	078	226	099	346	120	503	141	732
058	115	079	243	100	351	121	506	142	734
059	116	080	244	101	356	122	516	143	743
060	122	081	245	102	364	123	523	144	754
061	125	082	246	103	365	124	526		

4.5.25   SET ENCODE CTCSS TONE or DCS CODE MODE

This command selects the CTCSS tone or DCS code, encode mode. Modes 2 and 3 regenerate tones ONLY when valid COS/CTCSS tones are decoded on the receiver input. Mode 3 can be used to cross encode, see S-Command 24. In all modes, the controller stops encoding the tones ½ second before the PTT drops. Make sure you have S-Command 10 in mode 1 (HPF - CTCSS filter on) when S-Command 25 is in Modes 1, 2, or 3. DCS is only available if you ordered your controller with the DCS option installed.

SYNTAX:	25 [Mode]	
MINIMUM:	0	
MAXIMUM:	3	
UNITS:	Mode 0 = Off or no tone encoded.	
	Mode 1 = Encode tone is on all the time (encode tone or code is selected by master tone using S-Command 24).	
	Mode 2 = Controller regenerates last DECODED tone or code.	
	Mode 3 = Controller encodes tone or code selected by S-Command 24 when valid tone or code is detected. Alos used during cross tone encoding.	
DEFAULT:	0, Off	
EXAMPLE:	25 0	Turns CTCSS / DCS encode off
EXAMPLE:	25 1	Enables CTCSS / DCS encode on at all times.

4.5.26   SET CTCSS / DCS ENCODE LEVEL

Use this command to adjust the CTCSS / DCS encode level to the repeater transmitter. The level is adjusted in 0.86 dB steps and starts in the mid range.

SYNTAX:	26 [Level]	
MINIMUM:	0	
MAXIMUM:	6	
UNITS:	0.86 dB steps	
DEFAULT:	3	
EXAMPLE:	26 5	Raises encode tone level by 1.72 dB from default

4.5.27   DCS TX / RX DATA POLARITY CONTROL

Depending on your repeater installation, you may have to change the polarity of the DCS TX / RX data. If the controller will not decode DCS data, change the RX polarity. If your radio will no decode DCS data from the repeater, change the TX polarity. DCS is only available if you ordered your controller with the DCS option installed.

SYNTAX:	30 [TX / RX] [Pol]	
MINIMUM:	TX / RX 0, Pol 0	
MAXIMUM:	TX / RX 1, Pol 1	
UNITS:	0 = TX, 1 = RX, Pol 0 = Non-inverted, 1 = Inverted	
DEFAULT:	TX = 0, RX = 0	
EXAMPLE:	27 1 0	Set RX polarity to Non-inverted

4.5.28   RESERVED FOR FUTURE USE

4.5.29   RESERVED FOR FUTURE USE

4.5.30   EDIT MESSAGE BUFFER

The message buffer is a group of 16 individual buffers where in each buffer a CW or tone sequence message can be stored. Each buffer can store up to 16 message instructions. Each instruction in the message has a 3 digit value and these instructions include tone frequency, CW speed, CW character, tone duration or beep and pause. To edit a message buffer you start with S-command 30, than the two digit message buffer number to be edited followed by up to 16 groups of 3 digit instructions. Leading zeros are required on all message instructions.

> SYNTAX: 30 [Msg Buff #] [Msg data]
> MINIMUM: Msg Buff 01, Msg data 000
> MAXIMUM: Msg Buff 16, Msg data 167
> UNITS: Listed in the CW message data tables in section 11x.
> DEFAULT: Listed in the following default message table.
> EXAMPLE: 30 01 017 032 063 064 Message buffer 01, 697 Hz tone, 12 WPM, "HI"

DEFAULT MESSAGE TABLE																
Msg #	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	NOTE
01	017	105	018	105	019	105	020	105									Courtesy
02	020	105	019	015	018	015	017	015									Weak signal
03	018	036	073	074	075												Power on reset
04	024	116	020	116	017	116											Post time out
05	020	122	017	122													Pre time out
06	017	036	082	063	060	067	067	070									ID "HELLO"
07	024	036	060	073	073	070	073										Error
08	019	036	082	070	066												Acknowledgment
09	150	020	110	017	110	020	110	017	110	020	110	017	110	020	110	156	Auto patch ring
10	020	132															10 Sec Test Tone
11	024	110	137	019	110												Un-lock courtesy
12	017	040	082	063	060	067	067	070									ID "HELLO"
13	165	150	019	036	063	060	067	067	070								AP answer Msg
14	165	150	017	036	070	066											AP ack.
15	165	150	023	036	060	073	077	070	073								AP error
16	165	017	110	020	110	017	110	020	110	017	110	020	110	017	110		AP ring back

4.5.31   SET MESSAGE NUMBER TRIGGER

This command is used to assign an event trigger to a message buffer number. Event triggers are items like ID, courtesy messages and function telemetry. The triggers and their defaults are listed. The defaults can be changes so each event can trigger any of the 16 message buffer or 00 for no message. Setting an event to message 0 will disable that event from triggering any messages. When multiple messages are triggered at the same time, the program will service the messages with the higher message buffer number first. See section 5 for additional information in programming messages and triggers.

```
    SYNTAX:   31 [Trigger #] [Msg buff #]
   MINIMUM:   Trigger # 01, Msg buff # 0 (No Message)
   MAXIMUM:   Trigger # 13, Msg buff # 16
     UNITS:   Trigger #, Msg buff #
   DEFAULT:   See table below
   EXAMPLE:   31 02 14        Sets ID event to Message #14
   EXAMPLE:   31 08 0         Sets Power on reset to no message
```

Trigger #	Event	Msg #
01	Courtesy	1
02	ID	6
03	Acknowledge or function complete	8
04	Function error	7
05	Post time-out	4
06	Pre time-out	5
07	Weak signal courtesy	2
08	Power on reset courtesy	1
09	Telephone (auto-patch) Ring	9
10	Telephone Answer	13
11	Telephone Acknowledge	14
12	Telephone Error	15
13	Telephone Ring Back	16
14	Un-lock courtesy	11

4.5.32   TRIGGER A MESSAGE

This command can be used to force trigger a message. Such as a forced ID or beacon ID using the scheduler.

```
    SYNTAX:   32 [Message #]
   MINIMUM:   1
   MAXIMUM:   16
     UNITS:   Message buffer number
   DEFAULT:   N/A
   EXAMPLE:   32 2            Forces ID message to be sent.
```

4.5.33   AUXILIARY INPUT / OUTPUT MODE

The auxiliary port will allow you to connect multiple RI-200 controllers (or a RI-200 and a RI-100) together or when connecting the RI-200 to someone else's existing controller. This command sets up the mode of the receiving RI-200 and determines what the auxiliary input and output state will be. This mode selection is valid with both serial data out and digital out modes (see S-Command 37). This mode determines what types data and audio is sent to and from another controller. In modes 1 through 8, the auxiliary input is turned on.

```
    SYNTAX:   33 [Mode]
   MINIMUM:   0
   MAXIMUM:   4
     UNITS:   Mode 0 = Auxiliary input and output off or disabled
              Mode 1 = Auxiliary PTT output when repeater COS input is active.
              Mode 2 = Auxiliary PTT output when auxiliary CTCSS tone decode is detected.
              Mode 3 = Auxiliary PTT output when repeater COS and CTCSS tone decode is detected.
              Mode 4 = Auxiliary PTT output is continuously turned ON and squelch turned off.
              Mode 5 through 8 are the same as 1 through 4 but the DTMF audio is not muted.
   DEFAULT:   0, auxiliary off
   EXAMPLE:   33 1           Mode 1, Auxiliary PTT output when repeater COS input is active.
```

4.5.34   AUXILIARY INPUT CARRIER DELAY TIMER

This is the time that the repeater transmitter stays keyed after the auxiliary input has dropped. This carrier delay is set in tenths of seconds (100 ms) increments. Setting the auxiliary delay to zero seconds selects no carrier delay.

```
    SYNTAX:   34 [Time]
   MINIMUM:   0 (No delay)
   MAXIMUM:   255 (25.5 Seconds)
     UNITS:   Tenths of seconds (1/10 seconds or 100 ms)
   DEFAULT:   10 (1.0 Seconds)
   EXAMPLE:   3450           Set Auxiliary input carrier delay to 5.0 seconds.
              34 0           Set Auxiliary input carrier delay to 0 seconds, no delay.
```

4.5.35   AUXILIARY INPUT MODE, (MONITOR MUTE / MONITOR MIX)

This command selects if the auxiliary audio is muted or mixed when activity is on the repeater receiver. In mode 0, the auxiliary radio operates as in a 2 meter remote application where you would want to mute the 2 meter audio when someone is talking on the repeater. Mode 1 the auxiliary audio and the local repeater audio are mixed when the local repeater receiver is active.

```
    SYNTAX:   35 [Mode]
   MINIMUM:   0
   MAXIMUM:   1
     UNITS:   Mode 0 = Mute auxiliary input audio when the local repeater receiver is active.
              Mode 1 = Auxiliary and local repeater audio are mixed when the local repeater receiver is active.
   DEFAULT:   1
   EXAMPLE:   35 0           Mode 0, Mute auxiliary input audio when the local repeater receiver is active.
```

4.5.36   REGENERATE DTMF TONES FROM THE AUXILIARY INPUT

This command selects if DTMF tones from the auxiliary input will be regenerated on the local repeater or link transmitter. Regenerated DTMF tones are 150 ms long immediately following the end of the DTMF decoded string from another controller. With DTMF Mute On (S-Command 17 and 33) you can always pass quality DTMF tones to your link with this regenerate mode.

SYNTAX:	36 [Mode]	
MINIMUM:	0	
MAXIMUM:	1	
UNITS:	1 = On and 0 = Off	
DEFAULT:	0	
EXAMPLE:	36 1	Mode 1, regenerate DTMF digits on output from auxiliary input.

4.5.37   MULTIPLE CONTROLLER DATA LINK PROTOCOL MODE

This command is used to setup the method for multiple repeater controller to communicate. Mode 0 is typically used when connecting to someone else's controller. The TTL level input and output digital signals are LOW TRUE or LOW ACTIVE. The COS input is the same as the RXD input and the PTT output is the same as TXD output. Mode 1 is used when connecting multiple RI-200 (or one RI-200 and one RI-100) repeater controllers together. In mode 1 the controllers communicate to each other using serial data. Also in this mode macro data from one controller can be used to function another controller.

SYNTAX:	37 [Mode]	
MINIMUM:	0	
MAXIMUM:	1	
UNITS:	Mode 0 = Digital I/O	
	Mode 1 = Serial Data I/O	
DEFAULT:	1	
EXAMPLE:	37 0	Mode 0 selects the digital state port.

4.5.38   RI-200 CONTROLLER UNIT ADDRESS

This command is used to assign a RI-200 its unique address when more than 2 controllers are connected together. The unit address is used in a protocol when 2 or more controllers are setup to talk to each other. Valid unit addresses are 1 through 9 with default being 1. A controller with an S-command address in its macro will not process that S-Command, all other controllers will look for a matching address and execute the S-command. An externally executable S-command starts with the "A" prefix and a number like "A2". This will send the S-command following the A2 to all connected controllers with the unit address of "2". When connecting more than 2 controllers, you will have to assign each controller its own address. When only two controllers are connected, both controllers can have the same unit address if they are only talking to each other.

SYNTAX:	38 [Address]	
MINIMUM:	1	
MAXIMUM:	9	
UNITS:	Unit address	
DEFAULT:	1	
EXAMPLE:	38 3	Sets controller unit address to 3.

4.5.39   MACRO LINE JUMP

This command can be used at the end of a macro to jump to another macro line number. You can also use this command to test or execute a macro when you are in the S-command mode. Be careful not to create a loop where at the end of one macro you jump to another and at the end of the second macro you jump back to the first.

```
     SYNTAX:  39 [Macro start line]
    MINIMUM:  0
    MAXIMUM:  254
       UNITS:  Macro start line
    DEFAULT:  N/A
    EXAMPLE:  39 34          Jump to macro starting at line 34 and continue executing S-Commands
```

4.5.40   POWER ON MACRO TRIGGER

Whenever power is lost and then restored to the controller, a flag is set and the Power On Macro is executed. This S-command defines the macro start line for the power on macro trigger. This function can be used to return your repeater to a certain configuration when power is turn on. A function complete will occur when this process is used.

```
     SYNTAX:  40 [Macro start line]
    MINIMUM:  0
    MAXIMUM:  254, 255 = Disable
       UNITS:  Macro start line
    DEFAULT:  0
    EXAMPLE:  40 56           Sets power on macro start line to 56
```

4.5.41   RECEIVER INACTIVITY TIMER

The receiver inactivity timer can be used to reset the system when the repeater receiver activity goes away. This command is used to set the timer that will trigger a macro after the timer counts to zero. The timer is restarted each time the receiver activity goes away. When a time out occurs the macro pointed to by S-Command 42 will execute. Note: This function will generate an "OK" function complete without a user command being sent. For an example, this function can be used to turn on the CTCSS tone decode after there has been no activity on the repeater for the set time.

```
     SYNTAX:  41 [Time]
    MINIMUM:  0
    MAXIMUM:  240
       UNITS:  Minutes
    DEFAULT:  0
    EXAMPLE:  41 0            Clears the timer, no macro will execute.
    EXAMPLE:  41 60           Sets inactivity timer to 60 minutes
```

4.5.42   REPEATER RECEIVER INACTIVITY MACRO TRIGGER

This command is used to point to the macro start line that gets executed when the receiver inactivity timer (S-Command 41) reaches zero. Note: This function will generate an "OK" function complete without a user command being sent.

```
     SYNTAX:  42 [Macro start line]
    MINIMUM:  0
    MAXIMUM:  254, 255 = Disable
       UNITS:  Macro start line number
    DEFAULT:  255, Disabled
    EXAMPLE:  42 20           Receiver no activity timer points to macro line number 020
```

4.5.43   SET CLOCK TIME

The system time clock is used by the scheduler (S-Command 44). This command is used to set the system time clock. This must be done each time power is lost to the controller, if you wish to use the scheduler command. Executing this command resets the flag that triggered the power on reset courtesy message so that the normal courtesy message is used. The time is set in a 24 hour format. If you do not plan to use the scheduler, you can disable the power on reset courtesy message by putting this command in your power on reset macro or by changing the power on message trigger.

```
    SYNTAX:   43 [Hour] [Minutes]
   MINIMUM:   0000
   MAXIMUM:   2359
      UNITS:   Hours, Minutes
    DEFAULT:   Clock not set on power on.
   EXAMPLE:   43 07 30        Set time to 07:30 AM
```

4.5.44   SCHEDULER TO TRIGGER A MACRO AT START LINE

This is a simple scheduler, allowing you to instruct the controller to perform a macro at a certain time of the day. Eight individual schedulers are available. The time clock must be set properly after each time the power is lost (S-Command 43) for this command to work correctly. This command can be used to automatically turn on and off the repeater each day.

```
    SYNTAX:   44 [Scheduler #] [Time] [Macro start line]
   MINIMUM:   Scheduler # 1, Time 0000, Macro start line 0.
   MAXIMUM:   Scheduler # 8, Time 2359, Macro start line 254 and 255 is off.
      UNITS:   Scheduler #, Hours, Minutes, Macro start line.
    DEFAULT:   255 for all schedulers.
   EXAMPLE:   44 1 0730 32   Scheduler #1, Execute macro at start line 32 at 07:30 AM.
```

4.5.45   LOGIC INPUTS and INTERNAL FUNCTIONS - FALLING EDGE TRIGGER

The controller has three digital inputs. Each of these inputs can be setup so when the falling edge of a digital signal is detected (the signal goes from high to low), a macro starting at macro line address 0 through 254 will be executed. To disable this function use 255 as the macro start line address. The controller will also monitor the falling edge of internal functions which can also be used to trigger a macro. See section 7 for information on the pin numbers for each input. This function can be used to generate an alarm message or externally turn on/off a controller function.

```
    SYNTAX:   45 [Bit] [Macro start line]
   MINIMUM:   Bit 1, Macro start line 0
   MAXIMUM:   Bit 9, Macro start line 254 and 255 is off.
      UNITS:   Bit 1 = Input 1, 2 = Input 2, 3 = Input 3, Bit 4 = COS, 5 = Repeater CTCSS or DCS, 6 = PTT,
               Bit 7 = External AUX COS, 8 = External AUX CTCSS or DCS, 9 = External AUX PTT
               Macro start line number = 0 -255
    DEFAULT:   255 for all bits.
   EXAMPLE:   45 1 10         Input #1 Falling edge triggers macro starting at line 10.
   EXAMPLE:   45 6 11         Repeater PTT Falling edge triggers macro starting at line 11.
```

4.5.46   LOGIC INPUTS and INTERNAL FUNCTIONS - RISING EDGE TRIGGER

The controller has three digital inputs. Each of these inputs can be setup so when the rising edge of a digital signal is detected (the signal goes from low to high), a macro starting at macro line address 0 through 254 will be executed.. To disable this function use 255 as the start macro line address. The controller will also monitor the rising edge of internal functions which can also be used to trigger a macro. See section 7 for information on the pin numbers for each input. This function can be used to generate an alarm message or externally turn on/off a controller function.

         SYNTAX: 46 [Input] [Macro start line]
       MINIMUM: Bit 1, Macro start line 0
      MAXIMUM: Bit 9, Macro start line 254 and 255 is off
           UNITS: Bit 1 = Input 1, 2 = Input 2, 3 = Input 3, Bit 4 = COS, 5 = Repeater CTCSS or DCS, 6 = PTT,
                        Bit 7 = External AUX COS, 8 = External AUX CTCSS or DCS, 9 = External AUX PTT
                        Macro start line number = 0 -255
        DEFAULT: 255 for all inputs.
       EXAMPLE: 46 1 12   Input #1 Rising edge triggers macro starting at line 12.
       EXAMPLE: 46 6 13   Repeater PTT Rising edge triggers macro starting at line 13.

4.5.47   DIGITAL LOGIC OUTPUT, ON / OFF

The controller has three digital logic outputs. Each of these outputs can be directly turned on or off with this command. See section 7 for information on the pin numbers for each output. This function can be used to turn on something external to the controller.

         SYNTAX: 47 [Output #] [on/off]
       MINIMUM: Output 1, off
      MAXIMUM: Output 3, on
           UNITS: Output number, 1 = on and 0 = off
        DEFAULT: All outputs are off when power is turned on
       EXAMPLE: 47 1 1   Turns output number 1 on

4.5.48   DIGITAL LOGIC OUTPUT PULSED ON FOR X TIME

The controller has three digital logic outputs. Each of these outputs can be pulsed on for the programmed time duration, the output will go high for the programmed time and than low again. See section 7 for information on the pin numbers for each output. This function can be used to turn on something external to the controller for a set time.

         SYNTAX: 48 [Output #] [Pulse time]
       MINIMUM: Output 1, Pulse time 0
      MAXIMUM: Output 3, Pulse time 255 (25.5 Seconds).
           UNITS: Output, Pulse time in tenths of seconds
        DEFAULT: 0
       EXAMPLE: 48 1 65   Pulses output number 1 high for 6.5 Seconds.

4.5.49   SCHEDULE TO TRIGGER A MACRO AT A REGULAR INTERVAL

This command is used to trigger a macro start line at a regular timed interval. If you want to have a beacon ID every hour, you can use this command to trigger a macro line that starts the ID.

SYNTAX:	49 [Line] [Time]	
MINIMUM:	Line 0, Time 0	
MAXIMUM:	Line 254 and 255 to disable command, Time 240	
UNITS:	Macro start line, Minutes	
DEFAULT:	255, disabled	
EXAMPLE:	49 123 10	Trigger macro starting at line number 123 every 10 minutes.
	49 255	Disable this feature.

4.5.50   ADJUST SQUELCH

The RI-200 used a digital pot to control the squelch level. This command is used to set the squelch level to pot position 00 through 63 or adjusts squelch level by sending a * to increment the level up one step and the # key to decrement the level setting down one step. See section 3 for additional information on setting the squelch level. A macro can be written to step up or down 3 or 5 if desired.

SYNTAX:	50 [Level]	
MINIMUM:	0 or # Down	
MAXIMUM:	64 or * Up	
UNITS:	Pot position	
DEFAULT:	31	
EXAMPLE:	50 *	Adjusts squelch level setting up by one step.
EXAMPLE:	50 23	Sets squelch digital pot to position # 23.

4.5.51   SET SQUELCH MODE

Use this command to select between a standard squelch mode and SmartSquelch™. In the SmartSquelch mode, the processor is used to analyze the signal to noise and determine when to close the squelch fast or add delays for mobile flutter or a hand held radio moving in and out of nulls. This algorithm makes the squelch a fast 10 ms delay when the input signal is very quieting and proportionally longer time to squelch closure when the input signal becomes noisier.

SYNTAX:	51 [Mode]	
MINIMUM:	0	
MAXIMUM:	1	
UNITS:	0 = Normal Squelch, 1 = SmartSquelch	
DEFAULT:	1, SmartSquelch	
EXAMPLE:	51 1	Selects SmartSquelch

4.5.52   SET SQUELCH UPPER THRESHOLD

This command sets a digital value for the squelch upper threshold. This digital value is compared to the squelch A/D converter value. See the SQUELCH section of this manual for more information.

SYNTAX:	52 [Threshold]	
MINIMUM:	75	
MAXIMUM:	200	
UNITS:	ADC Threshold	
DEFAULT:	160	
EXAMPLE:	52 200	Sets new squelch upper threshold value to 200

4.5.53   SET SQUELCH LOWER THRESHOLD

This command sets a digital value of squelch lower threshold. This digital value is compared to the squelch A/D converter value. See the SQUELCH section of this manual for more information.

```
    SYNTAX:  53 [Threshold]
   MINIMUM:  50
   MAXIMUM:  130
     UNITS:  ADC Threshold
   DEFAULT:  110
   EXAMPLE:  53 90              Sets new squelch lower threshold value to 09
```

4.5.54   SET SQUELCH ACQUISITION TIME

This command sets the SmartSquelch acquisition time in 10 ms increments. This is the time that the squelch noise must be below the lower threshold in order to activate the COR. See the SQUELCH section of this manual for more information.

```
    SYNTAX:  54 [Time]
   MINIMUM:  0
   MAXIMUM:  50 (500 ms)
     UNITS:  10 ms increments
   DEFAULT:  8 (80 ms)
   EXAMPLE:  54 4               Sets SmartSquelch acquisition time to 40 ms
```

4.5.55   SET SQUELCH DELAY FACTOR

This command sets the SmartSquelch Delay factor. When the carrier on the repeater input goes away and depending on the previous noise level before the carrier went away, delay is factored into the final part of the squelch. This delay is used to keep the squelch open for a weak or choppy signal. The delay factor is the maximum time in 10 ms increments that the squelch will be kept open. See the SQUELCH section of this manual for more information.

```
    SYNTAX:  55 [Fact]
   MINIMUM:  0
   MAXIMUM:  255 (2550 ms)
     UNITS:  10 ms increments
   DEFAULT:  125 (1250 ms)
   EXAMPLE:  55 25              Sets SmartSquelch delay factor to 250 ms
```

4.5.56   SET AVERAGE FACTOR

This command sets the SmartSquelch average factor. The average factor is used by SmartSquelch to determine how long of a period in 10 ms increments it looks at the noise history. See the SQUELCH section of this manual for more information.

```
    SYNTAX:  56 [Fact]
   MINIMUM:  0
   MAXIMUM:  50 (500 ms)
     UNITS:  10 ms increments
   DEFAULT:  25 (250 ms)
   EXAMPLE:  56 40              Sets SmartSquelch average factor to 400 ms
```

4.5.57   WEAK SIGNAL MESSAGE THRESHOLD

The SmartSquelch Weak Signal Message is triggered based on an evaluation of its noise history. The weaker a signal is, the longer a squelch delay will occur. The length of this time delay can be used to trigger the "weak signal message". See the SQUELCH section of this manual for more information.

        SYNTAX: 57 [Time]
     MINIMUM: 3 (30 ms)
    MAXIMUM: 50 (500 ms)
           UNITS: 10 ms increments
       DEFAULT: 5 (50 ms)
      EXAMPLE: 57 10   Sets the weak signal message threshold time to 100 ms.

4.5.58   REMOTE SOFTWARE RESET

This command allows for a method to reset the controller remotely, same as turning the power off and back on. You can also execute this command through a link (another attached RI-200 controller) or over the telephone. The serial number of your controller is required to operate this command. The serial number of the controller is located on the controller. Make a note of the serial number and keep it in a safe place.

        SYNTAX: 58 [Serial number]
     MINIMUM: N/A
    MAXIMUM: N/A
           UNITS: Serial number is 8 digits long.
       DEFAULT: Your RI-200 Serial number
      EXAMPLE: 58 87654321   Resets the controller software only. This example will not be your serial number.

4.5.59   REMOTE EEPROM INITIALIZE

This command allows you to reset your EEPROM (Non-Volatile RAM) data with factory defaults, remotely. You can also execute this command through a link (another attached RI-200 controller) or over the telephone. This S-Command is the same as if you were to press the initialization button on the controller and turn the power on. However the digital potentiometer gain settings will not be reset. The serial number of your controller is required to operate this command. The serial number of the controller is located on the controller. Make a note of the serial number and keep it in a safe place.

        SYNTAX: 59 [Serial number]
     MINIMUM: N/A
    MAXIMUM: N/A
           UNITS: Serial number is 8 digits long.
       DEFAULT: Your RI-200 Serial number.
      EXAMPLE: 59 87654321   Initialize the EEPROM only. This example will not be your serial number

4.5.60   USER DEFINED TELEPHONE COMMANDS

This command is used to name a macro (user command) that will be used to dial the telephone. This is a special type of a macro, as it will allow extra digits after the macro name which it uses as the telephone number that will be dialed. This command requires the macro number (up to 8 telephone macros are available), the macro start line (the point in the macro table that the macro starts) and the macro name. The macro start line that this name will point to, should include the off hook S-command 82 for everything to work correctly. The on hook command does not require this type of macro. For on hook commands, use a standard macro. To clear a macro name, send the S-Command and macro number you want to clear. See section 5 for more information on programming macros.

SYNTAX:	60 [Telephone macro] [Macro start line] [Macro name]
MINIMUM:	Telephone macro 01, Macro start line 000, Macro name 0 digits (0 digits will remove the macro)
MAXIMUM:	Telephone macro 08, Macro start line 254, Macro name 4 digits
UNITS:	Macro number, Start line, Macro name
DEFAULT:	See default table below
EXAMPLE:	60 02 100 *44 Telephone macro #2 points to macro start line 100 and the name is "*44"

DEFAULT TELEPHONE MACRO NAME TABLE					
Macro Number	Macor Start Line	D1	D2	D3	D4	Notes
01	012	*	8			Telephone off hook, Simplex
02	014	*	9			Telephone off hook, Duplex

4.5.61   USER DEFINED S-COMMANDS, RENAME A SYSTEM COMMANDS

This command is used to define a "Mini macros". Mini macros are S-Commands that are renamed for "user commands". These user commands allow extra digits after the macro name which is passed along to the S-command that it points to. See the example in the default macro name table, the "A" is used to force a CW message. If the user where to enter an "A6", this will force the ID. To clear a mini macro name, send the S-Command and macro number you want to clear. See section 5 for more information on programming macros.

SYNTAX:	61 [Mini macro] [S-Command] [Macro name]
MINIMUM:	Mini macro 01, S-Command 00, Macro name 0 digits (0 digits will remove the macro)
MAXIMUM:	Mini macro 21, S-Command 99, Macro name 4 digits
UNITS:	Mini macro number, S-Command, Macro name
DEFAULT:	See default table below
EXAMPLE:	61 04 02 33 Mini macro 4 points to S-command 02 and the name is "33"
	S-command 02 is repeater mode, so a user command "334" will open the squelch.

DEFAULT MINI MACRO NAME TABLE					
Macro Number	System Command	D1	D2	D3	D4	Notes
01	32	A				Trigger a message
02	05	B				Lock on PTT

4.5.62   USER DEFINED MACRO COMMANDS

These are normal macros or user commands. When you enter a command in the locked mode, the program checks the user command to see if it is a valid command, the digits themself and total digits must be an exact match. If there are any extra digits in the user command, the command will be rejected. This type of macro will point directly to a macro start line where multiple S-command can be executed. To clear a macro name, send the S-Command and macro number you want to clear. See section 5 for more information on programming macros.

         SYNTAX: 62 [Macro] [Macro start line] [Macro name]
      MINIMUM: Macro 01, Macro start line 000, Macro name 0 digits (0 digits will remove the macro)
     MAXIMUM: Macro 99, Macro start line 254, Macro name 4 digits
           UNITS: Macro number, Start line, Macro name
       DEFAULT: See default table below
       EXAMPLE: 62 35 040 123 Macro #65 points to macro start line 40 and the name is "123"

DEFAULT MACRO NAME TABLE						
Macro Number	Macro Start Line	D1	D2	D3	D4	Notes
01	000	*	1			System on
02	001	#	1			System off
03	002	*	3			CTCSS tone decode on
04	003	#	3			CTCSS tone decode off
05	004	*	5			DTMF Mute on
06	005	#	5			DTMF Mute off
07	006	*	6			Squelch on
08	007	#	6			Squelch off
09	008	*	7			Carrier delay on
10	009	#	7			Carrier delay off
11	010	*	4			CTCSS tone encode on
12	011	#	4			CTCSS tone encode off
13	013	#	8			Telephone on hook
14	013	#	9			Telephone on hook
15	015	*	2			Link On, Duplex
16	017	#	2			Link Off

4.5.63   MACRO EDITOR, SET STARTING LINE NUMBER POINTER

When you want to edit or build a new macro, this command is used to set the macro start line where you want to start entering your S-commands into the macro table. Once the pointer has been set, you can begin to enter the S-commands into your macro. The controller will keep track of its exact position in the table until you set a new start line. There are 255 starting lines in the macro data table.

         SYNTAX: 63 [Macro start line]
      MINIMUM: 0
     MAXIMUM: 254
           UNITS: Macro start line
       DEFAULT: N/A
       EXAMPLE: 63 7   Sets the pointer to start on macro line number 7

4.5.64   MACRO EDITOR, INSERT COMMANDS

Once you have set the macro start line pointer, you can begin to enter S-Commands into the macro data table. One or many S-Commands can be strung together. Each S-command and its data is entered into the table, it is terminated with a un-key or "C". The last S-command must have a "D" on the end to tell the controller that this is the last S-command in the macro. When you un-key while entering an S-Command or use a "C" or "D", the program will insert a digit into the macro data table. When planing your macro data table, you need to allow for these digits. See the default table below for an example.

SYNTAX:	64 [S-Command] [S-Command data] [End]
MINIMUM:	S-Command 00, S-Command data as required, End with un-key / "C" / "D" as required.
MAXIMUM:	S-Command 99, S-Command data as required, End with un-key / "C" / "D" as required.
UNITS:	S-Command, S-Command data
DEFAULT:	See default table below
EXAMPLE:	64 02 1 S-command 02 (repeater mode), S-command data 1 (COS)
	64 10 1 D S-command 10 (RX source), S-command data 1 (LPF & HPF), End of macro
	This macro will set the repeater in COS and set the audio source to (LPF & HPF) with the following data in the macro data table (021C101D)

DEFAULT MACRO DATA TABLE																	
Line	Macro Name	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	Notes
000	*1	0	1	1	C	0	2	3	C	0	6	2	D					System on
001	#1	0	1	0	D													System off
002	*3	1	9	1	1	D												CTCSS tone decode on
003	#3	1	9	1	0	D												CTCSS tone decode off
004	*5	1	7	2	5	D												DTMF Mute on
005	#5	1	7	0	D													DTMF Mute off
006	*6	0	2	3	D													Squelch on
007	#6	0	2	4	D													Squelch off
008	*7	0	3	1	D													Carrier delay on
009	#7	0	3	0	D													Carrier delay off
010	*4	2	5	1	D													CTCSS tone encode on
011	#4	2	5	0	D													CTCSS tone encode off
012	*8	0	6	1	C	7	0	1	C	7	2	0	C	8	2	1	D	Telephone off hook
013	#8, #9	0	6	2	C	8	2	0	D									Telephone on hook
014	*9	0	6	1	C	7	0	2	C	7	2	1	C	8	2	2	D	Telephone off hook
015	*2	3	3	3	C	3	5	1	C	A	1	3	3	3	C	A	1	Link On, Full Duplex
016		3	5	1	D													
017	#2	3	3	0	C	A	1	3	3	0	D							Link Off

4.5.65   SET KEY-CODE FOR MACROS (USER COMMANDS)

The key-code is a 1 to 4 digit sequence that would be required in front of all macro commands (user commands). This function could be used as a site prefix so that all of your repeater sites would have the same macro command suffix.. The KEY-CODE or PREFIX maybe 0 to 4 DTMF digits long (C, D are NOT VALID digits). If you enter no key-code digits in the command, the key-code is disabled.

SYNTAX:	65 [Key-code]	
MINIMUM:	0 digits (0 digits will disable the KEY-CODE)	
MAXIMUM:	4 digits	
UNITS:	DTMF digits	
DEFAULT:	0 digits	
EXAMPLE:	65	Disable the key-code.
	65 *123	Sets *123 as the macro key-code or site prefix.

4.5.66   SET PASSWORD FOR S-COMMAND ACCESS

The PASSWORD is used to access the S-Command mode or un-lock the controller. The factory default password is 123456 and can be changed to another set of digits from 1 to 6, "C" is the only digit that can not be used in a password. When selecting a password, you should avoid using one that is similar to a macro command or the exact equivalent to an S-command and its data. For more information on passwords, see section 4.2 of this manual.

SYNTAX:	66 [Password]	
MINIMUM:	1 digit	
MAXIMUM:	6 digits	
UNITS:	DTMF digits	
DEFAULT:	123456	
EXAMPLE:	66 34*685	The new password is now 34*685
	66 12	The new password is now 12

4.5.67   SET PASSWORD FOR TELEPHONE INCOMING RING ACCESS

The telephone ring PASSWORD is used to start the ringing process on the repeater for incoming calls, also see S-Command 71, incoming call mode. This password is only to be used for S-command 71 modes 3 and 4. The controller will answer the telephone ring and provide an answer massage. After this message the ring password is used to start the ring message on the repeater to let someone on the radio know that a caller is waiting on the telephone. The factory default password is 343 and can be changed to another set of digits from 1 to 6, "C" is the only digit that can not be used in this password. Also avoid using "A", "B" and "D" as these digits are not typically available on standard telephones. For more information, see section 6 of this manual, telephone interface.

SYNTAX:	67 [Telephone ring password]	
MINIMUM:	1 digit	
MAXIMUM:	6 digits	
UNITS:	DTMF digits	
DEFAULT:	343	
EXAMPLE:	67 5419	The ring password is now 4519

4.5.68   SET PASSWORD FOR TELEPHONE INCOMING CONTROL ACCESS

The telephone incoming control PASSWORD is used to access the command mode of the controller during an incoming call. This password can only be used for S-command 71 modes 2 through 4. The factory default password is 654381 and can be changed to another set of digits from 1 to 6, "C" is the only that can not be used in this password. Avoid using "A", "B" and "D" as these digits are not typically available on standard telephones. When selecting a password, you should avoid using one that is similar to a macro command or the exact equivalent to an S-command and its data. For more information, see section 6 of this manual, telephone interface.

        SYNTAX: 68 [Telephone control password]
      MINIMUM: 1 digit
    MAXIMUM: 6 digits
          UNITS: DTMF digits
      DEFAULT: 343
      EXAMPLE: 68 5419   The control password is now 4519

4.5.69   EXIT S-COMMAND PROGRAMMING

When you are finished making S-Command changes, use this command to lock the controller and exit the S-command mode. If no S-Commands are executed for 5 minute, a timer will automatically lock the controller for you.

        SYNTAX: 69
      DEFAULT: N/A
      EXAMPLE: 69   EXIT S-COMMAND PROGRAMMING MODE

MACRO AND MESSAGE PROGRAMMING

5.0   MACRO PROGRAMMING INTRODUCTION

Macro programming in the RI-200 repeater controller is the means by which you generate custom and secure commands for the repeater users to send. Macros are made up of one or more system commands or S-Commands. This group of S-Commands are then given a custom command name (User Command). When the repeater user sends the custom command, the macro will automatically execute the S-Commands that are contained in that macro. Before entering your macro into the controller, organize your macros on the worksheets at the end of this manual. This planning effort will pay off with superior results.

In the RI-200 there are three distinctive forms or types of macros. The following paragraphs will outline these macros in more detail.

1.   Macro, used for all other applications.
2.   Mini-macro, used to directly rename an S-Command as a user command.
3.   Telephone macro, used for dialing the telephone.

IMPORTANT NOTE:
At all times the controller is in **one of two command modes**:

1.   **Normal operating mode** where macros or "user commands" are functional.
2.   **Programming mode** where S-Commands are entered by the repeater owner.

The controller is always in one of the two modes and never in both. To enter the programming mode the correct password (section 4.2) must be executed. To exit the programming mode back to the "Macro mode" or "Normal operating mode" the S-Command 69 is executed. Programming mode is often referred to as the controller "unlocked mode" and the Macro mode as the controller "locked mode"

5.1   PROGRAMMING NORMAL MACROS

Normal or full macros are used for more elaborate functions, usually containing the execution of multiple S-Commands. Also some of the controller functions point directly to starting positions in the macro data table, these functions includes power on initialization, scheduler, digital inputs, and timers that point to macro command lines.

When programming normal macros, there are two types of data tables that you need to enter into the controller. First you must setup the **Macro Name Table**. The name table holds the name (the command the user will send) of all your macros and each of these names point to a starting line in the macro data table where the macro will start its execution. The second table is the macro data table where the S-Commands are stored and executed. Worksheets of these tables have been provided at the end of this manual. The controller is shipped from the factory with some default macro commands, review S-Command 63 through 65.

When programming a macro, always follow these simple steps.

1.   Make plans for what you would like to do.
2.   Use the supplied macro name and data table worksheets and write down what you want to do.
3.   Send your PASSWORD and un-key, you should hear a function complete CW "OK". This will to un-lock the controller and you are now ready to program your macros.

Example of programming a normal macro name into the macro name table:

When a repeater user sends a command, the controller checks the command with the names in the normal macro name table for an exact match. The RI-200 has 100 normal macro names available for use. Each macro has number 01 through 99 which are like mail box's. Into this box, you put where the macro data starts (start address or macro start line), and then you give the macro its function name (user command). If you need to remove or clear a name, send the macro name S-Command followed by the macro name line number. Do not include the macro start line number or macro name. In the following example, you will create a macro with "*456" as the name.

1. Un-lock the controller with the password.
2. Send "62 20 050 *456" then un-key, you should hear a function complete CW "OK".
3. This is what you did:
   - 62 = S-command to define a macro name.
   - 20 = Macro number, the mail box number.
   - 050 = Macro data start line number.
   - *456 = Macro name or the function the user will send to execute the macro.

Example of programming macro data into the macro data table:

Anytime you begin to write a new or modify an existing macro, you first must tell the controller what line in the table you want to start on, this is the macro starting line number. Each line in a macro will hold up to 16 digits or characters of data. After you start entering macro data, the controller will keep track of what line and character position you are on until you wish to point to a new location. Once you set the macro line pointer, you are ready to enter you macro. To enter the macro data, you enter one S-command at a time, each time you un-key your radio you will get a "function complete" message. The controller will insert a "C" at the end of the S-Command to separate each S-Command in the macros. This process of entering an S-Command in to the macro has not error checking of the S-Command and it's data that you entered into the macro. When you reach the last S-Command in the macro, you will need to add a "D" to the end of this S-Command. The "D" is an End of Macro character or marker. The following example will turn off the CTCSS tone for the repeater and DTMF control.

1. Un-lock the controller with your password.
2. Send "63 50" and un-key, you should hear a function complete CW "OK". This will set the macro line pointer to line 50 as used in the macro name table above.
3. Send "64 19 10" and un-key, you should hear a function complete CW "OK". 64 is the macro editor command. 19 is the CTCSS decode table control S-Command. 10 is the repeater decode table off S-Command data.
4. Send "64 19 20 D" and un-key, you should hear a function complete CW "OK". 64 is the macro editor command. 19 is the CTCSS decode table control S-Command. 20 is the DTMF decode table off S-Command data. The "D" identifies the end of this macro.
5. The data stored in the macro table at line 50 will look like "1910C1920D".

So that the controller knows that you want to edit a macro and not execute the S-Command, you must send a 64 to tell the controller that the following is the S-Command and data for a macro. A large macro can start at a given line and continue past multiple lines.

5.1.1   PASSING S-COMMANDS TO ANOTHER CONTROLLER

S-Commands can be sent from one controller to another. This is done by including the destination controller's address in front of the S-Command. When the destination controller address leads the S-Command, that S-command is not executed in the source controller. When you have an S-Command that needs to be executed in another RI-200 controller, you simply insert a "A1" before the S-command and it's data into the macro. All data from the "A1" through the "C" or "D" (S-command terminator) will be sent to the second controller. In this setup, each controller in the system will have a controller number or controller address. When sending an S-Command to another controller , all controller with the same controller number as the "A" number in the S-Command, will execute that S-command. In other words, all "A1" controllers will respond to "A1" prefix and macro data. All "A3" assigned controllers will respond to the "A3" prefixed macro data. The "controller unit address" is set with S-Command 38 and can be any address 1 through 9. The default

address is 1 which can be used by both controllers, when only two controllers are connected together. To transfer serial data between multiple controllers S-Command 37 must be in the default state (S-Command 37 1) mode 1, serial port data transfer mode. The following example will send an S-Command to another controller to turn off the CTCSS tone for that controller.

1. Un-lock the controller with your password.
2. Send "63 51" and un-key, you should hear a function complete CW "OK". This will set the macro line pointer to line 50 as used in the macro name table above.
3. Send "64 A1 19 10 D" and un-key, you should hear a function complete CW "OK". 64 is the macro editor command. A1 is the address of the controller that will execute the following S-Command. 19 is the CTCSS decode table control S-Command. 10 is the repeater decode table off S-Command data. The "D" identifies the end of this macro.
4. The data stored in the macro table at line 51 will look like "A11910D".

5.2   MINI MACROS

Think of mini-macros as just renaming S-commands. In the RI-200, you have 21 mini-macros available. Mini-macros are executed by names just like full macros. Mini-macros are intended to be used by the repeater users and have security because the S-commands have new names. One does NOT issue a password to execute a mini-macro. Mini-macros can, but do not have to pass the data field of an S-command.

Use mini-macros for simple applications. Use normal macros for user execution of multiple S-commands. Reference the default mini-macro name table. The following example will allow a user to lock on the repeater transmitter for a set time.

1. Un-lock the controller with your password.
2. Send "61 05 21" and un-key, you should hear a function complete CW "OK". 61 is the mini-macro S-Command. 05 is the force PTT on S-Command. 21 is the name of the mini-macro.
3. Send "69" and un-key, you should hear a function complete CW "OK". This locked the controller
4. Send "22 15" and un-key, you should hear a function complete CW "OK". Next you should notice that the repeater transmitter will stay on for 15 seconds. The 22 was the name of the mini-macro and the 15 was the data that is passed to S-Command 05.
5. You now have a user command to force on the repeater transmitter.

5.3   PROGRAMMING CW MESSAGE TABLE

The message table is setup to be very easy to modify. Refer to the default message table located with S-Command 30. A worksheet and the CW Data table have been provided at the end of this manual. The RI-200 has 16 messages buffer and each buffer will hold up to 16 message instructions or commands. You can change any message in the RI-200 to make your controller compatible with existing systems. Any messages can have CW, DTMF tones, single tones, multiple tones or combinations of any of the above. Lets examine message #6 for our first example. This message is the factory default ID "HELLO".

Each character of the ID has a 3 digit instruction or command number. See the CW data table in section 11 for a list of all CW commands available.

Character 1 = 017   697 Hz tone
Character 2 = 036   CW speed, 16 WPM
Character 3 = 082   CW Space
Character 4 = 063   CW "H"
Character 5 = 060   CW "E"
Character 6 = 067   CW "L"
Character 7 = 067   CW "L"
Character 8 = 070   CW "O"

Review the procedure to enter this ID into the controller.

1. Unlock the controller, send the password and un-key, you will hear a function complete "OK".
2. Send the system command, buffer number and message data "30 06 017 036 082 063 060 067 067 070" and un-key. You should hear a function complete "OK". If you hear an error message "ERROR", a mistake was made and you will need to re enter the message
3. Test your message, send "32 06". You should hear your message.
4. You are done, send "69" to lock the controller.

This example will show you how to change your function complete message. This is currently stored on buffer 08. The factory default message is CW "OK" In this example the function complete will be two 1/10 second tones, first at 1206 Hz and the second at 770 Hz.

Character 1 = 021 Set tone generator to 1209 Hz tone
Character 2 = 110 Tone on for 100 ms
Character 3 = 138 Pause for 60 ms
Character 4 = 018 Set tone generator to 770 Hz
Character 5 = 110 Tone on for 100 ms

Now you are ready to enter this message into the controller as the new function complete.

1. Unlock the controller, send the password and un-key, you will hear a function complete "OK".
2. Send the system command, buffer number and message data "30 08 021 110 138 018 110" and un-key. You should hear a function complete "OK". If you hear an error message "ERROR", a mistake was made and you will need to re enter the message
3. Test your message, send "32 08". You should hear your new function complete message.
4. You are done, send "69" to lock the controller.

It should be noted that the program uses the one timer to measure the CW speed, tone beeps and pauses. If you were to set the CW speed, send a CW message and then send a tone beep or pause, you would have to reset the CW speed before you could send a CW message again.

A message in the message table is triggered by an event. Using S-Command 31, you can control which event will trigger or start which message. Your pre-time-out event and post-time-out event can be set to trigger the same message. You may not want the weak signal message, an easy way to disable that is to point the weak signal event to the same message number as the courtesy message.

5.4   EXITING PROGRAMMING MODE

Remember to execute an S-command 69 to lock your controller when you are finished with the programming mode. The controller will also exit the S-command mode after 5 minutes of no DTMF activity. You may discover this by an automatic function complete. Remember in the programming mode only S-Commands are functional. After exiting the programming mode, only the macros (user functions) will be processed.

7.1   RI-100 REPEATER CONTROLLER SCHEMATIC

INSERT SCHEMATIC HERE

7.2   RI-100 REPEATER CONTROLLER BOARD LAYOUT SECTION

INSERT PC BOARD LAYOUT HERE

TROUBLESHOOTING

8.0   STANDARD TROUBLESHOOTING

This section provides procedures to solve some common problems that may occur with the RI-200. For technical and customer support, contact us at:

PACIFIC RESEARCH
Tel: 619-924-2557
Fax: 619-924-2558
email: pacres@qnet.com

PROBLEM	SOLUTION
No Green System LED	+12 VDC power source not connected or voltage below 8VDC minimum. S-command 01 (system on/off) is off and or S-command 11 (display on/off) is off If the unit has adequate voltage, and the S-commands are correct, there may be some type of hardware failure.
No COS yellow LED	Confirm the receiver is on channel.
COS yellow LED on all the time	Confirm the receiver audio input level and the squelch level adjustments are correctly set. Check that the discriminator audio input is connected and working. If your discriminator does not have adequate filtering for 455 KHz, you will have to provide for this filtering between the radio and controller.
No CTCSS yellow LED	CTCSS may not be responding because either the controller or the input signal does not have the correct CTCSS tone. Confirm that the COS LED is working and the receiver audio level is correctly set.
No PTT red LED	If COS and PL operate properly, then check that the S-Command 01 and 02 are set correctly.
No DTMF yellow LED	Confirm that the COS and CTCSS LED is working and the receiver audio level is correctly set. CTCSS tone may not be correctly set for DTMF control. This LED should light with the beginning of the first valid DTMF and go out with a function complete or the inter-digit timer timing out.
No Aux input yellow LED	Valid only when the Aux input is connected to another RI-100 controller or a control receiver. When connected to another RI-200 confirm all the Aux function are correctly enabled on both controllers

8.1   PROBLEM CHECK LIST

Use the following check list if you are experiencing problems with your controller.

1. Confirm that you have 12 VDC power connected to the correct pins.
2. Turn on power to the repeater. You will first hear a CW "OK" and then the default ID "HELLO". The system LED should be the only LED on. If other LED's are on, see the above problem list.
3. Apply a carrier without a CTCSS tone on the input of the repeater. The COS LED should come on.
4. Apply a carrier with 100Hz CTCSS tone on the input of the repeater. The COS and the CTCSS LED should come on.
5. Apply a carrier with a DTMF tone on the input of the repeater. The DTMF LED should come on.

GLOSSARY AND WARRANTY REPAIR

9.0   GLOSSARY

ADC: Analog to Digital Converter, this is a device or circuit that converts an analog voltage to a digital number.

ANALOG: A voltage that has multiple or dynamic levels within a given range.

CARRIER DELAY: The time a repeater transmitter remains on after a valid receiver signal input.

CLOCK: The system clock utilized to meet the needs of the time operated scheduler.

CONTROL CODES: The sequence of DTMF digits sent to perform a command or function.

CONTROL OPERATOR: Any repeater operator, designated to control or modify the repeater's operation.

COR: Carrier Operated Relay. An old term referring to the detection of a signal present on a repeater input.

COS: Carrier Operated Switch. This is used interchangeable with COR

CPU: Central Processing Unit is the microprocessor or the brain of your controller.

CTCSS: A sub-audio tone use for access to the repeater, auxiliary, and DTMF command entry. CTCSS tones are normally between 67 Hz and 203.5 Hz.   Private Line or PL is the Trademark of Motorola.   Channel Guard or CG is the Trademark of GE. Quiet Channel is the Trademark of RCA.

DCS: Digital Controlled Squelch. A sub-audio tone with encoded data that can be used to control access to the repeater.

DEFAULTS: Pre-set values that define the system characteristics. A default is the value that the unit is set to when supplied from the factory.

DIGITAL INPUTS: 0-5 VDC (TTL level) CMOS input. An input can be used to trigger or initiate a Macro.

DIGITAL OUTPUTS: TTL levels, CMOS digital output. Each output can be individually changed in state by either an S-command or from within a Macro.

DISABLED: Turned off or not active.

DTMF: Dual Tone Multi Frequency. Used by telephone systems for dialing, also referred to as Touch-Tone.

EEPROM: A special type of non-volatile memory that retains its programming information without power.

ENABLED: Turned on or active.

EOC: End of Command. This DTMF character is entered at the end of a command sequence.

EOM: End of Macro. This DTMF character is entered at the end of the desired macro sequence.

FUNCTION: A valid DTMF sequence command executed by the controller.

FUNCTION COMPLETE: Telemetry response generated by the controller following execution of a valid command.

HOOK: This is like the hook switch on a standard telephone. Off hook means the hand set is off the telephone and on hook means the hand set in on the telephone.

INTER-DIGIT TIMER: Sets the maximum allowed time in seconds between valid DTMF command inputs.

INITIALIZE: To set up the minimum data requirement for the system.

KEY CODE: A programmable code that is used with a command code to provide security of the command codes.

MACROS: Macros allow the repeater owner to define user commands that execute one or more S-Commands thus customizing the commands for your repeater.

MICROCONTROLLER: A type of microprocessor that contains RAM, ROM, some I/O, etc. into one IC package. This significantly reduces RFI noise generated by the controller board as all interconnects are very short.

MUTE: Turning off the receiver audio to the transmitter. Mute is usually turned on when DTMF commands are being received and processed in order that the tones are not applied to the repeater transmitter. This would limit other people at ground level from decoding your commands and breaking into your repeater.

PASSWORD: A system access code that is used to secure access to all S-Commands in the RI-200. The repeater owner can change the password at anytime.   DO NOT FORGET YOUR PASSWORD or you will have to initialize the controller which will load default data and you will have to reload all your macros and other information.

PL: Private Line or PL is a Trademark of Motorola for the EIA standard sub-audio tones used for repeater access.

PTT: Push to Talk is the keying of a transmitter. The RI-200 controller generates PTT to your repeater when a proper user is on the repeater input or when the controller is generating telemetry or carrier delays.

SCHEDULER: At specified times of the day when macros are automatically executed.

S-COMMAND: A system command code tells the controller to perform a function or set the controller in a given configuration.

SECURITY: Security is the limiting of access.   Password protection is provided for security.

SYSTEM COMMAND: An instruction that tells the system to perform a function.

TELEMETRY: Responses generated by the repeater interface controller in response to DTMF commands entered or in response to time-outs and courtesy tones.

TOGGLE: To change state, turns on if off or turns off if on.

TOUCH TONE: Used by telephone systems for dialing a telephone number (also see DTMF). Used in the RI-200 to enter desired functions or commands. Also see Macros and S-Commands.

WATCHDOG TIMER: A hardware counter set to count for a predetermined time. If the count is reached without being restarted, the watchdog timer resets the microcontroller. This is the means to reset the system in the case of a software or hardware error. The software program restarts the watchdog timer periodically whenever the system is not operating correctly.

9.1   LIMITED WARRANTY

PACIFIC RESEARCH will repair this product with new or rebuilt parts free of charge in the United States for a period of 1 year from the date of the original purchase, in the event of a defect in the material or workmanship.

This warranty is extended only to the original purchaser. A purchase receipt or other proof of date of original purchase will be required before warranty performance is rendered. This warranty only covers failures due to defects in materials or workmanship which occurs during normal use. It does not cover damage which occurs in shipment or failures which are caused by products not supplied by **PACIFIC RESEARCH** or failures which result from an accident, misuse, abuse, neglect, lightning, mishandling, misapplication, alteration, faulty installation, modification, or serviced by anyone other than **PACIFIC RESEARCH** or authorized service centers of **PACIFIC RESEARCH** or damage that is attributed to **ACTS OF GOD**.

If a problem with the product develops during the warranty period, you may contact your dealer. If the problem is not handled to your satisfaction, you may contact us in writing at:

PACIFIC RESEARCH
PO Box 3028
123 Commerce Dr., Unit B-2
Mammoth Lakes, CA 93546
Customer Service Dept.

Tel: 619-924-2557
Fax: 619-924-2558
email: pacres@qnet.com

LIMITS AND EXCLUSION

There is no other expressed warranty except as listed above. **PACIFIC RESEARCH** is not liable for indirect incidental or consequential damages in connection with the use of this product including but not limited to, any cost or expense of providing substitute equipment or services during period of malfunction or non-use and or, any destruction to and or loss of property or bodily injury.

This warranty gives you specific legal rights and you may have other rights which vary from state to state.

System Command	System Command Description and Data Format	Command Syntax	Factory Setting	Stored
RI-100 REPEATER CONTROLLER SYSTEM COMMAND LIST
00	No Operation Used for clearing a macro area	00	N/A	N/A
01	System enable (Repeater PTT, Aux PTT & AP access) 1 = Enable (on), 0 = Disable (off)	01 [on/off]	1 on	Power On
02	Repeater access mode. Mode 0 = PTT Off, 1 = COS, 2 = CTCSS, 3 = COS and CTCSS, 4 = Open squelch, 5 = No repeat audio	02 [Mode]	3 COS + CTCSS	NV RAM
03	Repeater carrier delay enable 1 = Enable (on), 0 = Disable (off)	03 [on/off]	1 on	Power On
04	Repeater carrier delay time Time = 0 to 255 in 1/10 second increments	04 [Time]	30 3.0 Sec	NV RAM
05	Force on repeater PTT for set time Time = 0 to 3600 second	05 [Time]	0 0 Sec.	Power On
06	Repeater telemetry mode No Mode = Suppress function complete and error one time Mode 0 = Disable (off), 1 = ID only, 2 = Enable (on)	06 [Mode]	2 on	NV RAM
07	CW Message carrier delay time after message sent Time = 0 to 99 in 1/10 second increments	07 [Time]	20 2.0 Sec	NV RAM
08	ID interval time Time = 0 to 255 in 6 seconds increments, 0 = disable	08 [Time]	100 10.0 Min.	NV RAM
09	Courtesy message timer, COS falling to start of message Time = 0 to 99 in 1/10 second increments, 0 = disable	09 [Time]	20 2.0 Sec.	NV RAM
10	RX Source mode Mode 1 = Reject sub audio, 2 = Pass sub audio, 3 = De-emphasis & reject sub audio 4 = De-emphasis and pass sub audio.	10 [Mode]	1 Reject sub audio	NV RAM
11	LED Status Display (lowers current drain) 1 = Enable (on), 0 = Disable (off)	11 [on/off]	1 on	NV RAM
12	Repeater time-out time Time = 0 to 255 in 6 seconds increments, 0 = disable	12 [Time]	30 3.0 Min.	NV RAM
13	Repeater time-out reset	13	N/A	N/A
14	Transmit audio output adjust Adj. = 0 to 63 or * up one count, # down one count	14 [Adj]	31	NV RAM
15	Macro command decode enable 1 = Enable (on), 0 = Disable (off)	15 [on/off]	1 Enable	NV RAM
16	DTMF Decode Inter digit time Time = 1 to 99 in 1/10 seconds increments	16 [Time]	35 3.5 Sec.	NV RAM
17	DTMF Decode Mute time Time = 0 to 99 in 1/10 seconds increments, 0 = No mute	17 [Time]	25 2.5 Sec.	NV RAM
18	Resend DTMF on repeater Digits = 0 to 9, A, B, D, *, # (48 digits max.)	18 [Digits]	N/A	N/A
19	CTCSS / DCS Decode table enable. Table 0 = All, 1 = Repeater, 2 = DTMF, 3 = AUX, 4 = Tel 1 = Enable (on), 0 = Disable (off)	19 [Table] [on/off]	0 Disable	NV RAM

System Command	System Command Description and Data Format	Command Syntax	Factory Setting	Stored
**RI-100 REPEATER CONTROLLER SYSTEM COMMAND LIST**				
20	Repeater CTCSS / DCS decode table enable Tone = 001 to 144 decode tone number, 000 = All 1 = Enable (on), 0 = Disable (off)	20 [Tone] [on/off]	013 100.0 Hz on	NV RAM
21	DTMF (Control Functions) CTCSS / DCS decode table enable. Tone = 001 to 144 decode tone number, 000 = All 1 = Enable (on), 0 = Disable (off)	21 [Tone] [on/off]	013 100.0 Hz on	NV RAM
22	AUX CTCSS / DCS decode table enable Tone = 001 to 144 decode tone number, 000 = All 1 = Enable (on), 0 = Disable (off)	22 [Tone] [on/off]	013 100.0 Hz on	NV RAM
23	Telephone access CTCSS / DCS decode table enable Tone = 001 to 144 decode tone number, 000 = All 1 = Enable (on), 0 = Disable (off)	23 [Tone] [on/off]	013 100.0 Hz on	NV RAM
24	CTCSS / DCS encode Encode Tone = 0 to 144 tone number, 0 = Disable Decode Tone = 0 to 144 tone number, 0 = All, <Optional>	24 [Encode Tone] <Decode Tone>	13 100.0 Hz	NV RAM
25	CTCSS / DCS encode mode. Mode 0 = Off, 1 = Encode on, 2 = Regen decoded tone 3 = Regen stored S-Command 24 tone.	25 [Mode]	0 Off	NV RAM
26	CTCSS / DCS encode level Level = 0 to 6 in 0.86 dB steps	26 [Level]	3	NV RAM
27	DCS TX / RX data polarity control 0 = TX, 1 = RX, Pol 0 = Non-inverted, 1 = Inverted	27 [TX/RX] [Pol]	TX=0 RX=0	NV RAM
28	Reserved for future use	28 []	N/A	N/A
29	Reserved for future use	29 []	N/A	N/A
30	Edit a message buffer Buff = 01 to 16 and Msg = 0 to 16 CW commands	30 [Buff] [Msg]	See sec. 4.5.30	NV RAM
31	Set message number trigger. Trig 01 = Courtesy, 02 = ID, 03 = ACK, 04 = Error, 05 = Post time-out, 06 = Pre time-out, 07 = Weak signal, 08 = Power on, 09 = Ring, 10 = AP answer, 11 = AP ACK, 12 = AP Error, 13 = AP Ring Back Msg = 1-16 and 0 = no message	31 [Trig] [Msg]	See section 4.5.31	NV RAM
32	Trigger a message Msg = 1 to 16 CW message	32 [Msg]	N/A	N/A
33	AUX input/output mode, Mode 0 = Off, 1 = COS, 2 = CTCSS, 3 = COS and AUX CTCSS, 4= Open squelch, 5 = COS no DTMF mute, 6 = CTCSS no DTMF mute, 7 = COS and CTCSS no DTMF mute, 8 = Open squelch no DTMF mute	33 [Mode]	0 Off	NV RAM
34	AUX input, repeater carrier delay time Time = 0 to 255 in 1/10 second increments	34 [Time]	10 1.0 Sec	NV RAM
35	AUX input mode, mute/mix AUX audio on local activity Mode 0 = Mute audio, 1 = Mix audio	35 [Mode]	1 Mix audio	NV RAM
36	Regenerate DTMF from AUX input 1 = Enable (on), 0 = Disable (off)	36 [on/off]	0 Off	NV RAM
37	Multiple controller data link protocol mode Mode 0 = digital state port, Mode 1 = serial data port	37 [Mode]	1 serial data	NV RAM
38	Controller Unit Address, serial communication Address = 1 through 9	38 [Address]	1	NV RAM
39	Macro Line Jump Line = 0 to 254	39 [Line]	N/A	N/A

System Command	System Command Description and Data Format	Command Syntax	Factory Setting	Stored
center	**RI-100 REPEATER CONTROLLER SYSTEM COMMAND LIST**			
40	Power on macro trigger Line = Macro starting line number 0 to 254, 255 = disable	40 [Line]	0	NV RAM
41	Inactivity timer Time = 0 to 240 minutes after no receiver activity triggers macro pointed to in S-command 46	41 [Time]	0	Power On
42	Repeater receiver no activity macro trigger Line = Macro starting line number 0 to 254, 255 = disable	42 [Line]	255 Disable	NV RAM
43	Set time clock Time = HHMM in 24 hour mode	43 [Time]	Not Set	Power On
44	Schedule to trigger a macro Sch = Scheduler 1 to 8, Time = HHMM in 24 hr mode Line = Macro starting line number 0 to 254, 255 = disable	44 [Sch] [Time] [Line]	255 disable	NV RAM
45	Bit input, trigger a macro on falling edge Bit = 1-3 (Input number), 4 = COS, 5 = CTCSS or DCS 6 = PTT, 7 = Ext. AUX COS, 8 = Ext AUX CTCSS or DCS 9 = Ext. AUX PTT Line = Macro starting line number 0 to 254, 255 = disable	45 [Bit] [Line]	255 Disable	NV RAM
46	Bit input, trigger a macro on rising edge Bit = 1-3 (Input number), 4 = COS, 5 = CTCSS or DCS 6 = PTT, 7 = Ext. AUX COS, 8 = Ext AUX CTCSS or DCS 9 = Ext. AUX PTT Line = Macro starting line number 0 to 254, 255 = disable	46 [Bit] [Line]	255 Disable	NV RAM
47	Bit output on/off Bit = 1-3 (Bit number) 1 = On, 0 = Off	47 [Bit] [on/off]	0 off	Power On
48	Bit output pulse on for time Bit = 1-3 (Bit number) Time = 0 to 255 in 1/10 second increments	48 [Bit] [Time]	0	Power On
49	Schedule to trigger a macro at a regular interval Line = Macro starting line number 0 to 254, 255 = disable Time = 0 to 240 Minutes	49 [Line] [Time]	255 Disable	NV RAM
50	Squelch adjust Adj. = 0 to 63 or * up one count, # down one count	50 [Adj.]	31	NV RAM
51	Set squelch mode Mode 0 = Normal, Mode 1 = SmartSquelch	51 [Mode]	1	NV RAM
52	Set upper squelch threshold Threshold = 75 to 200	52 [Threshold]	160	NV RAM
53	Set lower squelch threshold Threshold = 50 to 150	53 [Threshold]	130	NV RAM
54	Set squelch equitation time Time = 0 to 50 in 10 ms increments	54 [Time]	8 80 ms	NV RAM
55	Set squelch delay factor Fact = 0 to 255	55 [Fact]	125	NV RAM
56	Set squelch average factor Fact = 0 to 50	56 [Fact]	25	NV RAM
57	Weak signal threshold Thres = 3 to 50, (30 ms through 500 ms in 10 ms increments)	57 [Thres]	5 50 ms	NV RAM
58	Remote software reset Controller Serial Number (SN) is 8 digits	58 [SN]	Serial Number	N/A
59	Remote EEPROM initialize Controller Serial Number (SN) is 8 digits	59 [SN]	Serial Number	N/A

System Command	System Command Description and Data Format	Command Syntax	Factory Setting	Stored
RI-100 REPEATER CONTROLLER SYSTEM COMMAND LIST				
60	User define telephone commands Mac = 01 to 08, Line = 000 to 254 and Name = 1 to 4 digits	60 [Mac] [Line] [Name]	See sec. 4.5 60	NV RAM
61	User define commands, call S-Command Mac = 01 to 21, S-Cmd = 00 to 99 and Name = 1 to 4 digits	61 [Mac] [S-Cmd] [Name]	See sec. 4.5.61	NV RAM
62	User define macro commands Mac = 01 to 99, Line = 000 to 254 and Name = 1 to 4 digits	62 [Mac] [Line] [Name]	See sec. 4.5.62	NV RAM
63	Macro editor, set starting line number pointer Line = 0 to 254	63 [Line]	N/A	N/A
64	Macro editor, insert a S-Cmds S-Cmd = 00 to 99 and Data = as req. for S-Cmd End = "D" for last S-Cmd	64 [S-Cmd] [Data][End]	See Section 4.5.64	NV RAM
65	Set Key code (prefix) for macros Key = 0 to 4 digits (C and D are NOT VALID)	65 [Key]	0 Digits	NV RAM
66	Set Password for S-Cmd access PW = 1 to 6 digits	66 [PW]	123456	NV RAM
67	Set Password for telephone incoming ring access PW = 1 to 6 digits	67 [PW]	343	NV RAM
68	Set Password for telephone incoming control access PW = 1 to 6 digits	68 [PW]	654381	NV RAM
69	Exit system command mode	69	N/A	N/A
70	Telephone outgoing call mode Mode, 0 = Disable AP, 1 = Simplex, 2 = Duplex 3 = Mute talk back, Simplex	70 [Mode]	1 Simplex	NV RAM
71	Telephone incoming call mode Mode, 0 = Disable, 1 = Delay - On Hook - Ring TX 2 = Delay - Off Hook- Ring TX 3 = Delay - Off Hook - Ring PW required to ring TX 4 = Delay - Off Hook Ring PW, CTCSS tone # and optional DTMF string to ring TX (Tone and DTMF used during ring)	71 [Mode]	1	NV RAM
72	Telephone DTMF mute to telco 1 = Enable (on), 0 = Disable (off)	72 [on/off]	1 on	Power On
73	Telephone incoming call control time-out DTMF inactive to on hook Time = 0 to 15 minutes, 0 = no time-out	73 [Time]	3 minutes	NV RAM
74	Telephone incoming call ring command and PW time-out Time = 1 to 120 seconds	74 [Time]	30 seconds	NV RAM
75	Telephone incoming ring delay Ring = 0 to 15	75 [Ring]	4 Rings	NV RAM
76	Telephone TX ring limit Ring = 0 to 31, 0 = no limit	76 [Ring]	8 Rings	NV RAM
77	Telephone off hook time-out Time = 0 to 240 minutes, 0 = no time-out	77 [Tine]	10 minutes	NV RAM
78	Telephone, no activity on RX time-out Time = 0 to 240 seconds, 0 = no time-out	78 [Time]	60 seconds	NV RAM
79	Telephone AGC level set Level = 0 to 7 (0 = AGC off)	79 [Level]	4	NV RAM

RI-100 REPEATER CONTROLLER SYSTEM COMMAND LIST				
System Command	System Command Description and Data Format	Command Syntax	Factory Setting	Stored
80	Flash hook switch Used for call waiting and hold	80	N/A	N/A
81	Telephone dial tone/pulse select 0 = tone, 1 = pulse	81 [Dial]	0 tone	NV RAM
82	Telephone on/off hook and access code Code = 1 to 8 off hook than code, 0 = on hook	82 [Code]	See sec. 4.5.82	NV RAM
83	Telephone number auto-dial Store = 01 to 99 memory location, Number = 0 to 16 digits (0-9, *, #, A = Pause) *xx to recall stored number when dialing *00 to recall last number radial	83 [Store] [Number]	None	NV RAM
84	Clear last number radial	84	N/A	N/A
85	Telephone number accept table enable 1 = Enable (on), 0 = Disable (off)	85 [on/off]	0 off	NV RAM
86	Edit telephone number accept table Accept = 00 to 99 table entry Number = 0 to 16 digits (0-9, * = Wild card)	86 [Accept] [Number]	None	NV RAM
87	Telephone number reject table enable 1 = Enable (on), 0 = Disable (off)	87 [on/off]	0 off	NV RAM
88	Edit telephone number reject table Reject = 00 to 99 table entry Number = 0 to 16 digits (0-9, * = Wild card)	88 [Reject] [Number]	See section 4.5.88	NV RAM
89	Edit telephone access code table Access = 01 to 08 memory location, Number = 0 to 16 digits	89 [Access] [Number]	None	NV RAM
90	Telephone on hook macro line Line = 0 to 254	90 [Line]	13 line	NV RAM
91	Wait for dial tone Time = 0 to 99 in 1/10 seconds increments (0 = Auto detect)	91 [Time]	50 5.0 Sec.	NV RAM
92	Reserved for future use	92 []	N/A	N/A
93	Reserved for future use	93 []	N/A	N/A
94	Reserved for future use	94 []	N/A	N/A
95	Reserved for future use	95 []	N/A	N/A
96	Reserved for future use	96 []	N/A	N/A
97	Reserved for future use	97 []	N/A	N/A
98	Reserved for future use	98 []	N/A	N/A
99	Reserved for future use	99 []	N/A	N/A

CW DATA TABLE							
Data	Operation	Data	Operation	Data	Operation	Data	Operation
000	No Operation	042	CW speed, 22 WPM	084	CW End-of work SK	126	Tone beep 4.0 Sec
001	DTMF Tone 1	043	CW speed, 23 WPM	085	CW Break N	127	Tone beep 5.0 Sec
002	DTMF Tone 2	044	CW speed, 24 WPM	086	CW Double Dash BT	128	Tone beep 6.0 Sec
003	DTMF Tone 3	045	CW speed, 25 WPM	087	CW Comma ,	129	Tone beep 7.0 Sec
004	DTMF Tone 4	046	CW "0"	088	CW Period .	130	Tone beep 8.0 Sec
005	DTMF Tone 5	047	CW "1"	089	CW Slash /	131	Tone beep 9.0 Sec
006	DTMF Tone 6	048	CW "2"	090	CW Question mark ?	132	Tone beep 10 Sec
007	DTMF Tone 7	049	CW "3"	091	CW Colon :	133	Pause 10 ms
008	DTMF Tone 8	050	CW "4"	092	CW Semicolon ;	134	Pause 20 ms
009	DTMF Tone 9	051	CW "5"	093	CW Parentheses ( )	135	Pause 30 ms
010	DTMF Tone 0	052	CW "6"	094	CW "Wait"	136	Pause 40 ms
011	DTMF Tone *	053	CW "7"	095		137	Pause 50 ms
012	DTMF Tone #	054	CW "8"	096		138	Pause 60 ms
013	DTMF Tone A	055	CW "9"	097		139	Pause 70 ms
014	DTMF Tone B	056	CW "A"	098		140	Pause 80 ms
015	DTMF Tone C	057	CW "B"	099		141	Pause 90 ms
016	DTMF Tone D	058	CW "C"	100		142	Pause 100 ms
017	Tone at 697 Hz	059	CW "D"	101	Tone beep 10 ms	143	Pause 150 ms
018	Tone at 770 Hz	060	CW "E"	102	Tone beep 20 ms	144	Pause 200 ms
019	Tone at 852 Hz	061	CW "F"	103	Tone beep 30 ms	145	Pause 250 ms
020	Tone at 941 Hz	062	CW "G"	104	Tone beep 40 ms	146	Pause 300 ms
021	Tone at 1209 Hz	063	CW "H"	105	Tone beep 50 ms	147	Pause 400 ms
022	Tone at 1336 Hz	064	CW "I"	106	Tone beep 60 ms	148	Pause 500 ms
023	Tone at 1477 Hz	065	CW "J"	107	Tone beep 70 ms	149	Pause 600 ms
024	Tone at 1633 Hz	066	CW "K"	108	Tone beep 80 ms	150	Pause 700 ms
025	CW speed, 5 WPM	067	CW "L"	109	Tone beep 90 ms	151	Pause 800 ms
026	CW speed, 6 WPM	068	CW "M"	110	Tone beep 100 ms	152	Pause 900 ms
027	CW speed, 7 WPM	069	CW "N"	111	Tone beep 150 ms	153	Pause 1.0 Sec
028	CW speed, 8 WPM	070	CW "O"	112	Tone beep 200 ms	154	Pause 1.5 Sec
029	CW speed, 9 WPM	071	CW "P"	113	Tone beep 250 ms	155	Pause 2.0 Sec
030	CW speed, 10 WPM	072	CW "Q"	114	Tone beep 300 ms	156	Pause 2.5 Sec
031	CW speed, 11 WPM	073	CW "R"	115	Tone beep 400 ms	157	Pause 3.0 Sec
032	CW speed, 12 WPM	074	CW "S"	116	Tone beep 500 ms	158	Pause 4.0 Sec
033	CW speed, 13 WPM	075	CW "T"	117	Tone beep 600 ms	159	Pause 5.0 Sec
034	CW speed, 14 WPM	076	CW "U"	118	Tone beep 700 ms	160	Pause 6.0 Sec
035	CW speed, 15 WPM	077	CW "V"	119	Tone beep 800 ms	161	Pause 7.0 Sec
036	CW speed, 16 WPM	078	CW "W"	120	Tone beep 900 ms	162	Pause 8.0 Sec
037	CW speed, 17 WPM	079	CW "X"	121	Tone beep 1.0 Sec	163	Pause 9.0 Sec
038	CW speed, 18 WPM	080	CW "Y"	122	Tone beep 1.5 Sec	164	Pause 10 Sec
039	CW speed, 19 WPM	081	CW "Z"	123	Tone beep 2.0 Sec		
040	CW speed, 20 WPM	082	CW Space	124	Tone beep 2.5 Sec		
041	CW speed, 21 WPM	083	CW End-of-message	125	Tone beep 3.0 Sec		

MINI MACRO NAME TABLE						
Macro Number	System Command	D1	D2	D3	D4	Notes
01						
02						
03						
04						
05						
06						
07						
08						

MACRO NAME TABLE						
Macro Number	Macro Start Line	D1	D2	D3	D4	Notes
01						
02						
03						
04						
05						
06						
07						
08						
09						
10						
11						
12						
13						
14						
15						
16						
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19						
20						
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22						
23						
24						
25						
26						
27						

28						
29						
30						
31						
32						
33						

MACRO NAME TABLE						
Macro Number	Macro Start Line	D1	D2	D3	D4	Notes
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
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Line	Macro Name	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	Notes
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