RC-100
Repeater Controller
Manual of Operations

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Table of Contents

1.0 INTRODUCTION

The RC-100 is a repeater controller for use with a radio receiver and transmitter operated in a repeater mode. The controller is all that is needed to control the repeater functions including a CW ID and control functions.

With DTMF codes the controller can be placed in DTMF access, sub-audioable (PL) and various other modes. The various parameters such as time-out can also be programmed with DTMF.

Fifteen AUX 0 to 5 volt TTL logic outputs are provided each controlled with DTMF codes.

A remote base feature is also included allowing the connection of a transceiver to the control and linking the repeater to another repeater or frequency.

The controller interface requires receiver audio and COS, the transmitter audio and PTT. The remote base has its own set of these inputs and outputs.

1.1 Definitions

The following is a list of terms used in this manual.

Repeater...a unit which receives a radio transmission on one frequency and re transmits the transmission on another frequency.

Control code...DTMF code for enabling and disabling function within the controller.

User code...DTMF code for accessing various function.

DTMF...dual tone multifrequency employing eight audible tones two at a time for remote signaling.

DTMF pad...device for generating DTMF signaling tones.

Remote Base...transceiver for linking a repeater to another frequency.

Crossband repeater...repeater operating on two separate bands where an input on one band will transmit on the other band. This mode uses transceivers.

CW...continous wave, international Morse code employing short and long tones for sending alphanumeric characters.

COS...carrier operated squelch used by the controller for sensing when the repeater receiver has an input.

PTT...push to talk used by the controller to key the transmitter.

EEPROM...Electrically Erasable Programmable Read Only Memory.

1.2 Controller Details

The RC-100's design is state of the art which is why it is small requiring the least number of components. The heart of the controller is an Intel 87C52 microcomputer which contains a microprocessor, uvEPROM containing the controller instructions and operating system, RAM for temporary storage of data and the necessary I/O for monitoring and outputting the controller signals. The DTMF decoder, U3, is a Mitel 8870 containing all the necessary stages for decoding directly from audio to TTL digital DTMF signaling tones.

The various other components act as buffers, amplifiers, audio switches and drivers for controlling and interfacing to the repeater.

The RC-100 is DTMF programmable meaning the control and user codes, CW ID and repeater parameters (time-out, etc) are set up using DTMF. This programmed data is stored in an EEPROM (U8) which is a surface mounted device mounted on the solder side of the controller PC board. This memory will retain its data for at least 40 years without the need for a battery. After this 40 years the data simply needs to be reprogrammed.

If a component fails the only part which cannot be obtained from sources other than Micro Computer Concepts (MCC) is the 87C52 CPU. This is due to the program inside the IC was developed and is owned by MCC. Thus to replace the 87C52 one must obtain it preprogrammed from MCC. The cost is $35.00.

2.0 POWER UP CONDITIONS

When power is applied to the controller it initializes itself placing the repeater into a know state. This state is controlled by the controller software and the state stored in the EEPROM memory. The features of the controller can be changed with DTMF codes and when this is done the state is stored in the EEPROM.

As received from MCC the RC-100 is in the repeater enabled mode with remote base enabled, but off, CW ID set to "INIT ID/R", all codes except programming codes erased, time-out set to 3 minutes, tail timer set to 3 seconds and a climbing tail beep.

3.0 REPEATER OPERATION

The RC-100 contains the necessary interface and control for providing repeater operation. The

interface includes the audio interface and control between the repeater receiver and transmitter. The receiver interface allows for direct connect from unsquelched or squelched receiver audio and COS indicator inputs. The outputs include buffered and amplified transmitter audio and a open collector PTT. All receiver audio is adjustable providing separate level controls for each path to the transmitter and DTMF decoder.

3.1 Controller Connections

To control the interface between the repeater receiver and transmitter the required connections are the receiver audio, receiver COS, transmitter audio and transmitter PTT. These connections permit the controller to sense a receiver input and passing the receiver audio to the repeater transmitter.

The receiver to transmitter audio is switched by the audio switch U2b and passed when the proper access is provided by the receiver. Op-amp U1 amplifies and buffers all transmitted audio.

The receiver COS has two inputs, COS HI and COS LO. The controller will see these inputs and take the necessary control actions in keying the transmitter and unmuting the receiver to transmitter audio.

The transmitter PTT is an open collector transistor active low output. It is controlled by the CPU and is the only source for keying the transmitter.

For a detailed description of the controller connections see Section 12 Controller Installation.

3.2 Access Modes

The repeater access mode is carrier, sub-audible (PL) or DTMF access.

In the carrier mode any input to the controller COS will cause transmitter keying and receiver audio to pass to the transmitter.

In the sub-audible access mode AUX 11 is converted to a "PL DECODER INPUT" to be driven high by an external tone decoder when a repeater user has the proper tone. Both the COS and tone input must be present as they are anded together meaning if either is removed it is treated as if both were removed.

In the DTMF access mode a three digit *XX DTMF code must be entered for repeater access. Once this code has been entered the control will function in the selected mode, carrier or sub-audioable, until at least 20 seconds of no repeater input. Then the DTMF access code must be re-entered.

3.3 Repeater Time-out

The time-out timer limits the re-transmission from a single user's transmission.

The repeater time-out is programmable from 20 seconds to 42 minutes. The time-out timer is reset with the repeater tail beep or DTMF digit one (1). If a user transmits for the time-out period or more 10 seconds prior to timing out the repeater will generate a series of beeps indicating time-out and then unkey the transmitter until the user unkeys at which time the repeater transmitter will rekey. This re-keying give notice to the other users the time-out timer has been reset.

If the user timing out the repeater can be overridden by another user that user can reset the time-out timer with a DTMF one. This reset digit 1 will reset the time-out timer any time it is entered.

3.4 Tail Timing

The tail timer is provided for keeping the transmitter keyed for a period after the receiver input drops. This prolongs the transmitter's relay life and prevents unwanted transmitter PTT chattering. Within the tail are the various tail tones which are provided for user signaling. The repeater tail timer is programmable from .2 to 25 seconds.

See section 10, Tail Beep Control.

3.41 Zero Tail

The zero tail control code can force the tail to zero time. When the "Zero Tail" is enabled the repeater PTT will unkey the moment the repeater and remote base, if on, inputs are removed.

When the controller is giving a response tone such as after a control code is entered the PTT will keep the repeater keyed to allow for receiving the response.

3.5 DTMF Muting

Whenever the COS input is active the controller normally unmutes the transmitted audio. However, to prevent the passing of DTMF codes over the repeater the controller will mute all DTMF once a valid DTMF is decoded by the DTMF decoder, U3. The muting will continue for 2 second after the release of the incoming DTMF.

This muting action can be prevented if the first digit entered is a 5 or the muting is disabled with a control code. If the first digit is a 5 the muting will remain off for the duration of the users transmission. Also, the muting control code will toggle the enabling/disabling of muting. When disabled no muting of DTMF will take place. Their is only one control code for enabling and disabling the muting with this single code toggling the mute state.

See section 15 for programming this code.

3.6 Anti-Kerchunker

To keep distant stations and noise burst from bringing up the repeater an anti-kerchunker can be

turned on. When on a continuous carrier must exist on the repeater input before the repeater is accessed. This required time can be programmed from .2 to 25 seconds with the "Anti-kerchunk access time" parameter. Once the required input has occurred the repeater will function until at least 20 seconds of no repeater input after which the repeater input must be provided for the programmed time to re-access the repeater.

3.7 Sub-audible Tone Decoding

If sub-audioable tone operation is desired for the repeater and/or autopatch operation an optional external sub-audioable tone decoder must be installed. The operation in the sub-audioable tone mode is controlled by the RC-100 determining if a feature must have sub-audioable tone to function. This allows the selective use of the sub-audioable tone for some features and not require for other.

The decoder need only be connected to the receiver and controller. The receiver must supply the sub-audioable tone to drive the decoder for decoding. The decoder logic output is then coupled to the RC-100 as an active high logic signal at the "PL Decoder Input" of the controller. When the decoder has decode its logic output must go high. The controller will see this high signal as a valid decoder input and the controller will take the required action.

The "PL Decoder Input" is transistor buffered allowing for up to 30 volts. A high input (tone present) must be at least 2 volts (during decode) and low (no decode) must be .5 volts or less.

To aid some decoders for proper operation a 10 kOhm pull-up resistor is provided on the "PL Decoder Input".

3.7.1 Tone Decoders

Most commercial repeater manufactures either use their own tone unit designs or employ third party tone units. Probably the most widely used decoders are from Communications Specialist, Inc's (phone 800-854-0547). They manufacture two decoders which are described below.

3.7.2 TS-32P Tone Decode/Encode Unit

The TS-32P is a dip switch tone frequency selectable decoder and encoder. Communications Specialist no longer manufactures this unit and has replaced it with the TS-64 (see below for TS-64 information). However, many of these units are in the field and is described here.

To use the TS-32P decoder with the RC-100:

1. Connect the TS-32P's OUT-2 to the RC-100 "PL Decoder Input".

2. Connect the TS-32's "TONE INPUT" to the receiver audio. This receiver audio must have low frequency response and is usually connected to the receiver discriminator output.

3. Connect the TS-32's +V input to +6.0 to +30.0 volts, its ground to power ground and its

"HANG UP" must be grounded.

4. Set the TS-32's dip switches to the proper positions for the tone frequency desired. See TS-32 data sheet for these settings.

After the TS-32 has been connected the RC-100 must be placed into sub-audioable tone mode with the "PL access mode en (4143) code if tone is to be required for operation.

3.7.3 TS-64DS Tone Decoder/Encoder Unit

The TS-64DS is a dip switch tone selectable decoder/encoder for sub-audioable tone operation. It should be noted the TS-64 comes without the dip switch unless the TS-64DS is specified. Without the dip switch solder pads are provided for selecting the tone frequency.

The TS-64DS is supplied with a connector and color coded wires for identifying the various inputs and outputs. The following is a table describing these wires and how they are used with the RC-100.

TS-64 wire	WIRE LABEL	FUNCTION	CONNECTION
VIOLET	HANG UP	decode disable	ground
ORANGE	PTT INPUT	turns on encoder	ground for encode
BLUE	HIGH PASS OUTPUT	HP filter output	no connection
YELLOW	TONE OUTPUT	encode tone out	no connection
WHITE	RCVR MUTE	decode logic out	PL Decoder Input
GREEN	DISC INPUT	decode audio in	rcvr discriminator
BLACK	GROUND	power ground	power ground
GRAY	PTT OUTPUT		no connection
RED	POWER	power input	6 to 20 volts

Set the TS-64DS's dip switches to the proper positions for the tone frequency desired. See TX-64DS data sheet for these settings.

The TS-64DS's RCVR MUTE (GREEN wire) is the decode logic output. It is this logic output for connection to the RC-100 "PL Decoder Input".

3.7.4 Tone Decode Trouble Shooting

If sub-audioable operation does not function properly the following are trouble shooting steps. Both the tS-32P and TS-64DS are addressed.

1. When decoding the TS-32s OUT-2 or TS-64's RCVR MUTE WHITE wire, connected to PL Decoder Input, is to go high and when not decoding it must be low. The HANG UP must be grounded or the output will remain high in the decode state.

2. If the TS-32s OUT-2 or TS-64's RCVR MUTE WHITE wire remains low disconnect from RC-100 PL Decoder Input. This input should now be about 2.5 volts. If not RC-100 has a

problem on this input. If high then reconnect TS-32s OUT-2 or TS-64's RCVR MUTE WHITE wire to RC-100 PL Decoder Input. If remaining high either HANG UP not grounded or decoder board has a problem.

3. If TS-32s OUT-2 or TS-64's RCVR MUTE WHITE wire remains low dip switches might not be set for proper tone frequency or the "disc" input is not connected to proper point on receiver.

The above does not use the TS-32's or TS-64DS's high pass filter or tone encoding. The high pass filter is used between the receiver and RC-100 to remove the received sub-audioable tone so it will not be re-transmitted.

The encode feature can be used by simply connecting the TS-32's ENCODER OUTPUT or the TS-64DS's YELLOW wire to the transmitter designated tone input. The normal transmitter audio input will not pass this low frequency audio so a special input is provided on most FM transmitters for the tone encoder. There is a pot on the TS-32 and TS-64 for adjusting the encode level.

NOTE: WHEN THE SUB-AUDIOABLE MODE IS ENABLED AUX 11 IS NO LONGER ACCESSIBLE WITH DTMF CONTROL BECAUSE AUX 11 IS FORCED BY THE CPU AS AN INPUT FOR THE SUB-AUDIOABLE TONE.

3.8 Sub-audible Tone Encoder Control

AUX 10 can be used to control the ON/OFF of an external sub-audible tone ENcoder. This feature is useful for opening and closing user receivers employing tone decoders to open their squelch. This feature can also aid linking systems connecting the repeater to other repeater systems.

A programmable timer (.2 to 25 seconds in .1 sec steps) controls the time AUX 10 remains high keeping the encoder on after the repeater input drops.

When enabled AUX 10 will go high and remain high until the user drops the repeater input plus for the time programmed by the parameter "Sub-audioable tone on time" (4167) for the encoder. If the programmed timer is set to say 05 then AUX 10 will remain high for .5 seconds after the user drops the input.

AUX 10 only responds to repeater input, carrier or sub-audible tone mode. The CW ID will not force AUX 10 high.

When this feature is disabled AUX 10 can be used as a normal AUX output. If the sub-audible tone encode feature is enabled and then disabled the disabling will turn OFF AUX 10 output turning off the PL encoder. Now the AUX output code can be used to manually turn on/off the encoder.

4.0 AUTOPATCH

The RC-100 can control an external autopatch. Their is no autopatch phone line interface hardware on the RC-100 requiring the user to supply it.

The interface uses AUX 14 as the signal to close a phone line interface relay and use AUX 15 to control audio direction to and from the interface and repeater.

Their are four DTMF codes which select and control the autopatch. These are "AUTOPATCH SELECT", "AUTOPATCH ENABLE/DISABLE", "AUTOPATCH ON" AND "AUTOPATCH OFF".

As received from MCC the autopatch feature is deselected. In the deselected mode AUXs 14 & 15 are affected as if no autopatch exist. Using the "AUTOPATCH SELECT" control code the patch software can be turned on and off. When ON AUXs 14 & 15 will be controlled by the autopatch software.

The "AUTOPATCH SELECT" control codes selects or deselects, toggles, the user of AUX 14 & 15 for patch control and the RC-100 autopatch software.

The "AUTOPATCH ENABLE/DISABLE" control code allows for control operator control of the autopatch.

The "AUTOPATCH ON" code is a *XX user code for accessing the patch for giving dial tone. When this code is entered AUX 14 will go high commanding the phone interface relay to seize the phone line. After the patch is accessed AUX 15 will go low when an input to the repeater COS is active (receiver has input) and go high with no input. AUX 15 is to control the phone audio between the repeater and phone line. This switching is usually used with a half-duplex patch.

The "AUTOPATCH OFF" code is the same as the "CLEAR ALL" code. This code will terminate the patch forcing AUXs 14 & 15 low causing the phone relay off and muting the phone to transmit audio.

A three minute patch time-out timer is provided. This time-out timer will automatically terminate the patch after 3 minutes. The time-out timer can be reset with DTMF 4. Ten seconds prior to time-out a series of beeps will warn of time-out.

WARNING: WHEN USING THE AUTOPATCH AUXS 14 & 15 MUST BE FREE FROM THE AUX MOMENTARY MODE (OFF) FOR THE MOMENTARY MODES MAY ALSO USE AUXS 14 & 15.

The autopatch code are as follows:

AUTOPATCH SELECT	4136	D __ __ (toggle)
AUTOPATCH ENABLE/DISABLE	4137	D __ __ (toggle)
AUTOPATCH ON	4076	* __ __

AUTOPATCH OFF 4063 # __ (clear all)

5.0 Control and User Codes

The RC-100 contains a DTMF decoder, interface to the repeater receiver and control software for receiving DTMF commands and performing control operator and user functions.

The control operator codes are three digit codes starting with either an A or D. Optional use of two digit # codes permits replacement of the A or D enabling control using a 12 digit DTMF pad.

The user codes are two digit # and three digit * codes. All DTMF decoding is performed by U3 and interface directly to U4, the microcomputer controller.

The control and user codes are programmable using DTMF. They are stored in the EEPROM (U8). See section 15 for programming these codes.

5.1 Control Operator Codes

The control operator codes are used to enable and disable various repeater functions such as the repeater and remote base. They also allow selection of various operational parameters such as the tail beep.

The A & D control code access can be enabled and disabled with the "CONTROL CODE EN/DIS" code. This is one code with the entry of the code turning ON access to the codes if OFF and OFF if ON (this means toggle). this one code is for control security.

Below is a list of the control codes and their function:

Master Enable/Disable	Enables/Disables all transmitter keying. When disabled the transmitter will not key for any reason.

Master Enable & Disable does not enable or disable any function, but rather unkeys the repeater transmitter remote base transmitter and tape. When enabled the various repeater functions will be in the state when the master was disabled.

NOTE: EN=enable,DIS=Disable

Repeater EN/DIS	Enables/Disables repeat function
Remote Base EN/DIS	Enables/Disables remote base/tape
Freq. Programming EN/DIS	Enables/Disables freq. programming.
Controller Reset	Forces the controller to the power up condition. CW ID will run on entry.
Control code EN/DIS	Enables/Disables A & D codes.
AUX CODE	master code for controlling AUX outputs.

AUX Momentary	controls AUXs12-15 for momentary.
Tape Select	Forces remote base I/O for tape.
Remote Base Select	Forces I/O for remote base.
Remote Base beep	ON/OFF of remote tail beep signal.
RB DTMF access en/dis	enables/disables remote base DTMF decoding scan mode
Crossband Select	Forces control to crossband mode.
Autopatch Select	Selects AUXs 14 & 15 for patch control.
Autopatch en/dis	if patch selected enable/disables patch.
External ID en/dis	enables/disables external ID.
External ID Record	controls recording of external voice ID.
PL encode en/dis	enables control of a PL encoder.
PL access mode en	places repeater into PL access mode.
PL access mode dis	places repeater into carrier access mode.
normal/CW tailbeep sel	toggles between CW tail beep and normal tail beep.
CW tailbeep program	for programming CW tail beep.
DTMF muting en/dis	enables/disables DTMF muting.
DTMF access en/dis	enables/disables requiring entry of
DTMF	user code to access repeater.
Tone access en/dis	en/dis requiring logic from tone decoder to access repeater.
AUX 1-of-8 output	code for selecting 1 of AUXs 1 thru 8.
AUX HEX	output of hex value on AUXs 9-12.
Master First Digit en/dis	toggles master first digit requirement.
Master First Digit	for programming master first digit.
Send ID Continuous	En/Dis IDing every ID interval.

A equivalent code	two digit # code replacing A in code
D equivalent code	two digit # code replacing D in code

(A/D equivalent or A/D digits may be used in codes)

For the following programming codes to function the programming must first be enabled.

Program CW ID	places into CW ID entry mode
Program Disable	Disables programming of control
Programming Code 1	First code enabling programming
Programming Code 2	Second code enabling programming

5.2 User Codes

The user codes are as follows:

Tape start	same as remote base OFF code
Remote base	Turns ON remote base if enabled
Remote base OFF	Turns OFF remote base
Remote Base Freq. Prog.	allows entry of frequency
Pad tester ON	#8 - Turns ON DTMF pad tester
Pad tester OFF	Same as all clear code

Force CW ID	Forces CW ID to be sent, if CW ID enabled.
All Clear	Turns off DTMF pad tester and patch off code.
DTMF access code	code for accessing repeater when in DTMF access
Remote Base XMT cntrl	#* xmt on ## rcv only mode

5.3 Control Action Indicator

Whenever a control code is entered via the repeater receiver the controller will respond at the end of the control operators transmission with a single short beep followed by a second high or low pitched tone indicating a function was acknowledged. If a function was enabled or turned ON the second beep will be high pitch. If the entered control code disabled or turned OFF a function the second tone will be low pitch. This is meant to signal the control operator of the acceptance of the entered code, but does not indicate what function was affected.

5.4 Master First Digit

In the event the RC-100 is employed on a repeater which is part of a large system where each repeater must have separate control codes, and to insure no conflict in control, a "MASTER FIRST DIGIT" for ALL DTMF codes can be required. As received from MCC this feature is disabled.

When enabled this first digit must proceed any DTMF code. As an example if the first digit is set to a 6 and the force CW id code were #9, the code forcing the sending of the CW D will be 6#9. All DTMF codes will require this 6 to be entered.

The first digit can be programmed for any of the 16 DTMF digits. This digit is programmed using the "MASTER FIRST DIGIT" programming.

The first digit is enabled/disabled (toggled) with the Master 1st digit en/dis DXX code. As shipped from MCC the first digit defaults to #.

See section 15 for programming the first digit and control code.

5.5 Fixed Misc Codes

The RC-100 has as few fixed, cannot be changed, control codes as follows:

Tail beep enable/disable (toggle)	D04
Time-out timer enable/disable (toggle)	D05
CW tail beep of cw character W	D06
CW tail beep of cw character N	D07
CW tail beep of cw character R	D08

D06 thru D08 replace the tail beep with W, N or R.

normal tail beep	D09

D09 returns the tail beep to the programmed tone tail beep.

send CW 73 at end of tail ON	D0*
send CW 73 at end of tail OFF	D0#

Due to these fixed codes having 0 as the second digit it is advisable that no D control code be programmed with 0 as its second digit (no D0x codes).

6.0 TAPE FUNCTION

The RC-100 can be used to add a tape player to the repeater for announcing group functions on DTMF command. This DTMF command is the same programmed code as the remote base OFF #x code.

The inputs and outputs provided are shared with the remote base I/O. The use of this I/O will depend on wheather the remote base port is selected for remote base by the "Remote Base Select" (4123) or for tape mode selected by the "Tape Select code" (4122). For the I/O to function for tape use the tape must be selected with the "Tape Select" control code.

NOTE: If the tape function is used the remote base function cannot be used. This is due to the same inputs and outputs are used for both.

The I/O provided for tape playback is tape run (active low). The tape audio muting is controlled by the CPU and U2b and is the same as the remote base mute. The audio input for the tape is the same as the remote base receiver input.

A tape end signal is provided to signal the controller the tape has ended. This is an active high signal requiring at least 2 volts to indicate tape end. When the tape is running the tape end signal must be low. The tape end signal is the same connection as the remote base COS input.

The tape function is enabled/disabled using the "Remote Base Enable/Disable" codes. When disabled the tape run will remain low (OFF) and muted.

6.1 Tape Operation

When enabled the tape can be accessed and forced to run using DTMF remote base OFF code. When accessed the tape run output will go low turning on the tape and the transmitter will be keyed. This output is an open collector transistor meant to drive the tape player motor. The tape run output will remain low and the repeater transmitter keyed until a high is received on the "tape end" input indicating the tape has ended. If a tape end signal is NOT received within one minute after tape start the tape will automatically time out placing the tape function in the off mode. This will prevent long transmitter key ups in the event the tape player should malfunction.

Tape muting occurs when the tape is off or disabled and whenever a repeater input occurs. This gives priority to the repeater users over the tape message.

7.0 REMOTE BASE

Two outputs and two inputs are provided for controlling a transceiver for linking to another repeater or frequency and is known as the remote base. The two outputs are remote base PTT (low for key) and remote base transmitter audio. The inputs are remote base receiver COS for sensing the remote base receiver input (high for an active input) and remote base receiver audio. The PTT, COS and receiver audio input lines are shared for use with a tape player (see section 6.0).

See assembly drawing for remote base connections.

The on board DTMF decoder can be accessed via the remote base receiver if this feature is enabled. See below for details.

7.1 Remote Base Operation

The operation of the remote base is turned ON using a three digit *XX (4070) user code. When turned ON a remote base receiver input will force keying of the repeater transmitter and remote base audio transmitted. When no remote base input is present the remote base receiver audio will be muted.

The remote base transmit is OFF when the remote base is first turned on (receive mode only). This is indicated by the low tone (500 Hz) additional tail beep sent just after the normal tail beep. To turn on the remote base transmit enter the "Remote Base Xmt on/off" #x (4066) code and the additional beep will become a high tone (1 kHz). Now with the repeater input the remote base will key. To return to the receive only mode by turning off the remote base transmit re-enter the "Remote Base Xmt on/off" #x code and the extra beep in the tail beep will return to a 500 hz tone. "Remote Base Xmt on/off" code toggles the remote base transmit on and off.

When the remote base is OFF or disabled the remote base will be unkeyed and the receiver muted.

The remote base will be turned OFF if the repeater is disabled. When the repeater is re-enabled the remote base will be in the state when the repeater was disabled.

7.2 Remote Base ON Tail Beep

When the remote base is ON a special additional tail beep at the end of a repeater users transmission will be generated. This beep will occur after the normal tail beep. If the remote base transmit is OFF the additional beep will be a low tone (500 Hz) and if ON the tone will be high (1 kHz). This extra tail beep can be turned ON/OFF with a control code. This might be desirable in the event the remote base is turned on at all times.

The repeater tail beep will not occur at the end of a remote base transmission. This is useful in determining if a repeated signal is from the repeater receiver or remote base receiver.

7.3 Remote Base Frequency Programming

If desired the remote base transceiver's frequency can be DTMF controlled using AUX outputs 1 thru 13 via U4 and U5. If, however, these outputs are not desired for frequency control they may be used as independent AUX outputs (see section 14 for details of the AUX outputs).

Programming of the remote base's frequency can be enabled and disabled with control codes. When enabled the frequency programming can be turned on and the frequency entered. When disabled any attempt to program a frequency will be ignored with the existing frequency in place remaining. Whenever the frequency is programmed it is stored and on power up the last frequency programmed is on AUXs 1 thru 13.

The frequency outputs are in four sets with each set controlling a digit of the remote base frequency. Within the four sets there are three sets of 4 and one set of one output. The four sets allow for control of MHz, 100 kHz, 10 kHz and 0/5 kHz. The MHz, 100 kHz and 10 kHz each contain four lined in a binary coded decimal (BCD) format. The 0/5 kHz output is a single line being at a logic 0 state for 0 kHz and logic 1 for 5 kHz.

Along with the frequency the offset and offset direction can be entered. (offset refers to the difference of the transmit frequency to the receive frequency and offset direction refers to transmit frequency being above, below or the same as the receive frequency).

7.3.1 Programming

If the frequency programming is enabled the remote base frequency can be changed. To program a remote base frequency first enter the programming DTMF code #0 followed by the MHz value, 100 kHz, 10 kHz, 0 or 5 kHz, offset direction and offset value in MHz and 100 kHz. The offset value is limited to MHz and 100 kHz and will not affect the 10 and 0/5 kHz.

When programming the frequency and offset the only data changed on any programming sequence will be the data entered. Thus, if the frequency only is to be changed enter #0 followed by the frequency and the offset direction and offset value will remain unchanged. Normally the offset value is never changed due to the offset being established by the band of the remote base operation.

To select the offset direction of plus, no offset or minus use DTMF digits 1 for plus, 2 for no offset and 3 for minus. Then when the remote base is in transmit the controller will change the remote base frequency by the offset value. If an offset value of 0.0 MHz is programmed there will be in effect no offset regardless of offset direction selected.

As an example of frequency programming if the desired frequency to be selected is 6.760 MHz with a negative offset of 0.6 MHz the following DTMF sequence is entered.

#0 6760 3 06

The #0 forced frequency programming mode. The 6 7 6 0 set the frequency to 6.760 MHz. The 3 selected a minus offset forcing the remote base frequency to become 6.760 minus 0.6 (6.160) during transmit set up by the last two digits of 0 6. Now the remote base frequency will be 6.760 MHz in receive and 6.160 MHz in transmit. If the frequency is now to be changed to 6.970 MHz with the same offset direction and value use the following code sequence.

0 6 9 7

Since the 0/5 kHz, offset and direction were not changed the last 4 digits of the 8 digit programming sequence need not be entered.

During programming the frequency entry can be terminated by either using DTMF digit * or simply not entering a digit for 2 seconds. When entering the frequency care must be taken to insure a 2 second pause between digits does not occur or programming entry will terminate leaving the remaining data unchanged.

The remote base frequency will change after 2 seconds of no DTMF. Thus the frequency will not actually change until programming is complete.

7.3.2 Remote Base Frequency Control Connection.

Thirteen outputs are provided for controlling the remote base frequency. These consist of 4 for MHz, 4 for 100 kHz, 4 for 10 kHz and one for 0/5 kHz. All of these are TTL lines meaning when each is at a low or zero level it will be 0 to .6 volts and when high or one level it will be 2.4 to 5 volts. If a remote base is used requiring other levels proper buffers must be used between the remote base and RC-100 controller.

The connections are shown on the assembly drawing.

7.4 Remote Base DTMF Access

The on board DTMF decoder, U3, can be accessed from the remote base receiver if this feature is enabled. When enabled the controller scans between the repeater receiver and remote base receiver audio. The DTMF decoder audio is switched between the two receivers. This is done until a valid decode is obtained and the scanning stops locked onto the receiver the DTMF tone was received from. After 2 seconds of no DTMF the scanning resumes.

This feature is provided to permit users on the remote base end to turn on and off the remote base.

To enable this DTMF scanning feature the "RB to DTMF Decoder" must be enabled. This control code is a DXX code and is a toggle enable/disable. When disabled the DTMF decoder remains locked to the repeater receiver. As received this feature is disabled.

When a DTMF tone is detected from the remote base receiver it will NOT cause muting of the repeater to transmitter audio as it will when a DTMF tone is from the repeater receiver. This insures the remote base control will not affect repeater operation.

7.5 Remote Base Key During CW ID

At times it may be desirable for the remote base to send the CW ID when the controller IDs the repeater. The RC-100 can be forced to key the remote base PTT during the CW ID with the "Remote Base ID" control code. When enabled and if the remote base is ON and if the remote transmit is ON the remote base will key during the CW ID.

By using the Remote Base TX Audio #1, P2-pin 4, the CW ID audio will be coupled to the remote base transmitter. Only the repeater receiver audio is at Audio #2, P2-pin 3, and this audio output does not have the CW ID audio.

7.6 Remote Base Automatic Time-out

The Remote Base or the remote base xmt can be programmed to automatically turn off with no repeater or remote base activity.

The timer is programmed at the "Remote Base Time-out" timer value. The "Remote Base time-out sel" control code will select which is automatically turned off.

When disabled, getting a low tone response, the transmit will turn off leaving the remote base on, but in receive mode. When enabled, getting high tone response, the time-out will turn off the entire remote base.

The time-out timer is programmed in 10 second intervals 20 seconds to 40 minutes. If the time-out is not desired program the time-out value to be maximum with DTMF #* as the time-out value.

Again this time-out is for NO repeater or remote base activity.

8.0 DTMF PAD TESTER

The controller can be forced to read back in CW an entered DTMF digit for testing DTMF pads. The tester is turned ON with the two digit #8 code. When ON the user can enter a single digit and if decoded the controller will send in CW the DTMF digit at the end of the users transmission. The user can enter all of the 16 DTMF digits listening for the CW response after each digit.

The pad tester will automatically turn OFF if no repeater input occurs for 15 seconds. It can also be turned off with the "All Clear" code.

9.0 REPEATER IDENTIFICATION

The controller has a CW ID control program for identifying the repeater system. The ID takes place at the time interval programmed by the user (see section 15). For Amateur Radio use this is required by FCC regulation every 10 minutes max and at 20 words per minute (wpm) or less.

An external ID can be used using AUX 13 as the strobe for starting this ID. The ID can be another CW ID, a tape, voice IC device, etc. (see section 9.2 below).

When the repeater is in use the ID waits for the end of a users transmission preventing competing with the user. This is known as a smart or polite ID.

Timing of the ID is controlled by the "ID time interval". The ID data, the actual characters sent during the CW ID, are stored in the ID table in the EEPROM. The ID tone and speed are programmable and also stored in the EEPROM. The ID level is adjusted with pot LA-1.

The CW ID can also be forced with a #X DTMF code.

9.1 Continuous CW ID

Normally the CW ID is sent only when the repeater is in use and with a final trailing ID. However, the controller can be forced to ID on every ID time interval using the "CONTINUOUS ID" control code. This single control code will toggle the state of the continuous IDing. When enabled the controller IDs at every ID time interval regardless of repeater usage.

9.2 External ID

AUX 13 can be selected to start an external ID. This ID must be supplied by the user and can be any form such as voice IC, tape, etc. If the external ID used has a record/playback input then remote recording can be done using the "External ID Record start" (4141) code. AUX 12 functions as a record/playback control (high for playback) and should be connected to the external ID record/playback input.

There are two control outputs for the external ID; AUX 13 for strobing the external ID and AUX 12 for controlling record and playback. If the external ID used has no record featue then AUX 12 need not be used, however, AUX 12 will still be dedicated to the external ID.

The DTMF code used to control the external ID is the "EXTERNAL ID ENABLE/DISABLE" control code. The record code is "ID Record" code and functions only if the external ID is enabled.

When both the CW ID and external ID are enabled and the time to ID occurs the controller examines the control for activity in the previous 10 seconds. If their was activity the internal CW ID is use. If no activity the external ID is strobed. However, if only the CW ID is enabled only the CW ID is used or if only the external ID is enabled only the external ID is used.

9.21 External Voice ID Recording

When the external ID feature is used with an ID device with external recording capability, such as MCC's VID-1, AUX 13 is used to start the ID playback. It is also used to start the recording of the ID.

To record an external ID do the following:

1. turn on programming if not on.
2. enter the "External ID Record start" code and without unkeying say into the users rig the ID desired. This will first force AUX 12 low, forcing into the record mode, followed by AUX 13 low to start the recording.
3. unkey the rig and the ID will stop brings AUX 12 & AUX 13 high.

During this ID record the controller will time the ID length and store in EEPROM. When the external ID is sent the controller will strobe the external ID via AUX 13 going low and will keep AUX 13 low and the repeater PTT keyed for this length of time.

NOTE: WHEN THE EXTERNAL ID IS ENABLED AUXS 12 & 13 ARE BOTH USED FOR THE EXTERNAL ID FEATURE. ANY OTHER FEATURE WILL NOT CONTROL THESE TWO AUX OUTPUTS.

10.0 Tail Beep Control

The controller provides a tail beep to signal other users of the end of a transmission. The tail beep tones and time it occurs within the repeater tail are programmable and stored in EEPROM.

At the beginning of the beep the repeater time-out timer is reset. The tail beep consist of four segments each segment programmable to have either a tone of 1000 Hz/n or no tone. For programming the tail beep see Section 15.

10.1 Special Tail Beeps

The control has provisions for either a programmable tone tail beep or a CW character tail beep. The tone tail beep is programmed with the "TAIL BEEP PROGRAMMING" select code (4050).

The CW tail beep can be any CW character and is programmed in the same manner as the CW ID except only one character is allowed. The CW tail beep and tone tail beep are toggled between each using the "NORMAL/CW TAIL BEEP" control code.

To program the CW tail beep character enter the "CW tailbeep program" code followed by 1s for dits, 2s for dahs and then *#. Only one character is allowed. As an example if the character were to be C then enter 2121 *#.

Their are three additional fixed CW tail beeps. The following fixed control codes select these CW character:

character of W	D06
character of N	D07
character of R	D08
programmed tone tail beep	D09
ALL tail beeps OFF	D04

A special sending of 73 in CW just prior to the repeater transmitter unkeying, at the end of the tail, can be forced to be sent using the following codes:

D0*	turns 73 ON	D0#	turns 73 OFF

11.0 CROSS BAND MODE

The RC-100 can be used to control a cross band type repeater. This mode uses the repeater port of the control to interface to a transceiver and the remote base port to interface to another transceiver. When an input is detected on either port of the control the other port will be keyed.

This operation differs from normal repeater operation in that if an input is detected from either the repeater port or, if on, the remote base port the repeater transmitter is keyed requiring the repeater to be full duplexed (transmit and receive at the same time). In the cross band mode only the transmitter on the other port of the active receiver is keyed.

The RC-100 is forced into the cross band mode with the "CROSS BAND" control code. This control code will toggle the cross band state. When in cross band mode the states of the repeater and remote base are ignored providing cross band operation at all times except if the Repeater Disable control code is used to disable operation. Thus the "Repeater Disable" control code is to be used to disable the controller.

As received the RC-100 has a tail beep for both ports of the cross band mode. This tail beep can be turned on or off with the "REMOTE BASE BEEP ON/OFF" control code. If off their is no tail or tail beep on either port of the crossband operation.

If the Remote Base beep is ON a 0.4 second tail exist on both ports of the cross band repeater. When a receiver releases its COS the other port will remained keyed for .4 seconds. During this tail a tail beep is generated indicating the end of the users transmission.

When in the cross band mode the CW IDing will be transmitted on both transmitters at the same time. Thus when time to ID both transceivers are keyed and the ID sent.

Normally DTMF control must be performed from the repeater port, P1, of the control. However, if the remote base DTMF scan is enabled DTMF contol and access can come from the

remote base port, P2 and the repeater port P1. The control will scan between the two ports sampling the two receivers for DTMF audio.

12.0 CONTROLLER INSTALLATION

Installation of the controller requires little effort. Installation of the controller requires the connection of 12 volts DC with ground, receiver COS and audio, transmitter PTT and audio. Due to the on board buffers and voltage regulation the RC-100 can be connected directly to an all solid state, all transistor, repeater.

12.1 Controller Power

The controller is powered by 10 to 15 volts DC at 100 ma. Two regulator circuits of a 7805 5 volt regulator (U8) for the logic circuits and an 8 volt zener diode (D1) for regulation of the audio circuit voltage control the power to the RC-100.

The controller power is connected to P1-pin 2. Also a good power supply ground must be connected to P1-pin-1.

12.2 Repeater Connections to the Control

A minimum of six connections must be made to the controller. These are the receiver COS and audio, transmitter PTT and audio and 10 to 15 VDC and ground.

12.2.1 Repeater Receiver

The COS is a DC signal going either high or low with a valid repeater receiver input, squelch open. Their are two COS inputs, COS HI and COS LO.

The first item to determine is what the receiver COS does when the squelch is open and closed. Using a volt meter measure the voltage on the COS from the receiver with the squelch open and then when closed.

The COS HI input (P1-pin 3) is for receivers which have a high level (2 to 30 volts) when the receiver squelch is open and less than 0.5 volts when squelch is closed.

NOTE: IF COS HI IS USED RESISTOR R20 SHOULD BE REMOVED.

The COS LO (P1-pin 7) is for low level (.5 volts or less) when the squelch is open and high (2 to 30 volts) when the squelch is closed.

If you have a receiver which the specifications state the COS is open collector this means it acts like an on/off switch. Thus it will pull to ground, but when not pulling to ground the output floats. Think of it as if it were just a toggle switch opening and closing. If this is the case one must install a pull-up resistor between the receiver COS and some plus voltage. It is suggested the value of this resistor be about 20 kOhm.

The receiver audio input (P1-pin 4) drives the controller DTMF decoder and the repeater transmitter audio buffer. Each of these are adjustable. The input impedance is about 10 kOhm and can be driven by most any receiver. The controller audio response is very flat between 300 Hz and 10 kHz. It is also switched on and off from the COS thus allowing unsquelched audio to be used.

NOTE: The repeater receiver audio should pass through the controller and should not go directly to the transmitter. This permits DTMF muting and muting in response to the COS in the event unsquelched audio is used.

12.2.2 Repeater Transmitter

Two transmitter outputs are provided on the controller; PTT and audio.

The PTT is an open collector transistor, Q3. The PTT output pulls to ground when the transmitter is to be keyed.

WARNING: If the transmitter employs relays in its keying circuit care must be taken to insure the relay turn off spikes do not feed back into the controller when the transmitter unkeys. This can be prevented by placing a diode across the transmitter relay coil with the cathode to the relay power supply side and the anode to the PTT side of the relay. If this is not done damage to the control or weird operation may occur.

The transmitter audio output is an op-amp buffered amplifier capable of driving 1000 Ohms. If the transmitter mike input is used as the audio input a resistor divider circuit may be required due to the gain of the controller transmitter audio output. This will be indicated if the CW ID tone level, LA1, is set to less than 1/4th up from fully counter-clock-wise and the ID audio level is much more than desired. If this occurs it is recommended an attentuator be inserted between the control and transmitter audio input.

The specific values for this attentuator cannot be stated here, but a good start is to insert a 10k in series with the audio and a 2k to ground at the transmitter input. By increasing the 10k or decreasing the 2k the audio level will decrease. The audio may also be reduced by reducing the value of R5 (200 k). R5 determines the op-amp gain. Lowering R5 lowers the gain.

12.3 Audio Adjustments

There are four level adjustments on the controller. LA1 adjust the CW ID/tone level. LA2 adjust the receiver to DTMF decoder level. LA-3 adjust the repeater receiver to transmitter level. LA-4 adjust the remote base receiver to repeater receiver level. The following is the

procedure for adjusting each.

12.3.1 CW ID Level Adjustment, LA-1.

The CW ID level is adjusted with LA-1. This adjustment should be adjusted with the CW ID running. The ID is sent whenever the controller is powered up. The recommended level is 2 kHz deviation.

If it is found the proper level is obtained with LA-1 set low this indicates the controller has way too much gain. The gain can be reduced by lowering the value of R5 (200 k). This resistor controls the gain of U1, the transmitter audio buffer/amp.

12.3.2 Receiver to DTMF Decoder Level, LA-2.

The receiver DTMF decoder level is adjusted by LA-2. When the decoder detects DTMF pin 15 of U3 remains high until the tone is removed. Using a voltmeter to monitor U3-pin 15 provide a repeater receiver input with DTMF digit 8. From the fully CCW position slowly adjust LA-2 in the CW direction until pin 15 goes high (3 to 5 volts). Note this setting of LA-2. Continue to adjust LA-2 CW until pin 15 returns low (near 0 volts) and note this setting. If LA-2 is adjusted all the way CW and pin 15 remains high use this fully CW point for the high limit setting. Now adjust LA-2 to the point half way between the two noted setting.

If one has access to an oscilloscope adjusting LA-2 for 2 volts peak-to-peak on U3-pin 3 using DTMF audio will most often be all the adjustment of LA-3 needed.

Either methods should provide for a wide range of levels for the DTMF decoder to operate. Normally the decoder will accept a 10 db range providing more than typically necessary for accepting many different users.

If you experience DTMF decoder problems it has been most always found to be level related. Very seldom is it the fault of the HT or rig. By listening to a rig on another rig and it sounds clean then one should not suspect the rig. If it is the rig check the frequency and make sure the HT batteries are charged.

12.3.3 Receiver to Transmitter Level, LA-3

The receiver to transmitter audio level is controlled by LA-3 and should be adjusted for the same level coming into the repeater receiver as going out the repeater. Using an oscilloscope across a monitor receiver speaker terminals is a good indicator. In this setup one should sample a transmission from a users input, then tune the receiver to the repeater output and with the same user transmitting adjust LA-3 for the same repeater output level. In this procedure a single continuous tone can be used. This is often easy to obtain by pressing two side by side DTMF pad digits at the same time forcing the pad to generate a single tone. A complete DTMF may cause muting of the transmitter audio due to the controller muting action. This can be prevented by turning LA-2 CCW preventing DTMF decoding.

12.3.4 Remote Base Receiver to Transmitter Audio, LA-4.

LA-4 adjust the remote base receiver to repeater transmitter level. Specifics on LA-4 are in the Remote Base section.

12.4 Programming Codes and CW ID

After connecting the controller to the repeater the controller must be programmed using DTMF. Prior to programming the controller it will have a CW ID of "INIT ID/R", time-out of 3 minutes, have a tail beep and a tail timer of 3 seconds.

Once the connections have been made refer to section 15 for programming details.

13.0 TONE ACCESS MODE

In some parts of Europe the government requires for a repeater to be accessed by a tone, usually 1750 Hz, transmitted by the user for a given period of time. The Tone Access Mode is provided if this feature is needed. In this mode the controller requires a logic HIGH signal from an external tone decoder driving the "PL DECODER INPUT". This input must be high for the programmed time interval to access the repeater. After this input has occurred the repeater will operate normally until the repeater sets dormant with no input for 20 seconds. Then the PL DECODER INPUT must again be driven high to access the repeater.

NOTE: the RC-100 does not have a tone decoder, but only a logic input to be driven by the external decoder. The PL DECODER INPUT is used as this tone decoder logic inputs. This input has a voltage range of 0 to .5 volts for low and 2 to 30 volts for high.

The following are the codes and programmable time period settings.

Tone Access Enable/Disable	4112 A __ __
programmable time	4160 __ __ (0.1 sec steps)

14.0 AUX OUTPUTS

Their are 15 AUX outputs for controlling various user defined functions. These outputs are labeled "AUX 1" thru "AUX 15". Each output can be controlled independently with DTMF

codes.

Although each of the 15 AUX outputs can be controlled independently some can be gained together as follows:

AUXs 1 thru 8 can be gained to form a 1-of-8 output.

AUXs 9 thru 12 can be accessed with a single DTMF code with these outputs forming a four bit hexadecimal output.

AUX 12 thru 15 can be placed into momentary mode each going high when a single DTMF digit is active and low otherwise.

On power up all AUX outputs will be forced to the state they were in when power was lost. The controller saves the AUX output states whenever changed.

14.1 Remote Base Frequency Control Using AUXs 1 - 13.

AUX 1 thru 13 outputs can be used for remote base frequency control in a binary coded decimal (BCD). If these outputs are used for controlling the remote base frequency the DTMF AUX codes will not affect outputs 1 thru 13.

If the remote base frequency programming is not desired AUX 1 thru 13 outputs can be controlled with the AUX DTMF codes. To place these AUX outputs under DTMF control use the remote base frequency programming code #0 and set the frequency to 0.000 MHz by entering six zero.

AUX outputs 14 and 15 can be controlled regardless of the remote base frequency programming mode.

See the Remote Base section for AUX 1 thru 13 frequency programming.

14.2 AUX Outputs Control Codes.

AUX outputs 1 thru 15 are controlled by the DTMF. The procedure for turning ON/OFF any AUX output is to first enter the "AUX CODE" followed by the two digits associated with the AUX given in the below table.

As an example if the "AUX CODE" were D46 then to turn ON AUX 12 one would enter D46 12. To turn it off enter D46 32.

The following table provides the ON/OFF codes for each of the 15 AUX outputs.

Function	ON Code	OFF Code
AUX 1	AUX CODE 01	AUX CODE 21
AUX 2	AUX CODE 02	AUX CODE 22

AUX 3	AUX CODE 03	AUX CODE 23
AUX 4	AUX CODE 04	AUX CODE 24
AUX 5	AUX CODE 05	AUX CODE 25
AUX 6	AUX CODE 06	AUX CODE 26
AUX 7	AUX CODE 07	AUX CODE 27
AUX 8	AUX CODE 08	AUX CODE 28
AUX 9	AUX CODE 09	AUX CODE 29
AUX 10	AUX CODE 10	AUX CODE 30
AUX 11	AUX CODE 11	AUX CODE 31
AUX 12	AUX CODE 12	AUX CODE 32
AUX 13	AUX CODE 13	AUX CODE 33
AUX 14	AUX CODE 14	AUX CODE 34
AUX 15	AUX CODE 15	AUX CODE 35

ON means output at 2.4 to 5 volts. Output OFF means output 0 to .6 volts.

14.3 One-of-Eight AUXs 1-8 Outputs

The one-of-eight outputs on AUXs 1 thru 8 are accessed by entering the "AUX One-of-Eight" DTMF code followed by a single digit of 0 thru 8. If 0 is entered AUXs 1 thru 8 go low. If the digit entered is 1 thru 8 then the AUX with the same number as the digit entered will be latched high and the remaining 7 outputs will be forced low.

This operation will not affect AUXs 9 thru 15. If one of the AUX latched command codes is entered that AUX will be turned on or off overriding the one-of-eight command.

14.4 AUXs 9-12 Hexadecimal Output

The hexadecimal control of AUXs 9 thru 12 is controlled with the "AUX HEX" DTMF code followed by a fourth digit. This fourth digit value will be transferred to AUXs 9 thru 12 with AUX 9 being msb. This operation will only affect AUXs 9 thru 12 and not disturb the remaining AUXs.

As an example if the AUX HEX code were D41 then entering D41 4 then AUX 9-12 would have the 4 bit value of 5 (0100).

14.5 Momentary AUX 12 - 15 Outputs

AUXs 12 thru 15 can be placed into momentary mode which means when the associated DTMF digit is entered the associated AUX output will go high and remain low when this digit is not being entered.

To place an AUX into the momentary mode first enter the programmed "AUX momentary"

DTMF code followed by the associated digit given in the table below.

AUX 12	AUX MOMENTARY 1	then AUX 12 high during a DTMF 1
AUX 13	AUX MOMENTARY 2	then AUX 13 high during a DTMF 2
AUX 14	AUX MOMENTARY 3	then AUX 14 high during a DTMF 3
AUX 15	AUX MOMENTARY 4	then AUX 15 high during a DTMF 4

Re-entering the code will toggle the momentary mode off.

As a example if the "AUX momentary" code were programmed to be D45 then entering D45 followed by a 3 will force AUX 14 into the momentary mode and each time DTMF digit 3 is entered AUX 14 will go high. If D45 3 is entered again AUX 14 will return to the non-momentary mode.

Each of AUX 12 - 15 can be placed into the momentary mode. Only the ones of the four desired can be set for momentary with affecting the others.

15.0 RC-100 PROGRAMMING

The RC-100 contains an EEPROM which stores control codes, user codes, CW ID and operational parameters. This data will be retained for at least 40 years and does not require any battery or power to retain data. The data is programmed into the EEPROM by using DTMF control and software within the CPU (U4).

The following are the procedures for programming or entering the controller data.

15.1 EEPROM Initialization

If you received the RC-100 from MCC with the EEPROM installed the initialization need not be performed for it was done by MCC and tested. If you are upgrading software the initialization must be done as described below.

The initialization clears the EEPROM of all codes and data, forces the CW ID to "INIT ID/R" and forces programming control codes to know values.

The procedure for initialization is as follows.

1. Ground pin 5 of the CPU (U4).
2. With pin 5 grounded enter DTMF code "AAA".

If accepted controller will respond with the tone/high tone acceptance signal. Also after a few seconds the "INIT ID/R" CW ID will be sent.

In performing steps 1 and 2 above if the tone/high tone response is not received or after a few seconds the INIT ID is not heard the initialization was not successful or the EEPROM is defective.

The following control codes and parameters are forced when the initialization is complete:

1. All control and user codes are cleared.
2. Programming Enable Code 1 is set to D7B.
3. Programming Enable Code 2 is set to D7C.
4. Programming Disable Code is set to D7A.
5. CW ID is set to "INIT ID/R".
6 . Repeater parameters are as follows:
    a. time-out is 3 minutes
    b. tail timer is 3 second.
    c. tail beep set to four tones.
    d. tail beep sent .7 seconds into tail.
    e. CW ID speed is 15 wpm and tone 500 Hz.

The programming code is used with a select code selecting the code to be programmed...more about this later.

15.2 Enabling Programming

To make changes of the codes, CW ID and parameters the programming must be ON.

Whenever power is lost the programming of the EEPROM is disabled by both the EEPROM itself and the CPU control software. Thus, any attempt to change the codes or CW ID will require enabling the programming mode.

To enable programming the "Programming Enable Codes 1 and 2" must be entered.

As received from MCC these two codes are D7B and D7C. However, these codes can be changed as desired. Due to others having RC-100s it is strongly advised these codes be changed (see section 15.3, Control Code Programming for details).

To enable programming follow this procedure:

1. Enter programming code 1 D7B.
2. Wait at least 3 seconds.
3. Enter Programming code 2 D7C.

Programming codes 1 and 2 are two separate codes requiring the 3 second delay between them. Also the two codes must be entered using code 1 first followed by code 2. If accepted the tone/high tone response will be heard after D7C. If not accepted no response will be sent. If no tone is received the problem may be due to DTMF decoding level or defective EPROM or installation. It will do no good to continue programming if the tone/high tone is not sent by the RC-100 after the D7C code. In the case of DTMF decoding problem try the pad tester #8.

NOTE: THE PROGRAMMING CODES OF ABOVE (D7A, D7B AND D7C) ARE INITIALIZED AT MCC. DUE TO OTHERS OBTAINING THE CONTROL IT IS STRONGLY ADVISED THESE CODES CHANGED SO AS TO PREVENT ANOTHER PARTY FROM ENABLING PROGRAMMING AND ALTERING REPEATER PARAMETERS. THESE CHANGES CAN BE DONE USING THE PROCEDURE IN ECTION 15.3.

15.3 Control and User Code Programming

The programming of the user codes follows a sequence of entering the four digit select code followed by the code to be programmed. There is a select code for each code and parameter. It tells the RC-100 what you wish to program. Table 15.1 identifies the select code for each control and user code. Other repeater parameters (repeater time-out) are programmed in this same manner. However, the CW ID follows a different method to be explained in section 15.5.

When programming any code after entering the code and if accepted the controller will send in CW "RR". If not accepted no response will be heard.

When programming any code no more than 1 second can be left between any DTMF digit or programming of the code will be aborted requiring restarting the entry with the programming code. If a mistake is made simply stop entry and start over after about 3 seconds.

15.3.1 Control Code Programming

The control codes are the A _ _ and D _ _ codes. These are three digit code with the first digit being A or D (the A and D are fixed and cannot be altered).

When programming an A or D code only the second and third digit is to be entered when programming. To program a control code get the select code of the code to be programmed from Table 15.1 and follow the procedure of entering select code followed by the second and third digits to be programmed.

As an example of programming a control code let us take the "REPEATER ENABLE" code to be programmed. Let us say we wish the code to be A12. From Table 15.1 the select code is "4100".

To program this code enter:

4100 12 making the Repeater Enable Code A12

NOTE: The 4100 is the repeater select code from Table 15.1. and 12 sets the code to A12. The repeater enable code will now be A12 again with the A being a fixed part of the code.

All of the A and D control codes are programmed in this same manner. After programming any of the codes the controller will respond with CW "RR" if accepted.

15.3.2 User Code Programming

The user codes are the * (star) and # (pound) codes. The * codes are three digits with the first digit always being *. The # codes are two digits with first digit #.

When programming a * code only the second and third digit are to be entered since the * is fixed. To program a * code enter the select code followed by the second and third digit to be programmed. The select codes are listed in Table 15.1.

As an example if the "REMOTE BASE ON" code to be programmed is *56 one would enter the following:

4070 56 making the Remote Base ON Code *56

If the code was accepted the control will respond with CW "RR".

NOTE: The 4070 select code came from Table 15.1. The 56 is the code to be programmed.

When programming a # code two digits must be entered with the first digit always being a zero (0) followed by the desired second digit of the code.

When programming a # code the second digit of the code CANNOT be a 0, 8, * or # for these are used for other controller functions.

As an example let us say we wish to make the "REMOTE BASE OFF" code #7. The "Remote Base OFF" select code from Table 15.1 is 4060 and for programming we would enter:

4060 07 making the Remote Base OFF Code #7

NOTE: The 4060 is the select code for remote base off from Table 15.1. Even though only the 7 is used with the # the two digits of 07 must be entered. If something other than the 0 were to be entered the code would then be inoperative. If desired this allows for the code to be erased preventing its use.

15.4 Repeater Parameters Programming

The repeater parameters which can be programmed are the tail beep, the tail beep time which is when the tail beep is sent within the tail, tail timer limit, repeater time-out, CW ID time interval, ID tone and speed. See Section 15.5 for ID parameter details.

NOTE: Below is information for programming timers among other items.

When programming any timer the entered value is in HEX. So the proper entry must be converted from decimal to HEX using the conversion table at the end of this section. More about this later.

Also when making the timer entry value the lowest any timer can be set is 02.

15.4.1 Tail Beep Programming

The tail beep is formed in four .1 second segments. Each segment can be programmed for no tone or a tone of 1 kHz/N tone. The value of N is programmed with 0 for no tone and 1 and up for the desired tone. To program a tail beep enter the select code 4050 followed by four digits; one digit for each segment.

As an example of programming a tail beep say we wish to program in a single .2 second 500 Hz tone.

The entry would be:

4050 2200 making the tail beep = 500 Hz, 500 Hz, no tone, no tone

The 4050 was the tail beep select code (Table 15.1) with the 22 programming two segments of 500 Hz (1000 Hz/2) each and 00 programming two segments of no tone.

As another example say we wish for 250 Hz, 330 Hz, 500 Hz and 1000 Hz tail beep.

The entry would be:

4050 4321 making the tail beep=250, 330, 500, 1000 Hz

If no tail beep is desired entry of 4050 0000 will produce such a tail beep. The tail beep can also be toggled ON/OFF with the fixed control code D04.

15.4.2 Tail Beep Time Programming

The tail beep time is when the tail beep occurs within the tail timer after the user drops the repeater input is programmed with select code 052. The time is in .1 second steps and is programmable from .2 to 25.5 seconds with the programmed entry must be in HEX.

To program .7 seconds tailbeep time enter:

4052 07 making the tail beep time of .7 seconds

15.4.3 Repeater Time-out Programming

The repeater time-out is programmable in 10 second intervals from 20 seconds to 2550 seconds (42.5 minutes). The time-out select code is 4054.

As with all timers the valued entered is in HEX (see decimal to HEX conversion table).

As an example of programming the time-out timer to 3 follow the below:

1. convert to seconds... 3 min. = 180 seconds
2. since time-out in 10 seconds intervals value is 180/10 = 18.
3. convert 18 to HEX using conversion table at end of this section...18 dec = 12 hex.

To program the time-out for 3 minutes enter:

4054 12	making the time-out 180 seconds or 3 minutes

15.5 CW ID Programming

The CW ID is programmable with up to 31 characters. However, the programming is different from that of the other codes in that once the CW ID programming has been turned on the CW characters are entered using DTMF 1s for dits, 2s for dahs, * for end of character and # for programming complete.

Also, before the CW ID can be changed or programmed the programming must be enabled using the two programming enable codes of D7B and D7C. After this the CW ID programming code must be entered placing the controller in the CW ID entry mode.

Before programming the CW ID the control code for turning on programming must be performed. This is done in the same manner the other control codes are programmed except using select code 4121 (from Table 15.1).

To make the code D49 enter:

4121 49	making CW ID programming code D49

15.5.1 CW ID Programming Example

As an example say we wish to program the CW ID to read (space) W8ABC (space) (space). We will use as the CW ID programming code in the above example of D49. However, you can make the code whatever you want.

With programming on first enter the CW ID programming code using the example above of D49. Follow this with DTMF *, 122* (W), 22211* (8), 12* (A), 2111* (B), 2121* (C), *, *. #.

The first * placed a space as the first character. Any time a space is desired the single entry of * will produce this. The 122 programmed a dit dah dah (W) with the * forcing advancement to the next character. This process continued until the finish of programming at which time the # ended programming.

When programming the CW ID as much time can be left between DTMF digits for once ID programming is turned on it will remain on until # is entered. Unlike entry of codes there is not limit of time between digits.

Also when CW ID is on no other codes will work giving total entry of the ID.

The CW ID capacity is 31 characters. If it is attempted to exceed this limit the controller will automatically place the end of CW ID character (#) in the ID table and abort programming.

15.5.2 CW ID Time Interval

The time between CW IDs is programmable in 10 second intervals from 20 seconds to 2550 seconds (42.5 minutes). The select code of 4055 is used for programming and using the same procedure as that for programming control codes.

As with all timers the valued entered is in HEX (see decimal to HEX conversion table).

15.5.3 CW ID Tone Programming.

The CW ID tone is programmable using select code 4056. The tone can range from a few Hertz to 1 kHz max. The tone is 1000 Hz/NN where NN is the two digits programmed. A programming of 01 will produce a tone of 1 kHz (1000 Hz/01), 02 a tone of 500 Hz (1000 Hz/01); the larger the number the lower the tone.

To program a tone of 500 Hz enter:

4056 02 CW ID tone of 500 Hz.

15.5.4 CW ID Speed Programming

The CW ID speed is programmable from about 50 wpm to 5 wpm. When programming the speed the larger the number programmed the slower the speed. A programmed value of 07 is about 15 wpm. It is advised a speed parameter of from 5 to 9 be used.

THIS COMPLETES THE DESCRIPTION OF PROGRAMMING. AFTER PROGRAMMING IS COMPLETE ONE SHOULD ALWAYS DISABLE PROGRAMMING WITH THE PROGRAMMING DISABLE PROGRAMMING CONTROL CODE (D7A). THIS WILL PREVENT UNWANTED ALTERING OF THE PROGRAMMED DATA.

Table 15.1 RC-100 Control and User Codes REV 3.60

FUNCTION	SEL	CODE	FUNCTION	SEL	CODE
Repeater Enable	4100	A _ _	Send ID Continuous	4120	D _ _
Repeater Disable	4101	A _ _	CW ID Prog ON	4121	D _ _ @
Freq prog Enable	4102	A _ _	Tape Select code	4122	D _ _ @
Freq prog Disable	4103	A _ _	Remote Base Select	4123	D _ _ @
Master Enable	4104	A _ _	DTMF muting en/dis	4126	D _ _
Master Disable	4105	A _ _	Master 1st digit en/dis	4127	D _ _
Remote Base En	4106	A _ _	Master 1st digit prog	4130	D 0 _
Remote Base Dis	4107	A _ _	Crossband en/dis	4132	D _ _ @
Controller Reset	4110	A _ _			
DTMF access en/dis	4111	A _ _	CW ID enable/disable	4135	D _ _
Tone Access en/dis	4112	A _ _	Autopatch select	4136	D _ _
AUX 1-of-8 output	4113	A _ _	Autopatch en/dis	4137	D _ _
AUX HEX (aux 9-12)	4114	A _ _	External ID en/dis	4140	D _ _
AUX momentary	4134	D _ _x	External ID Record start	4141	D _ _
AUX CODE	4146	D _ _	PL encode en/dis	4142	D _ _
Remote Base beep	4115	A _ _	PL access mode en	4143	D _ _
Remote Base ID TX	4150	D _ _	PL access mode dis	4144	D _ _
Remote Base timeout sel	4151	D _ _	Zero Tail en/disable	4147	D _ _
RB DTMF access en/dis	4145	D _ _	Normal/CW tailbeep sel	4156	D _ _
			CW tailbeep program	4155	D _ _ @
			Control code en/dis	4170	D _ _

Programming Disable	4172	D _ _	(default D7A)
Programming Enable 1	4173	D _ _	(default D7B)
Programming Enable 2	4174	D _ _	(default D7C)

NOTE: CODES WITH @ REQUIRE PROGRAMMING ON TO FUNCTION.

Table 15.1 RC-100 Control and User Codes REV 3.60 (cont'd)

PARAMETERS	SEL	VALUE	Time steps/tone/speeds
Tail beep programming	4050	_ _ _ _ @	4 segments each 1 kHz/n
Tail beep time	4052	_ _ @	.1 sec
Tail Time	4053	_ _ @	.1 sec
Time-out Timer	4054	_ _ @	10 sec
CW ID timer	4055	_ _ @	10 sec
CW ID tone (01=1 kHz)	4056	_ _ @	1 kHz/n
CW ID speed (07=15 wpm)	4057	_ _ @	higher value lower speed
Anti-krchunk access time	4160	_ _ @	.1 sec
Sub-audible tone on time	4167	_ _ @	.1 sec
Remote Base Timeout	4161	_ _ @	10 sec

FUNCTION	SEL	CODE	FUNCTION	SEL	CODE
Remote Base ON	4070	* _ _	Remote Base OFF	4060	# __
Remote Base xmt on/off	4066	#_			
Patch ON	4076	* _ _	OFF/clear all	4063	# __
A equivalent	4061	# __	D equivalent	4062	# __
Anti-kerchunker ON/OFF	4071	* _ _			
DTMF Access code	4072	* _ _	Force CW ID	4064	# __

NOTE: CODES WITH @ REQUIRE PROGRAMMING ON TO FUNCTION.