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Binder 1 of 2

RC-850 Repeater Controller
Operation Manual

Firmware Version 3

Got a question? Be sure and check the manual supplement,
"Most Often Asked Questions and Answers".

RC-850 Repeater Controller
Firmware VERSION 3.8
(relative to Version 3.7)

Installation

Remove your controller from service. Be sure that power is completely removed. If you have a backup battery, disconnect it, or at least be sure that the controller's power switch is off.

Remove the four EPROMs at locations U8 on the main controller board, and at locations U15, U16 and U17 on the Computer Interface board. Place these in the black conductive foam supplied.

Plug the new EPROMs provided into their respective locations on the main controller board and the Computer Interface board.

You are now ready to turn the controller back on. **Before doing so, double check that the new EPROMs are in their proper locations, that they are oriented correctly, and that there are no bent pins.**

Turn the controller back on. It should sign on saying "RC-850 V3.8," and possibly an initial ID.

Please return the old EPROMs to ACC in the original box after applying the return label and supplied postage. Thanks!

Changes

The following bug fixes are made in V3.8 relative to V3.7.

1. Autodial Bank 0 slots 10-39 can be programmed with phone numbers up to 11 digits.

2. Autodial Bank 0 slots 40-99 can be programmed.

3. Pauses can be programmed into Patch Dialing Prefixes using the Message Editor character 34 (pause).

4. The patch can be activated from Link 2 (assuming the port is defined as a link with command enabled).

5. The "Miles Per Hour" VRT response is returned to "MPH" to undo a computer port response problem.

RC-850 Repeater Controller V3.8 Installation (from V3.5 or V3.6)

Review these instructions and the manual errata sheets provided. Insert the errata sheets in your original manual binders.

Remove your controller from service. Be sure that power is completely removed. If you have a backup battery, disconnect it, or at least be sure that the controller's power switch is off.

Remove the four EPROMs at locations U8 on the main controller board, and at locations U15, U16 and U17 on the Computer Interface board. Place these in the black conductive foam supplied.

Plug the new EPROMs provided into their respective locations on the main controller board and the Computer Interface board.

The External Device Busy and the VOX Logic inputs which shared a single pin are now separate. The Dial Tone Detector input has been eliminated to accommodate the separate VOX Logic input.

> *If you are using external VOX detector hardware:*
> Move the VOX detector logic output from pin 19 of the Analog Input connector to pin 17 (formerly the Dial Tone Detect input).

> *If you are using external Dial Tone Detector hardware:*
> The Dial Tone Detector input has been eliminated, and is redefined to be the VOX Logic input (above). Program pauses into the Patch Dialing prefixes to provide sufficient delay to dial tone.

You are now ready to turn the controller back on. **Before doing so,** double check that the new EPROMs are in their proper locations, that they are oriented correctly, and that there are no bent pins.

Turn the controller back on. It should sign on saying "RC-850 V3.8," and possibly an initial ID.

Reprogramming

It will be necessary to do a small amount of reprogramming, since certain information is stored in the E^{2}PROM non-volatile memory differently than in Version 3.6.

Message Macros can now hold up to 22 characters each. They need to be reprogrammed using the message editor if you are using them in any of the controller's programmable messages.

Scheduler Macro Sets must be re-stored with the following new Control Op selections set as desired (see page 1 of "V3.7 Changes and Additions" for codes):

    Individual User Access Codes Required/Not Required

    Transmitter Turn-On Delay Enabled/Disabled

For each macro set used in your controller, select the macro set manually, make the appropriate Control Op selections, and re-store the macro set by unlocking and entering *591x (x=0-9).

Check out operation of your patch, remotes, etc. to feel confident that the system is working normally.

This completes the installation and programming changes to accommodate Version 3.8. You may now proceed to use the variety of new features of the software.

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END OF INSTALLATION INSTRUCTIONS

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RC-850 Repeater Controller V3.7/3.8 Changes & Additions

Items are organized by order of appearance in the manuals.

Access and Command Modes

Individual User Access Codes can be enabled or disabled (required or not required for access) with Control Op commands.

	Root 1	Root 2	Root 3	Root 4
Enabled	277	467	747	007
Disabled	278	468	748	008

The Transmitter Turn On Delay can be enabled or disabled with Control Op commands.

	Root 1	Root 2	Root 3	Root 4
Enabled	227	417	697	957
Disabled	228	418	698	958

The control receiver (when Control Op enabled for on-air) now behaves as follows:

1. A mobile keying up the control receiver will interrupt speech messages (if Speech Interrupted by Carrier is Control Op selected).
2. A mobile through the control receiver can "click" to initiate patch dialing.
3. A mobile through the control receiver will refresh the Patch Activity Timer.
4. A mobile through the control receiver will key link and remote transmitters that are on.

When Touch Tone Access is Down, Control Op commands are accepted through the repeater receiver.

With the Repeater Receiver Disabled (Control Op), a Touch-Tone "D" entered through the repeater receiver will no longer cause the transmitter to key up with a hang time.

Identification

When a macro set is selected, PID2 was automatically selected at the same time. If the macro set was repeatedly loaded by Repeater Activity Timer timeout, the controller appeared to be stuck in PID2. This is changed to allow continued ID rotation.

Courtesy Tones

If a courtesy tone is programmed with "Delay to Segment 1" less than 82 ms, the tone will generate properly.

Telephone Interconnect
Outgoing Calls
Autopatch

When Autodial numbers are loaded from the phone, the telephone control timer is reloaded automatically to allow continuous programming.

Autodial numbers can be read back from the phone and from over the air. The command is:
[User-Loadable Autodial Bank 0/1/2 Load/Erase Prefix] * [two digit location]

Autodial numbers containing pauses can be programmed from the terminal with the "A" command using the * key on the keyboard.

Touch-Tone entered during "click pauses" and phone number dialing no longer cancel the patch (to eliminate abuse).

User Loadable Autodialer

The patch can no longer be accessed from links which are turned off (at the User level).

With "Dial Without Click" mode Control Op disabled, PTT will not drop briefly after the second pause.

It is no longer possible to accidentally load phone numbers into Autodial slots above 249 from the terminal using the "A" command.

Incoming Calls

Unanswered directed reverse patches leave mailbox messages properly in Reverse Patch Mode 1. *** ??? not fixed??? 5/4/93 ***

General
Phone Number Macros

Touch-Tone * can be generated by the controller for use in Patch Dialing Prefixes, Phone Number Macros, and Leading 1 Override, by programming vocabulary code 73 (letter S) into the appropriate message.

Remote Phone Lines

If the repeater transmitter is defined as the Remote Phone Line Down Channel, the CTCSS encode output is now active during the patch up and down sequences to allow the receiver at the phone line to operate in tone squelch.

The same port can now be used for the Remote Phone Line Up and Down Channels, allowing a single link transceiver to be used at the repeater, or allowing linking to a simplex patch or another repeater.

The FC-900 Interface works properly with Remote Phone Line operation.

Remote Bases and Links
User Command Control
The crosslink off message is changed from "X" to "OK".

With an FC-900 band unit on in transmit, a mobile keyup while the controller is talking will not disable speech.

When Touch-Access Mode is down, enabled link and remote base transmitters will not key up.

The patch can no longer be accessed from links that are user level "off."

Command Acknowledgement
When frequencies are entered without * as a decimal point, the response "Frequency" is not interruptible by a mobile on the link so it will be heard.

In BCD mode (not FC-900 mode), when a new frequency is entered, the controller will say the programmable frequency prefix correctly.

With Link 1/2 BCD and 3/4 FC-900, the controller will say Link 3/4 prefixes and frequencies correctly.

The word "base" is no longer missing from certain programming commands.

Alarms
Alarms that occur when Touch Tone Access is Down leave a mailbox message properly.

Voice Response Telemetry
Analog Measurement
The number of Emergency Autodial calls is logged to VRT channel 30, and the count can be cleared using channel 62.

The "MPH" wind speed response is changed to "miles per hour."

Internal Datalogging Telemetry
The Period of Last Repeater Timeout (channel 31) can be cleared using channel 63.

Paging
When Touch Tone Access is Down, a paging command from the phone responds with "TT Down."

Demo Messages, Bulletin Board, and the Mailbox
Mailbox
Mail Present Message (MPM):
1. If the mailbox is empty, the controller will substitute silence correctly.
2. If programmed with a Morse message, it will play as Morse correctly.
3. If the mailbox is empty, a tail message containing the MPM is handled properly.

When the controller is reset, the day stamp on mailbox messages is not changed.

Computer Interface
General
The unlock timer is refreshed by every keyboard key press.

Autodial numbers programmed using the A (Autodial) command accept * key as pause.

Certain rare keyboard entry conditions will not corrupt data in E^2PROM.

Command Log
Entries in October, November, and December now date stamp properly.

When a remote base frequency change is entered, the command log does not add a bogus "IUAC" command entry.

A VRT command consisting of VRT Prefix + Touch Tone "C" will not freeze the output of the command log.

Auxiliary Touch-Tone Decoders
The Auxiliary Touch Tone Decoders Sequence-to-End-of-Transmission Timer is changed to 8 seconds to accommodate long linked repeater hang times.

Control Operator Commands
Entering the Don't Answer Phone Next Time command from the phone no longer extends the two minute Telephone Control timer.

Programming Commands
Timers
The unlock timer is changed from 1 minute to 1 minute 45 seconds.

Messages
Message Macros 1-4 are expanded to hold 22 characters each.

DVR Interface
With the FC-900 and DVR, the first track of a programmable message plays properly when the remote base is on in transmit mode.

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(p. 7-8 8/87/V3)
Add...
Previewing the User Loadable Autodialer Numbers
Autodial numbers can be read back from the phone and from over the air without dialing them in order to determine or verify their contents.

User Command
[User Loadable Autodial Bank 0/1/2 Load/Erase Prefix] * [two digit location]

(p.11-3 8/87 V3)
Add...
Telemetry Channels
Channel #   Description
30   Number of Emergency Autodials

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(p. 3-13 8/87 V3)
Change...

Macros	Morse	Speech	Response	# Chars
Macro 1	*10141	*11141	"M1"	~~10~~ 22
Macro 2	*10142	*11142	"M2"	~~10~~ 22
Macro 3	*10143	*11143	"M3"	~~6~~ 22
Macro 4	*10144	*11144	"M4"	~~6~~ 22

About these manuals...

The RC-850 Repeater Controller documentation consists of five manuals.
They are the

- Operation Manual
- Control Operator's Reference Manual
- Programming Reference Manual
- Hardware Reference Manual
- Computer Interface Manual

Operation Manual – This provides general information about the operation
of the repeater controller. It's purpose is to provide a broad overview of the
controller and should be read thoroughly once or twice as background
information. User command level features are described in detail in this
manual. Control Operator and programming commands are referenced but
not detailed in this manual.

The Operation Manual also includes a **glossary** and a **Most Often Asked
Questions** section.

Control Operator's Reference Manual – This reference manual
describes in detail the Control Operator level commands available in the
controller. After becoming familiar with the controller, it will typically be
necessary only to use the command summary provided in Chapter 3.

Programming Reference Manual – This reference manual describes in
detail the programming level commands available in the controller. Since
programming operations typically are performed infrequently, this manual
will be used primarily for reference prior to and during programming
sessions.

Hardware Reference Manual – This manual provides specifications and
the information necessary for interfacing the controller to the repeater and
when designing system expansions. It is intended to be used when working
directly with the controller hardware or when designing hardware for the
repeater system.

Computer Interface Manual – This manual describes in detail the
Computer Interface operation and commands.

You may find it convenient to place each manual in a separate binder, so that
you can easily refer to sections of more than one manual at a time, without
having to thumb back and forth.

About This Manual . . .

This manual provides general information about the operation of the repeater controller. Its purpose is to provide a broad overview of the controller, and it should be read thoroughly once or twice as background information. User command level features are described in detail in this manual. Control Operator and programming commands are referenced but not detailed in this manual.

Table of Contents

Chapter 1
Introduction

We understand.....

that for most repeater groups, the purchase of an RC-850 repeater controller is a major financial decision. Your decision to purchase an RC-850 was probably based upon a number of factors – your group has heard them on the air, read about them in the various Amateur Radio publications, seen them demonstrated at a convention, and so on. You became convinced of the power, flexibility, and reliability of ACC products. And now, the day has arrived, and your own RC-850 has been delivered to you. You are justifiably eager to explore the operation of the controller and to put it to work for your repeater (or remote base).

Rest assured, you won't be disappointed. The RC-850 is everything as advertised, and more! Here is a suggestion to help you get the most from your new RC-850 as quickly as possible: please, do take the time *first* to read through this Operation Manual and the other manuals provided. They contain important information on the operation, command structure, hardware interface, and programming of your controller. We promise that you'll discover features and capabilities that you didn't even suspect would be there at your command!

With the introduction of the Version 3 series of firmware, we've completely rewritten the documentation with a view toward making the pleasant task of learning about the RC-850 a most rewarding one. We've tried to anticipate your questions and to answer them for you. But we do realize that along with the power of the RC-850 comes a certain degree of complexity. As hard as we've tried, you may have a question for which the answer isn't apparent in the manuals. Which leads us to:

We care.....

If you have a question or problem that can't be resolved, we're ready to help:

> Any question regarding the RC-850, whether it relates to hardware interfacing, programming, or general operation, may be directed to our plant and offices in California by mail or by telephone to (408) 975-2055.

We welcome your comments and suggestions about our products, our service, and our documentation and support.

May we take this opportunity to welcome you as a customer and as a friend, and to thank you for choosing ACC equipment!

Chapter 2
Command Structure

You speak to the RC-850 controller in a simple Touch-Tone command language. The controller speaks back to you in voice and Morse code. Commands can be entered over the air, over the phone, through a control receiver, or from the local microphone.

With the Computer Interface option, serial ASCII commands may be entered through the serial ports, allowing terminal or computer based commands.

There are several command levels. Your repeater group probably consists of three types of persons – the repeater owner or technical group, the Control Operators, and the general users. Therefore, there are three levels of commands in the controller.

User commands are those which would typically be made available to the general users for activating the autopatch, remote base, bulletin board, and other user type functions. The user command level is the lowest level of command classification.

Control Operator commands are those which allow enabling and disabling the various functions of the repeater and selecting from various operating modes. For example, the Control Operator may enable or disable the autopatches and autodialers or select the repeater access mode.

Programming commands change parameters of the repeater such as content of the ID and tail messages, timer values, emergency autodial telephone numbers, and command codes. Programming commands are the most secure type, and require that the repeater be placed in a special mode to execute them (unlocked). Typically, details on programming commands would be reserved for the repeater owner or the repeater's technical group.

Note that all user and Control Operator command codes can be changed remotely with programming commands.

User Commands

There are 27 classes of user commands, each with its own independent command code. User command codes consist of a prefix followed immediately by a command root. The prefix may be changed remotely by the repeater owner, using programming commands, while the command roots contain information related to the action desired. For example, if the User Loadable Autodial prefix is *, dialing autodial location 45 is done by entering the command *45. The * is the prefix, 45 is the root.

User command code prefixes may be between one and seven digits long. Since each user command type is given its own independent prefix, different users may be provided with subsets of the overall command set.

The user command code classifications include:

> Touch-Tone Pad Test
> Primary, Secondary, Tertiary Autopatch
> Primary and Secondary Emergency Autodialer
> User Loadable Autodialer Bank 0, Bank 1, Bank 2
> Patch Utility Group P, Q
> Patch Hangup
> User Loadable Autodialer Load/Erase Bank 0, Bank 1, Bank 2
> Reverse Patch
> Voice Response Telemetry
> Demo / Bulletin Board
> Mailbox
> Remote Base / Linking
> Paging
> Touch-Tone Access Mode Up/Down
> Spare Audio Select
> User Function Remote Control
> User Mapped Control Operator Commands
> Individual User Access Commands

Each user command classification may have an independent command code prefix, and codes may be changed at any time remotely by the repeater owner. Certain user commands may be assigned the same prefix to minimize the number of "codes". For example, the Autopatch, Emergency Autodialer, and User Loadable Autodialer, plus the Patch Utility Prefixes, may all be assigned "*". This would make it very easy for the user to remember how to activate any of the patch functions.

User commands may be independently assigned several "attributes", or characteristics. One attribute, if set, requires that the user have PL present on his signal in certain access and command modes that don't otherwise require PL for user commands. This allows the repeater owner to limit command of certain of the repeater's functions. An example would be a 24 hour a day un-toll restricted Secondary Autopatch, which would require PL. A toll restricted, non-PL'd Primary Autopatch might be available only certain hours of the day.

A similiar attribute, if set, enables carrier-only signals to command some functions in certain access and command modes that otherwise require PL for user commands. This allows the repeater owner to "open up" features such as the Emergency Autodialer and the Bulletin Board while requiring PL for access to other functions.

Most of the user commands may be assigned to Group A or Group B. Control Operator commands are available for enabling and disabling Group A and B user commands independently. For example, at night it might be desirable to turn off a variety of features, but leave others on. The repeater owner can decide which should be turned off by assigning them to a group, and then disabling that group at night.

Finally, any user commands may be assigned as "individual user access code" required. To access these commands, the user must first "turn the key" by entering his own individual access code. Eight hundred 3 digit codes are available, which may each be enabled or disabled by the repeater owner. For example, before accessing the un-toll restricted Autopatch, the user may be required to identify himself. This provides security and facilitates automatic call tracing using the controller's datalogging output downloaded to a remote computer.

Control Operator Commands

Control Operator commands, those that enable and disable various repeater functions and select operational modes, consist of a command prefix which may be programmed by the repeater owner remotely with programming commands, followed by root codes. The command prefix may consist of between one and seven digits so that Control Operator commands may be made as secure as is necessary in your system. Easy or secure – it's up to you.

Control Operator selections may be grouped into ten "Macro Sets". That is, the enable/disable and mode selections can be grouped together and stored in the controller's non-volatile memory using a programming command. The Control Operator Macro Sets make it easy to select a special mode, like "night operation", "jammer present", or "emergency". One easy to remember Control Operator Macro command can be the equivalent of entering many commands.

One of the Macro Sets defines the way in which the controller operates when it powers up. The repeater owner can specify which features are enabled and disabled, and which modes are selected, by storing the information in Macro Set 0.

The function of the various Control Operator commands is described in detail in the Control Operator's Reference Manual and are referenced throughout the Operation Manual. The command groups include:

> Access and Command Modes
> Alarm Enable / Disable / Clear
> Control Operator Utilities
> Courtesy Tone Selection
> ID Selection and Preview
> Macro Sets
> Patch (Autopatch, Autodialers, Reverse Patch)
> Remote Bases / Links
> Repeater Timers
> Scheduler
> Speech Synthesizer
> Tail Messages

Programming Commands

Programming commands are the top secret, super secure commands which allow you to remotely change user and Control Operator codes, ID and other messages, Morse code characteristics, courtesy tone characteristics, timer values, etc.

Since programming commands need to be very secure to prevent tampering, they are accessible only when the controller is "unlocked". Unlocking the controller accesses the programming commands. When the controller is locked in normal operation, any programming commands entered are ignored. The controller is unlocked by entering a long Touch-Tone "unlock" command. The actual command is field programmable by the repeater owner among ten billion possible codes and is unique to each controller.

While unlocked, the various ID and response messages in the controller may be edited, timer values may be changed, Emergency Autodial numbers may be reprogrammed, and command codes may be modified. At the end of a programming session, the controller is "locked up" so that it's secure from tampering.

The classes of programming commands include:

> Messages
> Morse Code Parameters
> Courtesy Tone Parameters
> Timers
> Command Codes and Channels
> Emergency Autodial Numbers
> Macro Sets and the Scheduler
> Telemetry Meter Faces
> Patch Restrictions and Mapping
> Remote Base Frequency Memories
> Pager Memories
> Misc. Selections

Command Channels

The controller supplies up to three independent Touch-Tone command decoders and two serial ASCII command channels. The primary Touch-Tone decoder is provided in the standard RC-850 controller. The second and third Touch-Tone decoders and the serial ports reside on the optional Computer Interface board.

The primary Touch-Tone decoder supports several command channels, with responses supplied to the channel indicated:

Command Channel - - - - - - >	Response Channel
Local microphone (highest priority)	Local speaker
Control receiver	Repeater transmitter
Telephone	Telephone
Repeater receiver	Repeater transmitter
Link / Remote Receivers (lowest)	Repeater / link / remote transmitter

Priority of the primary decoder is in the order listed with the local microphone having the highest priority. Entry of programming and Control Operator commands may be inhibited over the telephone line and repeater / link receivers to enhance security.

The auxiliary decoders may be hard wired to any audio sources for full-time, non-prioritized command input.

In addition to Touch-Tone decoders available for command entry, commands may be sent as ASCII characters to Serial Port 1 or 2 on the Computer Interface option. Commands should be terminated with <CR><LF> (carriage-return, line-feed). ASCII response messages are provided on the serial ports.

Command Evaluation

The controller evaluates Touch-Tone or ASCII commands to determine the function requested. Touch-Tone commands may be entered over the repeater receiver, the link receivers, the phone line, the command receiver, or the local microphone. When entered through a receiver, the controller examines the sequence of Touch-Tone digits sent during the transmission *after the carrier drops* (after the user unkeys and the COS to the controller goes inactive). The controller examines the length of the command, as well as the digits present, and checks for a perfect match to valid commands in order to act on the command received.

Commands entered over the telephone (where there is no carrier drop to detect) must be terminated with the # key. The controller collects the digits sent and evaluates the sequence when it receives the terminating # key.

Special Keys

There are several special keys that affect the operation of the command decoder. Over the phone, since the controller doesn't know when you've finished entering your command (since there's no carrier to drop), the controller looks for a special command terminator key – the # key. For example, to enter the command "123" over the phone, it must actually be entered as "123#", where the # indicates the completion of the command sequence. This applies to user, Control Operator, and programming commands entered over the phone.

On rare occasions, it is desirable to force a command evaluation when a command is entered over the air. For example, if a continuous weak carrier is present at the receiver input, the controller won't detect a carrier drop which would normally cause a command evaluation. Over the air, the D key serves as an optional command terminator. As an example, let's assume that a weak carrier is present at the repeater input, and the Control Operator wants to turn the repeater off. If the command to do this is 3A45, he may enter "3A45D" [the D key is the terminator], and the command will be accepted by the controller even though the carrier has not dropped. The D key functions as a terminator from the telephone as well.

Finally, when sending a command to the controller *over the air*, if you make a mistake part way through the sequence, a # key will cancel the digits sent up to that point during the transmission and the correct command may immediately follow the #. For example, if the desired command is 3A45, and you mistakenly enter 33, you may enter a # followed by 3A45; i.e., 33#3A45 entered over the air is interpreted by the controller as 3A45.

The # key sent as the *first* key of a sequence over the air can also unmute Touch-Tone for the remainder of that transmission and cause the controller to ignore the sequence. Touch-Tone unmute is useful for passing tones through a remote base transmitter to another repeater, or down the phone line. The "Unmute Touch-Tone After # Key" mode must be selected by the Control Operator to function as described.

- # Command terminator for commands entered over the *phone*.
- D Optional command terminator for commands entered over the air or phone.
- # In the middle of a sequence entered *over the air*, cancels preceding keys.
- # As first key of a sequence entered *over the air*, unmutes Touch-Tone for remainder of sequence, and the controller ignores the sequence.

Command Decoder Timers

Several timers relating to command entry eliminate the effects of rare but unavoidable Touch-Tone decoder falsing on voice. They may also serve to qualify valid command entry procedures on the part of users. All timers are remotely programmable by the repeater owner.

An "interdigit" timer cancels a sequence where any digit occurs more than several seconds after the preceding digit. This means that digits can't be entered too slowly. This timer should normally be set to roughly 3-5 seconds.

A "to end of transmission" timer cancels any sequence where the last digit was received greater than several seconds before the end of the transmission. This means that a command followed by a long period of time until the user unkeys will be disqualified. This timer should normally be set on the order of 5-10 seconds.

Finally, a "from beginning of transmission" timer requires that the user key down for several seconds before starting to enter a command. This can encourage users to ID before sending commands, or require that jammers key down long enough to activate direction finding equipment. This timer may be disabled by setting it to zero.

Chapter 3
Access and Command Modes

The RC-850 controller offers the repeater owner a great deal of flexibility in defining access to and control of the repeater system. Eleven access/command modes permit various combinations of PL required for access and levels of command, and a Touch-Tone Access mode either required in combination with PL or as an alternative to PL. Each user command prefix has a set of attributes associated with it which allows further tailoring of access and control of various features.

In addition to the eleven basic access modes, two groups of user commands may be enabled or disabled, many user command functions may be enabled or disabled independently, a VOX Access Mode may be selected, and the repeater system and repeater receiver and transmitter may be enabled or disabled.

Access
Access and command modes may require combinations of PL and/or Touch-Tone "up" for access and command entry. PL is sensed at a logic input to the controller, derived from an external subaudible tone decoder tied to the repeater receiver. An alternate PL may be used by repeater users – the User Only PL input allows access and activates user level commands but *not* Control Operator level commands.

When PL is required for access, the controller operates as a true tone operated squelch – that is, receiver audio is gated through to the transmitter by the PL logic signal supplied to the controller. When in PL access, both COS *and* PL must be active for the controller to respond to a signal from the receiver.

The Touch-Tone Access Mode, when activated by the access/command mode, may be taken "up" and "down" by users. The up state is active, allowing access and/or command. When down, access and/or command is inhibited. A programmable timer allows the controller to automatically return to the down state after a period of inactivity. The Touch-Tone Access Down ID message is generated when the Touch-Tone Access Mode goes down, if there has been activity since the last repeater ID.

Some modes can require PL *and* Touch-Tone Up for access or command. These modes increase the security of the system since users must know both the PL frequency and the Touch-Tone mode "up" command.

Modes that require PL *or* Touch-Tone Up provide users with an alternative to the need for PL. Users that don't have PL encoders in their radios may command the repeater up with a Touch-Tone command instead.

User Commands
Touch-Tone Up   (Touch-Tone Access Up/Down Prefix) 1
Touch-Tone Down   (Touch-Tone Access Up/Down Prefix) 0

Example (assuming Touch-Tone Access Up/Down Prefix = 741)
The repeater is Touch-Tone Access mode down. A user may bring it up by
entering "741 1". When he's done, he may take it back down with "741 0".

Access modes A-K are summarized below. The requirements for access and
command are

CARRIER   Carrier only needed
PL   PL needed (main PL input for Control Op level
                  commands, main or User Only PL input
                  for access and user level commands)
TT   Touch-Tone Access must be "up"
PL AND TT   PL needed *and* Touch-Tone Access must be "up"
PL OR TT   PL needed *or* Touch-Tone Access must be "up"

ACCESS AND COMMAND MODES			
MODE	ACCESS	USER COMMAND	CONTROL OP COMMAND
A	CARRIER	CARRIER	CARRIER
B	CARRIER	CARRIER (X)	PL
C	CARRIER	PL (Y)	PL
D	PL	PL	PL
E	TT	TT	TT
F	TT	TT (X)	TT AND PL
G	TT	TT AND PL (Y)	TT AND PL
H	TT AND PL	TT AND PL	TT AND PL
I	TT OR PL	PL (Y)	PL
J	TT OR PL	TT OR PL (X)	PL
K	TT OR PL	TT OR PL	TT OR PL

ATTRIBUTES:
X IF SET <u>REQUIRES</u> PL FOR PARTICULAR USER CMDS
Y IF SET <u>DOES NOT REQUIRE</u> PL FOR PARTICULAR USER CMDS

	DOES PL INPUT QUALIFY?	
	USER ONLY PL INPUT	MAIN PL INPUT
USER CMDS	YES	YES
COP CMDS	NO	YES

The access modes are mutually exclusive – the repeater is always in one of the
eleven modes.

PL Attributes

Each user level command code prefix may have defined with it attributes which modify the PL requirement for command. Attributes are assigned to each user command prefix by the repeater owner using the Command Code Attributes programming commands.

Attribute X requires specified user commands to need PL in modes B, F, and J, which would not otherwise require PL. For example, while most user commands may be accessed with just carrier, the repeater owner may specify that the remote base commands require PL.

Attribute Y applies to modes C, G, and I, which normally require PL for user command entry. User commands with attribute Y set do *not* require PL. An example would be a repeater where PL is normally required for user commands, but the repeater owner would like to have an open Emergency Autodialer. The Emergency Autodialer command may have attribute Y set to make it an exception to the need for PL.

User Command Enable

Several of the user level commands may be enabled or disabled independently, including:

> Primary, Secondary, and Tertiary Autopatch commands
> Primary and Secondary Emergency Autodialer commands
> User Loadable Autodialer Bank 0, 1 and 2 commands
> User Loadable Autodialer Bank 0, 1 and 2 Load/Erase (lock/unlock)
> Reverse Patch command
> Remote Base / Links
> Touch-Tone Pad Test
> Spare Audio 1

The *remainder* of the user level commands may be assigned into two groups, and may then be enabled and disabled as groups by the Control Operator. The commands are placed into group A or B by the repeater owner with the User Command Attribute programming commands. Control Operator commands are provided for Group A and B Enable and Disable.

VOX Access Mode

The VOX Access Mode is independent of the access/command modes A-K. When the VOX mode is enabled, a new signal appearing at the repeater receiver when the repeater transmitter is off requires the VOX logic input to be low (active). Holding the VOX logic input high (inactive) prevents the repeater transmitter from responding to the new signal. The VOX input may connect to a VOX detector, or other circuitry, to limit access or prevent keyups due to noise and intermod. The VOX Access Mode requires an *external* VOX detector.

Repeater System Enable/Disable

The Control Operator level Repeater System Disable command inhibits all transmitters in the system. It also inhibits all user level command entry except from the local microphone.

These commands are, in effect, the repeater's "big switch". Control Operator and programming commands may be entered, but the repeater is effectively "off the air".

Repeater *Receiver* Enable/Disable

The Control Operator level Repeater Receiver Disable command effectively removes the repeater receiver from the system.

The receiver disable command is useful during teleconference nets, Westlink bulletin transmissions, and other times when retransmitting signals from the repeater input frequency is not desired.

When the receiver is disabled, user level command entry is inhibited, but Control Op level commands may be entered.

Repeater *Transmitter* Enable/Disable

The repeater transmitter may be disabled independently of the link transmitters in the system. The disable command may be useful when testing or for other special purposes.

Individual User Access Codes

Users may be assigned individual access codes for selective access to certain functions. Each class of user command may be assigned an attribute "requires individual user access". The access codes are three digit numbers ranging from 000 to 799. Each code may be enabled or disabled with programming commands. One hundred of the access codes may be tied to stored user call signs so that when a user enables individual user access, the controller responds with his call sign.

User Commands

Enable Access	(IUAC Prefix) (3 digit code)
Disable Access	(IUAC Prefix) *
Interrogate state	(IUAC Prefix)

Example (assuming IUAC Prefix = 1*)

User #375, WA6AXX, would like to use the un-toll restricted Autopatch which requires Individual User Access.

Enter 1*375. Controller responds with, "WA6AXX, Control up". User may then activate the patch.

When he's done, he can allow the IUAC function to time itself down, or be sure that it's disabled by entering 1**. The response is, "Control down".
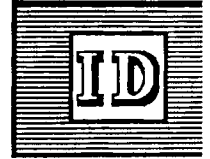
Chapter 4
Identification

Repeaters are required to ID periodically while in use. The RC-850 controller offers an intelligent ID algorithm which selects one of 17 remotely programmable ID messages based on various circumstances.

The ease of remotely programming the ID messages, and the custom repeater oriented speech vocabulary, allow the repeater owner to include *informational messages* as part of the ID. Messages such as "Radio club meeting tomorrow at 8. This is WA6AXX, Repeater", can be entered in a minute or two.

In addition, any or all of the programmable ID messages may be *recorded* remotely using ACC's Digital Voice Recorder, or ID's may be contained in external tape playback units.

ID Sequencing
If the repeater has not been in use for a period of time and a new user comes up, the controller will ID after he unkeys with the "Initial ID Message". This message could say, "Hi", or "Welcome", etc., followed by the call sign. If the new user holds his carrier up for a period greater than a few seconds, preventing generation of the Initial ID, the controller will send the "Forced CW ID Message" on top of him so that the repeater is ID'd.

After the Initial ID or Forced CW ID, the Pending ID Timer starts to run. When it times out, the controller looks for no repeater activity or for users to let the repeater carrier drop. If they do, the controller sends a "Pending ID Message" at the end of the repeater hang time. The Pending ID can rotate between three ID messages for variety. In addition, a "Special ID Message" can be added to the rotation for special events. The Pending and Special ID's can conveniently contain informational messages, as they occur, without interfering with conversations on the repeater. Additional Pending ID messages are available, automatically selected by the Scheduler.

If the repeater carrier is not allowed to drop during the Pending ID period (such as when a conversation is in progress), the controller looks for a break between user's transmissions for a period of time to work in the "Anxious ID Message". The Anxious ID could typically be a straight call sign in Morse code or brief synthesized speech ID to minimize distraction to users.

Finally, if the controller isn't given the opportunity to ID between user's transmissions, it sends a "Forced CW ID Message" over the conversation in progress following timeout of the Forced CW ID Timer. The cycle then repeats, and continues as long as there is repeater activity following an ID.

ID TIMING

```
                                      ANXIOUS ID   FORCED CW ID
        PENDING ID PERIOD               PERIOD        PERIOD
    |--------------------------------|------------|------------|

    ↑ |_____|  |_____|  |_____| ↑
    |         NO ID ATTEMPTED      PENDING ID     ANXIOUS ID
    |                              ATTEMPTED      ATTEMPTED
    |
    |__ INITIAL OR OTHER ID        FORCED CW ID GENERATED ____|
```
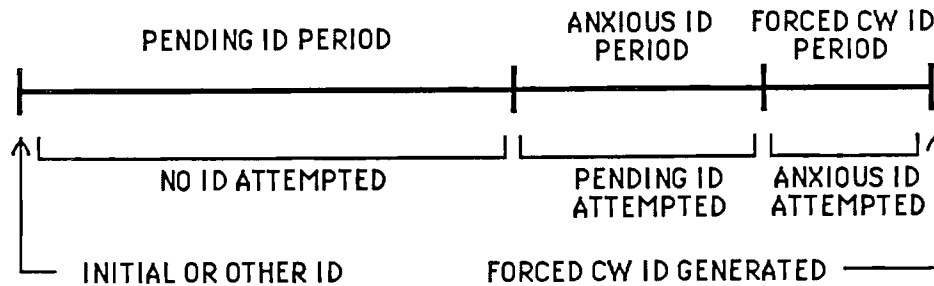
Initial ID
The Initial ID is generated in response to a new user after a period of inactivity. Three Initial ID messages may be programmed by the repeater owner. When an Initial ID is to be generated, the controller *randomly* selects from the three available to provide some variety.

Programming Commands
        Initial ID 1 Message
        Initial ID 2 Message
        Initial ID 3 Message
        Initial ID Timer

Control Operator Commands
        Preview Initial ID Message

Pending ID
The Pending ID is generated when it's time for an ID and no users are talking or if the repeater carrier is allowed to drop. One of a number of different ID messages may be generated at the Pending ID point. A Control Operator may specify any one of four messages (Pending ID1-3 or Special ID), or he may specify rotation through Pending ID1-3 or through Pending ID1-3 and the Special ID. The Pending ID3 message is actually one of five messages, based on the current Macro Set selected manually or by the Scheduler.

Programming Commands
        Pending ID 1 Message
        Pending ID 2 Message
        Pending ID 3A Message
        Pending ID 3B Message
        Pending ID 3C Message
        Pending ID 3D Message
        Pending ID 3E Message
        Special ID Message
        Pending ID Timer

Control Operator Commands
        Select Pending ID 1
        Select Pending ID 2
        Select Pending ID 3
        Select Special ID
        Select Rotate Pending ID 1/2/3
        Select Rotate Pending ID 1/2/3 – Special ID
        Preview Pending ID 1
        Preview Pending ID 2
        Preview Pending ID 3
        Preview Special ID

Pending ID Selection and Rotation

Select Pending ID 1 → [Pending ID 1]

Select Pending ID 2 → [Pending ID 2]

Select Pending ID 3 → [Pending ID 3]

Select Special ID → [Special ID]

Select Rotate PID 1/2/3 → [Pending ID 1] → [Pending ID 2] → [Pending ID 3] ↺

Select Rotate PID 1/2/3/ Special ID → [Pending ID 1] → [Pending ID 2] → [Pending ID 3] → [Special ID] ↺
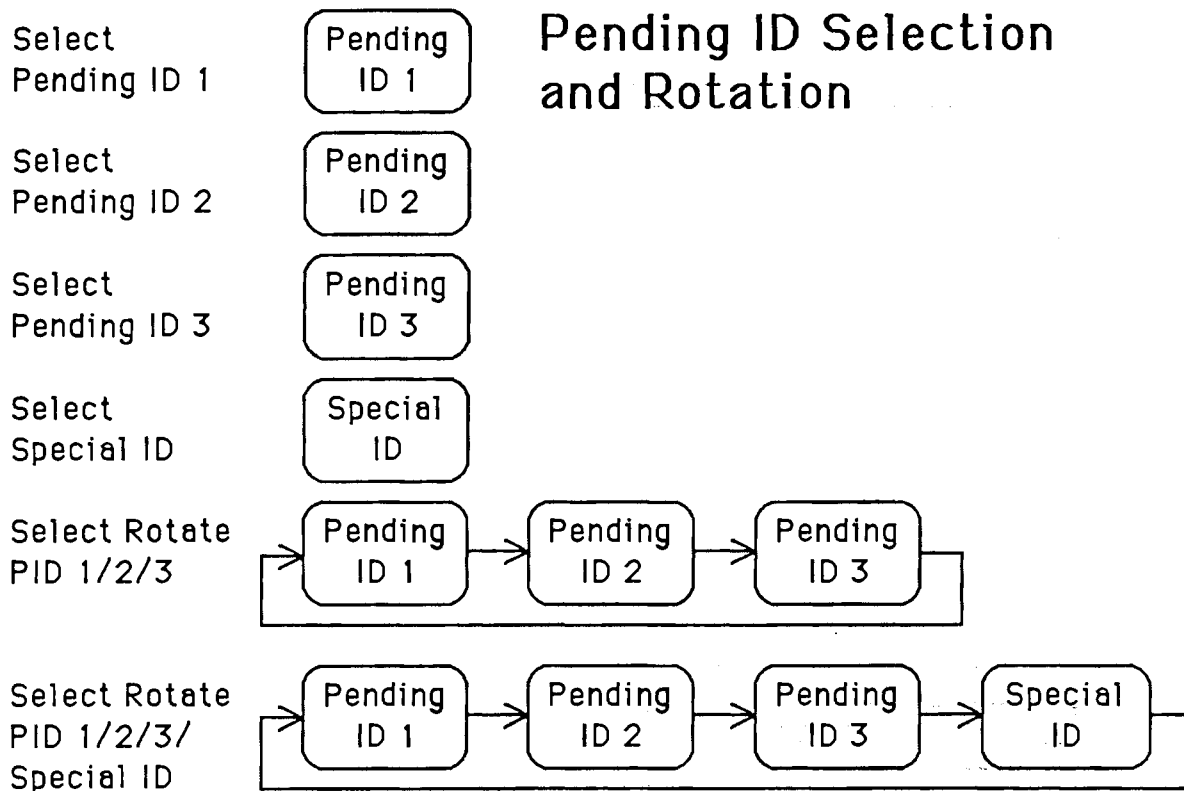
Macro Set	Pending ID 3
0,1	PID3A
2,3	PID3B
4,5	PID3C
6,7	PID3D
8,9	PID3E

Anxious ID
The Anxious ID is generated when it's getting late in the ID cycle and a user unkeys (just before the courtesy tone).

Programming Commands
        Anxious ID Message
        Anxious ID Timer

Control Operator Commands
        Preview Anxious ID

Forced CW ID
The Forced CW ID is generated on top of a user's transmission if it's very late in the ID cycle and the controller hasn't had an opportunity to send a Pending or Anxious ID. It also may be generated in response to a new user who doesn't unkey in order to allow the controller to send the Initial ID within a few seconds. This message also replaces any other ID messages which are empty (i.e., haven't been programmed by the repeater owner).

Programming Commands
        Forced CW ID Message
        Forced CW ID Timer

Control Operator Commands
        Preview Forced CW ID

Periodic QST ID
Following a period of repeater activity, the last Pending ID would be generated as a "cleanup" ID, then no more IDs would occur until the next user activity. The Periodic ID, if enabled, will cause the repeater to ID at fixed intervals during periods of no user activity. The Periodic QST ID Message may contain information of interest to the amateur service, such as the repeater's PL frequency, the name of the group which operates the system, etc.

In the amateur service, the equipment which periodically IDs when there is no user activity is not considered to be in repeater operation. That means that automatic control is not authorized. A Control Operator must be present at a local or remote control point of the station when it periodically IDs. If there is reason to believe that the periodic ID may cause interference to co-channel users, *turn it off*. Read and understand Part 97 before operating with the Periodic QST ID.

Programming Commands
        Periodic QST ID Message
        Periodic QST ID Timer

Control Operator Commands
        Periodic QST ID Enable/Disable
        Preview Periodic QST ID

Touch-Tone Access Mode "Down" ID

When the Touch-Tone Access Mode is taken down manually by a user or is allowed to time out automatically, the Touch-Tone "Down" ID Message is generated to ID the repeater properly following a series of transmissions. If there has been no activity since the last ID, then this message is not generated when the repeater times itself down.

Programming Commands
> Touch-Tone Access Down ID Message

Control Operator Commands
> Preview Touch-Tone Down ID

Paging ID

An ID message is sent following a paging tone sequence directed to the auxiliary (remote base) transceivers. For example, a user on a two-meter repeater activates a pager memory which is directed to the UHF transceiver (the person he's paging has a UHF pager modified to receive on a frequency inside the amateur band). The controller brings up the auxiliary transceiver on the frequency stored in its memory 9, sends the page, then IDs with the Paging ID Message.

The Paging ID is *not* generated on pages directed to the repeater transmitter.

Programming Commands
> Aux. Transmitter Page ID Message

Control Operator Commands
> Preview Paging ID Message

Remote Phone Line ID

An ID message is sent at the end of patch calls which access remote phone lines through the auxiliary transceivers. For example, a user brings up the patch directed to a remote phone line at someone's home. The controller brings up the auxiliary transceiver which performs the linking function to the remote phone line. At the end of the call, the Remote Phone Line ID message IDs the down link. If the down link is also retransmitted back the uplink (full duplex), both links are automatically ID'd.

Programming Commands
> Aux. Transmitter Phone ID Message

Control Operator Commands
> Preview Remote Phone Line ID Message

ID Timers

In the amateur service, Part 97 requires the repeater to ID "at the end of each communication, and every ten minutes or less during a communication". Typical recommended values for the timers are:

Initial ID Timer:	$\approx$ 10 seconds
Pending ID Timer:	$\approx$ 6 minutes
Anxious ID Timer:	$\approx$ 3 minutes
Forced CW ID Timer:	$\approx$ 1 minute

In the amateur service, the sum of the Pending, Anxious, and Forced CW timers should be less than ten minutes. The Periodic QST ID timer may be programmed to any value within the limits available for repeater timers (1 second to 30 minutes).

Programming Commands
> Initial ID Timer
> Pending ID Timer
> Anxious ID Timer
> Forced CW ID Timer
> Periodic QST ID Timer

Chapter 5
Tail Messages

Thirteen different tail messages may be programmed by the repeater owner to be selected by the Control Operator or Scheduler. These messages are sent at the end of the hang time, just prior to dropping the transmitter carrier, and can remind users of the status of the machine or an approaching net or meeting. Some examples of tail messages are, "net tonight", "weather alert", or "PL".

The tail messages may also consist of friendly greetings, such as a female "Good morning", or "Welcome to the repeater". Since the messages are fully programmable, they may also include the current time, any of the meter readings, or may consist of remotely recorded Digital Voice Recorder tracks.

Tail Message Selection
There are four tail messages available for selection at any time. Tail message #4 is actually an array of ten messages, with one message assigned to each Scheduler Macro Set. If Macro Set #7 is selected, and tail message 4 is selected, tail message 4(7) will be announced. The tail message 4 array allows automatic selection of a number of messages to help with reminding users of events and lets the repeater owner program suitable messages for various times of day and days of the week.

Programming Commands
>   Tail Message 1 Message
>   Tail Message 2 Message
>   Tail Message 3 Message
>   Tail Message 4(0) Message
>   Tail Message 4(1) Message
>   Tail Message 4(2) Message
>   Tail Message 4(3) Message
>   Tail Message 4(4) Message
>   Tail Message 4(5) Message
>   Tail Message 4(6) Message
>   Tail Message 4(7) Message
>   Tail Message 4(8) Message
>   Tail Message 4(9) Message

Control Operator Commands
>   Select Tail Message 1
>   Select Tail Message 2
>   Select Tail Message 3
>   Select Tail Message 4
>   Tail Message Off

Tail Message Frequency

In addition to the ability to select a tail message for use, the Control Operator and the Scheduler may specify how frequently the tail message will be generated. For example, an important message such as "weather alert" could be generated at each tail. The time of day might be announced every fourth tail during rush hours so that users can get the information relatively frequently. But routine announcements may be generated only occasionally, such as no more frequently than every ten minutes.

The Control Operator or Scheduler can select tail message every tail, every fourth tail, or based on the programmable tail message timer. If the timer is selected, tail messages will be generated *no more frequently* than the timer value.

Programming Commands
        Tail Message Timer

Control Operator Commands
        Select Tail Message Every Tail
        Select Tail Message Every Fourth Tail
        Select Tail Message Timer

Chapter 6
Courtesy Tones

Following each user's transmission, a courtesy tone indicates that the repeater's timer has reset and that the other user may transmit. If no user comes on the air, the repeater transmitter remains on for a programmable period (hang time). The delay from the end of the user's transmission to the tone allows other stations to break into the conversation. The fact that the repeater carrier may stay up continuously during a conversation eliminates the "second squelch tail" in the user's receiver, replaced instead by a pleasant, programmable courtesy tone. The controller also contains circuitry which mutes the squelch tail on the *user's* signal as well, so that normally no squelch tails are heard during a QSO.

Each courtesy tone may consist of a sine wave tone *set*, or a programmable *message*. The tone characteristics of one of thirteen tones selected (duration, pitch, delays, Morse code characters, etc.) may convey information to the repeater owner and users, such as source of the signal (repeater or links), status of the repeater or user's signal, or any special status of the repeater.

Sine Wave Courtesy Tone Sets
At the end of a user's transmission, a programmable delay occurs before the beginning of the tone sequence. Up to three tone segments, each programmable in pitch, duration, and spacing between segments, can be generated. Following the tone sequence, the repeater carrier drops at the end of the repeater hang time unless a user resumes transmitting. Each tone segment consists of two independent frequeny components. The two frequencies may be the same, different, or either or both may be zeroed out.

The detailed timing characteristics of the sine wave tone sets are shown below.
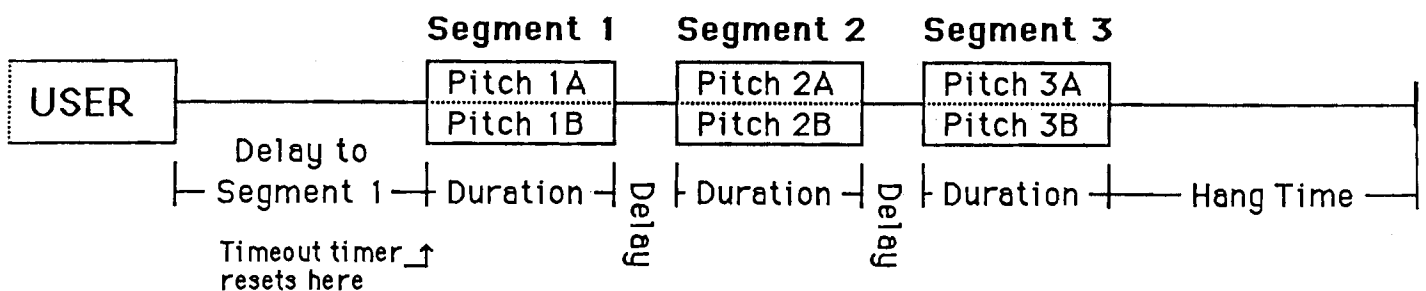
Courtesy Tone Messages

Courtesy tones may also consist of programmable messages instead of the three tone segments described above. These messages may consist of Morse code characters, synthesized speech sound effects, or remotely recorded audio with ACC's Digital Voice Recorder.

After the user unkeys, the message follows a programmable delay. At the end of the message, the hang time begins, and the repeater carrier drops at the end of the hang time unless a user resumes transmitting.

Examples of courtesy tone messages could be "tic-toc", Morse code "N" or "WX", speech "over temperature", or (with the DVR) a remotely recorded bell.

Programmable Message

```
┌─────────┐                  ┌────────────────────────────────┐
│ USER    ├──────────────────┤     Courtesy Tone Message      ├──────────────────┤
└─────────┘   Delay to       └────────────────────────────────┘
           ├─ Segment 1 ─┤                                      ├────── Hang Time ──┤
```
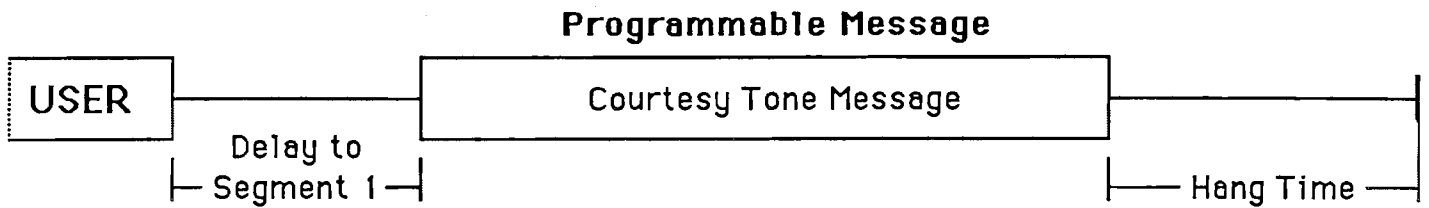
Courtesy Tone Selection

Thirteen different courtesy tones are stored in the controller. Eight are available for signals originating from the repeater receiver. Four are dedicated to tagging signals entering through the remote bases and links. One is generated *in addition to* the otherwise selected tone if a link or remote base is in the transmit enabled mode.

One of the eight repeater receiver tones is selected based on logic inputs to the controller and Control Operator selection. One of the eight may be selected in several ways, described below. The highest active set selected determines which tone will be generated. For example, if tone selects 3, 7, and 8 are active, the controller will produce courtesy tone 8. This allows the repeater owner complete flexibility in designing tone priorities.

Up to three hardware logic inputs to the controller allow selection of one of the eight courtesy tones. The three logic inputs may connect directly to external sensors to encode information of interest to repeater users. This selection provides compatibility with earlier versions of firmware.

The Control Operator or Scheduler may activate one of the eight tone selects.

Again, the highest active tone select determines which courtesy tone tags a repeater user.

Programming Commands
>> Courtesy Tone Parameters 1-13
>> Courtesy Tone Messages 1-13

Control Operator Commands
>> Courtesy Tone Select 1-8
>> Courtesy Tone Deselect

Repeater Signal Courtesy Tone Selection

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

UT HW Input
Select
(1 of 8)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

Control Op
Select
(1 of 8 or more)

Logically
"OR'd"

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
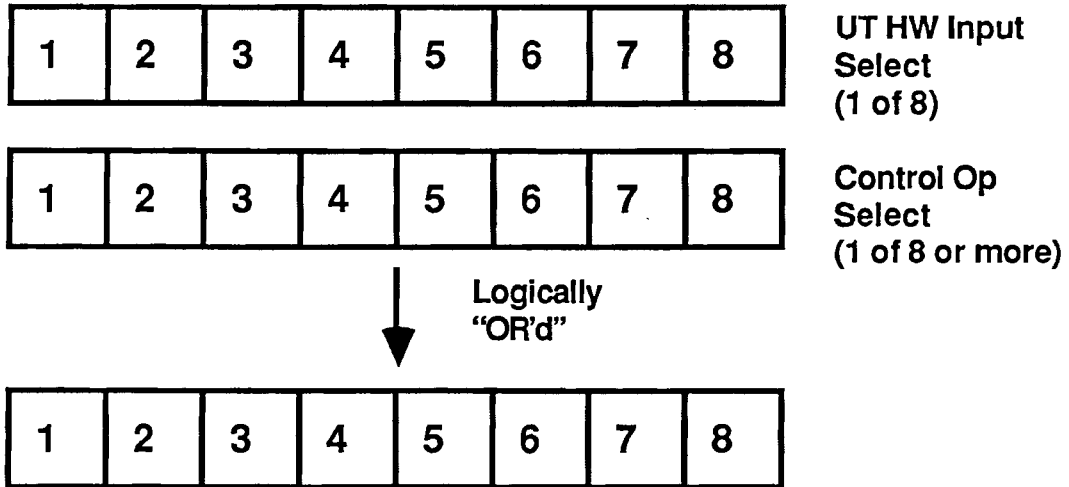
Highest active determines repeater
signal Courtesy Tone

UT HARDWARE INPUT SELECT			
UT3	UT2	UT1	SELECT
L	L	L	1
L	L	H	2
L	H	L	3
L	H	H	4
H	L	L	5
H	L	H	6
H	H	L	7
H	H	H	8

Repeater and Link / Remote Base Tone Priority					
Repeater CT	CT	CT	CT	CT	CT
Link / RB 1 Signal?	NO	YES	NO	NO	NO
Link / RB 2 Signal?	NO	NO	YES	NO	NO
Link / RB 3 Signal?	NO	NO	NO	YES	NO
Link / RB 4 Signal?	NO	NO	NO	NO	YES
Courtesy Tone Select	CT	9	10	11	12

Note: CT = Repeater signal CT 1-8 as determined above.

Chapter 7
Telephone Interconnect

The RC-850 controller's telephone interconnect provides various features which support outgoing and incoming calls.

The outgoing call capability includes:
> Autopatch
> Emergency Autodialer (10 telephone numbers)
> User Loadable Autodialer (240 telephone numbers)
> Manual Phone Patch (by Control Operator)

The incoming call capability includes:
> Reverse Patch
> Telephone Access Mailbox
> Dial Access Paging
> Phone Line Control

The controller's firmware supports interconnect to one or two local phone lines, and supports an rf link to up to three remote phone lines.

This chapter describes the operation of the interconnect features. Interfacing information is provided in the Hardware Reference Manual.

This chapter is divided into three sections – Outgoing Calls, Incoming Calls, and General Topics.

Outgoing Calls
Repeater users may place phone calls using the Autopatch, the Emergency Autodialer, or the User Loadable Autodialer. The telephone line may also be accessed manually, if necessary, by the Control Operator.

* Autopatch – The user enters the actual phone number as part of the command to activate the patch. The controller can optionally read back the phone number before dialing. The Autopatch allows any phone number with four or more digits to be dialed (subject to the antidialer and toll restrictions).

* Emergency Autodialer – The user enters a command which specifies one of ten autodial memory locations which hold emergency service numbers. The controller reads back the name of the emergency service (SC Police, SJ Fire, etc.) before dialing the number.

* User Loadable Autodialer – The user enters a command which specifies one of 240 autodial memory locations which store frequently called phone numbers. The controller can optionally read back the autodial location and phone number before dialing.

All Autopatch and autodial operations are supervised by the controller. It regenerates Touch-Tone or dial-pulse signalling into the phone line to ensure a high degree of reliability. Marginal decoding by the phone company of fluttery, improper signal level, or even of misdialed numbers, is prevented by readback to the user and signalling regeneration. Phone number readback allows the Control Operator to monitor patch activities. This combination of features makes the RC-850 controller's patch as reliable and easy to use as possible.

Autopatch - Dial any number you wish (almost!)

Activating the Autopatch
The Autopatch is activated by entering the Autopatch command prefix followed by the phone number to be dialed. *The command is entered as one sequence without unkeying between the prefix and the phone number.* Phone numbers may consist of between 4 and 18 digits. The Operator and three-digit telephone company services may not be dialed from the Autopatch (such numbers may, however, be stored in either autodialer).

Control Operator options determine if the phone number is read back immediately after entering the patch command or if phone number readback is left as an option to the user. If readback is *forced* by Control Op selection, an Autopatch proceeds as follows:

> User enters Autopatch prefix and telephone number and unkeys
> Controller says phone number and pauses
> If the phone number is correct, the user "clicks" his mic PTT
> Controller dials the number and establishes the connection

The "click" refers to a brief transmission (>200ms) by the user to signal the controller to go ahead and dial. The "click" must appear as a receiver COS signal – not a local mic PTT or control receiver COS. If the phone number had been entered incorrectly, the user could enter any Touch-Tone during the pause to cancel the patch, or could simply wait for the courtesy tone without clicking his mic to allow the patch to cancel by itself.

If phone number readback is *left optional to the user* by Control Operator selection, and the user doesn't want the number read back, an Autopatch proceeds as follows:

User enters Autopatch prefix and telephone number and unkeys
Controller says Autopatch Activate message (such as "Autopatch")
     and pauses
User clicks his mic
Controller dials the number

If the user wants the number read back:

User enters Autopatch prefix and telephone number and unkeys
Controller says Autopatch Activate message and pauses
Controller says the phone number and pauses
User clicks his mic
Controller dials the number

Again, the patch could be cancelled at either pause by entering any Touch-Tone digit. If the number read back was wrong, the user could again simply wait for the courtesy tone without clicking his mic to allow the patch to cancel.

If phone number readback is disabled by Control Operator selection, an Autopatch proceeds as follows:

User enters Autopatch prefix and telephone number and unkeys
Controller says Autopatch Activate message and pauses
User clicks his mic
Controller dials the number

The need for the "click" to initiate dialing is software selectable by a Control Operator. A *"Dial Without Click" Mode* causes the patch to dial the number without the user clicking his mic.

An overall flow chart of Autopatch operation is shown in Figure 1.

Autopatch User Commands
Several programmable user commands are available to activate the Autopatch. Three access commands may be enabled or disabled independently by a Control Operator. Each access command may also be long distance protected independently. The repeater owner could offer more than one level of Autopatch, such as an open, toll restricted patch available certain times of day, and a closed, unrestricted patch available 24 hours a day to certain users.

User Commands
     Primary Autopatch Activate
     Secondary Autopatch Activate
     Tertiary Autopatch Activate
     Command = (P/S/T Autopatch Activate prefix) (telephone number)

Example   Primary Autopatch prefix = *
     Secondary Autopatch prefix = A9*
     User sends "* 2538085" or "A9* 2538085"
     Controller says Autopatch Activate message, etc.

See Also   Hangup – see Hanging Up the Patch
Miscellaneous utilities – see remainder of this chapter (cover tone, duplex, timers, etc.)

Figure 1. **Autopatch Flow**
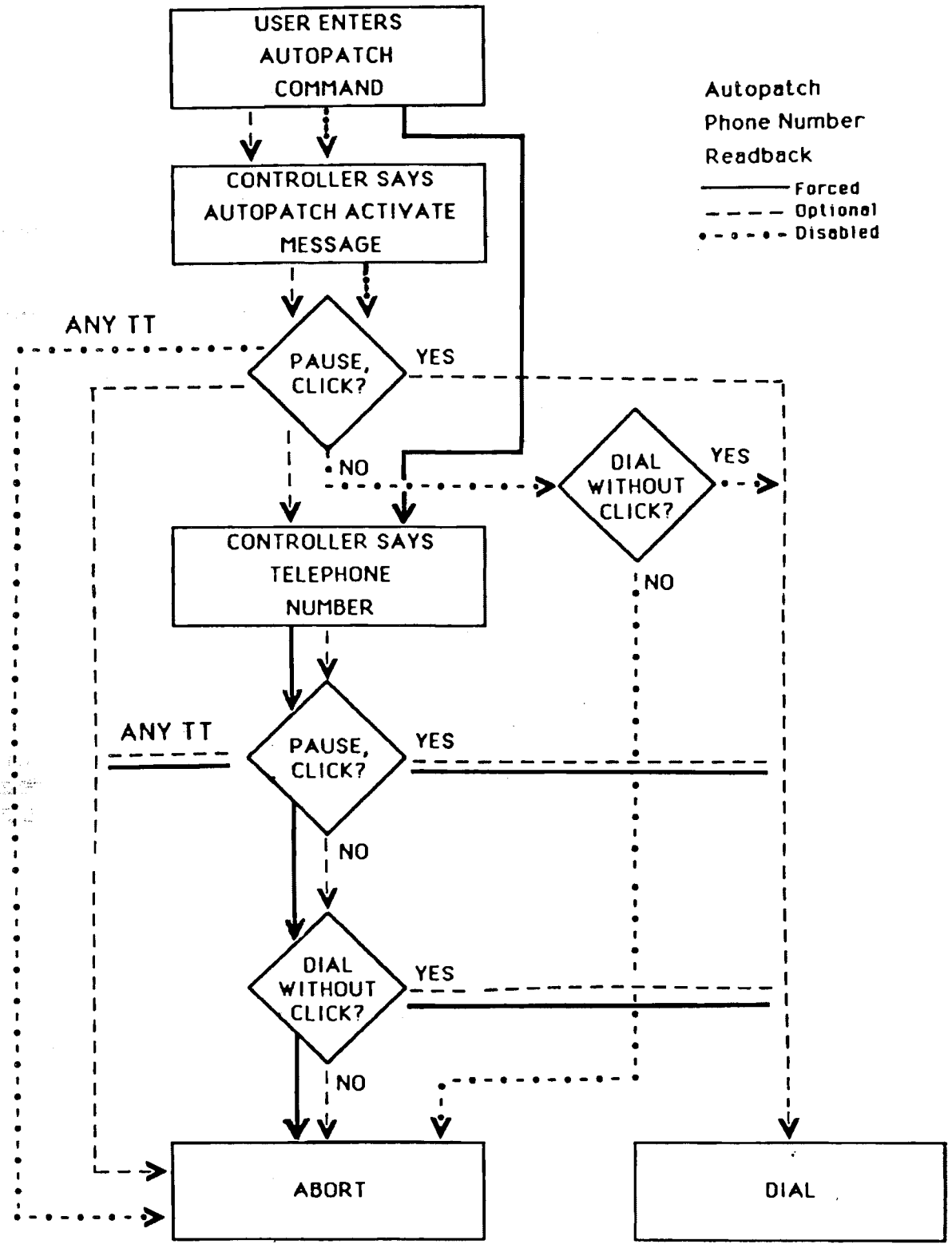
Autopatch Control Operator Commands

The primary, secondary, and tertiary Autopatch user access commands may be enabled and disabled independently, as can the option of long distance protection. The phone number readback mode may also be selected.

Control Op Commands

> Primary Autopatch Enable/Disable
> Secondary Autopatch Enable/Disable
> Tertiary Autopatch Enable/Disable
> Primary Autopatch Long Distance Enable/Disable
> Secondary Autopatch Long Distance Enable/Disable
> Tertiary Autopatch Long Distance Enable/Disable
> Optional/Forced/Disable Autopatch Phone Number Readback
> Dial Needing Click / Without Click

See Also   Patch Timer Enable/Disable – see Patch Timers

Autopatch Programming Commands

Each of the three Autopatch user access command prefixes may be programmed by the repeater owner. The message generated when the Autopatch is activated (such as "Auto patch") may be programmed (this message is not generated in the Force Phone Number Readback Mode).

Programming Commands

> Primary Autopatch command prefix
> Secondary Autopatch command prefix
> Tertiary Autopatch command prefix
> Autopatch Activate Message

See Also   Hangup command – see Hanging Up the Patch
Phone Hangup Message – see Hanging Up the Patch
Autopatch Timer – see Timers

Hanging Up the Patch

When the Autopatch is completed, the user hangs up by entering the Hangup command code. The controller responds by returning to the on-hook condition and sending the programmable Patch Hangup Message (such as "Call complete").

User Command   Hangup
Command = (Hangup Command)

Example   Hangup command = #
User sends "#"
Controller disconnects the patch and announces the
  "Phone hangup message"

Emergency Autodialer – Quick Access When Seconds Count

The Emergency Autodialer offers quick access to ten prestored telephone numbers. When activated, the Emergency Autodialer reads back a message preprogrammed for the particular number as feedback to the user that he

entered the correct command. The ten phone numbers and response messages are programmed by the repeater owner.

The Emergency Autodialer is intended for storage of the most frequently called emergency numbers, such as the various police, fire, ambulance, and other services. When making a patch from the scene of an accident, the assurance provided to the user by a response message such as "CHP" (California Highway Patrol) lets him concentrate on accurately reporting the circumstances of the emergency without worrying about having dialed the correct number.

Activating the Emergency Autodialer

An Emergency Autodial proceeds as follows:

> User enters Emergency Autodial prefix and location and unkeys
> Controller reads back message for that memory location
> Controller dials the number and establishes the connection

It is *not* necessary for the user to click his mic to initiate dialing with the Emergency Autodialer. The patch is terminated with the Hangup command as with the Autopatch.

When assigning various emergency services to the ten autodial locations, it can be helpful to users to select the location based on the first letter of the service; e.g., ambulance to location 2, fire to location 3, 911 to 9, etc.

Emergency Autodialer User Commands

Two programmable user commands are available to activate the Emergency Autodialer. They may be enabled or disabled independently by the Control Operator. For example, the repeater owner could offer two levels of Emergency Autodialer, such as an open autodialer available certain times of day, and a closed autodialer available 24 hours a day to certain users.

User Commands

> Primary Emergency Autodialer Activate
> Secondary Emergency Autodialer Activate
> Command = (P/S Emergency Autodialer Activate)(0-9)

Example   Primary Emergency Autodialer command prefix = *
> Secondary Emergency Autodialer command prefix = A9*
> Location 3 stores phone number for "Fire"
> User enters "* 3" or "A9* 3"
> Controller says, "Fire" and dials the Fire number

See Also   Hangup – see Hanging Up the Patch
> Miscellaneous utilities – see remainder of this chapter

Emergency Autodialer Control Operator Commands

The primary and secondary Emergency Autodialer access commands may be enabled and disabled independently.

Control Operator Commands
>>Primary Emergency Autodialer Enable/Disable
>>Secondary Emergency Autodialer Enable/Disable

See Also   Patch Timer Enable/Disable – see Patch Timers

Emergency Autodialer Programming Commands
Both Emergency Autodialer user access command prefixes may be programmed
by the repeater owner. The messages generated when the Emergency Autodialer
is activated (such as "SC Police", "Fire", etc.) may be programmed, as well as the
actual phone numbers.

Programming Commands
>>Primary Emergency Autodialer command prefix
>>Secondary Emergency Autodialer command prefix
>>Emergency Autodialer #0-9 Messages
>>Emergency Autodialer #0-9 Telephone Numbers

See Also   Hangup command – see Hanging Up the Patch
>>Phone Hangup Message – see Hanging Up the Patch
>>Emergency Autodialer Timer – see Timers

User Loadable Autodialer – To Each His Own
The User Loadable Autodialer stores up to 240 telephone numbers and is
intended for storage of users' home phone numbers and other frequently called
numbers. It can also store additional phone numbers for emergency services if
the ten provided by the Emergency Autodialer are not sufficient. All autodialer
numbers are stored in the controller's non-volatile memory, so they aren't lost if
power is removed from the controller.

Locations 40-99 can store up to 8 digit numbers, while locations 10-39 and
100-199 store up to 11 digits. Locations 200-249 store up to 35 digit phone
numbers and are suitable for MCI/Sprint access numbers and codes and credit
card numbers.

The phone number "macro" capability described later in this chapter allows
storing area codes in a single digit position, if necessary, to conserve space.

The User Loadable Autodialer can be made available to users for loading and
changing their own phone numbers in memory. The numbers are stored in three
"banks". Bank 0 stores 90 numbers (10-99), Bank 1 stores 100 numbers
(100-199), and Bank 2 stores 50 numbers (200-249). Separate user command
code prefixes apply to loading and erasing numbers from each of the memory
banks and to activating numbers from each bank of the autodialer. Each bank may
be locked or unlocked by a Control Operator.

Loading and Erasing Numbers
If the User Loadable Autodialer is unlocked, a number may be loaded by entering
the load/erase prefix, followed by the autodial memory location, followed by the
phone number:

User enters load/erase prefix, location, and phone number
Controller says, "Autodial write" and stores number in memory

A number may not be stored in a location already containing a number – it is necessary to first erase a location if a number is stored there before writing in a new number. To erase a number:

User enters load/erase prefix and memory location
Controller says, "Autodial cancel" and erases number in memory

The user may now load a new telephone number into the empty location.

Activating the User Loadable Autodialer
To activate the User Loadable Autodialer, the user enters the User Loadable Autodialer prefix followed by the autodial memory location. Control Operator selections determine whether the location and phone number are read back. These selections include:

Location read back; phone number read back as user option
Location and phone number read back as user option
Location only read back as user option
No location or phone number read back

Figure 2 shows the operational flow of the autodialer. As with the Autopatch, the user may click his mic to initiate dialing during the pause after readback of the location or phone number. The Dial Without Click Mode eliminates the need for the user to click his mic to initiate dialing.

User Loadable Autodialer User Commands
Independent user commands are available to activate numbers from each bank of the User Loadable Autodialer. Each bank may be enabled and disabled independently by a Control Operator.

User Commands
User Loadable Autodialer Bank 0 Load/Erase
User Loadable Autodialer Bank 1 Load/Erase
User Loadable Autodialer Bank 2 Load/Erase
Erase command = (Bank 0/1/2 Load/Erase prefix)(location)
Load command = (Bank 0/1/2 Load/Erase)(location)(phone number)

Example Location 50 in bank 0 currently contains an old phone number.
Bank 0 Load/Erase prefix = 456
We can erase location 50 by entering "456 50"
Controller responds, "Autodial cancel" and erases the old number
We can load our new number by entering "456 50 2538085"
Controller responds, "Autodial write" and loads the new number

User Loadable Autodialer Bank 0 Activate
User Loadable Autodialer Bank 1 Activate
User Loadable Autodialer Bank 2 Activate
Activate command = (Bank 0/1/2 Activate prefix)(location)

Example   Bank 0 Activate prefix = *
We can call bank 0 location 50 by entering "* 50"
Controller says Autodial Activate message, etc.

See also   Hangup – see Hanging Up the Patch
Miscellaneous utilities – see remainder of this chapter

Figure 2. <u>User Loadable Autodialer Flow</u>
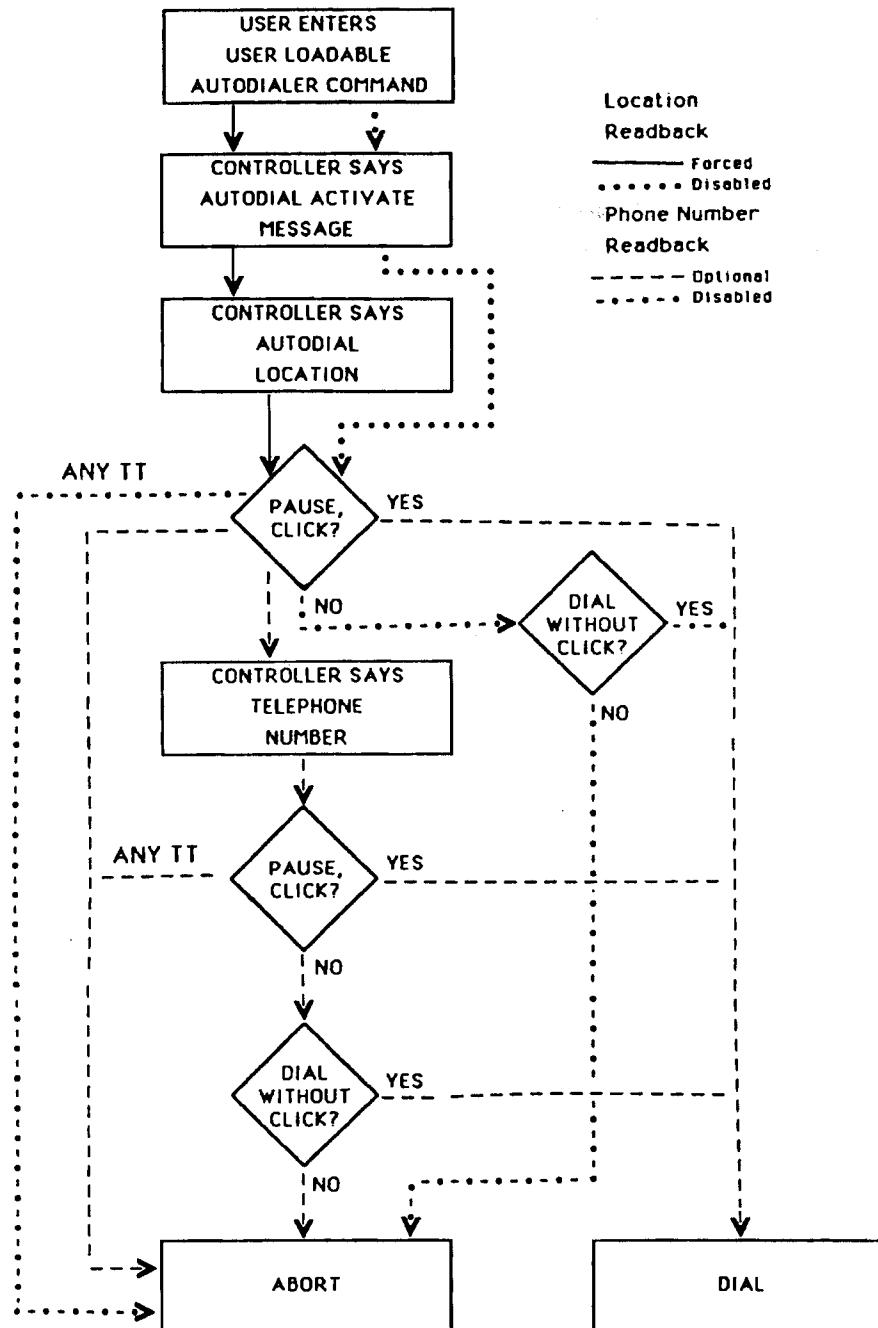
User Loadable Autodialer Control Operator Commands
Each bank may be enabled/disabled and locked/unlocked independently. The
phone number readback mode may also be selected.

Control Operator Commands
User Loadable Autodialer Bank 0 Enable/Disable
User Loadable Autodialer Bank 1 Enable/Disable
User Loadable Autodialer Bank 2 Enable/Disable
User Loadable Autodialer Bank 0 Lock/Unlock
User Loadable Autodialer Bank 1 Lock/Unlock
User Loadable Autodialer Bank 2 Lock/Unlock
User Loadable Autodialer Phone Number Readback Optional/Disable
User Loadable Autodialer Location Readbk Enable/Disable

See Also   Patch Timer Enable/Disable – see Patch Timers

User Loadable Autodialer Programming Commands
Access and load/erase command prefixes may be programmed by the repeater
owner. The message generated when the autodialer is activated (such as "Auto
dial") may be programmed.

Programming Commands
User Loadable Autodialer Bank 0 Activate Command Prefix
User Loadable Autodialer Bank 1 Activate Command Prefix
User Loadable Autodialer Bank 2 Activate Command Prefix
User Loadable Autodialer Bank 0 Load/Erase Command Prefix
User Loadable Autodialer Bank 1 Load/Erase Command Prefix
User Loadable Autodialer Bank 2 Load/Erase Command Prefix
User Loadable Autodialer Activate Message

See Also   User Loadable Autodialer Timer – see Timers

Timers
An overall timer and an activity timer may limit the duration of all autopatch/
autodial calls. Three separate values may be programmed for the Autopatch,
Emergency, and User Loadable Autodialer overall timers. A common program-
mable activity timer applies to all three. The patch timers may be enabled or
disabled by a Control Operator.

If the overall timer is allowed to time out during a patch, it notifies the user
when he is listening (waiting until he unkeys, if necessary) with the Patch
Timeout Warning Message (such as "30 seconds left"). The user then has 30
seconds to either complete the call or extend the timer or the controller will
automatically hang up the patch.

The timer may be extended over and over, but no warning is given before it
times out again. The Timer Extend command is ignored *before* the "30 seconds
left" warning is given.

The activity timer hangs up the patch either if there is no activity on the receiver channel for the specified period or if there is a constant carrier. It is reset at the beginning and end of each user transmission. A "warble" warns of impending timeout of the activity timer. When it is heard, the user may refresh the timer by keying down to produce a brief carrier.

The overall timer may be selectively disabled for any one of the patch functions by setting its timer value to zero. For example, the Emergency Autodialer may operate with only the activity timer by setting the Emergency Autodialer overall timer value to zero. See the Programming Reference Manual for details on disabling timers by setting their values to zero.

User Commands
> Patch Timer Extend = (Patch Utility P Prefix) *3

Example   Patch Utility P Prefix = *
> User sends "* *3" during patch after the controller informed him
> > that there was 30 seconds left.
> Controller says, "Timer X", and reloads patch timer with the Patch
> > Timer Extend value.

Programming Commands
> Patch Timer Extend Timer
> Patch Utility P Command Prefix
> Autopatch Timeout Timer
> Emergency Autodialer Timeout Timer
> User Loadable Autodialer Timeout Timer
> Patch Activity Timer

Control Operator Commands
> Patch Timer Enable / Disable

Cover Tone
The patch offers a "cover tone" which results in muting of the user's audio through the repeater, replaced instead by the cover tone. It offers a degree of privacy by allowing only one side of the conversation to be heard over the repeater transmitter (the telephone side). The cover tone may be selected by the Control Operator to be always on, to be user selectable, or to be disabled. The cover tone itself is a "message", programmable by the repeater owner.

If in the *user selectable mode*, to activate the cover tone, enter the Cover Tone Command before or during a patch. The cover tone selection is cancelled at the end of the patch and may be selected again for the next patch.

User Command = (Patch Utility P Prefix) * 2

Example   Patch Utility P Prefix = *, and user selectable
> User enters "* *2" before or during a patch.
> Controller responds with, "C" and the cover tone is activated
> > for the next/current patch.

Programming Commands
>> Cover Tone Message
>> Morse Code Parameters / User Command Response, Speed, pitch,
>>> level (applies if cover tone is defined as a Morse character)
>> Patch Utility P Command code prefix

Control Operator Commands
>> Cover Tone User Selectable / Disable / Always On

Full/Half-Duplex Mode

Telephone audio during a patch is normally muted at the repeater transmitter while the user is transmitting (half-duplex). This allows the user to immediately block inappropriate remarks made by the party on the phone by simply keying his microphone.

In the full-duplex mode, phone audio is not muted while the user transmits. This allows users with a full-duplex transceiver or a pair of ordinary transceivers to make patches allowing them to talk and listen at the same time.

In the full-duplex mode, inappropriate remarks made by the party on the phone can only be blocked by terminating the patch.

The Control Operator may select full-duplex mode as "user selectable" or "always on".

If in the *user selectable mode*, the patch operates half-duplex unless the user specifies full-duplex by entering the duplex command before or during a patch. The full-duplex selection is cancelled at the end of the patch and may be selected again for the next patch.

If full-duplex is Control Op selected as "always on", then the user may specify half-duplex for a particular call by entering the duplex command. He may also enter the cover tone command to activate the cover tone and operate the patch half-duplex.

The activity timer is disabled during full-duplex patches.

User Command = (Patch Utility P prefix) *1

Example   Patch Utility P prefix = *, full-duplex user selectable
>> User enters "* *1" before or during a patch
>> Controller says, "D" and prepares for full-duplex patch

>> Patch Utility P prefix = *, full-duplex always on
>> User wants this patch only to be half-duplex
>> User enters "* *1" before or during the patch
>> Controller says, "D" and prepares for half-duplex patch

Control Operator Commands
>> Full-duplex user selectable / always on

Custom Hangup

To prevent malicious patch hangup during a call, the user has the option to define his own three-digit hangup code *prior* to making the call. The custom hangup code permits him to define the hangup code for his call, which inhibits the normal Patch Hangup command from terminating the call.

To define a custom hangup code, enter the command within 15 seconds of initiating the patch (do it *before* activating the patch). The hangup code is returned to the normal repeater owner programmed code after the completion of the current call or if the patch isn't initiated within 15 seconds.

If you forget the custom code you define, the Control Op can hang up the patch with the phone onhook Control Op command.

```
| HINT |
```

If you start to enter a patch command and unkey, and then hear the controller say, "cancel", wait 15 seconds to let the accidental custom hangup code clear before retrying.

User Command = (Patch Utility P Prefix) (any 3 keys except # or D, and not beginning with Pad Test prefix)

Example   Patch Utility P Prefix = *
User sends "* 3A7" within 15 seconds of starting the patch
Controller responds with, "cancel" and redefines the patch hangup code for this call to 3A7.

Control Operator Commands
Custom Hangup Enable / Disable
Phone On-Hook

Last Number Redial

The user can later redial the last number called through the patch with a simple command, in case the number was busy, or for any other reason. The last number dialed is stored for ten minutes, after which it is erased automatically by the controller.

User Command = (Patch Utility Q Prefix) *

Example   Patch Utility Q Prefix = *
User sends "* *" within 10 minutes of last placing the call to retry.

Hook Flash

The hook flash command allows the user to simulate depressing the hook switch momentarily, allowing access to a variety of PBX or telephone company ESS (Electronic Switching Station) features.

User Command = (Patch Utility Q Prefix) *5

Example   Patch Utility Q Prefix = *
        A system has a phone line to an ESS office and has the call
            waiting feature provided by the phone comany. During a
            patch, the user hears that there is a call waiting. He can
            put the first line on hold and answer the waiting call by
            entering "* *5".

Manual Phone Patch
The Control Operator can manually "pick up the phone" to place a call or listen
to the phone line from over the air. After picking up the phone, he can pass
Touch-Tone digits directly through to the phone line to place a call (if in
"Touch-Tone Unmute after #" mode). The Autopatch and activity timers apply
to a call-initiated in this way. *No long distance protection applies.*

The call can be terminated with the Hangup command.

Control Operator Commands
        Phone Off-hook
        Phone On-hook (similar to user Hangup command)

User Commands
        Hangup

Antidialer
A flexible "Antidialer" inhibits specific telephone numbers or blocks of numbers
from being dialed through the *Autopatch.* It can supplement the toll-restrict
cabability (see "Toll Restrict") or can specifically deny access to certain phone
numbers, such as the pizza parlor, places of business, etc. Ten antidial slots are
available, capable of storing up to eleven digits each. The numbers are loaded by
the repeater owner with programming commands.

Antidial numbers may include wildcards (?) and globals (*). A wildcard in an
antidial phone number matches any digit at that position. As an example of
wildcards, an antidial number 253-8??? would trap numbers 253-8000 through
253-8999.

A global matches any digit at that position and through the remainder of the
number. For example, an antidial number 1301* traps any 4 digit or longer
number beginning with 1301.

If a phone number in the antidialer is attempted through the Autopatch, the
controller responds with the programmable Antidial Message (such as, "Contact
control operator").

Pause digits are ignored by the Antidialer so that it can't be fooled by users
inserting pauses in a phone number.

Programming Commands
       Antidial Response Message
       Antidial Phone Number Load

Toll Restrict

The controller has a sophisticated toll restrict, or long distance protect capability, which may be selectively applied to each Autopatch access command. [Toll-restrict does not apply to the autodialers.] When long distance is disabled, telephone numbers defined as toll calls cannot be dialed. When it's enabled, any telephone numbers may be called, unless they're trapped out by the antidialer.

Two forms of toll restrict are available. *Toll Restrict Mode A* blocks phone numbers beginning with zero or one and numbers longer than 7 digits. This simple mode is useful and easy to use if long distance access in your area requires a leading 0 or 1 and custom tailoring of the dialing area isn't needed.

Toll Restrict Mode B allows defining permitted exchanges in two area codes, regardless of whether a leading one is required. The controller stores the status of each of eight hundred telephone exchanges (200-999) for two area codes. Additional area codes may be "permitted" as a whole. This capability allows you to define the calling areas available to your users and those which are denied when long distance is disabled.

The ability to selectively apply long distance protection to the three Autopatch access commands allows you to support several levels of users.

When long distance is disabled, and toll-restrict mode B is selected, only 7, 8, 10 and 11 digit numbers may be dialed.

Telephone Number

7 digit number:			(exchange)	(4 digit number)
8 digit number:		(0 or 1)	(exchange)	(4 digit number)
10 digit number:		(area code)	(exchange)	(4 digit number)
11 digit number:	(0 or 1)	(area code)	(exchange)	(4 digit number)

One of the telephone exchange tables applies to seven- and eight-digit numbers, and to ten- and eleven-digit numbers which use the *local area code*. The other exchange table applies to ten and eleven digit phone numbers using an *adjacent area code*.

Programming commands are available to load *all* exchanges in each exchange table as long distance or local and to selectively define each of eight hundred exchanges (in each area code) as long distance or local. If most of the exchanges in the area code are long distance, we can first define the entire exchange table as long distance. Then we can go back and set as local those which we want users to be able to call. If most are local, then first we can define the entire table as local, then go back and set as long distance those that we want to block.

Let's look at an example using Toll-Restrict Mode B. Our local area code is 408 and the adjacent area code is 415. We'll let 800 area code numbers go through.

Local Area Code = 408
Adjacent Area Code = 415
Permitted Area Code #1 = 800
Permitted Area Code #2 = (empty)
Permitted Area Code #3 = (empty)

Local Area Code Exchange Table should be loaded with exchanges
        we want to permit in area code 408.
Adjacent Area Code Exchange Table should be loaded with
exchanges we want to permit in area code 415.

Control Operator Commands
Primary Autopatch Long Distance Enable/Disable
Secondary Autopatch Long Distance Enable/Disable
Tertiary Autopatch Long Distance Enable/Disable

Programming Commands
Toll Restrict Mode A/B Select
(the following apply only in Mode B, area codes loaded as messages)
Local Area Code
Adjacent Area Code
Permitted Area Code #1
Permitted Area Code #2
Permitted Area Code #3
Define Entire Local Area Code Exchange Table as Long Distance/Local
Define Entire Adjacent Area Code Exchange Table as Long Distance/Local
Define Specific Exchange in Local Area Code Exchange Table as Long
        Distance/Local
Define Specific Exchange in Adjacent Area Code Exchange Table as Long
        Distance/Local

Toll Restrict - Mode A

Exchange	

↑
Not 0 or 1

Permits 4-7 digit telephone
numbers without leading
0 or 1.

Toll Restrict – Mode B

1/0	Area Code	Exchange	

Permits 7, 8, 10, and 11 digit telephone numbers.

- Local Area Code
- Adjacent Area Code
- Permitted Area Code #1
- Permitted Area Code #2
- Permitted Area Code #3

Adj Area Code Exchange Table		
Exchange	Loc	LD
200	x	
201		x
202		x
203	x	
204	x	
205		x
⋮		
996		x
997		x
998		x
999		x

Local Area Code Exchange Table		
Exchange	Loc	LD
200	x	
201	x	
202	x	
203		x
204	x	
205	x	
⋮		
996	x	
997	x	
998		x
999	x	

(applies to 7 and 8 digit numbers also)

Phone Number Macros

Frequently dialed digit strings can be stored in the controller and referenced as leading digits (the first digits) in phone numbers. For example, a 1 and area code can be stored as a macro and can be referenced in eight-digit autodial slots, thereby allowing eleven-digit phone numbers to be stored in eight-digit slots. Leading digits available for macro expansion include A, B, C, and 1.

As an example, we have many phone numbers that begin with 1-415 and 1-707 that we'd like to store in the User Loadable Autodialer eight-digit slots. We can assign Macro "A" to be "1415", and Macro "B" to be "1707". Telephone number 1-415-964-8034 could then be loaded in an eight-digit slot in the autodialer as "A9648034".

Suppose our telephone company requires a leading "1121" for long distance calls instead of the more common leading "1". We can load Phone Number Leading 1 Override with "1121". Autopatch or autodial phone numbers with a leading 1 are expanded out to a leading 1121 as required by the phone company.

The use of A, B, or C as prefixes in phone numbers stored in autodialers has a second effect, in addition to expansion of any phone number macros stored. Autodial phone numbers can be directed to one of the three logical phone lines, based on the A/B/C prefix. See the section on Multiple and Remote Phone Lines, later in this chapter.

Patch Dialing Prefix

All Autopatch and autodialer calls can result in stored digit strings preceding dialing of the actual phone number specified. For example, if our controller is connected to a PBX extension, and it is necessary to get an outside line first by dialing 9, we can load the Primary Patch Dialing Prefix with "9 (pause)". The pause allows the controller time to get the outside dial tone before continuing to dial.

Secondary and Tertiary Patch Dialing Prefixes may be specified, which, if loaded, cause Autopatch calls placed with the Secondary or Tertiary Autopatch Command prefixes to be preceded by the secondary or tertiary prefix rather than the main dialing prefix. Suppose, for example, that our PBX uses a 9 to get a local outside line and a 7 to get a tie line to a nearby town. We can load the main Patch Dialing Prefix with "9 (pause)" and the Secondary Patch Dialing Prefix with "7 (pause)". The Primary Autopatch Command may be used for local calls, and the Secondary Autopatch Command may be used for calls using the tie line. The Tertiary Autopatch Command, with an "empty" dial prefix defined, could be used for placing calls *within* the PBX.

Autodial numbers may include the Primary, Secondary, or Tertiary Dialing Prefix by using a leading A, B, or C. The Primary Dialing Prefix is also used when no leading A/B/C is present. (Any or all prefixes may be left empty.)

Mute / Hear Dialing

When the patch is activated, a burst of dial tone and the controller's Touch-Tone signalling into the phone line can be heard over the air (unless pulse dialing is selected). This audio provides feedback to the user that dial tone was received and that the controller did signal into the line. The Touch-Tone signalling over the air can also signal a remote phone line as described later in this chapter.

The audio may be muted by Control Operator selection so that after the user enters the patch command, all is silent until the ringing (or busy) signal is heard. Some users consider this mode more pleasant. Either way, signalling is sent over the air when directed to *remote* phone lines.

Control Operator Commands
Mute / Hear Dialing

Phone Number Readback Voice

The controller reads back phone numbers in its male or female synthesized voice, or in Morse code. The mode is selectable by a Control Op command.

Control Operator Commands
Phone Number Readback Male / Female / Morse code

Signalling Type

The controller is capable of dialing into the telephone line using regenerated Touch-Tone or dial pulse. Normal 10 digit per second DTMF and a slower 5 digit per second Touch-Tone dialing are available. Both 10 and 20 pulse per second dial pulse are supported, allowing the option of faster dialing for those cases where Touch-Tone is not supported but where 20 pps dial pulse will work.

The signalling type is selected by the repeater owner with a programming command. Signalling to *remote* phone lines is always DTMF 10 digits/sec.

Programming Commands

Touch-Tone 10/20 digits per second, or Dial Pulse 10/20 pps.

Incoming Calls

The controller can automatically answer the phone. The repeater owner and Control Operators can call into the repeater to program and control it; users can call in to activate the reverse patch, paging, and to access the mailbox.

Phone Line Control

The phone is allowed to ring for a period determined by the Phone Answer Delay Timer. If the phone rings for this length of time, it is answered and the Phone Answer Message is announced. The primary Touch-Tone decoder switches to the telephone and the caller has 15 seconds to enter a valid command. If no valid command is entered, the controller announces the Phone Hangup Message over the phone and hangs up.

Entry of Control Operator level commands or unlocking the controller and entry of Programming commands extends the protective timer to two minutes. The timer protects against accidental disconnect. Normally, when you're done entering commands from the phone, enter the Control Operator Onhook Command or user level hangup command to instruct the controller to hang up.

The repeater owner may disable programming and Control Operator control through the telephone line command channel to enhance security. If enabled, any valid Control Operator command, or the unlock command, extends the phone line control timer to two minutes. Control Operators can enter a series of Control Op commands. The repeater owner can unlock the controller and enter programming commands. A Control Operator can also listen-only to the repeater receiver, or he may place himself on the air directly like a patch.

A system user calling into the repeater has 15 seconds to enter a valid user level command, such as a reverse patch, mailbox, or paging command.

The controller may be instructed not to answer the phone the next time it rings. This allows an auto-answer modem sharing the phone line to answer next time without interference by the controller also answering the line.

HINT

Commands entered over the phone must be terminated with the # key.

Two alternate modes modify this normal form of telephone access to the controller. Reverse Patch Mode 1 allows the caller five seconds to enter a valid command – if none is entered, a general reverse patch (ringout) begins. This mode is useful for reverse patch callers without Touch-Tone capability.

Reverse Patch Mode 2 does not allow phone line control – a call into the repeater causes the controller to ring out as a general reverse patch without answering the phone. If the reverse patch is answered from over the air, the controller picks up the phone.

Programming Commands
        Phone Answer Message   Phone Answer Delay Timer
        Control From Phone Enable/Disable

Control Operator Commands
        Phone Line Control Timer Extend (this function is also performed
                by any valid Control Operator command)
        Phone On-Hook (hangup)
        Control Operator On Air
        Reverse Patch Mode 0/1/2
        Listen On Phone On / Off
        Don't Answer Next Call

Reverse Patch

A caller from the phone may request to be placed on the air with the reverse patch. The caller may even specify the user that he's looking for with the directed reverse patch, which announces the user's call sign as stored in one of the controller's 100 user "call sign slots".

The controller automatically answers the phone as described above (except in Reverse Patch Mode 2). A caller may enter either the general or directed reverse patch command. The repeater transmitter activates with an electronic "ring" signal to alert users that a call is waiting. If the directed reverse patch command was used, the controller will announce the call sign of the user specified by the caller. The controller waits until any users on the repeater have unkeyed before announcing the call sign. This activity is heard by the caller on the phone line as well as over the air. The primary Touch-Tone decoder switches back to the receiver when a signal is present to allow a user to answer the reverse patch. When no signal is present at the receiver, the Touch-Tone decoder remains on the phone, allowing the caller to load a mailbox message or terminate the reverse patch early.

The ringing will continue after call sign announcement for a period equal to the Reverse Patch Ringout Timer. This ensures that the user being called is given the opportunity to hear that the call is for him and to answer it.

When the reverse patch is answered, the patch continues like an Autopatch, with the Autopatch overall timer and the activity timer limiting the call duration. The user on the air hangs up the patch with the Phone Hangup command.

If a directed reverse patch is not answered, the controller automatically creates a mailbox message for the user, from call sign slot 79, tagged with the time and date of the call.

Reverse Patch Mode 0 requires the Reverse Patch Command to be entered from the phone. This ensures that only authorized persons may activate it – wrong numbers into the repeater system will not activate the transmitter. Only persons supplied by the repeater owner with the telephone number and access code may use it. The command code may be changed at any time as well, in case the code is found out by anyone not authorized to use the reverse patch.

Reverse Patch	Auto-answer	Auto-ringout	Command from phone
Mode 0	yes	no	yes
Mode 1	yes	yes, after 5 seconds	yes
Mode 2	no	yes	no

Reverse Patch Activate Command = (Reverse Patch Activate Command)
Reverse Patch Answer Command = (Patch Utility P Prefix)

Example   Reverse Patch Activate Command = 1, Patch Utility P Prefix = *, Mode 0 selected
A person calling into the repeater's phone line may activate the patch by entering "1#". A user may answer the reverse patch from the radio by entering "*".

> HINT

When answering the reverse patch from the radio, enter the command and *unkey* to allow the command to be evaluated. *Then* key down again and say hello.

The reverse patch ringout can be ended early from the phone or the radio by entering the hangup command without having answered the patch.

Programming Commands
 User Call Sign Messages
 Reverse Patch Ringout Timer
 Reverse Patch Activate Command

Control Operator Commands
 Reverse Patch Enable/Disable
 Reverse Patch Mode 0/1/2

User Commands
 Reverse Patch Activate (from the phone)
 Reverse Patch Answer Command (from over the air)
 Hangup Command

Mailbox

Callers may retrieve and erase mail stored for them and send mail to system users from the phone. Any of ten "stored" messages may be loaded. Data, such as phone numbers, may be appended to the messages, allowing the caller to leave a return phone number. See the Mailbox section of the manual for more details.

If the repeater system includes the ACC Digital Voice Recorder, the caller may retrieve and store digitally recorded voice messages from the memory of the DVR. See the DVR Manual for more details.

Dial Access Paging

A caller into the system may activate a paging sequence over the air. Any two-tone sequential device may be paged and any other selective call device whose format and address have been stored in a pager memory may be called. The page may be tone only, tone and synthesized speech message, or tone and data, depending upon the paging format used.

The caller may leave a mailbox message for the repeater user, if desired, in addition to activating the page.

See the Paging section of the manual for more details.

Programming Commands
    Paging Command Prefix
    Paging Memory Load

User Commands
    Paging

General Topics

Sharing the phone line and use of multiple or remote phone lines, are specialized applications. If you're using a single phone line at the site, it isn't necessary to read this section. However, you may get some good ideas!

Sharing the Phone Line

Several repeater controllers may share one phone line. The RC-850 controller supplies an open collector "Phone Line Busy" output, which may be "or-tied" with other controllers at the same location. The Phone Line Busy signal should also be tied to the controllers' "Phone Line Busy" inputs. Before a controller goes off-hook for an outgoing call, it checks the Phone In Use input – if it's active, the user is notified with a "Busy" message. If it's not active, the controller goes offhook and activates its Phone Line Busy output, which prevents other controllers from simultaneously trying to use the line.

The several controllers sharing the line should be programmed with the same phone answer delay timer value. In that way, all controllers will answer, and commands may be directed to a particular controller. Those controllers which do not receive valid commands will drop out after 15 seconds. Alternately, one or

more controllers may be instructed not to answer the phone by setting its phone answer delay timer to zero.

A programming command selects a Shared or Unshared Phone Line Mode. See the Hardware Reference Manual for details on interfacing multiple controllers to one phone line.

Programming Commands
Shared / Unshared Phone Line Mode

Multiple and Remote Phone Lines
The controller's firmware supports up to three "Logical Phone Lines". These logical lines are like the buttons on a key telephone – one of the three may be selected when making a call. Each logical line may be one of two local phone lines at the site itself, or one of three remote phone lines linked through the repeater system's auxiliary (remote base or link) transceivers.

Multiple local lines can be useful when the repeater serves a wide area, and the phone company can supply lines with different local calling areas. Remote lines, linked through the auxiliary transceivers, can eliminate the need for expensive commercial lines on mountain-top sites. The lines can instead be located at residences. The ability to support up to three local and/or remote lines provides a high degree of flexibility.

Each Logical Phone Line (Line #1, #2, and #3) is assigned to be Local Phone Line #1 or #2, or Remote Phone Line #1, #2, or #3. The assignment is done by the repeater owner with programming commands.

The two *local* phone lines use the internal telephone interface board and are distinguished by a signal which may drive an outboard DPDT relay to select one of two lines into the controller.

Remote phone lines are defined by a down channel (repeater to remote phone line site) and an up channel (remote site to repeater). Pager memories optionally store patch activate and shutdown signalling information to distinguish between the several remote sites. Calls directed to remote phone lines automatically bring up the appropriate auxiliary transceivers for the up and down channels and send optional pager memory signalling information to activate the appropriate site. This is done automatically by the controller, transparant to the repeater user.

The repeater transmitter may also perform the down link function. A logic signal is available from the controller to enable a PL encoder at the repeater transmitter to gate audio into the remote phone line to prevent a "loop around".

If desired, the up link may be shared with the repeater's control receiver.

In general, calls are directed to one of the three logical phone lines based on:

(1) the Autopatch command prefix used (primary, secondary, or tertiary), or
(2) a leading A, B, or C stored in autodial numbers.

Logical Phone Line	Autopatch Access	Autodial Access
#1	Primary Autopatch command	Leading "A" or no leading prefix
#2	Secondary Autopatch command	Leading "B" in number stored
#3	Tertiary Autopatch command	Leading "C" in number stored

Physical Phone Line	Phone Line Select Output	Pager Up Memory	Pager Down Memory
Local #1	Low	-	-
Local #2	High	-	-
Remote #1	Low	50	53
Remote #2	Low	51	53
Remote #3	Low	52	53

When a patch is initiated which is directed to a local phone line, the Phone Line Select output may drive a relay to select the proper line. The patch occurs through the telephone interface board in the controller.

Patches directed to the remote lines cause the up and down channels to activate. If auxiliary transceiver 1 or 2 is specified as the up or down channel, it is activated on its memory frequency 8. User audio may be supplied by the repeater transmitter or auxiliary transmitter to the remote phone line site. Telephone audio from the remote site is supplied to the repeater through an auxiliary receiver or the control receiver. Optional selective call signalling, stored in pager memories 50, 51, or 52, activates the remote phone line at the beginning of the patch, and either pager memory 53 or the Phone Hangup Message may include signalling to knock it down.

Equipment required at the remote phone line sites includes just a receiver and transmitter, a signalling decoder such as ACC's HSC tone decoding board, and a simple phone patch such as the Heathkit HD-1515. If the repeater transmitter, rather than one of the auxiliary transmitters, performs the down link, then a PL encoder and decoder are needed at the repeater and remote site, respectively.

Remote Phone Line Down and Up Channels

Down Channel	Up Channel
Repeater transmitter	Control receiver
Auxiliary transceiver 1	Auxiliary transceiver 1
Auxiliary transceiver 2	Auxiliary transceiver 2
Auxiliary transceiver 3	Auxiliary transceiver 3
Auxiliary transceiver 4	Auxiliary transceiver 4

Programming Commands
Logical Phone Line #1/2/3 Assignment
Remote Phone Line Down Channel Assignment
Remote Phone Line Up Channel Assignment

See Also   Remote Base Memories
Pager Memories

Chapter 8
Remote Bases and Links

Several auxiliary frequency-agile (synthesized) half duplex transceivers and full duplex links may be connected to the repeater system. Remote base transceivers may serve several functions, including remote phone line linking, paging, Scheduler event transmission, and general use by repeater users for operating a remote base through the repeater. Full duplex links might typically be 220 or 420 MHz links which tie the repeater system into other repeater systems at other locations, or may be wire links to other repeaters located at the same site.

The remote base application gives users the opportunity to share equipment for other bands located at an optimum site. The remote base also allows simple on-channel linking to other repeaters and simplex frequencies from the repeater site. In addition to manual control by users, the Scheduler can automatically bring up the remotes and links at predefined times in listen only or listen / transmit for nets and other regular activities.

The controller supports up to four link / remote base channels. Each channel may connect to a full duplex link transceiver or a half duplex remote base transceiver. Channel 3 may alternatively function as the user selectable "Spare Audio 1", and channel 4 may alternatively serve as the control receiver. Assignment of each channel is made by the repeater owner with programming commands.

Channel	Link	Remote Base	Spare Audio 1	Control Receiver
1	Link 1	RB 1	-	-
2	Link 2	RB 2	-	-
3	Link 3	RB 3	OK	-
4	Link 4	RB 4	-	OK

For example, the system could directly support two remote base transceivers, one full-duplex link, and a control receiver. Or it might support one remote base transceiver, two links, and Spare Audio1 function. The system may be expanded to meet larger requirements with the resources on the Computer Interface Board and external circuitry.

Logic I/O is supplied for remote base and link COS inputs and PTT outputs. Switched audio inputs to the controller are available for each channel. Remote base and link transmitter audio may be taken from the controller's repeater transmitter audio output. Since this audio output may include command response audio and audio from other links mixed under computer control, it can permit remote base and link access to many of the controller's features. The link transmit audio may also be taken from the "processed receiver audio" which consists of *only* repeater receiver audio with Touch-Tone and squelch tails removed.

Generally, a remote base is designed to simulate as closely as possible normal operation of an amateur transceiver. This means that stations listening to the remote base transceiver output shouldn't be able to distinguish its users from any other users on the channel. If desired, however, users may activate repeater functions *from* the remote base frequency.

Audio to the repeater transmitter is prioritized, with repeater receiver audio overriding remote base and link audio. If the repeater receiver is inactive, the audio from the active links is prioritized out to the transmitter, with Remote Base / Link 1 having highest priority.

Touch-Tone commands may be entered from the remotes and links with the repeater receiver having highest priority, followed by Remote / Link 1, 2, 3 and 4. Commands may be entered from the remotes and links even if they are turned off by user level commands, as long as they are "Control Operator" enabled and specified as "command OK from remote" by the repeater owner. The secondary Touch-Tone decoder on the Computer Interface Board may be assigned to any audio channel, such as a link, for full-time availability.

Users entering the system from remotes or links 1-4 are identified by courtesy tones 9-12. Users easily know whether signals are from the repeater receiver or the remotes / links. Courtesy tone 13, generated *in addition to* the otherwise selected tone, indicates that at least one remote or link is in receive/transmit mode.

User Command Control

Each of up to four remote base or link transceivers may be user commanded to receive only, receive / transmit, or off. In addition, the frequency of two of the transceivers may be commanded by users, with the frequency read back in synthesized speech for verification.

The user commands for controlling the remote bases include:

> Remote Base / Link 1-4 Receive Only, Receive/Transmit, Off
> Remote Base / Link 1-2 Frequency - direct entry
> Remote Base / Link 1-2 Frequency - memory select (7 memories each)
> PL Frequency Select (for outboard PL encoder)
> Antenna Direction (for outboard analog servo or ACC's Rotor Control Board)
> Band Select (for switching between multiple VHF/UHF transceivers
> or bands on one remote base / link port)

Receive Only - Receive/Transmit - Off
Activating the remote or link in receive only causes signals received through the auxiliary transceiver to bring up the repeater transmitter and be retransmitted through the repeater. Users may talk on the repeater, however, without interfering with the stations on the auxiliary frequency. Repeater users' audio overrides auxiliary audio to allow a conversation to take place on the repeater in this mode.

The user may activate the auxiliary transmitter. Now, signals received at the repeater receiver are retransmitted over the auxiliary transmitter. Touch-Tone commands are fully muted, as are squelch tails, and users appear to listeners through the remote or link as any other user on that frequency. The remote may be tied to other repeaters, or to simplex frequencies. [Refer to Part 97 for regulations relating to multiple repeater transmitters on the same band at the same location, auxiliary linking, and remote control of an amateur station.]

The Remote Base / Link Off command turns off the receive and transmit capabilities of the remote or link.

Remote Base / Link Receive Only
Remote Base 1 - (Remote Base prefix) 1
Remote Base 2 - (Remote Base prefix) 4
Remote Base 3 - (Remote Base prefix) 7
Remote Base 4 - (Remote Base prefix) *

Remote Base / Link Receive/Transmit
Remote Base 1 - (Remote Base prefix) 2 [*]
Remote Base 2 - (Remote Base prefix) 5 [*]
Remote Base 3 - (Remote Base prefix) 8 [*]
Remote Base 4 - (Remote Base prefix) 0 [*]

The * appended to the receive/transmit command activates the remote or link in the crosslink mode. A signal received on another remote or link will be retransmitted out that remote or link. Courtesy tones and command responses will also be transmitted out that remote / link.

Remote Base / Link Off
Remote Base 1 - (Remote Base prefix) 3
Remote Base 2 - (Remote Base prefix) 6
Remote Base 3 - (Remote Base prefix) 9
Remote Base 4 - (Remote Base prefix) 9

Command Responses (see also Command Acknowledgement, later this chapter)
    Receive Only - or "(Remote base name) RX" or "(Remote base prefix) (MHTO) (minus,s,plus)"
    Receive / Transmit - "(Remote Base Name) TX"
    Off - "(Remote Base Name) Off"

All examples which follow assume Remote Base prefix = 7.

Examples
Turn on Remote Base 2 in receive only – 74
Turn off Remote Base 3 – 79

Frequency Change
Users may change the frequency of the VHF or UHF transceiver by entering the desired frequency in a format similar to that of keyboard entry HT's. The user also selects the transmit offset.

Several frequency memories for the two synthesized remote bases are available for easy selection by users. Programmable names associated with each memory are read back to the user when memories are selected. The names may be an abbreviation of the frequency for simplex frequencies (e.g., "five two") or the repeater's call for repeater frequencies ("KHP repeater").

Remote Base Frequency Change
Remote Base 1 - (Remote Base prefix) 1 M * H T O F
Remote Base 2 - (Remote Base prefix) 4 M * H T O F
    M = MHz
    H = Hundreds kHz
    T = Tens kHz
    O = Ones kHz
    F = OFfset (1=minus, 2=simplex, 3=plus)

Command Response
    Frequency readback "(Remote base prefix) (MHTO) (minus,s,plus)"
    If the * is omitted or MHTO are all zeros, "(Remote Base name) RX"

Remote Base Memory 1-7 Select, Receive only
Remote Base 1 - (Remote Base prefix) 1 (1-7)
Remote Base 2 - (Remote Base prefix) 4 (1-7)

Command Responses
    "(Remote Base memory name)" if present, or frequency readback

Examples
Set Remote Base 1 to 6.940 MHz, minus offset – 7169401
Recall Remote Base 2 Memory 3 – 743

PL Select
As part of the serial data stream supplied by the controller, six bits of PL information specify one of 32 PL frequencies and PL on/off. This data may be supplied to an *external* PL encoder. Users may specify PL frequency 1-32 or off. The controller responds with "PL" or "PL Off". The selected PL freqency isn't read back because PL information is often considered to be sensitive.

The PL information is also included in frequency memories so that calling up a memory frequency for a particular repeater may automatically select its PL. See the Hardware Reference Manual for details on interfacing PL to the remotes.

    (Remote Base prefix) 7 (0-32)
        0 = off, 1-32 = 67 - 203.5 Hz, based on outboard SS-32 PL encoder

Examples
Select PL 67 Hz – 771
Turn off PL – 770

HINT

Recalling a frequency memory for Remote Base / Link 1 *or* 2 overrides a previous PL selection.

Band Select
In advanced installations, multiple remote base transceivers may be connected to one hardware port. For example, an ICOM IC-2A, IC-3A, and IC-4A could be wired to Remote Base #1. The controller supplies three "band select" bits as part of the serial data stream and a Band Select user command to select one of several transceivers to be activated. This capability is also useful when using a multiband transceiver, such as the Drake UV-3, which automatically provides three-band capability on one remote base hardware port.

The controller responds to the band select command with the name of the band selected ("Ten meters" through "Twelve hundred", and "HF").

    (Remote Base prefix) 9 (0-6)
        0 = 10M, 1 = 6M, 2 = 2M, 3 = 220, 4 = 440, 5 = 900, 6 = 1200, 7 =
HF

    (Remote Base prefix) 9 *
        Band Interrogate

Example
    Select 6M for the multiband remote base channel – 7<u>91</u>
    Interrogate band – 7<u>9*</u>

HINT

Recalling a frequency memory for Remote Base 1 *or* 2 will override a previous band select.

Direction
The controller supports antenna rotor control through seven bits of direction information included in the serial data stream supplied by the controller. This information may drive a hardware servo-like circuit to control a rotor.

Users may command the rotor direction. Direction information is also stored in each of the frequency memories and is recalled when a memory is brought up. Finally, direction information may be scheduled so that the antenna will rotate to the proper direction as the remote base is brought up for a net, etc.

    (Remote Base prefix) 8 (0-360)
        Command Direction

Examples
    Rotate to 90 degrees – 7<u>890</u>

```
HINT
```

Recalling a frequency memory for Remote Base 1 *or* 2 will override a previous direction selection.

Command Acknowledgement

When bringing up the remote or changing frequency, the controller acknowledges commands and reads back the frequency that the remote is programmed to. The repeater owner may program a name for each remote and a frequency prefix for remotes 1 and 2.

For example, a UHF repeater may have a two-meter remote base transceiver. The remote name may be programmed as "Two meter sss". The frequency prefix could be programmed as "One four -ty". In response to bringing up the remote in receive only, the controller says the frequency, such as "*One four -ty* six point nine four, minus". Commanding to transmit causes it to read back "*Two meter sss* TX". Shutting it off causes it to say, "*Two meter sss* off".

Hardware Interface

The controller provides PTT and COS signals for each transceiver. Frequency information is supplied in the form of a serial data stream from two of the controller's logic outputs. The data is converted to parallel information using external shift registers to drive the transceiver frequency synthesizer. ACC offers a frequency control board which may perform the serial to parallel function. The serial data format minimizes the number of interconnect wires to the transceivers – the shift registers would typically be mounted directly in the rig. Usually, some form of level shifting would be required to match to the logic levels of the frequency synthesizer, so some interface logic would be required in most cases anyway. See the Hardware Reference Manual for details on hardware interfaces.

Programming Commands
Remote Base / Link Messages
Courtesy Tone Parameters and Messages
Logic I/O Senses
Remote Base Memories
Remote Base / Link Channel 1-4 Assignment

Control Operator Commands
Remote Base / Link 1-4 Enable / Disable

User Commands
(see above)

Chapter 9
Alarms

The controller offers several alarm functions to assist with site security and to notify users of dangerous or out-of-spec operation of the repeater. If an alarm condition occurs, a programmable over-the-air announcement is made identifying the alarm condition. The message is repeated every ten seconds for a programmable period. The alarm state can be cleared by a Control Operator or if allowed to continue until timeout. An electronic mailbox message consisting of the alarm announcement is left for the repeater owner or Control Op in mailbox slot 78. The message is tagged with time and date of the alarm condition so that the time the condition occurred is known. (The message is left *for* call sign slot 78 *from* call sign slot 79.)

The alarms may be triggered by hardware logic inputs to the controller. Hardware inputs can be connected to sensor switches, weather radio storm alert signals, aviation ELT receivers, or other devices which provide logic level indications. Sensor switches can detect intrusion, overvoltage, water on the floor, or other conditions.

The alarm inputs are edge triggered. An alarm condition is set when an alarm input goes from low (inactive) to high (active). The condition is latching – the alarm condition remains even if the input returns quickly to the low state. If the alarm is cleared by a Control Operator, the alarm input must return to the inactive state before it is re-armed.
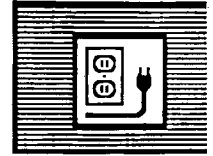
Chapter 10
General Purpose Remote Control

In addition to the controller's internal functions, the capability for remote control of external equipment is provided. The remote control capabilies can be commanded manually by users, and 32 logic outputs (UF1-32) may be scheduled for fully automatic operation.

Remote Control Logic Outputs

The controller supports a number of remotely controllable logic outputs for control of equipment at the repeater site. Eight User Function logic outputs are provided. One of these are dedicated to the remote base serial data output, but most outputs may be reassigned using the logical I/O structure.

An expanded mode may be selected by the repeater owner. In this mode, a total of 64 bits of user function information is shifted serially out of the controller, which may be captured using external shift registers. The data is shifted out of UF1, UF2, and UF3, which serve as serial data, clock, and transfer signals respectively. One FC-1 Frequency Control Board may capture 32 outputs – two boards may capture all 64 signals. UF1-32 may be scheduled, while UF 33-64 may not and are initialized to the low state. [The data stream provided at UF1/2/3 in the expanded mode is independent of remote base frequency information, also supplied serially, but from different logic outputs.]

Sixteen of the outputs may be controlled as two 8 bit groups, allowing convenient control of PL frequencies, level controls, etc. Group 1 consists of UF17-24; Group 2 consists of UF25-32.

Each of the remotely controllable logic outputs may be interrogated, or commanded high or low. In response to commands for user functions 1-8, the controller reads back a "high beep" or "low beep" and a programmable message, which may indicate the specific function in your repeater. For example, if one output turns on and off an ATV camera and transmitter at the site for visual monitoring, the response messages could be programmed to be "TV on" and "TV off".

Outputs 9-64 respond with a high or low beep, and the output number. Group commands to the two eight bit groups respond with a programmable group name, and the group value (0-255).

When the state of UF 1-8 outputs are interrogated, the controller produces a short (roughly 200 us) toggle pulse on the output. The pulse is too short to disturb relays or other devices driven by the output, but may be stretched to any desired length by an external one-shot or 555 timer.

User Commands
The user commands for controlling the remote control logic outputs include:

UF 1-8
Output ON – (UF Prefix) (1-8) 1
Output OFF – (UF Prefix) (1-8) 0
Interrogate – (UF Prefix) (1-8)

UF 1-64
Output ON – (UF Prefix) (1-64) * 1
Output OFF – (UF Prefix) (1-64) * 0
Interrogate – (UF Prefix) (1-64) *

Group 1 (UF 17-24)
Force 0-255 – (UF Prefix) * (0-255)
Interrogate – (UF Prefix) *

Group 2 (UF 25-32)
Force 0-255 – (UF Prefix) * * (0-255)
Interrogate – (UF Prefix) * *

Examples (assume UF Prefix = 9)
Interrogate UF 4 – 94
Set UF 4 On – 941
Set UF 14 Off – 914*0
Interrogate UF 27 – 927*
Set Group 1 to 38 – 9*38

Programming Commands
    UF 1-8 On / Off Messages
    UF Group 1 and 2 Name Messages
    UF User Command Prefix

Chapter 11
Voice Response Telemetry

The RC-850 controller provides measurement capability with synthesized speech readback on command. The controller also periodically makes measurements and stores highs and lows for the various measurement channels, tagged with time and date of the high/low reading. Measurement readings can be included in any programmable message.

The remote metering provides a general remote diagnostic capability for the repeater equipment, allows users to determine the characteristics of their signals, and provides information of general interest to repeater users.

Analog Measurement

Analog measurement capability consists of a 16 channel analog-to-digital converter capable of measuring 16 input voltages between 0 and 5 volts DC. Signals may be provided to the analog inputs from the receiver S-meter and deviation metering circuits, from wattmeters, temperature sensors, and other transducers. Predefined in the firmware are a number of "meter faces" which correspond to various scales of the types of signals we'd like to measure. Meter faces are provided for S-units, kHz, watts, degrees, volts, amps, etc.

Each hardware analog input channel (1-16) may be assigned a meter face using programming commands. The input signals sometimes must be scaled to match the predefined meter faces, which are defined in Table 1. In some cases, the signals need to be scaled using external hardware.

Two of the 16 channels are dedicated to measuring the temperature at the controller board and the on-board supply voltage. The other 14 input channels are available at the 25 pin "ANALOG INPUT" connector on the rear panel. Since each channel may be assigned any of the meter faces, the repeater owner has total flexiblity in metering his system. For example, he may want to meter several temperatures – outdoor, indoor, PA heat sink, and inside cabinet. He may want to monitor the 12 volt supply voltage and the battery voltage, output power from several repeaters at the site, and internal test points in equipment.

Internal Datalogging Telemetry

The controller maintains internal logging information, including the period of time the repeater was last timed out, the number of messages in the mailbox, total time the repeater has been active, the number of patches, etc. This information may be accessed by users in a manner similar to other meter channels and may be included in programmable messages.

Readback On Command

Users may read back by Touch-Tone command the readings of the various channels. This capability allows users to check their S-meter reading, quieting, and other signal characteristics, or the repeater output power, temperatures, etc.

Stored Highs and Lows

The controller periodically measures all telemetry channels and stores running maximum and minimum values. If the measured value is higher than the previous high stored, or lower than the previous low stored, the new value replaces the old high or low and is tagged with the time and date. The stored values may be cleared with Control Operator commands, or they may be cleared automatically as Scheduler events.

For example, the lowest overnight temperature is automatically stored for an outdoor temperature channel. It may be interrogated by users, with the controller providing the temperature and the time that the low was measured. The stored low may be cleared each night by the Scheduler so that it contains valid low temperature information throughout the following day.

Measurements in Messages

Meter readings can not only be provided on demand to users, but can also be built into any of the programmable messages as run-time variable speech strings. That means the repeater can say, "At fifty-four watts, this is WA6AXX, repeater", and mean it! Stored highs and lows can be included in messages as well – such as, "Good morning, today's low temperature – fourteen degrees, at WA6AXX, repeater".

Telemetry Channels

Users may interrogate telemetry channels with a command consisting of the VRT prefix followed by the channel number. Channels 0-32 provide the actual current value. Adding a * or ** at the end of the command causes the stored low and high value to be read back, respectively.

Channel #	Description
0	Time of day
1-16	Hardware Analog Inputs 1-16, read back based on scale and units "meter face" assigned to analog channel
17	Instantaneous wind speed, mph (with Heathkit ID-1590)
18	Five second average wind speed, mph (with Heathkit ID-1590)
19	Five minute average wind speed, mph (with Heathkit ID-1590)
20	Instantaneous wind direction (with Heathkit ID-1590)
21	Five second average wind direction (with Heathkit ID-1590)
22	---
23	Barometric pressure (with Heathkit ID-1990)
24	---
25	Number of repeater input keyups
26	Minutes repeater up
27	Number of patches
28	Number of maibox accesses
29	Number of command entries
30	---
31	Timed out period of last timeout
32	Number of messages in mailbox

Meter Faces

The following meter faces are provided. Any meter face may be assigned to any hardware analog input channel 1-16. The meter scales are shown on the following pages.

Voltage (0-16, 0-32, 0-256 volts)
Current (0-4, 0-8, 0-16, 0-32 amps; 0-64 microamps)
Power (0-2, 0-4, 0-8 watts, .1 watt resolution; 0-8, 0-16, 0-32, 0-64,
          0-128, 0-256 watts, 1 watt resolution)
S-meter
Frequency error
Quieting percentage
Deviation
General Purpose 0-100
Temperature (direct interface to LM335 temperature sensor)
High Resolution Temperature
Direction (cardinal and degrees)
Wind Speed

Most meter channels are measured when interrogated. In addition, each channel is measured approximately every five seconds to permit storage of the lowest and highest value of each channel in memory, addressable with * or ** following the channel number. (Of course, not all min/max values are meaningful, such as the "lowest S-meter" reading.) The min/max memories may be cleared by the Control Operator or may be cleared by the scheduler as events.

The receiver related meter faces (S-meter, frequency error, quieting, deviation) are measured automatically at one second into each repeater user transmission for later recall during the transmission. Alternate meter faces are available for

making these measurements at the command evaluation time, which is *after* the repeater user's signal has gone away. These alternate meter faces are useful for making receiver readings on remote base or link receivers where the signal remains present at the command evaluation time.

User Commands

Current Reading	(VRT Prefix) (channel #0-32)
Stored Low	(VRT Prefix) (channel #1-16) *
Stored High	(VRT Prefix) (channel #1-32) * *

Example (assuming VRT prefix = 8)
Read channel 8 – 8<u>8</u>
Read channel 15 – 8<u>15</u>
Read stored high on channel 15 – 8<u>15</u>**
Read stored low on channel 15 – 8<u>15</u>*

Programming Commands

       Message Editor – run time variable speech strings
       Meter Face Assignment
       VRT User Command Prefix

Control Operator Commands

       Telemetry memory channel clear

VOLTAGE - 0-16V (.1V RESOLUTION)

```
00
      READBACK "VOLTS"
0      5      10      15

0   1   2   3   4   5
acc    INPUT VOLTS
```
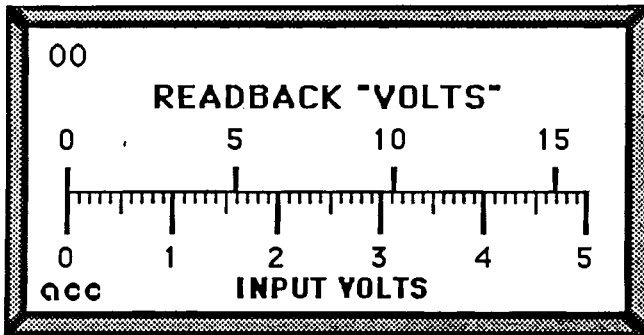
APPLICATIONS:
SUPPLY VOLTAGE
BATTERY VOLTAGE
INTERNAL REGULATED VOLTAGES

VOLTAGE - 0-32V (.1V RESOLUTION)

```
25
      READBACK "VOLTS"
0     10     20     30

0   1   2   3   4   5
acc    INPUT VOLTS
```
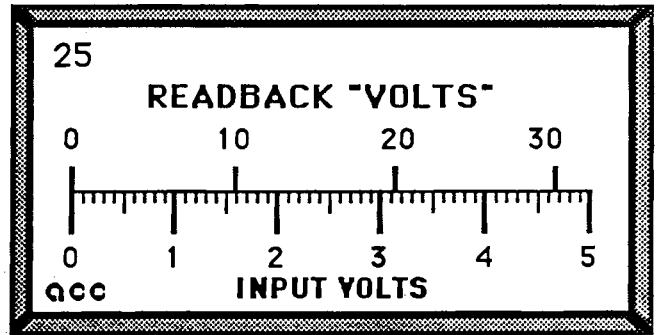
APPLICATIONS:
SUPPLY VOLTAGE
BATTERY VOLTAGE
INTERNAL REGULATED VOLTAGES

VOLTAGE - 0-256V (1V RESOLUTION)

```
24
      READBACK "VOLTS"
0  50  100  150  200  250

0   1   2   3   4   5
acc    INPUT VOLTS
```
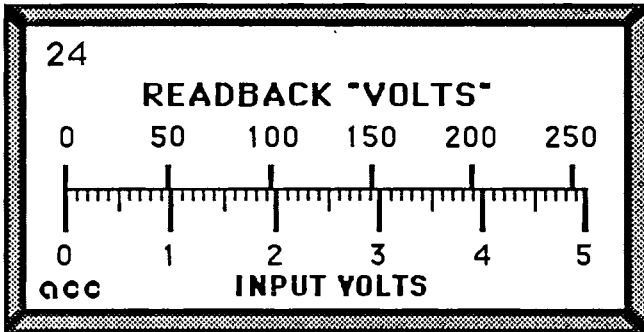
APPLICATIONS:
AC LINE VOLTAGE
HIGH VOLTAGE SUPPLIES

CURRENT - 0-4A (.1A RESOLUTION)

```
22
      READBACK "AMPS"
0   1   2   3   4

0   1   2   3   4   5
acc    INPUT VOLTS
```
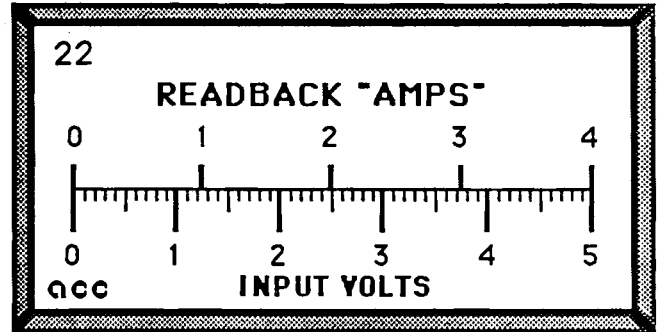
APPLICATIONS:
TRANSMITTER CURRENT DRAIN
BATTERY CHARGING CURRENT

CURRENT - 0-8A (.1A RESOLUTION)
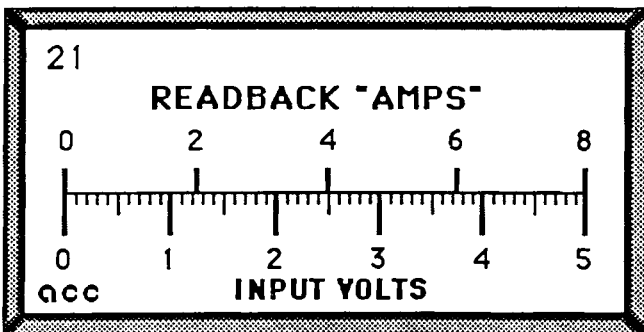
```
21
      READBACK "AMPS"
0   2   4   6   8

0   1   2   3   4   5
acc    INPUT VOLTS
```

APPLICATIONS:
REPEATER CURRENT DRAIN
TRANSMITTER/PA CURRENT DRAIN
BATTERY CHARGING CURRENT
AC LINE CURRENT

CURRENT - 0-16A (.1A RESOLUTION)
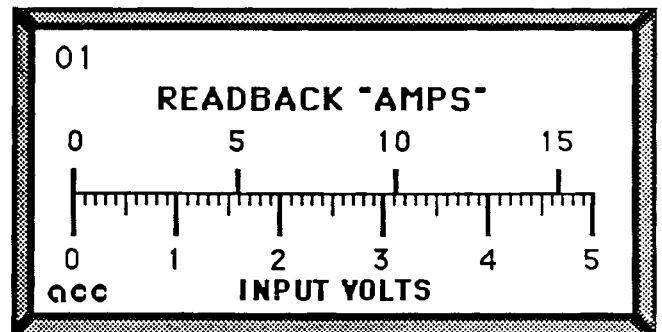
```
01
      READBACK "AMPS"
0     5     10     15

0   1   2   3   4   5
acc    INPUT VOLTS
```

APPLICATIONS:
REPEATER CURRENT DRAIN
TRANSMITTER/PA CURRENT DRAIN
BATTERY CHARGING CURRENT
AC LINE CURRENT

CURRENT - 0-32A (.1A RESOLUTION)

```
20
        READBACK "AMPS"
  0         10        20        30

  0     1     2     3     4     5
  acc        INPUT VOLTS
```
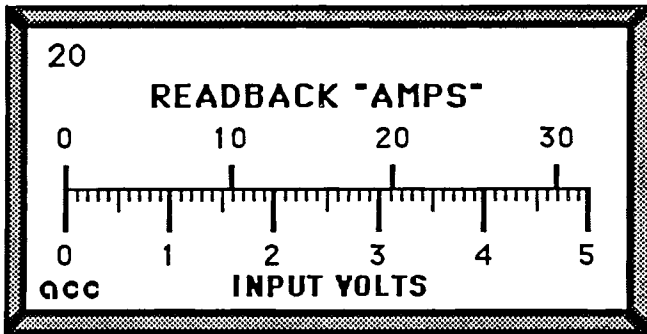
APPLICATIONS:
REPEATER CURRENT DRAIN
TRANSMITTER/PA CURRENT DRAIN
AC LINE CURRENT

CURRENT - 0-64 uA (.1 uA RES.)

```
23
        READBACK "MICROAMPS"
  0   10  20  30  40  50  60

  0     1     2     3     4     5
  acc        INPUT VOLTS
```
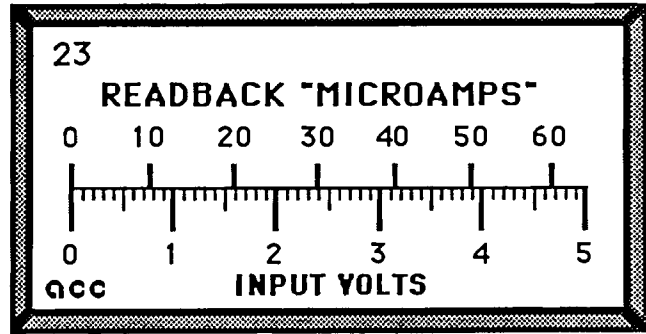
APPLICATIONS:
INTERNAL TEST POINTS

POWER - 0-2W (.1W RESOLUTION)

```
17
        READBACK "WATTS"
  0      .1     .5      1       2

  0     1     2     3     4     5
  acc        INPUT VOLTS
```
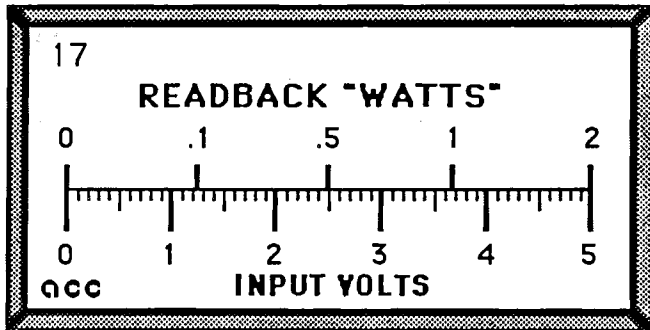
APPLICATIONS:
REPEATER REFLECTED POWER
REMOTE BASE REFLECTED POWER

POWER - 0-4W (.1W RESOLUTION)
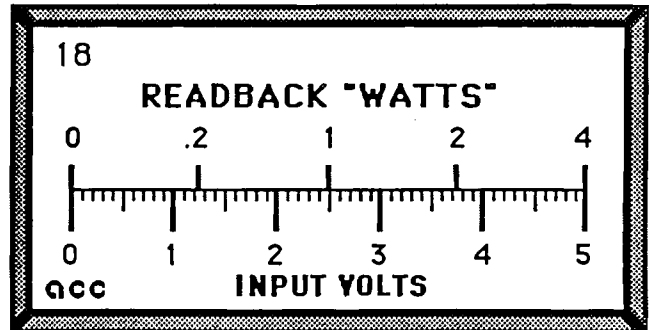
```
18
        READBACK "WATTS"
  0      .2      1       2       4

  0     1     2     3     4     5
  acc        INPUT VOLTS
```

APPLICATIONS:
REPEATER REFLECTED POWER
REMOTE BASE REFLECTED POWER

POWER - 0-8W (.1W RESOLUTION)

```
19
        READBACK "WATTS"
  0      .5      2       4       8

  0     1     2     3     4     5
  acc        INPUT VOLTS
```

APPLICATIONS:
REPEATER FORWARD POWER
REPEATER REFLECTED POWER
REMOTE BASE FORWARD POWER
REMOTE BASE REFLECTED POWER

POWER - 0-8W (1W RESOLUTION)

```
11
        READBACK "WATTS"
  0          1    2      4       8

  0     1     2     3     4     5
  acc        INPUT VOLTS
```
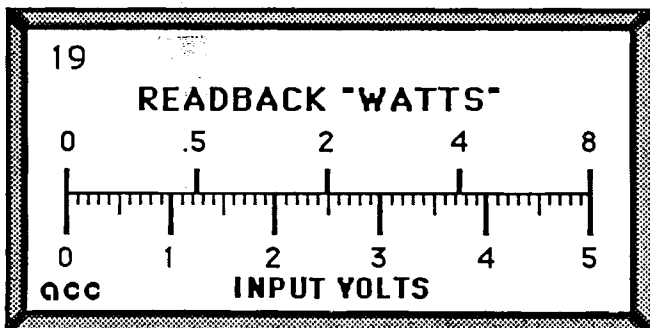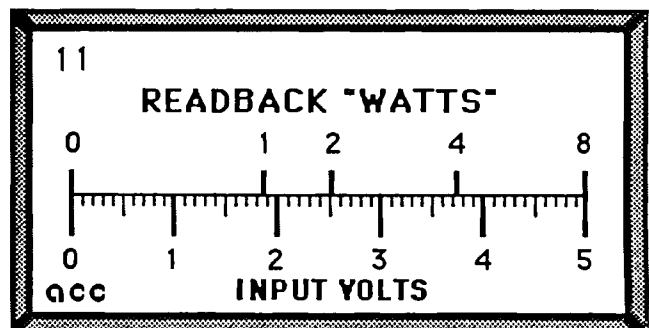
APPLICATIONS:
REPEATER FORWARD POWER
REPEATER REFLECTED POWER
REMOTE BASE FORWARD POWER
REMOTE BASE REFLECTED POWER

POWER - 0-16W (1W RESOLUTION)

```
12
        READBACK "WATTS"
  0       1      4      8      16

  0       1      2      3      4      5
acc          INPUT VOLTS
```
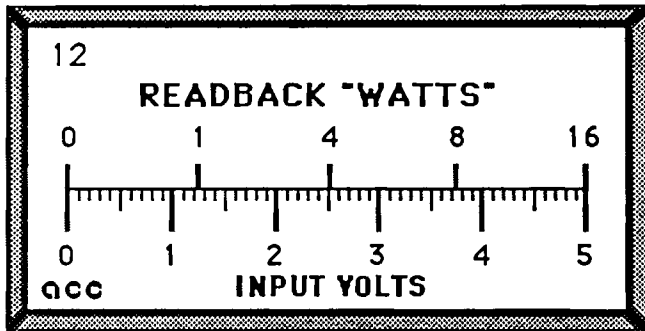
APPLICATIONS:
REPEATER FORWARD POWER
REMOTE BASE FORWARD POWER

POWER - 0-32W (1W RESOLUTION)

```
13
        READBACK "WATTS"
  0       2      8      16     32

  0       1      2      3      4      5
acc          INPUT VOLTS
```
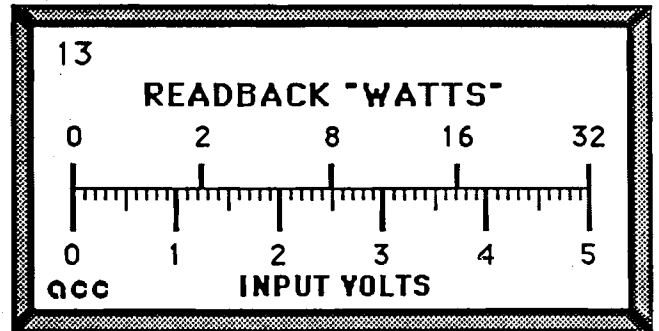
APPLICATIONS:
REPEATER FORWARD POWER
REMOTE BASE FORWARD POWER

POWER - 0-64W (1W RESOLUTION)

```
14
        READBACK "WATTS"
  0       4      16     32     64

  0       1      2      3      4      5
acc          INPUT VOLTS
```
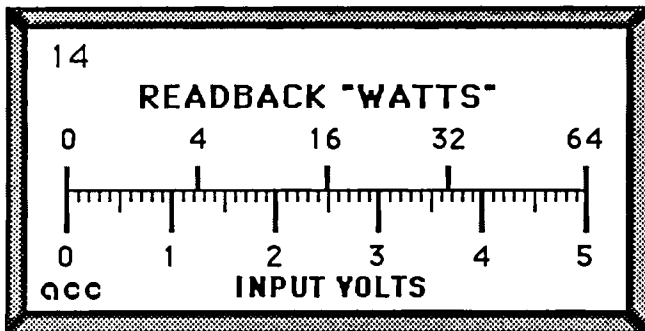
APPLICATIONS:
REPEATER FORWARD POWER
REMOTE BASE FORWARD POWER

POWER - 0-128W (1W RESOLUTION)

```
15
        READBACK "WATTS"
  0       8      32     64     128

  0       1      2      3      4      5
acc          INPUT VOLTS
```
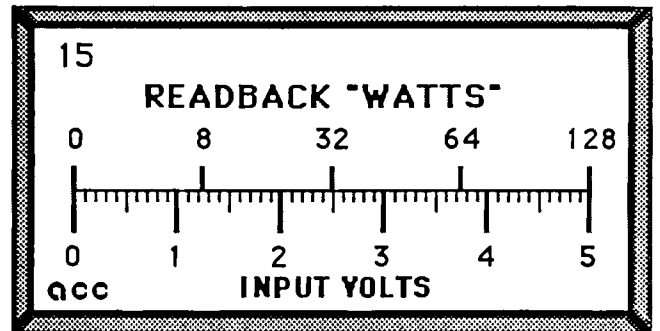
APPLICATIONS:
REPEATER FORWARD POWER
REMOTE BASE FORWARD POWER

POWER - 0-256W (1W RESOLUTION)

```
16
        READBACK "WATTS"
  0       16     64     128    256

  0       1      2      3      4      5
acc          INPUT VOLTS
```
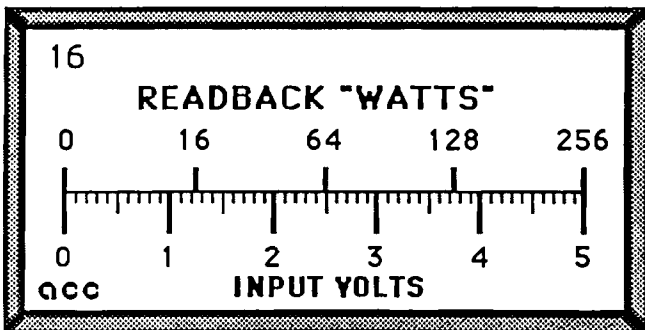
APPLICATIONS:
REPEATER FORWARD POWER
REMOTE BASE FORWARD POWER

S-METER (S-UNITS, DB OVER S9)

```
02,30
          READBACK
  S0              S9        S9+60

  0       1      2      3      4      5
acc          INPUT VOLTS
```
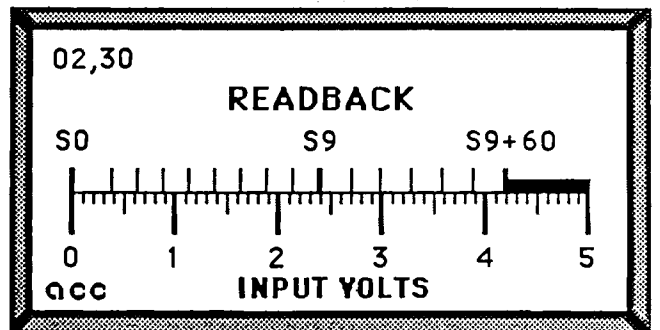
APPLICATIONS:
REPEATER RECEIVER S-METER
REMOTE BASE RECEIVER S-METER

FREQUENCY ERROR

```
03,31
           READBACK
-5kHz       UNDER 200 HZ      +5kHz

         ▮
|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|
  0     1     2     3     4     5
acc        INPUT VOLTS
```
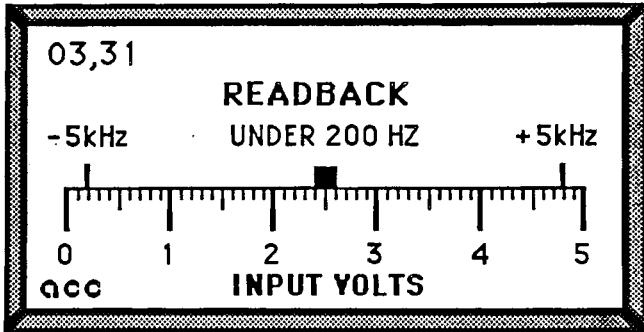
APPLICATIONS:
   REPEATER RECEIVER FREQ. ERROR
   REMOTE BASE RECEIVER FREQ. ERROR

QUIETING (1% RESOLUTION)

```
04,32
           READBACK "PERCENT"
100   75    50    25    0

|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎▬▬▬|
  0     1     2     3     4     5
acc        INPUT VOLTS
```
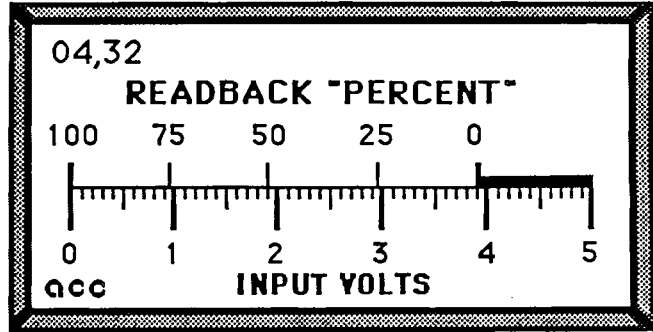
APPLICATIONS:
   REPEATER RECEIVER QUIETING
   REMOTE BASE RECEIVER QUIETING

DEVIATION (.5kHz RESOLUTION)

```
10,33
           READBACK "kHz"
0           5          10

|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎▬▬▬|
  0     1     2     3     4     5
acc        INPUT VOLTS
```
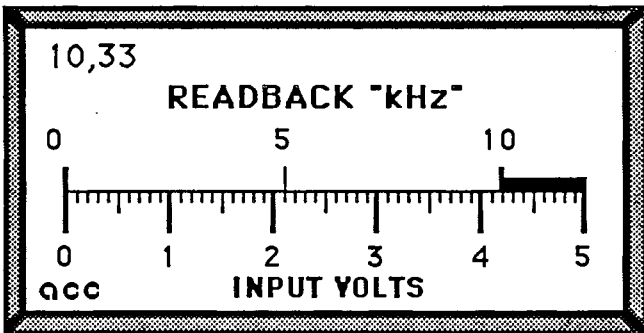
APPLICATIONS:
   REPEATER TX DEVIATION
   REMOTE BASE TX DEVIATION

GENERAL PURPOSE 0-100

```
07
           READBACK
0    25    50    75   100

|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎▬▬▬|
  0     1     2     3     4     5
acc        INPUT VOLTS
```
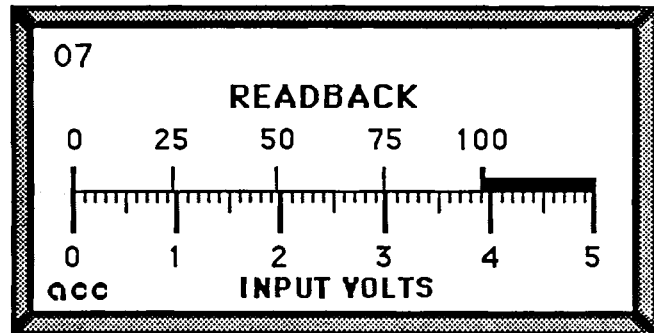
APPLICATIONS:
   MISC. METERING

TEMPERATURE - LM335 SENSOR

```
05
           READBACK "DEGREES"
                 0 75  +5.55 mV/deg F

|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|
  0     1     2     3     4     5
acc        INPUT VOLTS
```
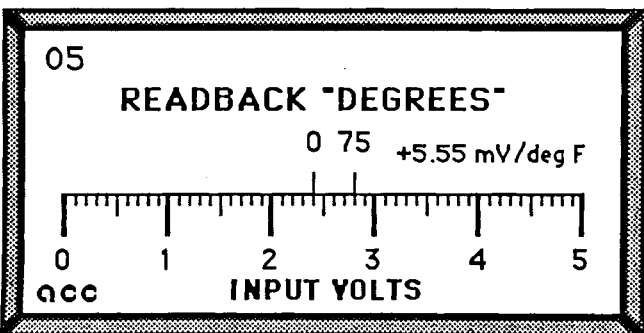
APPLICATIONS:
   INDOOR, OUTDOOR TEMPERATURE
   PA HEAT SINK TEMPERATURE
   CABINET TEMPERATURE

HIGH ACCURACY TEMPERATURE
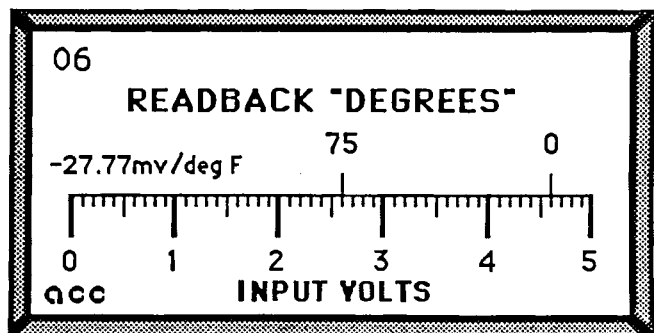
```
06
           READBACK "DEGREES"
                      75           0
-27.77mv/deg F

|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|᠎᠎᠎᠎᠎᠎᠎|
  0     1     2     3     4     5
acc        INPUT VOLTS
```

APPLICATIONS:
   INDOOR, OUTDOOR TEMPERATURE
   PA HEAT SINK TEMPERATURE
   CABINET TEMPERATURE

DIRECTION (CARDINAL)

```
08              READBACK
    N    E   E   S   S   W   W   N
    N N N   S S S   S S S   N N N
  N E E E E E E E S W W WW W WW W N
  |   |   |   |   |   |   |   |   |
0        1       2       3       4       5
acc           INPUT VOLTS
```
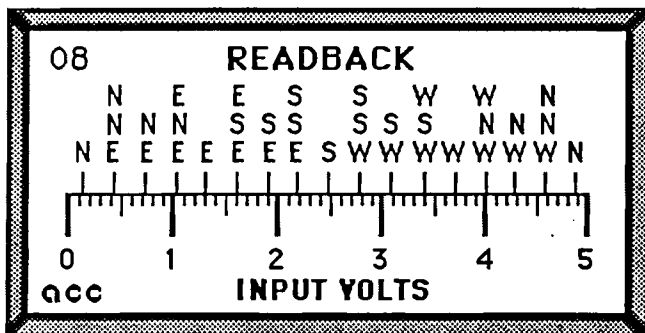
APPLICATIONS:
WIND DIRECTION
ROTOR DIRECTION

DIRECTION (DEGREES)

```
26
      READBACK "DEGREES"
0          180      360
|          |        |
0     1     2     3     4     5
acc       INPUT VOLTS
```
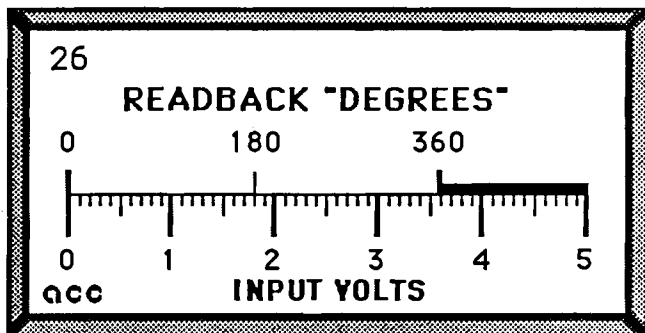
APPLICATIONS:
WIND DIRECTION
ROTOR DIRECTION

WIND SPEED

```
09       READBACK "MPH"
0          50      100
|          |        |
0    1    2    3    4    5
acc       INPUT VOLTS
```
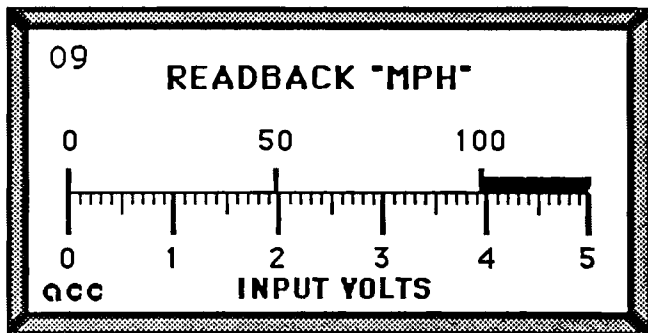
APPLICATIONS:
WIND SPEED

Chapter 12
Paging - Selective Call

The RC-850 Repeater Controller can function as a paging terminal capable of generating a variety of formats. Selective call capability allows users to be available without having to constantly listen to the repeater. Users may carry paging receivers or may install selective call decoders in their radios. The paging capability can also provide sophisticated, secure signalling for remote phone line access, alarms, and other control applications.

Paging tones can be commanded by users over the air, allowing user-to-user selective call. Telephone access paging allows callers to page system users. Paging tones can be included in any programmable messages, such as alarm and patch messages, allowing system initiated signalling. Messages may be scheduled as events for such applications as periodic pager tests, net reminders, and remote scheduled control of other systems.

For simplicity, each pager is treated as a unique device. Fifty pager memories store information characterizing each pager, and each unit is referenced by its memory number. Selective call devices are characterized by

- Signalling format
- Address ("cap-code")
- Receive frequency

Signalling Format
The signalling formats supported include:

Two-tone sequential
Five/six-tone sequential
DTMF (Touch-Tone)
CTCSS (sub-audible)
Hexadecimally Sequentially Coded (HSC)

All formats are compatible with any voice grade repeater or auxiliary transmitter. The paging tones are generated by the controller's internal digital sine wave synthesizer.

GENERAL PAGING CAPABILITIES					
FORMAT	TONE ONLY	TONE-VOICE	TONE-DATA	TONE-V/D	REMOTE CONTROL
2 TONE	X	X			X
5/6 TONE	X	X			X
DTMF	X				X
CTCSS	X	X			
HSC	X	X	(NUMERIC)	(NUMERIC)	X

Address
The addressing capability of each paging format is described in detail in the following sections. The pager's address is stored in its memory location in the controller.

Receive Frequency
Each selective call device consists of an rf receiver with a signalling decoder to function with a particular format. The controller's firmware supports receivers listening on four different frequencies – the repeater output frequency, one memory frequency each for Remote Base #1 and #2, and one fixed frequency for Remote Base #3.

For example, a two-meter repeater group may have access to a group of surplus UHF pagers. The paging transmissions can be made through an auxiliary (remote base) transmitter on a frequency stored in memory. The page transmission is followed by the Auxiliary Transmitter Pager ID message.

The paging frequency is assigned with each unit's format and address in its memory slot.

Paging Formats
This section provides a technical description of each of the paging formats supported by the controller.

Two-Tone Sequential
The controller can generate two-tone no-gap signalling with durations of 1-3, 2.7-.8, or .4-.8 seconds. The timing is based on Motorola's Quick Call II and is compatible with most two-tone sequential tone only and tone/voice pagers and two-tone sequential decoders. The 60 standard Motorola reed frequencies, plus 30 GE Type 99 tone frequencies, are supported. An 8 second group call allows simultaneous activation of all pagers with a common second tone frequency which are equipped with a group call option.

The figure below shows the timing associated with the two-tone sequential formats. The table lists the standard frequencies supported and their corresponding group and tone numbers. The tones are generated by the controller at 0 db level (maximum tone amplitude).

Recommended Rf Deviation – 3.3 kHz
Sensitivity – decoder will operate at 6 db quieting

Typical Equipment
Pagers – Motorola - Director, Spirit, Minitor, Pageboy, Pageboy II, Pagecom,
          Dimension IV
Decoders – Communications Specialists SD-1

Paging Supported – tone only, tone/voice

TWO-TONE SEQUENTIAL TIMINGS

TONE A	TONE B
1 second	3 seconds

TONE A	TONE B
2.7 seconds	.8 second

A	TONE B
.4	.8 second

TONE B
8 seconds
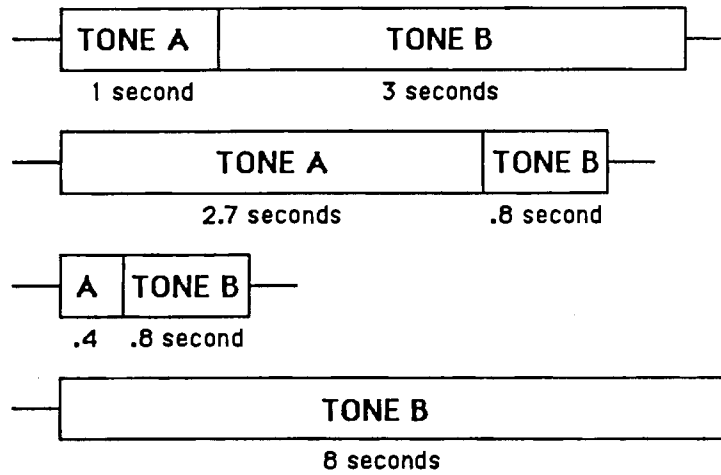
2-TONE SEQUENTIAL MOTOROLA TONE FREQUENCIES

TONE #	GROUP 1 CODE	FREQ	GROUP 2 CODE	FREQ	GROUP 3 CODE	FREQ	GROUP 4 CODE	FREQ	GROUP 5 CODE	FREQ	GROUP 6 CODE	FREQ
1	111	349.0	121	600.9	138	288.5	141	339.6	151	584.8	191	1153.4
2	112	368.5	122	634.5	108	296.5	142	358.6	152	617.4	192	1185.2
3	113	389.0	123	669.9	139	304.7	143	378.6	153	651.9	193	1217.8
4	114	410.8	124	707.3	109	313.0	144	399.8	154	688.3	194	1251.4
5	115	433.7	125	746.8	160	953.7	145	422.1	155	726.8	195	1285.8
6	116	457.9	126	788.5	130	979.9	146	445.7	156	767.4	196	1321.2
7	117	483.5	127	832.5	161	1006.9	147	470.5	157	810.2	197	1357.6
8	118	510.5	128	879.0	131	1034.7	148	496.8	158	855.5	198	1395.0
9	119	539.0	129	928.1	162	1063.2	149	524.6	159	903.2	199	1433.4
0	110	330.5	120	569.1	189	1092.4	140	321.7	150	553.9	190	1122.5

GE TYPE 99 TONE FREQUENCIES

TONE #	GROUP 7 FREQ "A"	GROUP 8 FREQ "B"	GROUP 9 FREQ "C"
1	592.5	607.5	712.5
2	757.5	787.5	772.5
3	802.5	832.5	817.5
4	847.5	877.5	862.5
5	892.5	922.5	907.5
6	937.5	967.5	952.5
7	547.5	517.5	532.5
8	727.5	562.5	577.5
9	637.5	697.5	622.5
0	682.5	652.5	667.5

Five/Six Tone Sequential
The 5/6 tone capability is based on Motorola's "Metropage" format, which is the de facto U.S. 5/6 tone standard. The signalling consists of an optional "wakeup tone", or preamble, and gap followed by five 33 ms duration tones with no gaps between them. An optional sixth tone accesses a second address of the user's pager. The timing and frequency assignments are shown below. The optional wakeup tone allows the pager to operate in a battery saver mode.

Sample Equipment
Pagers – Motorola BPR 2000, Envoy, Sensar
Decoders – Midian MTSD 2
Chip Set – MX-COM MX003Q Sequential Tone Receiver, MX103Q Address
          Selector

Paging supported – tone only, tone/voice

5/6 TONE SEQUENTIAL TIMING

690 ms	T1-T5 = 33 ms

PREAMBLE (1) | T1 (0) | T2 | T3 | T4 | T5 | X

gap = 45 ms   X = 45 ms
                     (optional)
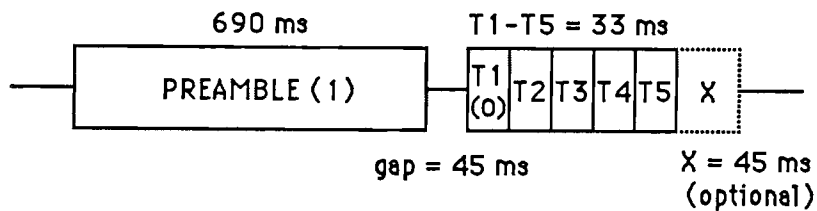
5/6 TONE SEQUENTIAL	
TONE	FREQUENCY
0	600
1	741
2	882
3	1023
4	1164
5	1305
6	1446
7	1587
8	1728
9	1869
X	2010
R	459

DTMF

The DTMF paging capabilities support 15 standard tone pairs (all except D) for use with DTMF decoders and sequence detectors. The frequencies and timing for DTMF signalling are shown below.

Sample Equipment
Decoders – Advanced Computer Controls - ITC-32 Intelligent Touch-Tone
                Control Board
            Communications Specialists - DTD-1

DTMF TIMING

—|T1|—|T2|—|T3|—|T4|—

100 ms on/
100 ms off
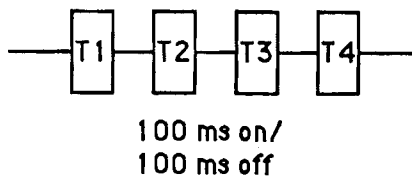
DTMF FREQUENCIES		
TONE	F1	F2
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1366
6	770	1477
7	852	1209
8	852	1336
9	852	1477
0	941	1336
*	941	1209
☛	941	1477
A	697	1633
B	770	1633
C	852	1633

CTCSS

The controller can generate bursts of sub-audible tone to unsquelch radios which include a tone decoder. A user can command a CTCSS burst, then talk while the tone is sent so that the target receiver unsquelches and allows the user to be heard ("tone and voice"). Another capability is a CTCSS burst mixed with a warble tone which functions like a "tone only" page, alerting the listener at the target receiver.

Use of CTCSS signalling requires that the audio output from the controller drive the transmitter at a point which will pass low frequencies (i.e., after any high-pass filtering). Repeater receiver audio supplying the controller should be high-pass filtered to remove a user's tone before entering the controller. Subaudible decoders *cannot* decode tones when more than one is present at a time (the user's and the controller's).

The 32 tones supported are shown below. The tones are sent at -9 db relative to maximum tone level. For example, if the tone generator is set to 3 kHz deviation at 0 db, CTCSS is sent at 1000 Hz deviation.

Sample Equipment
Transceivers – Yaesu FT-209RH, FT-270RH, FT-2700RH
Decoders – Communications Specialists TS-32

CTCSS FREQUENCIES

01	67.0	17	118.8
02	71.9	18	123.0
03	74.4	19	127.3
04	77.0	20	131.8
05	79.7	21	136.5
06	82.5	22	141.3
07	85.4	23	146.2
08	88.5	24	151.4
09	91.5	25	156.7
10	94.8	26	162.2
11	97.4	27	167.9
12	100.0	28	173.8
13	103.5	29	179.9
14	107.2	30	186.2
15	110.9	31	192.8
16	114.8	32	203.5

CTCSS TIMING

"TONE ONLY"

WARBLE
SUBAUDIBLE TONE

3 seconds

"TONE AND VOICE"

REPEATER RECEIVER AUDIO
SUBAUDIBLE TONE

5 seconds
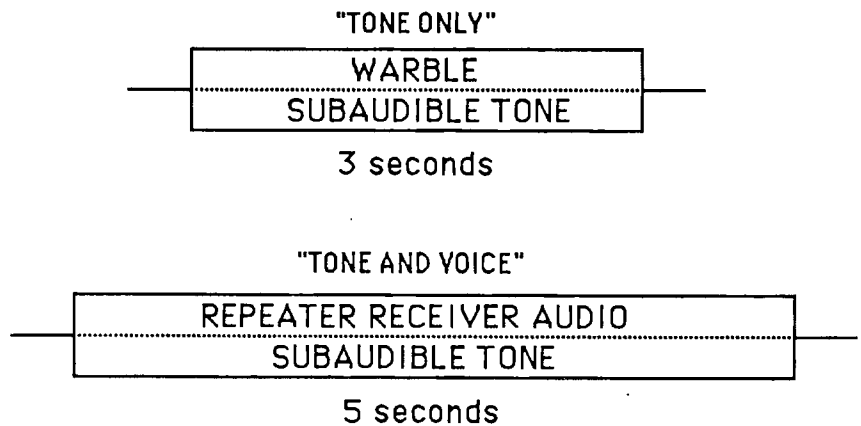
Hexidecimally Sequentially Coded (HSC)
The HSC format is an extension of 5/6 tone signalling and supports numeric display paging. With available decoder chip sets, the HSC format may be used as a secure, reliable signalling format for general purpose control applications. It can overlay in a system with 5/6 tone and two-tone without conflicts.

HSC paging provides tone only, tone and voice, and tone and data with or without voice paging. The controller supports the majority of the HSC capabilities, including:

Tone only, tone/voice, tone/data, tone/data/voice pages
Overlay with 5/6 tone paging without conflicts
Automatic speaker silencing after a voice page
12 digit message display
Various levels of group call

The details of the HSC format are too complex to provide in this manual, but tone frequencies and examples of signalling timing are shown below. The tone durations are increased from the standard 33 ms to 65 ms to optimize the signal-to-noise performance of the decoder. The tone signalling is quick and pleasant sounding and should not be irritable to users.

Sample Equipment
Pagers – Standard Communications PG-50 [service block 0, beep period 3]
Evaluation Board – MX-COM EVKIT-2 (Rx)
Chip Set – MX-COM MX003Q Sequential Tone Receiver, MX103Q Address
Selector

HSC	
TONE	FREQUENCY
0	600
1	741
2	882
3	1023
4	1164
5	1305
6	1446
7	1587
8	1728
9	1869
A	2151
B	2435
C	2010
D	2295
E	459
F	NO TONE

SIMPLIFIED HSC TIMING

65 ms per tone
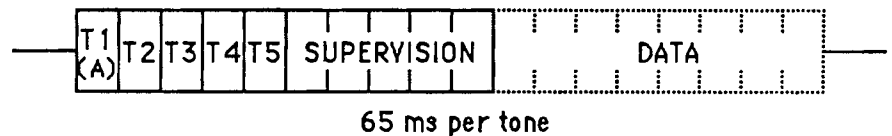
Pager Memories

Information identifying each pager in the system is stored in one of fifty memories. The pager is identified by its format, address, and frequency.

Memories are loaded with programming commands of the format:

*29xx f aaaa *f*

xx = pager memory 00-53

f = format

0 = two-tone 1 - 3 second	7 = CTCSS
1 = two-tone 2.7 - .8 second	8 = HSC pager activate
2 = two-tone .4 - .8 second	9 = HSC board mute
3 = two-tone group call 8 second	* = HSC board activate
4 = DTMF	D = HSC pager mute
5 = five-tone	
6 = six-tone (extended address)	

aaaa = address

two-tone = A/G# A/T# B/G# B/T# (A=B for group call)
DTMF = T1 T2 T3 T4 (1-4 digits)
5/6-tone = T2 T3 T4 T5 (T1 fixed as 0, preamble fixed as 1)
CTCSS = xx (2 digits, 01-32, see CTCSS frequency table)
HSC = T2 T3 T4 T5 (T1 fixed as group call,
            T2-T5 may be group call - key "*")

f = frequency

0 = repeater transmitter
1 = Remote Base #1 memory 9
2 = Remote Base #2 memory 9
3 = Remote Base #3 (fixed frequency)

Examples

Memory 14 – Two-tone .4-.8 second, A = group #2 tone #3,
            B = group #1 tone #5, repeater transmitter *2914 2 2315 0

Memory 3 – Six-tone, address 01234, Remote Base #1 - *2903 6 1234 1

Memory 25 – HSC pager address A1357, repeater transmitter - *2925 8 1357 0

Memory 38 – CTCSS 110.9 Hz, repeater transmitter - *2938 7 15 0

Memory 46 – Two-tone 8 second group call, group #5 tone #3, Remote Base #2
            *2946 3 5353 2

User-to-User Paging

Users may activate any of the pagers stored in memory with Touch-Tone commands. They may also activate *any* two-tone sequential pager with 1 - 3 second signalling by specifying its group and tone numbers.

User Commands
Activate pager stored in memory
> (Paging prefix)(2 digit memory number) [*] [data]
>> * is optional – indicates voice page
>> data is optional – 1 digit represents mailbox canned
>>> message number; multidigit represents numeric
>>> or alphanumeric data

Activate other two-tone sequential pager
> (Paging prefix)(A Group #)(A Tone #)(B Group #)(B Tone #)

Examples
> Paging Prefix = 2
> Paging Memory 7 addresses a five tone sequential pager
> User enters "2 07 *"
>> Controller sends five tone page as stored in memory 7 and
>> prompts user with "Pager Prompt" message to start talking

> Paging Memory 25 addresses an HSC pager
> User enters "2 25 * 2538085"
>> Controller sends voice/data page to HSC pager and prompts
>> user when to talk, then closes pager squelch

> User enters "2 23 15"
>> Controller sends two tone sequential tones, A tone Group #2,
>> Tone #3 (669.9 Hz), B tone Group #1 Tone #5 (433.7 Hz) over
>> the repeater transmitter

Dial Access Paging

Pagers may be addressed by callers from the phone similar to the way in which
they may be addressed by repeater users. A true tone and voice mode is not
supported from the phone; however, one of the ten stored mailbox messages may
serve as the "voice" portion of a voice page. The paging command from the
phone is acknowledged with "P A G E", and the paging transmission occurs as
soon as the repeater input channel is clear (waits for a break between
transmissions).

Example
> Paging Prefix = 2
> Paging Memory 7 addresses a five-tone sequential pager

> Caller enters "2 07 * 3"
>> Controller pages and announces the message stored in
>> mailbox message #3

Chapter 13
Demo Messages, Bulletin Board, and the Mailbox

Various demo, bulletin board, and mailbox messages may be activated by users. Demo messages cause the controller to say various IDs and other standard announcements. The bulletin boards may be loaded by the repeater owner with general information of interest to repeater users. The maibox allows users to leave messages for other users, and the system to leave messages for users and Control Operators.

Demo Messages
Users may ask the repeater to make a variety of announcements with the Demo Message command, including IDs, timeout announcements, and the controller firmware revision level.

(Demo prefix) 0	Initial ID Message (randomly selected)
(Demo prefix) 1	Forced CW ID Message
(Demo prefix) 2	Anxious ID Message
(Demo prefix) 3	Pending ID 1 Message
(Demo prefix) 4	Pending ID 2 Message
(Demo prefix) 5	Pending ID 3 Message
(Demo prefix) 6	Special ID Message
(Demo prefix) 7	Repeater Timout Message
(Demo prefix) 8	Repeater Timeout Clear Message
(Demo prefix) 9	Time of Day
(Demo prefix) *	Firmware Revision Level
(Demo prefix) (call slot)	Call sign followed by "Demo Tag" message

Examples (Demo prefix = 3)
Announce Pending ID 3 Message – 3<u>5</u>
Announce Time of Day – 3<u>9</u>

[HINT]

The Demo Messages and the Mailbox are designed so that they may share a common command prefix. Only the "Demo Tag" function is lost if the prefixes are the same.

Bulletin Board

The repeater owner may program up to five Bulletin Board messages which may contain information of general interest to users. One might contain the latest repeater info, another might be reserved for Control Operators, etc. The Bulletin Board messages may be accessed with the commands

(Demo prefix) ** (1-5)   Access Bulletin Board message 1-5

Example (Demo prefix = 3)
    Access Bulletin Board #2 – 3**2

Mailbox

The Mailbox allows users with callsigns stored in the controller's non-volatile memory to leave messages for other users. The repeater owner may define up to ten general purpose "messages" that users might typically like to leave for each other. Examples could be "Call me tonight", "See you at the meeting", etc. In addition, numbers may be appended to a mailbox message by users, such as "Call me at... 5551212", or "Call me on... 52".

The mailbox offers an alternative to the reverse patch for use by non-hams. A caller on the phone can enter a note such as "WA6AXX, from home, phone home". The repeater simply handles third party traffic on a delayed basis.

Mail can be entered at any time over any command channel. A user command is available to list who mail is currently stored for. Additional commands allow users to retreive and erase their mail.

Mail is automatically tagged with the time and date of entry. When mail is retrieved, the time entered is announced, along with "today's" or "yest(erday)" to indicate the date of entry. Mail is automatically erased at midnight of the following day to prevent cluttering up with old mail.

A run time variable speech string is available for use with the message editor. If no mail is stored in the mailbox, no speech is generated by the Mail Present run time variable. If mail is stored, the Mail Present message is generated. Another run time variable indicates the number of messages currently stored in the mailbox.

System Generated Mail

In addition to the ability for users to leave mail for other users, the system may automatically leave mail for users and Control Operators under certain circumstances. These include unanswered reverse patches and telephone access pages, and alarm conditions which are not cleared before the alarm timeout. These messages may be retrieved like user generated messages.

User Commands

(Mailbox prefix)   **Interrogate mailbox** (says, "Empty" or "Messages for...)

(Mailbox prefix) * (0-9)   **Preview Mailbox message 0-9**

(Mailbox prefix)(call slot 1)(call slot 2)(message 0-9)
or (Mailbox prefix)(call slot 1)(call slot 2)(message 0-9)(any 4 digits)
                                    Store Message 0-9 for user 1 from user 2

(Mailbox prefix)(call slot 1)(call slot 2)(message 0-9) * (up to 8 digits)
                                    Store Message 0-9 appended by up to 8 digits for user 1 from user 2

(Mailbox prefix)(call slot)
or (Mailbox prefix)(call slot)(any 4 digits)
                                    Retrieve messages for (call slot)

(Mailbox prefix)(call slot) *
or (Mailbox prefix)(call slot)(any 10 digits)
                                    Erase messages for (call slot)

(Mailbox prefix)(call slot 1)(call slot 2)
                                    Announce "Call sign 1" "from" "Call sign 2"

– Call slot = 00-99 - must be two digit
– (any 4/10 digits) option maintains compatibility with Version 2 Firmware

Examples (assume Mailbox prefix = 3, call slot 05 = WA6ABC, call slot 06 = WB6XYZ)

Interrogate if any mail in mailbox – 3
Preview canned message #4 – 3*4
Store message #4 for WB6XYZ from WA6ABC – 306054 (or 3060541111)
Retrieve messages for WB6XYZ – 306 (or 3061111)
Erase messages for WB6XYZ – 306* (or 3061111111111)
Store message #7 appended by 253-8085 for WB6XYZ from WA6ABC –
                                    306057*2538085
Announce "WA6ABC, from WB6XYZ" – 30506

Chapter 14
Assorted User Utilities

Other sections of this manual describe in detail the operation of the patch, remotes, mailbox, and so on. This chapter picks up the leftovers.

Touch-Tone Pad Test

The Touch-Tone Pad Test allows repeater users to verify correct operation of their tone pads. The controller reads back the sequence of keys sent following the Touch-Tone Pad Test command prefix. The readback is in synthesized speech (or Morse code if speech is disabled). The sequence may consist of up to 32 keys.

The readback is derived from a repeater owner defined array of key names defined using the message editor (the "Pad Test Response Message"). The repeater owner determines the form of readback, primarily to prevent users from causing the controller to say "naughty" things with the Pad Test utility, such as spelling out bad words. For example, the pound (#) key may be identified as "P", "papa", "tic", etc. The star (*) key may be identified as "S", "sierra", etc.

The user Pad Test command consists of

(Pad Test prefix) (sequence of up to 32 keys)

Programming Commands
Pad Test Command Prefix
Pad Test Response Message

Control Operator Commands
Pad Test Enable / Disable

Spare Audio 1

The Spare Audio 1 input to the controller may connect to a monitor receiver, tape recorder output, etc. Users may activate the function, which causes the repeater transmitter to remain on and the Spare Audio 1 input to the controller to connect to the transmitter mixer. While Spare Audio 1 is up, users may talk over the repeater, causing spare audio to mute. A programmable timer may limit the duration that Spare Audio 1 function remains on. It is knocked down with the Hangup command.

The command to bring Spare Audio 1 up consists of

>   (Spare Audio 1 command)

The command to take it down is

>   (Hangup command)

Programming Commands
>   Spare Audio 1 Command Prefix
>   Spare Audio 1 Timer
>   Link / Remote Base Channel Assignment

Control Operator Commands
>   Spare Audio 1 Enable / Disable

Chapter 15
The Scheduler

The Scheduler offloads the routine chores of running the repeater onto your RC-850 controller. Aside from making life easier for the Control Operators, the Scheduler can actually remind you of events such as nets and meetings. Since functions can be enabled and disabled reliably at known times, users benefit from consistent, predictable operation of the repeater.

Macro Sets
A Macro Set is a description of what is enabled and disabled and of what modes are selected. It includes Control Operator command setup, such as function enable/disables and mode selects. For example, a few of the many Control Operator setups are Autopatch enable/disable, Repeater Timer Long/Short, and Tail Message Select. There are several hundred pieces of information stored in each Macro Set.

The Macro Set includes the state of the User Function remote control logic outputs (32) and the state of the remote bases. For example, User Functions 1, 2, 4 and 5 high, while UF 3 and 6 low may be part of the Macro Set. Also, Remote Base #1 in receive only mode on 6.940- MHz, Remote Base #2 off, PL frequency 1Z, and rotor direction 90⁰ may also be contained in the Macro Set.

The Macro Set also includes the user selected Touch-Tone Access up or down state for appropriate Access and Command Modes. For example, a nighttime state might be stored with Touch-Tone down.

A Macro Set is the collection of information describing the setup of the repeater.

Setpoints
A setpoint is a point in time, defined by time of day and day of week. For example, Fridays at 8 pm is a setpoint. Everyday at 6:15 am is another setpoint. Weekdays at 11 pm is another. Setpoints are important because they are the time of day and day of week which you define for selection of new Macro Sets or event occurances by the Scheduler.

A Setpoint is the time of day and day of week for selection of a new Macro Set or occurance of an Event.

Changeovers
A Changeover is the act of loading a new Macro Set at a setpoint time. Changeovers occur at setpoint times. A Changeover is announced by the controller with the programmable "Changeover" message, if the repeater is in use.

A Changeover is the act of loading a new Macro Set.

Events

An Event is a scheduled one shot "happening" which may occur at setpoint times. Events can be messages generated over the repeater ("Net in one minute") or clearing of internal memories (the telemetry min/max storages, system data-logging, etc.).

An Event is a scheduled one shot happening.

The RC-850 controller can store 10 complete Macro Sets and 30 Setpoints.

What Does A Macro Set Store?

Virtually everything selected by Control Operator commands is stored in Macro Sets. In addition, the Macro Set can include the state of UF1-32, plus the remote base receive/transmit/off status, frequencies, PL, band select, and direction information.

When we define a changeover, as described later, we specify whether Control Op, remote / link, and/or UF information is retreived from the Macro Set at a changeover time.

How Do We Store A Macro Set?

The Macro Set includes a lot of information. But we don't want to do a lot of work, so storing Macro Sets is made easy. We can unlock the controller and command it to take a "snapshot" of its current state with a single programming command. Then we change the few items we want different in another state, unlock it and take a new snapshot. We can repeat this procedure for up to ten Macro Sets.

Macro Set 0 is special. The controller always powers up into Macro Set 0. So in addition to Macro Set 0 being selectable at a setpoint time, the controller powers up into this state.

```
                              ┌──────────────────────────────┐
                              │  MACRO SET  *_9_              │
                              │            •                 │
                         ┌────────────── • ──────┐           │
                         │  MACRO SET  *_2_       │           │
                    ┌────────────────────────┐   │           │
                    │  MACRO SET  *_1_        │   │           │
               ┌────────────────────────┐    │   │           │
               │  MACRO SET  *_0_        │    │   │           │
               │  Repeater Enabled? yes  │    │   │           │
               │  Repeater Timer Enabled? yes                 │
               │  Repeater Timer Long/Short? long             │
               │  Access/Control Mode? A │    │   │           │
               │            ⋮            │────┘   │           │
               └────────────────────────┘────────┘           │
                         └──────────────────────────────┘
```
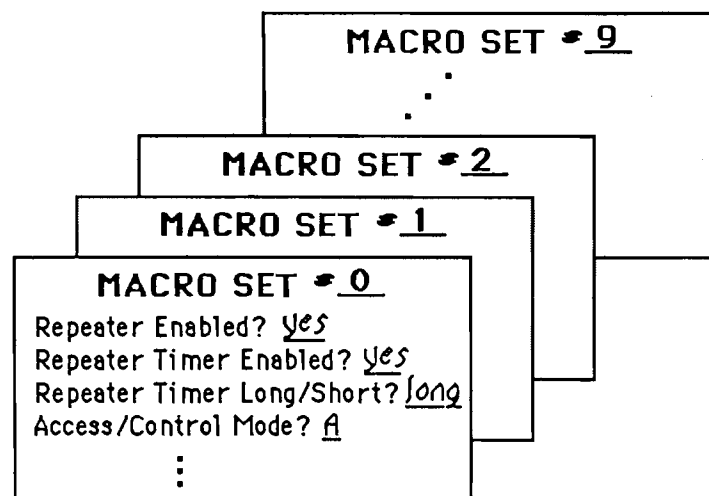
What Can An Event Do?

As we said before, an event is a one shot occurance. Unlike a changeover, which results in a new repeater setup for a period of time until the next changeover, an event happens and then it's over. Events can be messages (five are available). Examples would be the once a week reminder, "Net in two minutes" shortly before net time. Another would be a weekly pager test which would address all the users' pagers. Another could be an hourly ID message (unlike the Periodic QST ID messge which is *not synchronized* to the time of day). The messages can be specified to occur if the repeater is not in use, after a user unkeys, on top of users, or they may be directed to the auxiliary transceivers.

Events can also clear internal telemetry min/max memories and system logging registers – telemetry channels 33-80 plus several others. For example, we can clear the outdoor max temperature memory early in the morning so that it holds the day's high temperature until the following morning.
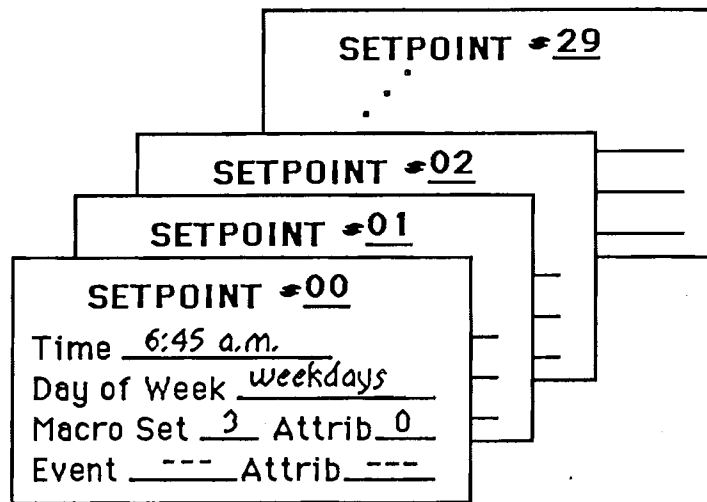
Events, like changeovers, occur at setpoints.

How Do We Define Setpoints?

Setpoints are the time and day of week points where a new Macro Set is to be selected for a changeover, or when an event is to occur. A programming command allows us to define each setpoint, including time and day of week information, plus the Macro Set number to be selected in the case of changeovers, or the message to be generated or memory to be cleared in the case of events.

The controller can store 30 setpoints. They are referred to as setpoint 00-29. Each setpoint defines a particular time/day/Macro Set or event. You may use as many or as few setpoints as you need. Each setpoint is independent. Once a minute, the controller checks through the setpoint list to see if a changeover or event should occur at the current time. Each changeover setpoint is characterized by an "attribute" which specifies which information from the Macro Set is to be loaded – Control Op info, link / remote base, and/or UF output information.

If we want to change a setpoint, we can simply define a new one over the old one. We can totally remove a setpoint by defining an illegal time as part of the setpoint, such as 00:00 or 99:99. To cancel the effect of a setpoint, it needs to be removed (or written over).

This is a good time to explain the flexibility of the day of week selection in setpoints. You will probably want certain changeovers to occur everyday, while others are to occurt only on weekdays or weekends, or only on a particular day of the week. For example, a "Net Reminder" Macro Set should be selected only on net day. Shortening the timeout timer during rush hour might only apply to weekdays. Turning the patch off at night may apply every day. To make the best use of the setpoints and to make things easier, the day of week portion of the setpoint can therefore define a particular day of the week, weekdays, weekends, or everyday.

```
                    ┌─────────────────────────┐
                    │    SETPOINT  #29        │──────
                    │         .               │──────
                  ┌─┴───────────────────────┐ │──────
                  │   SETPOINT  #02         │ │──────
                ┌─┴───────────────────────┐ │─┘
                │   SETPOINT  #01         │ │──
              ┌─┴───────────────────────┐ │─┤
              │   SETPOINT  #00         │ │─┘
              │                         │ │─
              │ Time  6:45 a.m.         │ │─┤
              │ Day of Week  weekdays   │─┘
              │ Macro Set  3  Attrib 0  │
              │ Event  ---- Attrib ---- │
              └─────────────────────────┘
```

Scheduled ID and Tail Messages

We know that the Scheduler can automatically select, just as the Control Operator can, ID and tail messages. But the standard four tail messages and three pending IDs don't let us really exploit the potential power of the controller.

For example, we may want tail messages for different times to say, "Net tonight", "TGIF", (time of day), "Good (morning/afternoon/evening)", "Timer 30 seconds", and so on. So the Scheduler expands the number of tail messages available by assigning a separate tail message #4 to each Macro Set. The ten TM4's can be thought of as an "array", or set, of TM4(0), TM4(1), TM4(2), ... TM4(9). Whenever TM4 is selected by the Control Op or the Scheduler, the proper one of the set is selected based on the current Macro Set in force.

Pending ID3 is handled similarly, but to save space in memory, five PID3(x)'s are assigned to pairs of macro sets. For example, PID3A is assigned to sets 0 and 1, PID3B to sets 2 and 3, etc. If the "Rotate Pending ID" mode is selected in Macro Set 2, the pending ID rotates through PID1/PID2/PID3B. In Macro Set 9, the ID rotation is through PID1/PID2/PID3E.

Manual Selection of Macro Sets

It's clear how automatic changeover of the Macro Sets at setpoint times makes life easy for your crew. But another important capability related to the Scheduler is manual selection of Macro Sets. The controller provides almost 200 Control Operator level commands. That means lots of flexibility, but obviously you don't want to have to remember all the commands. But if you define your Macro Sets strategically, then virtually any situation can be handled by one of the ten sets. That means that only ten commands need to be used by the Control Operators – actually a prefix followed by 0-9 for the different situations. What could be easier?

How Do We Know It Changed Over?

The controller should let us know at a changeover if we need to know (we don't want the repeater to "pull the rug out" from under users), but it shouldn't bother us if all is quiet. The rule is, if a user is talking at a changover time, the controller waits until he unkeys before performing the changeover. In any case, if the repeater trasnmitter is on the air at a changeover time (or after Control Operator manual Macro Set selection command), the "Automatic Control Operator Changeover" announcement is made just before the changeover (actually, the message is programmable so it can say whatever you'd like it to). Otherwise the changeover is done silently.

See - It's Easy!

The Scheduler is one of the most powerful capabilities of the RC-850 controller. Once you start letting it run your repeater, you'll wonder how you ever got along without it! And it isn't hard at all!

Programming Commands

   Store Macro Sets 0-9
   Changeover Announcment Message
   Define Changeover Setpoint
   Define Event Message Setpoint
   Define Event Telemetry Memory Channel Clear Setpoint

Control Operator Commands

   Scheduler On/Off
   Inhibit Next Changeover
   Macro Set Select 0-9
   Macro Set Interrogate

Glossary

abort	Message Editor command to terminate editing session without writing message.
active high	See "high true".
active low	See "low true".
activity timer	Patch timer which resets at start and end of each transmission.
Anxious ID	ID attempted between user transmissions because it's getting late in the ID cycle.
alarm	Over the air indication of activated Alarm logic input.
antidialer	Trap applied to Autopatch numbers to prevent dialing of phone numbers specified by the repeater owner.
ASCII	American National Standard Code for Information Interchange. Refers to coded character set for information-processing and communications systems.
attribute	Special characteristics assigned to various classes of user command codes.
autodialer	Speed dial patch where phone numbers are stored in memory.
Autopatch	Patch where user enters phone number as part of the command because the number isn't in an autodial location.
auxiliary receiver	Remote base or link receiver.
auxiliary transmitter	Remote base or link transmitter.
auxiliary transmitter pager ID	ID message generated at the end of a page directed to an auxiliary transmitter.
auxiliary transmitter phone ID	ID message generated at the end of a patch directed to a remote phone line.
bank	Group of User Loadable Autodial numbers.
BCD	Binary Coded Decimal. Logic data format for control of remote base transceiver frequency synthesizer.
bulletin board	Synthesized speech or Morse code messages stored in memory by repeater owner which can be retreived by users.
call sign slot	One of one hundred memories available for storing users call signs. Used for reverse patch, mailbox, and individual user access codes.
click	Short transmission by user to initiate dialing of Autopatch and User Loadable Autodialer.
changeover	The act of loading a new Macro Set.
command	Touch-Tone sequence which instructs controller to perform a function.
command channel	Priortized audio source for Touch-Tone decoder, including repeater receiver, phone line, etc.

command terminator key Touch-Tone key which instructs controller that the entire command has been entered. Optional over the air, required over the phone.

controller Device which supervises operation of the repeater system.

Control Operator Class of person having access to Control Operator commands.

Control Operator commands Touch-Tone commands available to the repeater's Control Operators.

control receiver RF receiver having highest priority of Touch-Tone control.

COR Carrier-operated-relay. Device which indicates signal present at receiver.

COS Carrier-operated-switch. Same as COR.

courtesy tone Indication to user that previous user has finished his transmission.

cover tone A programmable message which covers muted user Touch-Tone commands or user audio during a phone patch.

CPU Central processing unit. The heart of the microcomputer.

CTCSS Continuous tone coded squelch. Same as sub-audible tone or PL (Private Line).

custom hangup code User definable hangup code which prevents malicious hangup of patch by jammer.

Digital Voice Recorder ACC product which allows remote recording of voice messages with solid-state storage.

DIP switch Dual-inline-package switch. Switch array on controller board which allows selection of certain options.

down channel Repeater site to remote phone line site communication frequency.

DTMF Dual-tone Multi-frequency; another name for Touch-Tone.

DVR See "Digital Voice Recorder".

Emergency Autodialer Autodialer which contains 10 emergency service phone numbers and response messages.

EPROM Erasable-programmable-read-only-memory. Semiconductor memory device for storage of program and data.

E^{2}PROM Electrically-erasable programmable read-only-memory. In-system reprogrammable non-volatile memory.

event A scheduled one shot happening, including event messages and clearing of internal telemetry min/max memories.

exchange table Table of local / long distance definition for all 800 telephone exchanges in a particular area code.

external device	Tape playback unit or other audio source which may provide audio during message generation.
firmware	Computer program stored in EPROM.
five-tone sequential	Paging tone signalling format consisting of a sequence of five 33 ms tones.
Forced CW ID	ID message attempted when controller cannot generate a synthesized speech ID because a user is talking.
frequency synthesizer	Device in remote base transceiver which determines transmit and receive frequency of transceiver.
full-duplex	Patch in which telephone audio is not muted while the user transmits.
group call	Paging tone signalling format consisting of eight second continuous tone for alerting a group of pagers with common "B" tone.
half-duplex	Patch in which telephone audio is muted while the user transmits.
hang time	Period that repeater transmitter stays on after input signal goes away.
high true	Logic output where high state indicates active function.
hook flash	Momentary interruption of telephone loop current to signal central office to activate special features.
HSC	Hexidecimally sequentially coded. A tone paging format capable of numeric display.
individual user access codes	Codes unique to each user, required prior to activation of selected functions.
Initial ID	ID message attempted when a new repeater user appears after a period of inactivity.
interdigit timer	Timer which disqualifies a command sequence if too long a period between individual digits occurs.
Kerchunk filtering	Algorithm which discourages brief unidentified transmissions.
link	Hard wired connection to another repeater or to transceiver.
lock	User Loadable Autodialer state which prohibits entry or erasing of phone numbers. Also state of controller where Programming commands may not be entered.
logical input	Controller inputs driven internally by logical outputs or logical signals.
logical phone line	Analogous to buttons on a key phone for selection of a line prior to placing a call.
low true	Logic output where low state indicates active function.

macro set	Collection of information describing the setup of the repeater.
mailbox	Electronic storage center for user-to-user and system-to-user messages.
mapping	Assignment of functions.
message editor	Portion of controller command set which allows repeater owner to construct Morse code and synthesized speech messages from the available character set and vocabulary.
message macro	A programmable message which may be included inside other messages for conservation of space.
meter face	Predefined scale which may be applied to analog inputs for readback of various measurements.
MODEM	Modulator-demodulator. Unit to convert computer data signals to audio tones for transmission over telephone or radio link.
offhook	State of telephone circuit where call is in progress.
onhook	State of telephone circuit where call is not presently in progress.
open collector	Logic output consisting of solid state contact closure to ground without capability of sourcing current.
pad test	Command procedure which permits users to test their Touch-Tone pads for proper operation.
paging	Selective calling technique involving tone signalling.
patch	General term for phone patch, covering Autopatch, User Loadable Autodialer, Emergency Autodialer, and reverse patch.
patch utility P prefix	User level command prefix for reverse patch answer, custom hangup, duplex, cover, and timer extend.
patch utility Q prefix	User level command prefix for redial and hookflash.
Pending ID	ID message attempted when no repeater activity is in progress or when the repeater carrier is allowed to drop.
Periodic QST ID	ID message generated periodically when repeater is not in use.
permitted area codes	Entire area codes not considered long distance when Toll Restrict Mode B is selected.
physical phone line	Phone line selected for a particular call including one of two local lines or one of three remote lines.
PL	Private Line (trademark of Motorola, Inc.). Continuous sub-audible tone signalling. Same as CTCSS.
prefix	Portion of a Touch-Tone command which precedes the root portion.
program	Computer instructions stored in memory. Also the act of remotely configuring the controller.
programmable	Remotely changeable by repeater owner using Touch-Tone commands.
Programming commands	Touch-Tone commands which enable repeater owner to remotely program repeater characteristics.

PTT	Push-to-talk. Logic output from the controller which tells the transmitter to transmit.
QSO	Exchange of transmissions between users.
QST ID	See Periodic QST ID.
RAM	Random-access-memory. Semiconductor memory used for temporary storage by the controller.
readback	Synthesized speech or Morse code acknowledgement by the controller.
regenerated Touch-Tone	Touch-Tone audio synthesized by the controller into the phone line for improved patch reliability.
remote base	Remotely controlled Amateur radio station. Generally tied to repeater to allow shared access.
remote programming	The ability to remotely change various characteristics of the controller.
repeater owner	A person with access to Programming commands.
reset	Act of computer starting execution of its program from the beginning. Results from grounding Reset pin, entering the Reset Control Operator command, or protective circuitry.
reverse patch	Phone patch initiated from the phone line.
root	Portion of command following prefix.
root set	Group of Control Operator roots. Four root sets are available, selectable by the repeater owner.
rubout	Message Editor command which allows deleting last character entered.
run-time variables	Speech strings constructed at the time they are to be generated, including time and measurement related announcements.
scheduler	Time of day and day of week driven prearranged changes to repeater characteristics.
segment	A programmable portion of a sine wave Courtesy Tone.
setpoint	Time of day and day of week for selection of a new Macro Set or occurance of an Event.
site alarm	Same as alarm.
spare audio 1	Audio input to the controller which may be selected by users for monitoring, such as a microphone in the repeater building.
Special ID	ID message attempted at Pending ID time when selected by Control Operator.
speech synthesizer	Electronic device which generates audio closely resembling human speech.
squelch tail	Noise burst from FM receiver when input signal goes away.
subaudible tone	Same as PL, CTCSS.
tail	Period after user unkeys when repeater transmitter is still up.

tail message   Synthesized speech or Morse code message generated just before repeater transmitter drops off.

text-to-speech converter A device which converts ASCII serial text into synthesized speech with an unlimited vocabulary.

timeout timer   Timer which disables repeater transmitter if a continuous signal appears at repeater receiver for too long a period.

to end of transmission timer Timer which disqualifies a Touch-Tone command if too long a period elapses from the last Touch-Tone key to the end of the user's transmission.

Touch-Tone Access Mode Access mode which may be activated with user Touch-Tone commands.

Touch-Tone Down ID   ID message generated when controller goes to the Touch-Tone down state.

two-tone sequential   Paging tone signalling format consisting of two different tone frequencies in sequence.

unlocked   State of user Loadable Autodialer which permits entry and erasure of telephone numbers from memory. Also the state of the controller when Progamming commands are accepted.

unlock code   Touch-Tone command sequence which places the controller in the state where Programming commands are accepted.

up channel   Remote phone line site to repeater site communication frequency.

User commands   Class of Touch-Tone commands available to general repeater users.

User Function Logic Outputs Logic outputs from the controller which may be remotely controlled with Touch-Tone commands for remote control of various equipment at the repeater site.

User Loadable Autodialer Autodialer which contains 240 phone numbers that may be loaded and erased by users remotely.

user mapped Control Op commands Control Operator level commands mapped to a user level prefix to make several Control Op commands available to certain users.

VOX access mode   Access mode where audio must be present on the received signal to activate the repeater. Requires external VOX detector.

write   The act of storing programming information into memory using Programming commands.

Most Often Asked Questions and Answers

My controller acts erratically. What's wrong?

Be sure that you've connected both grounds to the power supply. They *both* need to get there – directly. Check for high electrical noise at the site, such as from heavy duty motors or solenoids. Be sure that the power to the controller is stable – ac power at repeater sites can be very poor. Make sure that all ICs and connectors are firmly seated. Check that the supply voltage is within tolerance. Measure it with the transmitter *on.*

The probability of a defective IC, unless damaged by lightning or static electricity, is *very low.* Always suspect other causes before concluding that an IC is defective.

The controller doesn't mute Touch-Tone and doesn't decode any commands.

Check DIP switch 3 – this selects the command receiver COS logic sense. If you don't have a command receiver, switch 3 should be ON. If not, the controller thinks that the command receiver is active, and the Touch-Tone decoder is monitoring the command receiver audio input – not the repeater receiver.

Touch-Tone doesn't always decode. Why not?

The dynamic range of the Touch-Tone decoder is very wide so that if the receiver audio to the controller is between a few hundred millivolts and 2.5 volts p-p, it should decode. But some mobile and portable rigs transmit tone levels very hot which causes clipping of the tones in the user's transmitter. If the level is hot enough to distort, the only solution is to reduce the tone level in the user's rig so that it transmits clean Touch-Tone. Other possibilities are non-flat frequency response somewhere between the user's transmitter and the controller, which causes the two tones of the Touch-Tone to be greatly different in level.

There are several other things to check. If you have a control receiver, be sure that it's squelch isn't opening when you don't suspect it is. Perhaps someone is calling the repeater on the phone, grabbing the Touch-Tone decoder. Be careful about who you give out your repeater number to.

The patch won't dial the phone number – it just reads back the number and beeps.

Don't forget that you need to click your mike during the pause to initiate dialing, unless you select the Control Op mode "Dial without click".

Why won't the controller accept commands from the phone.

Don't forget to terminate all Touch-Tone commands over the phone with a #. The # tells the controller to evaluate the command – without it, it'll just sit there.

I don't measure anything on the logic outputs. Why not?

The logic outputs are open collector transistors. The transistor is either on, so that there's a path to ground, or it's an open circuit. To see a voltage level, you need to add a pullup resistor to define the logic high when the transistor is off. It's very tricky to try to measure resistance of the transistor output with an ohmmeter – don't try it. Just connect a pullup and look for a voltage.

I can't enter commands for a while after the controller hangs up the phone. What's going on?

When the controller hangs up, the phone company sometimes reverses the battery ("winks"), and this can be seen by the controller as a ring, so it picks up the phone again. Set the Phone Answer Delay timer longer than about 10 seconds. Just before the controller answers the phone, it looks back in time eight seconds to see if the phone was still ringing in that period. With a longer answer delay time, it will reject the "wink" as a ring.

How do I change the Patch Hangup code back to #?

Enter the Command Code Prefix Programming command with an "empty" prefix, i.e., *5022 with nothing following. This tells the controller to look for a # for hangup.

Do I need to enter *0 to actually write programming information into E^{2}PROM?

No. The *0 command applies *only* to the message editor, so use it to write an edited message, but nothing else.

What information is stored in the E^{2}PROM?

All programming commands result in storage of information in the E^{2}PROM. Messages are stored after entering the *0. Control Op setup information is written into the E^{2}PROM only when storing a Macro Set with the programming command. All User Loadable Autodial Load/Erase commands also write to the E^{2}PROM.

Do I need to store a Macro Set whenever I make a change?

Only if you want changes in the Control Op setup or User Function / Remote Base setup to be stored for powerup, scheduler or manual macro set selection.

When I programmed something with a programming command, the controller said "E R, Write". What's wrong?

The "E R" message indicates that there was a problem writing into the E^{2}PROM. If you get this message, contact the factory to help determine the nature of the failure. It may also mean that you don't have the required 8K E^{2}PROM for that function.

How many digits can be in the autodial numbers?

The ten emergency numbers can store 11 digits each. User Loadable slots 10-39 can hold 11 digits, slots 40-99 hold 8 digits, 100-199 (Bank 1) hold 11 digits, and 200-249 (Bank 2) hold up to 35 digits each. The 8 digit slots can effectively hold more by using the Phone Number Macros to store a "1" and area code.

Why does the voice response wait up to a few seconds when I enter a programming command?

It's programming the E²PROM, which takes about 100 ms per byte. The Special ID, as an example, will take almost 5 seconds to program – it's normal.

If the Touch-Tone Access Mode is enabled but down, will a reverse patch come through?

Yes. A reverse patch will bring up the TT Access Mode and load the TTAM timer. Assuming the timer is non-zero, it will time itself back down if there's no activity.

Sometimes when entering the Remote Base / Link Receive Only command, the controller reads back the frequency, and other times it reads back the remote base / link name. What is the rule?

If the frequency is set to all zeros, it says the name. Otherwise it reads back the frequency. When selecting a frequency memory, it reads back the *memory* name if one is programmed.

The controller doesn't always ID when the Touch-Tone Access Mode goes down. How come?

Generally it will ID when going down only when it's necessary, i.e., there has been some activity since the last ID. For example, if the TTAM timer is set to 20 minutes, if no activity allows it to time out, it won't generally be necessary to ID because it would have completed the ID cycle several minutes earlier.

What's the patch activity timer for?

The activity timer causes a patch to be terminated if the mobile drives out of range or otherwise goes away. The timer resets at the beginning and end of each transmission. If it's allowed to time out (no carrier or stuck carrier, except during a full-duplex patch), there's a warning warble. If there's still no "activity" within 10 seconds, it will hang up. The patch activity timer can be used along with, or instead of, the overall patch timers.

How can I store MCI and Sprint numbers in the autodialer?

The autodial slots in Bank 2 hold up to 35 digits each. That means that there's enough room for the access telephone numbers, some pauses (the * key is a 1.5 second pause when dialing), and the access code. Even the destination telephone number can be stored in the same slot. Or the access phone number and code can be in one slot and the destination phone number can be in any other autodial slot, or it may be dialed with the Autopatch.

For example, say our Sprint access number is 555-1212 and our access code is 1234567890. We can store in any autodial Bank 2 slot,

"5551212 * * 1234567890"

We can activate the autodial slot when we want to dial a number through Sprint and we will get the secondary dial tone from Sprint. We can then activate another autodial number, or the Autopatch, such as "* 7498330".

Or, we can store in the Bank 2 slot, "5551212 * * 1234567890 7498330".
Activating this slot will get us through directly to the destination phone number.