KRP 5000Repeater

OPERATING MANUAL

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FIGURES AND TABLES

1.0 Introduction

KRP-5000 repeaters are designed and built to be the finest full-feature repeaters available to the radio communications community. Transmitter and receiver components of the KRP-5000 consistently demonstrate outstanding performance in harsh repeater environments around the world. Extensive telephone interconnect features include autopatch, reverse autopatch, 200-number autodial, and redial. Other built-in features include CW identifier, Morse and tone messages, sequential tone signaling, and site control functions.

The KRP-5000 simultaneously achieves exceptional flexibilty, ease of use, and high reliability by integrating all repeater related features into a single unit. The flexibilty to satisfy widely different field application needs is assured because all vital features can be controlled remotely using DTMF access codes. Almost 100 access codes allow precise setting of repeater operating characteristics; yet setting the characteristics is easy because all features are engineered to work together. The use of microprocessor technology enables the KRP-5000 to achieve high flexibility with fewer circuit components, fewer interconnections and, therfore, higher reliability.

1.1 Notices

The ownership, installation, adjustment, maintenance and operation of this equipment may require licensing by and compliance with the rules of regulatory agencies. It is the responsibility of the equipment owner to comply with such regulations; Kendecom Incorporated accepts no responsibility or liability for improper or illegal ownership or operation of this equipment.

KRP-5000 repeaters are intended to be installed and used by persons knowledgable in the safe and proper operation of electronic equipment. The equipment owner is responsible for insuring that the installation and operation of this equipment is in accordance with applicable fire and safety regulations and recommended practices. Kendecom Incorporated and Micro Control Specialties assume no responsibilty for the proper installation or operation of this equipment, nor do they accept any liability for incidental, consequential, or other damages or injury to persons or property resulting from improper or unsafe use of this equipment or from the use of this equipment in any manner not explicitly described in this manual.

All digital electronic equipment is subject to part 15 of the FCC regulations; in accordance with those regulations we are required to provide the following statement:

"This equipment generates and uses radio frequency energy and if not installed and used properly; that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures: reorient the receiving antenna, relocate the equipment with respect to the receiver, move the equipment away from the receiver, plug the equipment into a different outlet so that equipment and receiver are on different branch circuits.
If necessary, the user should consult the manufacturer or an experienced technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful:

'How to Identify and Resolve Radio-TV Interference Problems'

This booklet is available from the US Government Printing Office, Washington, DC 20402, Stock No. 004-000-00345-4.

1.2 Manual Organization

It is highly recommended that this manual be read carefully before installing and operating a KRP-5000 repeater. The following describes the information contained in each section of the manual.

Section 2 - This section contains a general description of all repeater features.

Section 3 - This section provides step-by-step installation procedures for the repeater, for the telephone interconnect, and for all other features which use rear panel connections.

Section 4 - The KRP-5000 sends a variety of tone/ Morse code messages to keep repeater users and system control operators informed of the repeater status. This section describes the messages sent by the repeater.

Section 5 - This section decribes those features which are accessible to all repeater users.

Section 6 - This section describes comand capabilities of the KRP-5000 which are used by system operators to set the operating characteristics of the repeater

Section 7 - This section contains circuit descriptions, circuit board adjustments, and troubleshooting information.

1.3 Limited Warranty

Kendecom Incorporated warrants to the original purchaser that this product shall be free of defects in material and workmanship for a period of 90 days from the original date of purchase.

During the warranty period, Kendecom Inc. will provide any parts necessary to correct said defects provided the unit is delivered by the original owner intact to us for our examination and provided that our examination discloses that the unit is defective.

This warranty does not apply to any unit which has been subjected to misuse, neglect, accident, improper installation, incorrect maintenance, or use in violation of instructions furnished by us, nor to any unit where the serial number has been removed, defaced, or changed, nor to and unit which has been modified or used with accessories not specified by Kendecom Inc.

The foregoing constitutes the entire obligation of Kendecom Incorporated with respect to this product and no employee or officer of Kendecom Inc. or its dealers or distributors shall have authority to modify or extent this warranty. The buyer agrees and accepts that no other remedy for incidental or consequential damages, injury to person or property, or other loss shall be available to him (her).

Kendecom Incorporated reserves the right to make changes to its products without obligation to install such changes into its previously sold products.

2.0 OPERATION AND FEATURES

All functions and operating features of the KRP-5000 may be accessed remotely by entering access codes consisting of DTMF digit sequences. Repeater features, and their corresponding access codes, are of two types: control operator commands and user access codes. Commands are used by system control operators to determine the operating characteristics of the repeater. User access codes may be entered by any repeater user to activate and release various repeater features.

2.1 General Repeater Operation

Repeater access for the purpose of re-transmitting a received signal can be operated in carrier or CTCSS mode. The selection of carrier or CTCSS mode is selected by control operator command. A transmission timeout timer is available to limit the maximum continuous length of any single transmission through the repeater. The transmission timer can be disabled or enabled and set to a specific duration by control operator command. A Timeout Message may be sent following a timeout (when the received signal ceases) to inform users of the reason that repeater operation was suspended. The transmission timer may also be reset using a tone access code. This feature allows the repeater to be re-activated under 'stuck mike' conditions.

At the end of each transmission the repeater transmitter remains active for a period of one second or five seconds (selectable by command). This is the tail interval. Brief tone or Morse coded messages can be sent during the tail interval to convey information to repeater users. The messages may consist of a courtesy tone or a programmable Tail Message. The courtesy tone is a short single tone burst which indicates that the previous repeater user has stopped transmitting and that the transmission timeout timer has been reset. The programmable Tail Message may contain a maximum of 19 Morse code characters or tone signals.

2.2 Callsign Identification

The KRP-5000 sends a callsign identification message at periodic intervals whenever the repeater is in active use. The callsign identification message can consist of as many as 19 Morse characters and is programmed using a DTMF access code sequence. A 'smart identifier' technique is used to cause the identification message to

be sent at the end of a transmission whenever possible to minimize any disturbance to users of the repeater.

2.3 Telephone Interconnect

Telephone interconnect features include Autopatch, Redial, and Autodial for the purpose of originating telephone calls, and Reverse Autopatch for the purpose of receiving incoming telephone calls.

Autopatch allows repeater users to originate telephone calls by entering the Autopatch access code followed by the telephone number to be called. Long distance calls having telephone numbers beginning with the digits 0, or 1 are prohibited as are calls having telephone numbers with more than 7 digits. A separate Long Distance Autopatch feature which bypasses these restrictions is accessible by control operators. The telephone number entered when making an Autopatch call is stored by the KRP-5000 so a subsequent call may be made to the same telephone number by using the Redial feature. Calls are originated with the Redial feature simply by entering the Redial access code.

The Autodial feature gives users quick access to as many as 200 frequently called telephone numbers by having the telephone numbers stored in the KRP-5000. Entering an Autodial access code causes the telephone interconnect to be activated and the associated telephone number to be dialed automatically. Autodial telephone numbers are readily programmed into the KRP-5000 and may be entered and changed at any time.

Reverse Autopatch gives access to the repeater from the telephone network. Three styles of Reverse Autopatch operation may be selected by control opertor command. The three styles of operation determine the level of security used to prevent unauthorized callers from gaining access to the repeater transmitter.

2.4 Tone Pad Test

The Tone Pad test feature allows repeater users to verify that their DTMF tonepads are operating properly. When this test function is active the KRP-5000 acknowledges the entry of a row and column digit sequence by sending a message on the repeater tail. Repeater users can verify the opertion of their DTMF tonepads by successively entering all seven row and column test sequences. The tests enable users to identify the malfunction of an individual tonepad key.

2.5 Function Outputs

Fourteen outputs are provided by the KRP-5000 for controlling external equipment at the repeater site. Three of these outputs are set and cleared by control operator commands. Ten of the outputs can be set and cleared manually by repeater users. A function timer governs the maximum duration of user settable outputs by clearing the outputs automatically after a prescribed time interval. The final output is a pulse output which is activated by entering the DTMF * character.

2.6 Alarm Reporting

The KRP-5000 may be used to monitor external equipment at the repeater site and to report an abnormal condition by sending an alarm message on the repeater transmitter. Status monitoring is done by connecting from an input on the repeater rear panel to the equipment to be monitored. A change in the external equipment status will cause the repeater to send a programmable Alarm message. The programmable Alarm message may consist of as many as 19 Morse characters or tones.

2.7 Emergency Power Operation

Capability is provided in the KRP-5000 for automatically transferring operation to an external emergency DC power source in the event of failure of commercial AC power. Messages may be sent by the repeater transmitter to indicate changes in power source conditions.

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3.0 INSTALLATION

The KRP-5000 repeater is designed for mounting in a standard 19-inch equipment rack or desktop cabinet. The repeater should be installed in a well-ventilated, moisture-free location. As with any electronic equipment, long-term reliability will be enhanced by insuring that the unit is not subjected to extreme temperatures.

The KRP-5000 is factory adjusted prior to shipment so no adjustments are normally required upon initial installation; however, it is recommended that mounting arrangements provide for future access to internal circuitry. Audio level adjustments are accessible by removing the unit top cover, and transmitter/ receiver adjustments are accessible by removing the unit bottom cover.

3.1 Installation - Repeater Operation

The following steps should be followed to place the KRP-5000 into service for basic repeater operation:

1. Connect a 16-gauge, or heavier, wire strap from the repeater cabinet to a good earth ground. Stranded or braided wire should be used for making this connection. Do not use solid wire. Do not rely upon mechanical mounting or power line connections to provide grounding.

2. Operate the front panel POWER/SQUELCH control to the off position (fully counterclockwise).

3. Connect the KRP-5000 power cord to a 120 VAC 60-Hz power source.

4. Connect from the rear panel RECEIVER coaxial jack to the receiving antenna or duplexer.

5. Connect from the rear panel TRANSMITTER coaxial jack through an in-line RF power meter (Bird model 43, or equivalent) to the transmitting antenna or duplexer.

> Both the transmitting and receiving antenna systems should present 50-Ohm impedances to the repeater. For proper operation an isolation of 90 dB, or greater, must be maintained between the repeater TRANSMITTER and RECEIVER ports. This isolation may be provided by using a duplexer in conjunction with a single antenna, or by using independent receiving and transmitting antennas. If independent antennas are to be used the antenna manufacturer should be consulted to determine the physical separation required between the two antennas to achieve an

isolation of 90 dB.

6. Operate the front panel CONTROL switch to the down (Local) position.

7. Rotate the front panel PWR/SQUELCH control fully clockwise and observe that the POWER lamp lights.

8. Wait approximately 10-seconds for the processor to reset then observe that status lamp TX (transmitter active) lamp is extinguished.

9. Momentarily depress the local microphone push-to-talk switch and observe that status lamp TX lights. Measure the forward and reflected power readings on the RF power meter and determine that the VSWR is 1.2:1 or lower.

> A VSWR greater than 1.2:1 indicates a faulty or improperly tuned antenna or duplexer and continued operation under this condition may cause damage to the repeater. The condition must be remedied by correcting the antenna system and cannot be cured by adjusting the repeater.

10. Set the front panel VOLUME control approximately 30 degrees from full counterclockwise.

11. Operate the front panel CONTROL switch to the up (Repeat) position. This allows the repeater to operate in response to received signals.

12. Set the receiver squelch by rotating the PWR/SQUELCH control counterclockwise until squelch noise is heard; then rotate the control clockwise until squelch noise just ceases.

This completes installation of the KRP-5000 for basic repeater operation. It is recommended that MONITOR meter readings be recorded for future reference. These readings may be taken with the microphone push-to-talk switch depressed and the meter switch set to the EXC, PA, and RF positions in turn.

The front panel VOLUME control sets only the local speaker audio level and does not affect the repeat audio level. Whenever the repeater is left unattended the VOLUME control should be set to minimum (fully counterclockwise) as a courtesy to other inhabitants of the repeater site.

Before placing the repeater into service the callsign identification message should be programmed into memory. The procedure for programming messages is given in section 6 of this manual.

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TABLE 3.1

FRONT PANEL LAMPS

Lamp	Lighted lamp indicates
RX	Received Signal Present (COS)
TX	Transmitter Active
TTS	DTMF Tone Present
CMD	Command Signal Present
CTCS	CTCSS Signal Present
AP	Telephone Interconnect Active
FUNT	User Function Outputs Active

3.2 Installation - Telephone Interconnect

1. Connect the two wires (tip and ring) from the telephone system to the KRP-5000 rear panel terminals 15 and 30. Either wire may be connected to either terminal.

2. Verify the operation of the telephone interconnect by accessibng the repeater with a received signal and entering the autopatch access code, 501, using a DTMF tonepad. Observe that front panel status lamp TTS lights as each DTMF digit is entered. Observe that front panel lamp AP lights after the complete 3-digit access code is entered.

3. Remove the received signal and observe that dial tone is sent on the repeater transmitter.

4. Access the repeater with a received signal and enter the digits of a telephone number to be called for test purposes. Observe that the TTS status lamp lights as each digit of the telephone number is entered.

5. Remove the received signal and monitor progress of the call by listening to the repeater transmitter.

6. When the called party answers, verify that telephone line audio levels are proper by conversing in half-duplex fashion. Telephone line audio levels are set at the factory to accommodate the normal range of telephone loop loss. In the event that the telephone loop loss is excessive it may be necessary to adjust audio levels. Instructions for setting audio levels are given in section 7 of this manual.

7. At the conclusion of the test telephone call, disconnect the call by entering the Clear access code, #50.

This concludes the basic telephone interconnect installation and test. Several different telephone interconnect features are provided in the KRP-5000; these are described in manual section 5. Extensive control capability is also provided to customize the telephone interconnect features. These control capabilities are described in manual section 6.

3.2.1 Telephone Line Sharing

Handshaking capability is provided by the KRP-5000 to allow several repeaters to share a single telephone line. The following connections

should be made for all KRP-5000 repeaters which are intended to share a common telephone line:

Connect from	Connect to
Rear panel terminal 5 of each repeater	Rear panel terminal 26 of each repeater

These connections allow each repeater to determine when the telephone line is in use by another repeater and therefore unavailable. If a repeater user attempts to use a telephone interconnect repeater when the shared telephone line is already being used, the repeater user is informed that the telephone line is unavailable by a message sent on the repeater tail.

3.3 Installation - DC Power Operation

An external DC power source may be used to furnish emergency backup power to the KRP-5000. When an external DC power source is used, power is normally taken from the AC power source and operation automatically transfers to the DC source in the event of failure of the AC source. Operation from the AC source is controlled by the front panel POWER switch. When this switch is toggled to the off position AC power is removed from the unit and operation automatically transfers to the DC source if a DC source is connected. The front panel POWER switch does not disconnect DC power from the unit.

A DC power source having a voltage of 12 to 14.5 volts and capable of supplying 3 Amperes should be used for DC operation. The source must be free of transients and should have a ripple voltage of less than 1 volt rms. Automobile storage batteries are well suited for this purpose. The KRP-5000 does NOT deliver current to the DC power source so external charging circuitry should be provided when storage batteries are used.

Warning: The KRP-5000 is a negative grounded load and must be used only with negative ground or floating DC power sources. Damage to the unit may result if a positive ground DC source is connected to the KRP-5000.

Some circuitry in the KRP-5000 operates at a nominal voltage of 26 VDC for maximum efficiency. Operation from a DC power source at lower voltages reduces efficiency and will cause transmitter output to be reduced.

Make the following connections to operate the KRP-5000 with an external DC backup power source:

1. Connect from the DC power source negative output to the black binding post terminal on the rear apron of the KRP-5000.

2. Connect from the DC power source positive output to the red binding post terminal on the rear apron of the KRP-5000.

The wire gauge used for making these power connections depends upon wiring length. 14-gauge wire is suitable for distances up to 6-feet (2-meters). Heavier gauge wire should be used for longer distances.

3.3.1 Power Source Indications

Three messages are sent on the repeater tail to indicate changes in repeater power status. These messages are:

The Power Fail (PF) message. This message is sent when the normal AC power source is restored following a failure if the repeater is not provided with an emergency power source. The purpose of this message is to inform repeater users and control operators of the reason that the repeater has been off-the-air; i.e. operation was suspended due to loss of power.

The Emergency Power (EP) message. This message is sent when normal AC power has failed and the repeater is operating on the emergency power source.

The Commercial Power (CP) message. This message is sent when normal AC power is restored following a transfer to the emergency power source. The message informs repeater users and control operators that repeater operation had been transferred to the emergency power source and has now returned to the normal AC power source.

The Emergency Power and Commercial Power status messages are sent automatically when a change in power status occurs if a DC power source is connected to the repeater as described above. The messages may also be sent, if desired, when an external AC power source is used to provide emergency backup power. In this case, a connection must be made from the external power source control circuits to KRP-5000 rear panel terminal 19. The input should be driven with a TTL compatible logic signal as follows:

Voltage at terminal 19 input	Condition indicated
0 volts DC or ground	Normal AC power source operating
+5 volts DC or open circuit	Normal AC power source failed (Emergency source in operation)

The Power Failure message is always sent when the KRP-5000 is restored to operation following a total power failure. This message will be sent on the repeater tail until it is removed by entry of a control operator command access code as described in manual section 6.

3.4 Site Status Alarm

The KRP-5000 can be made to send a message on the repeater tail to indicate an abnormal, or alarm, condition. The alarm message is intitiated by connecting a suitable logic signal to rear panel terminal 11 as follows:

Voltage at terminal 11 input	Alarm Status
Ground or no connection	No Alarm (no message sent)
+5 to +12 volts	Alarm (message sent)

A transition on the terminal 11 input from the non-alarm level to the alarm level will cause the repeater transmitter to be activated for the purpose of sending an immediate one-time alarm message. After the one-time alarm message is sent, the alarm message will also be sent on the repeater tail as long as the alarm condition exists.

3.5 Installation - CTCSS Decoder

CTCSS operation may be accomplished using either an optional factory installed CTCSS decoder or an external decoder. To use an external decoder, connect from the deooder output to KRP-5000 rear panel input terminal 4. For proper operation the signal connected to terminal 4 must have the following characteristics:

Signal applied to terminal 4	Condition
Ground	CTCSS present
Open circuit	CTCSS not present

These signal conditions are provided directly by most CTCSS decoders. The KRP-5000 can also accomodate CTCSS decoders which furnish only the inverse logicl states (i.e. Ground provided when CTCSS is not present.) To cause the KRP-5000 to respond to the inverse logic states from those listed here, operate rocker 1 of switch S1 on the processor circuit board to the OFF position.

Proper connection of an external CTCSS decoder can be verified by observing front panel lamp CTCS. Lamp CTCS is lighted whenever the signal applied to rear panel terminal 4 corresponds to the CTCSS present condition.

3.6 Installation - Site Control Outputs

Fourteen outputs provided on the rear panel of the KRP-5000 are controlled remotely by the entry of access codes. These outputs may be used for controlling external equipment at the repeater site. Connection may be made from the KRP-5000 to external equipment at any time as needed. The outputs are transistor switches with the following voltage/ current capabilities:

Output Off:

Outputs are open-circuit in the off condition. The open-collector output drivers can withstand an externally applied

voltage from zero to +25 volts. Output drivers may be damaged if negative voltages or positive voltages greater than +25 volts are applied by external equipment.

Output on:

Outputs are pulled to ground in the on condition. The saturated transistor output drivers can withstand a maximum current of 25 mA in the on condition. External equipment must have a maximum short-circuit current of 25 mA, or less, to insure that output driver transistors are not damaged. Saturation voltage of the output driver transistors is typically 0.3 volts.

TABLE 4.1

FIXED MESSAGES

KRP-5000 repeaters may be equipped to send fixed (non-programmable) messages as either Morse characters or tone bursts. The following gives the fixed messages sent by the repeater for the Morse and tone options.

Fixed Message Meaning	Message Sent: Morse Option	Message Sent: Tone Option
Clear code received	CLR	2 short
User or command code received	RRR	3 short
DTMF row or column entered during tone pad test	OK	3 short
Shared telephone line busy	BZ	2 long
Feature accessed by user inhibited. Command entered to inhibit function	OFF	2 long
Reverse Autopatch alert	TTTTTT	6 long
Power Failure	PF	1 long
Emergency power in use	EP	1 long, 1 short
Commercial power restored	CP	1 short, 1 long

4.0 MESSAGES

Messages can be sent by the KRP-5000 in the form of Morse code or tones to 1) perform the repeater identification, 2) acknowledge the entry of DTMF access codes, and 3) inform repeater users and control operators of repeater status.

Three messages are field programmable. The text of these programmable messages is determined by DTMF access code entry so these messages can be easily customized to meet specific application needs. The programmable messages include the callsign identification, tail message, and alarm message. The remaining messages are preprogrammed. The text of preprogrammed messages is given in Table 4.1.

The rate, or speed, at which messages are sent is selectable by control operator command as described in manual section 6. The pitch and level of message tones can be set using potentiometers R50 and R85, respectively, on the audio circuit board.

Callsign Identification

The callsign identification message is sent automatically at periodic intervals whenever the repeater is in active use. A 'smart identifier' technique is used by the KRP-5000 so that identification is normally sent at t end of a transmission rather than during a transmission. This te nique is used to prevent the identification message from voice traffic being passed through the repeater. Callsign identification is sent during a transmission only when a transmission is unusually long and the identification cannot be delayed until the end of the transmission without violating legal requeirements.

The callsign identification message is field programmable and can consist of any sequence of Morse code numbers and letters up to a maximum of 16 characters. Programming is done by DTMF access code entry and the procedure for programming the callsign identification message is given in manual section 6.

Clear

The clear message is sent on the repeater tail whenever the Clear Code is entered to end a function manually, or whenever a timeout causes a function to be ended automatically.

The clear message is also sent on the repeater tail when an attempt is made to access an autodial function which contains no stored telephone number.

Acknowledgement (RRR)

The acknowledgement message is sent in response to entry of DTMF access codes. This message informs the person entering an access code that the code was entered correctly and the KRP-5000 has taken the action requested by the access code. The acknowledgement message is sent on the repeater tail.

Tonepad Test (OK)

The Tonepad Test message is sent on the repeater tail following the entry of a DTMF row or column digit sequence when the user Tonepad Test function is active. The message indicates that the DTMF digit sequence has been received by the repeater and, therefore, that the user DTMF tonepad is operating correctly..

Off

The Off message is sent on the repeater tail when an attempt is made to access a user function which has been inhibited by control operator command. The message indicates that the function access code has been received by the repeater but that the function requested is turned-off and is, therefore, unavailable to the user.

The Off message is also sent on the repeater tail following the entry of control operator commands which cause functions to be inhibited. Certain commands operate in toggle fashion such that entry of the command when a function is enabled will cause the function to be inhibited and entry of the same command when the function is inhibited will cause the function to be enabled. Two different messages are sent to indicate whether the command entry caused a function to be enable or inhibited. If the command causes a function to be enabled then the acknowledgement message is sent. If the command causes a function to be inhibited then the Off message is sent.

Courtesy Tone

A brief Courtesy Tone may be sent on the repeater tail after each transmission to indicate that the previous user has stopped transmitting and the repeater is now available to be accessed by another user. The courtesy tone is an automatically generated message comparable to the spoken word 'over.'

The courtesy tone also indicates that the transmission timer has been reset; therfore, users should wait for the courtesy tone to be sent before beginning a transmission to avoid causing a timeout.

Timeout

A received signal of excessively long duration can cause a transmission timeout. If this condition occurs the repeater transmitter is immediately disabled, and the transmitter remains disabled until the received signal ceases. When the received signal ceases the repeater transmitter is activated briefly and the Timeout message is sent. The Timeout message informs all repeater users that repeater transmission was interrupted due to a timeout.

Busy (BZ)

The Busy message is sent on the repeater tail when an attempt is made to access a telephone interconnect function and the telephone line is already in use. The message is sent only when several KRP-5000 repeaters are sharing a single telephone line. The message informs repeater users that the telephone interconnect is busy and, therefore, unavailable.

Reverse Autopatch Alert

The Reverse Autopatch Alert message informs repeater users that an incoming telephone call is being received. This message may be regarded by repeater users as telephone ringing.

Power Fail (PF)

The Power Fail message is sent following a power interruption to infrom repeater users and control operators that the repeater had been unvailable due to a power failure. The message is sent on the repeater tail after each transmission until the message is manually removed by a control operator using the Normal command.

Emergency Power (EP)

The Emergency Power message is intended to be sent to inform repeater users and control operators that the repeater is operating from an emergency power source. The message is initiated by a transition of the logic signal applied to rear panel input terminal 19. The message is sent on the repeater tail after each transmission as long as emergency power operation is in effect.

Commercial Power (CP)

The Commercial Power message is intended to be sent to inform repeater users and control operators that the repeater had been operating from the emergency power source and that normal AC power has now been restored. The message is initiated by a transition of the logic signal applied to rear panel input terminal 19. The message is sent on the repeater tail after each transmission until the message is manually removed by a control operator using the Normal command.

Tail

The Tail message may be selected by a control operator to be sent on the repeater tail after each transmission to convey a brief informational message to all repeater users. The tail message is field programmable and can consist of any sequence of Morse code letters or numbers up to a maximum of 16 characters. Programming is done by DTMF access code entry and the programming procedure is given in manual section 6.

Control operator command selection determines whether the tail message is to be sent or not. Selecting that the tail message not be sent does not erase the message from memory; thus, once a tail message is programmed it remains in memory and may be selected to be sent at any time.

Alarm

The Alarm message is initiated in response to a transition of the logic signal applied to rear panel input terminal 11. The message is intended to inform repeater users and control operators of an abnormal condition of external equipment at the repeater site.

Whenever an alarm condition is sensed at terminal 11 the repeater transmitter is activated and the alarm message is sent immediately. If the alarm condition persists, the alarm message is sent on the repeater tail after each transmission.

The alarm message is field programmable and can consist of any sequence of Morse code letters and numbers up to a maximum of 16 characters. Programming is done by DTMF access code entry and the programming procedure is given in manual section 6.

TABLE 5.1

USER SETTABLE OUTPUTS

Access Code to turn output on	Access Code to turn output off	Output on rear panel terminal
505	515	23
506	516	27
507	517	13
508	518	28
509	519	7
510	520	22
511	521	8
512	522	16
513	523	24
514	524	25

5.0 USER FUNCTIONS

User functions may be entered by any repeater user to activate certain features of the KRP-5000.

All user functions, except the clear code, are timed functions. That is, the feature which is activated by entering a particular user function access code will remain activated for a specific length of time. At the end of the timed interval the function will be cleared automatically. Time intervals for the various user functions are set by control operator commands.

Access codes given below for user functions are those access codes which are in effect when the KRP-5000 is shipped from the factory. User function access code leading digits are remotely programmable and may be changed at any time by control operator command. The access code for each user function is given below in brackets, < >.

5.1 Timer Reset < 500 >

The maximum length of any continuous transmission made through the KRP-5000 is limited by a transmission timeout timer. The timer duration is set by control operator command. If a received transmission exceeds the timer limit the repeater transmitter is disabled and remains disabled until the received transmission ceases.

The timer reset function allows repeater users to manually reset the transmission timeout timer and, thereby, allow the repeater transmitter to operate. This function is especially useful when transmission timeout is caused by a mobile unit having a stuck microphone or by any other fault condition which can persist for very long periods of time.

For this function to operate, the user who is entering the Timer Reset access code must have a stronger signal into the repeater than the signal which is causing the repeater timeout. That is, the user entering the access code must be able to capture the repeater.

5.2 Clear Code < ~~#50~~ > # #51

All user functions described below (except the pulse output function) are timed functions and turn off (clear) automatically after a period of time determined by control operator command. However, normal operating practice is for repeater users to clear functions manually when they no longer wish to use the function. The Clear code is used for this purpose.

The Clear Code may be entered any any time to clear all active user functions. The KRP-5000 acknowledges receipt of the Clear Code by responding with the CLR message on the repeater tail.

5.3 Telephone Interconnect Functions

The following user functions activate telephone interconnect features. All of these functions, except for the Reverse Autopatch function are intended to be entered from the repeater receiver by a user for the purpose of originating an outgoing telephone call.

Telephone interconnect functions may be inhibited by control operator command. If an attempt is made to activate these functions while they are inhibited the KRP-5000 will acknowledge receipt of the access code on the repeater tail with the OFF message. This indicates to the user that the access code has been received correctly by the KRP-5000 and that the function is unavailable.

Capability is provided for several KRP-5000 repeaters to share a single telephone line; however, only one repeater may use the telephone line at any time. If an attempt is made to activate a telephone interconnect function when the telephone line is already in use by another repeater the KRP-5000 will resond with the BZ message on the repeater tail. This message indicates that the telephone line is in use (busy) so the access request cannot be honored at this time.

All KRP-5000 telephone interconnect features use half-duplex audio under control of the repeater user. Whenever signal is present at the repeater receiver, audio is routed from the repeater receiver to the telephone line and to the repeater transmitter. Audio is not routed from the telephone line to the repeater transmitter when received signal is present. Audio is routed from the telephone line to the repeater transmitter when no received signal is present.

5.3.1 Autopatch Function < 501 >

The autopatch access code is used by repeater users for activating the telephone interconnect for the purpose of originating an outgoing telephone call where the user intends to enter the called telephone number manually using a DTMF tonepad.

Although telephone number information is entered by the repeater user with DTMF tones, dialing information sent to the telephone network may be either DTMF or dial pulse. The choice of DTMF or dial pulse is determined by control operator command. When dial pulsing is selected the conversion from user-entered DTMF tones to dial pulses is done by the KRP-5000. When DTMF is selected user-entered DTMF tones are passed directly to the telephone network. It is suggested that DTMF

be used on those telephone lines which can accept DTMF since the telephone network may respond incorrectly to the combination of dial pulses from the KRP-5000 superimposed on DTMF entered by a user.

The KRP-5000 will activate the telephone interconnect immediately upon receipt of the Autopatch access code if the function is not inhibited by command and if the telephone line is not already in use. Therefore, the recommended procedure for using the autopatch function is as follows:

1. Enter the Autopatch access code. < 501 >.

2. Momentarily stop transmitting and listen for dial tone.

3. Enter the DTMF digit sequence corresponding to the telephone number to be called.

4. Stop transmitting and monitor call setup progress.

Transmission should resume when the called party answers. At the conclusion of the call the Clear code should be entered to terminate the Autopatch function.

5.3.1.1 Autopatch Restrictions

User autopatch telephone calls are restricted in an attempt to prohibit long distance calling. Telephone numbers entered when making an autopatch call must

1. Have a maximum of 7 digits,

2. Not have a leading zero (0) digit,

3. Not have a leading one (1) digit.

Entry of a telephone number which violates these restrictions will cause an immediate termination of the telephone call. A separate Long Distance Autopatch feature is provided which bypasses these restrictions. The Long Distance Autopatch feature is a control operator function and is described in section 6 of this manual.

5.3.2 Redial <502 >

Each time a telephone call is originated the telephone number called is remembered by the KRP-5000. Redial allows subsequent calls to be placed to the same telephone number without the need for users to re-enter the desired telephone number. To place another call to the same telephone number a repeater user may simply enter the Redial

access code, < 501 >. Upon receipt of the Redial access code the KRP-5000 will both acitvate the telephone interconnect and begin dialing the last-called telephone number. Dial pulsing is always used for redial calls. Redial may be used successively to place repeated calls to the same telephone number.

To operate the Redial feature a repeater user should enter the Redial access code and then cease transmission to monitor call setup progress. Transmission should be resumed when the called party answers. At the conclusion of the call the Clear code should be entered to terminate the Redial function.

5.3.3 Autodial < 600-699, 700-799 >

Autodial enables repeater users to activate the telephone interconnect and dial programmed (stored) telephone numbers by merely entering an Autodial access code. A maximum of 200 telephone numbers may be stored simultaneously in the KRP-5000 memory with each telephone number having its own unique autodial access code. Since Autodial access codes begin with two different leading digits, 6 and 7, the access codes are referred to as being in two different groups. Group 1 are those autodial numbers having access codes from 600 through 699, and group 2 autodial numbers are those having access codes from 700 through 799. Operation of the two different groups of autodial numbers is identical.

Tc operate the autodial feature a repeater user should enter the autodial access code corresponding to the telephone number to be called and then cease transmission to monitor call setup progress. Transmission should resume when the called party answers. At the conclusion of the call the Clear code should be entered to terminate the Autodial feature.

Dial pulse signaling is always used for Autodial calls.

5.3.3.1 Autodial Telephone Number Programming

Two hundred different telephone numbers may be stored simultaneously in the KRP-5000 for autodial calling. Each stored telephone number may consist of a maximum of eleven digits. No restrictions are place on the stored numbers by the KRP-5000. That is, autodial telephone numbers may begin with leading 1 or 0 digits.

A unique access code is associated with each stored telephone number. When the KRP-5000 is shipped from the factory the autodial access codes are in the range 600 to 699 and 700 to 799. The procedure for entering and changing telephone numbers is as follows:

1. Place the KRP-5000 in the Program Mode.
   (A control operator command is used to place the KRP-5000 into the Program Mode. This command is described in section 6 of this manual.)

2. Enter the autodial access code to be programmed, followed by the telephone number being programmed, followed by the # character.

The autodial access code, telephone number, and # character should be entered in one continuous transmission. The KRP-5000 will acknowledge that this programming information has been received by sending the RRR message on the repeater tail.

For example, to program autodial access code 633 with the telephone number 555-1212 enter:

6 3 3 5 5 5 1 2 1 2 #

To delete a telephone number from memory enter the autodial access code followed by the # character. For example, to delete the telephone number associated with autodial access code 745 enter:

7 4 5 #

Telephone numbers associated with an autodial access code may be changed simply by entering the new telephone number as shown in the first example above. It is NOT necessary to delete an old telephone number before entering a new number.

For the KRP-5000 to accept autodial programming information it must be placed in the Program Mode by a control operator. While in the Program Mode, ANY repeater user may enter programming information by following the procedure shown above. That is, programming need not be done by a control operator.

e Autodial feature can not be used to originate telephone calls when the KRP-5000 is in the Program Mode. Therefore, when the desired programming changes have been made a control operator should terminate the Program Mode to make the Autodial feature available to repeater users.

5.3.3.2 Autodial Prefix Digits

Each autodial telephone number can consist of a maximum of eleven digits which is sufficient to contain an area code plus a normal seven digit telephone number. In certain cases it may be desirable to have each autodial number preceded by a common set of prefix digits.

Prefix digits may be useful, for example, when the KRP-5000 is operated with a PBX telephone system where one or more digits must be entered to access an 'outside line.' The Autodial Prefix Digits feature allows extra digits to be added at the beginning of every autodial telephone number for this purpose.

When Autodial Prefix Digits are programmed by control operator command the digits are automatically sent at the beginning of every autodial telephone call and require no special action by repeater users.

5.3.4 Reverse Autopatch < 503 >

Reverse Autopatch allows incoming calls from the telephone line to be answered and routed to repeater users. Four levels of Reverse Autopatch security are provided by the KRP-5000 to prevent unauthorized callers from activating the repeater transmitter. The four security levels are selectable by control operator command as follows:

I. Access Code Required for Alert

In this style of operation incoming telephone calls are answered by the KRP-5000 approximately 10 seconds after ringing begins. When a call is answered the caller must enter the Reverse Autopatch access code < 503 > from the telephone line. If the Reverse Autopatch access code is not entered within 20-seconds after the call is answered the KRP-5000 will automatically disconnect the call.

Entry of the Reverse Autopatch access code causes 1) the repeater transmitter to be activated and 2) a tone-burst alerting signal to be sent over the repeater transmitter. The alerting tone burst informs repeater users that an incoming call has been received. Upon hearing the alerting signal any repeater user may respond to the call by entering the Autopatch access code <501 >. Once the Autopatch access code has been entered the call proceeds as a normal autopatch call. At the conclusion of the call the Clear code should be entered by the repeater user to terminate the call. If no repeater user responds to the alerting signal by entering the Autopatch access code thn the KRP-5000 will automatically disconnect the call in approximately one minute.

This style of operation provides the most secure operation. First, the caller must know the Reverse Autopatch access code to cause the repeater transmitter to activate. Thus, the repeater transmitter will not be activated in response to 'wrong numbers.' Second, the action of the caller only causes an alerting signal to be transmitted. The caller can not gain voice access to the repeater transmitter. In this style of operation audio connection

from the telephone line to the repeater transmitter/recevier is made only when a repeater user enters the Autopatch access code.

II. Automatic Alert

In this style of operation the repeater transmitter is activated and the alerting signal is sent as soon as an incoming telephone call is answered. Any repeater user may respond to the alert tone by entering the Autopatch access code to cause the telephone interconnect to be connected to the repeater transmitter/ receiver.

In this style of operation any caller can cause the repeater transmitter to operate for the purpose of sending the alert signal, but callers cannot gain voice access to the repeater transmitter

III. Access Code Required for Autopatch

In this style of operation incoming telephone calls are answered approximately 10 seconds after ringing begins but no signals are sent on the repeater transmitter. To gain access to the repeater transmitter the caller must enter the Reverse Autopatch access code from the telephone line. When the Reverse Autopatch access code is entered the caller is given voice access to the repeater transmitter and the call may proceed as a normal autopatch call. No alert signal is sent when this style of operation is selected.

IV. Automatic Answer

In this style of operation the repeater transmitter is activated and the telephone line is connected to the repeater transmitter/receiver as soon as an incoming telephone call is answered. Neither the caller nor any repeater user need enter access codes to allow the caller to gain access to the repeater.

No security is provided by the KRP-5000 when the Automatic Answer style of operation is selected.. Undesired, or unlawful, transmissions may be caused by 'wrong numbers' when operating in this manner if no safeguards are used external to the KRP-5000.

Any of the four styles of Reverse Autopatch operation may be selected by control operator command. The Reverse Autopatch access code is used only with operating styles I and III. Alert signals are sent only when operating styles I or II are selected. If it is desired that control operator commands be entered from the telephone line then

Reverse Autopatch operating style I or III should be used so that signals are not sent by the repeater transmitter when calls are made to the repeater for the purpose of entering command information.

5.3.5 Telephone Interconnect Timing

Autopatch, redial, and autodial are timed functions which will be cleared automatically after a prescribed time interval if they are not cleared manually by entering the Clear code.

The automatic timeout interval is determined by control operator command and may be selected as:

1. A fixed time interval of 1, 2, 3, 5, or 10 minutes,

2. Unlimited (no automatic timeout), or

3. Useage sensitive timing.

Useage sensitive timing allows a function to continue as long as it is being used. In fact, the KRP-5000 continuously resets sets the timeout limit to approximately 50-seconds whenever a received signal is present. Thus, if a signal is received at least every 50 seconds the function will not time out. If the function is not used for a period of 50 seconds (that is, if no signal is received) a timeout will occur.

5.4 Tonepad Test < 504 >

This feature allows repeater users to test the operation of their DTMF tonepads. The feature may be activated by any repeater user by entering the Tonepad Test access code, < 504 >. The KRP-5000 will acknowledge receipt of the Tonepad Test access code by sending the RRR message on the repeater tail to indicate that the feature is active. To perform tonepad tests, a repeater user may enter digits corresponding to the four rows and three columns of a standard tonepad. Seven individual tests can be performed to test individual rows and columns. For example, to test row 1 the digits 1, 2, and 3 should be entered. If the digits are received correctly the KRP-5000 will respond by sending the OK message on the repeater tail. The user may then proceed to enter digits corresponding to other rows and columns to completely verify the operation of all digit keys.

The seven digit test sequences are as follows:

1 2 3	(row 1)	1 4 7	(column 1)
4 5 6	(row 2)	2 5 8	(column 2)
7 8 9	(row 3)	3 6 9	(column 3)
# 0 *	(row 4)		

As shown, only three digits are used for column tests. Digits for the row 4 test must be entered in right-to-left order. Each of the seven tests are independent and may be entered in any order.

The Tonepad Test feature remains active until cleared, by entry of the Clear code, or until a function timeout occurs.

Tonepad Tests may use the exact same digit sequences as are used to activate other functions. For example, the sequence 7 8 9 is a Tonepad Test digit sequence; however the sequence 7 8 9 is also an Autodial access code sequence. When the Tonepad Test function is active the sequence will be interpreted as a Tonepad Test and will not activate the Autodial function.

5.5 User Controlled Outputs < 505-527, * >

Eleven logic outputs on the rear panel of the KRP-5000 can be activated by user function access codes to control other equipment at the repeater site. The rear panel terminal designation numbers for each contollable output are given in Table 5.1.

5.5.1 User Settable Outputs

Ten of the user controllable outputs may be individually set to an 'on' or 'off' condition by the entry of access codes. For each of the ten outputs there is a unique access code which may be entered to turn the output on and a different access code which may be entered to turn the output off. The access codes assigned to each settable output are given in Table 5.1. The KRP-5000 acknowledges the receipt of any of the access codes given in Table 5.1 by sending the RRR message on the repeater tail to indicate that the desired output has been turned on or off as requested.

Settable outputs may also be turned off manually by entering the Clear code. Entry of the Clear code causes all user settable outputs to be turned off simultaneously.

User settable outputs are timed functions which will timeout automatically if they are not cleared manually. The automatic timeout limit is normally 10 minutes but this may be altered by control operator command as follows:

1. If the timeout limit for telephone interconnect functions is set to 'useage sensitive' timing by control operator command then the time limit for user settable outputs will be a minimum of 10 minutes and will be 'useage sensitive' beyond ten minutes. (Useage sensitive timing is described in section 5.3.5 of this manual.)

2. If the timeout limit for telephone interconnect functions is set to 'unlimited' by control operator command then the timeout limit for user settable outputs will also be 'unlimited.' That is, no automatic clearing will occur; the functions will remain active until they are cleared manually.

3. For all other conditions the automatic timeout limit for user settable functions will be 10 minutes.

When any user settable output is activated, by entering one of the access codes shown in Table 5.1, front panel lamp FUNT 6 will be

lighted. The lamp will remain lighted until the function outputs are manually cleared, by entering the Clear code, or until a function timeout occurs. The lamp will NOT be extinguished if the function outputs are cleared by entering the output 'turn off' access codes shown in Table 5.1.

5.5.2 User Settable Outputs - Transmitter On

Three of the eleven user settable outputs may be operated in a manner which allows the repeater transmitter to be automatically activated when the outputs are turned on. These outputs and the access codes to activate them are as follows:

Rear Panel Terminal	Access Code to Activate Output
23	525
27	526
13	527

Once activated, the outputs will remain active and the repeater transmitter will remain active until they are manually cleared by entering the Clear code or until an automatic function timeout occurs. The automatic function timeout limit for these functions is identical to that for telephone interconnect functions.

5.5.3 Pulse Output

One of the eleven user controllable outputs is a pulse output. This output is activated by entering the DTMF * (star) tone. The output remains active as long as the * tone is present. The pulse output appears on rear panel terminal strip terminal 3.

5.6 Sequential Tones (2XX)

Individual and group call two-tone sequential paging signals can be generated by the KRP-5000 in respones to DTMF access codes. Access codes in the range 200 to 299 originate individual unit paging signals, and access codes in the range 20# to 29# originate group call paging signals. Paging signals are sent on the repeater tail after an access code is entered by a repeater user.

Motorola Group 2 tones are the standard tone frequencies furnished in the KRP-5000. Other tone frequencies are available as an option. Tone frequencies corresponding to DTMF digits entered are as follows:

DTMF Digit Entered	Tone Frequency in Hz	Motorola Reed number
0	569.1	120
1	600.9	121
2	634.5	122
3	669.9	123
4	707.3	124
5	746.8	125
6	788.5	126
7	832.5	127
8	879.0	128
9	928.1	129

To send an individual unit paging tones select DTMF digits from the above list which correspond to the tone frequencies to be sent. Enter the sequential tone access code leading digit (factory programmed as the digit 2) followed by the DTMF digits corresponding to the paging tone frequencies.

EXAMPLE: To send an individual unit page consisting of tone frequency 569.1 Hz followed by 832.5 Hz enter access code

207

where,

2 is the leading digit for sequential tone functions
0 is the DTMF digit corresponding to 569.1 Hz
7 is the DTMF digit corresponding to 832.5 Hz

Individual unit pages are sent with the first tone having a duration of ones second, and the second digit having a duration of three seconds.

To send a group call or all-call paging tone select desired the tone frequency from the above list. Enter the sequential tone access code leading digit (factory programmed as the digit 2) followed by the DTMF digit corresponding to the tone frequency to be sent followed by the # character.

EXAMPLE: To send a group call paging tone of 669.9 Hz enter the access code

23#

where,

2 is the leading digit for sequential tone functions
3 is the DTMF digit corresponding to 669.9 Hz

# indicates group call page.

Group call and all-call pages consist of a single tone having a duration of 8 seconds.

TABLE 6.1

MORSE CHARACTER CODES

The following are DTMF digit sequences corresponding to Morse message characters. The digit sequences are entered as part of command access codes to create programmable messages.

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

6.0 CONTROL OPERATOR COMMANDS

Control operator commands are those access codes which may be entered to change the operating characteristics of the repeater. Typically, these commands will be used only by control operators who are responsible for the proper operation of the repeater system and not by every repeater user.

6.1 Command Safeguards

Safeguards are built into the KRP-5000 to restrict unauthorized entry of control operator commands. These safeguards limit the manner in which commands may be entered into the repeater. Commands are accepted by the KRP-5000 only 1) when entered through an incoming call on the telephone line, and 2) when the Command Signal Input is present. Either, or both, of these means may be used to enter commands.

If it is desired to have commands entered from the telephone line then the Reverse Autopatch function should be set to use the 'Access Code Required for Alert' style of operation. With this style of operation the KRP-5000 is prepared to accept access codes from the telephone line when an incoming call is answered. The access code which is entered may be either the Reverse Autopatch access code which is entered by a caller to send the alert signal, or it may be a command access code.

If it is desired to control the repeater from the repeater receiver or from a separate command receiver then provisions must be made to activate the Command Signal Input when commands are to be entered.

The Command Signal Input appears on rear panel terminal strip terminal 2. This input is a high impedance TTL compatible input. In normal operation the input should be held at ground so that command access codes are not accepted. When a command is to be entered this input should be raised to +5 volts. (The sense of the Command Signal Input may be inverted by operating rocker switch S1 section 3 to the ON position.) Front panel lamp number 4 is lighted whenever a Command Signal is present.

A Command Signal Input can be generated in many different ways. One commonly used means is to equip the repeater with a CTCSS decoder exclusively for command purposes. The CTCSS frequency should be known only to control operators who are equipped with corresponding CTCSS encoders. This approach allows control operators to command the repeater directly from the repeater receiver. An alternative approach is to command the repeater on a separate UHF control frequency and to derive the Command Signal from the COS output of the command receiver.

6.2 Long Distance Autopatch < 901 >

TABLE 6.2

FACTORY PROGRAMMED CHARACTERISTICS

Command Access Code	Characteristic
905	User function access enabled
906	Autopatch access enabled
907	Reverse Autopatch access enabled
908	Transmitter enabled
909	Autodial access enabled
9100	Carrier access
9116	Transmission timeout = 3 minutes
9124	Function timeout = 3 minutes
9130	Access code needed for Reverse Autopatch alert signal
9141	5-second tail with courtesy tone
9253	CW speed = 18 words / minute
9260	DTMF signaling

TABLE 6.3

COMMAND SUMMARY

900	Normal
901	Long Distance Autopatch
9020	Command Output 1 (TB9) Normal Squelch
9021	Command Output 1 Tight Squelch
9030	Command Output 2 (TB29) Off
9031	Command Output 2 On
9040	Command Output 3 (TB14) Off
9041	Command Outout 3 On
905	User Function Inhibit (toggle)
906	Autopatch Inhibit (toggle)
907	Reverse Autopatch Inhibit (toggle)
908	Transmit Inhibit (toggle)
909	Autodial Inhibit (toggle)
9100	Carrier mode operation (not CTCSS)
9101	CTCSS operation
9110	Transmission timeout = no limit
9111	Transmission timeout = 30 seconds
9112	Transmission timeout = 1 minute
9113	Transmission timeout = 90 seconds
9114	Transmission timeout = 2 minutes
9115	Transmission timeout = 2 1/2 minutes
9116	Transmission timeout = 3 minutes
9117	Transmission timeout = 5 minutes
9120	Function timeout = no limit
9121	Function timeout = useage sensitive
9122	Function timeout = 1 minute
9123	Function timeout = 2 minutes
9124	Function timeout = 3 minutes
9125	Function timeout = 5 minutes
9126	Function timeout = 10 minutes
9130	Reverse Autopatch - access code needed for alert
9131	Reverse Autopatch - immediate connection to transmitter upon answer
9132	Reverse Autopatch - alert sent upon answer

COMMAND SUMMARY Cont'd

914	Tail Message select - programmed message or courtesy tone (toggle)
915	<not used>
9161	Program mode on
9162	Program mode off
917 (P)	Program command access code prefix digits
918 (P)	Program user function access code prefix digits
919 (P)	Program autodial group 1 access code prefix digits
920 (P)	Program autodial group 2 access code prefix digits
921 (P)	Program sequential tone access code prefix digits
922	Program tail message
923	Program Identification Message
924	Program Alarm Message
925X	Set CW Speed (X = 0 to 9, 0 is fastest, 9 = slowest, 3 = factory set value)
9260	Select DTMF autopatch
9261	Select dial pulse autopatch
927	Reset Processor
928	Reset operating parameters to factory values

User autopatch access restricts repeater users from originating long distance autopatch calls by terminating the call when telephone numbers are entered which begin with leading digits zero (0) or one (1) and when telephone numbers contain more than seven digits. The Long Distance autopatch command gives control operators the capability to originate telephone calls which are not subject to dialing restrictions.

The Long Distance Autopatch function operates in the same manner as the user autopatch except that the access code to activate the Long Distance autopatch is 901.

The Command Signal must be present for the Long Distance Autopatch access code to be accepted. Once the access code is entered it is not necessary for the Command Signal to be present during the entry of telephone number dialing information. Therefore, a control operator may activate the autopatch using this command to allow a long distance call to be made by any repeater user.

6.3 Command Outputs

Three outputs are provided on the rear panel terminal strip of the KRP-5000 which may be activated by control operator commands to control external equipment at the repeater site. The command outputs are dirven by open collector buffer devices and have the same output drive capability as user controllable outputs.

Individual access codes are provided for turning each command output on and off as shown below. The command outputs are not timed: when activated they remain active until they are individually cleared using the access codes shown. Command outputs are not affected by the user Clear Code.

Rear Panel Terminal	Access Code to turn output ON	Access Code to turn ouput OFF
9	9021	9020
29	9031	9030
14	9041	9040

6.4 Inhibits

The following commands allow control operators to selectively inhibit

features of the repeater available to users:

905 User Function Inhibit

906 Autopatch Inhibit

907 Reverse Autopatch Inhibit

908 Transmit Inhibit

909 Autodial Inhibit

9300 Sequential Tone Inhibit

9301 Sequential Tone Enable

Except for the sequential tone commands, these commands operates in toggle fashion. That is, entering the command once will cause the user feature to be inhibited, and entering the same command a second time will cause the feature to be enabled (available to users.) The first time that a command is entered the KRP-5000 will responds with the OFF message on the repeater tail to indicate to the control operator that the feature has been inhibited. The second time the command is entered the KRP-5000 will respond with the RRR message on the repeater tail to indicate that the feature is now enabled. Should a repeater user attempt to access a feature which is inhibited the KRP-5000 will respond with the OFF message on the repeater tail to indicate to the user that he feature is inhibited.

Two commands are used to control the sequential tone functions. Entering command 9300 causes the sequential tone function to be inhibited and entering command 9301 causes the sequential tone function to be enabled

Inhibit commands are not timed. A feature which is inhibited, by entering one of the above commands, remains inhibited until until it is enabled by a control operator entering the same command a second time.

The User Function Inhibit command controls the operation of the User Controlled Output functions and the Tonepad Test function.

Each of the telephone interconnect features is controlled by a separate inhibit command. These commands operate independently so it is possible, for example, to operate the KRP-5000 with the Autodial feature enabled and the Autopatch feature inhibited. Operation in this manner would allow repeater users to originate telephone calls only to those telephone numbers which have been stored in memory.

Reverse Autopatch Inhibit prevents the KRP-5000 from answering any incoming telephone calls. In some systems, repeater control is exclusively via telephone line with no alternate control link. In such cases, inhibiting the Reverse Autopatch would eliminate the only

means of control. To prevent this condition from occuring the KRP-5000 will not accept the Reverse Autopatch Inhibit command when the command is entered from the telephone line.

The Transmit Inhibit command acts as a system disable command. Entring this command will prevent the repeater transmitter from operating in response to a received signal. In addition, telephone interconnect features and other user functions will not operate when the transmitter is inhibited.

6.5 CTCSS Operation

This function allows repeater operation and all user functions to be restricted by requiring that a separate input signal, typically from a CTCSS decoder, be present for operation. The KRP-5000 is available with an optional CTCSS decoder which may be factory installed to provide this capability.

Alternatively, an external CTCSS decoder may be used to provide CTCSS operation. If an external, customer supplied, CTCSS decoder is to be used then connection should be made from the CTCSS decoder to rear panel terminal 4. The external decoder should supply a ground on terminal 4 when CTCSS is present and a pullup to +5 volts when no CTCSS signal is present.

CTCSS decoders providing a signal of the opposite logical sense (ground when no CTCSS signal is present and +5 volts when CTCSS is present) may be used by operating rocker switch S1 section 1 on the processor board to the OFF position.

Presence of a logic signal from the CTCSS decoder at the input to the KRP-5000 is indicated by front panel lamp 5. Lamp 5 is lighted when a logic signal from the CTCSS decoder is deliverd to the KRP-5000.

Control operator command access codes for CTCSS operation are as follows:

9100 Carrier operation

9101 CTCSS operation

Entry of either of these codes will cause the KRP-5000 to respond with the RRR message on the repeater tail.

When operating in the CTCSS mode, a signal must be present at the CTCSS logic input, terminal 4, for repeater operation and for the acceptance of all user function access codes. CTCSS is not required for the KRP-5000 to accept control operator commands.

6.6 Transmission Time Limit

The following control operator commands allow selection of the transmission timeout limit:

9110 Unlimited (no timeout limit)

9111 Timeout limit = 30 seconds

9112 Timeout limit = 1 minute

9113 Timeout limit = 90 seconds

9114 Timeout limit = 2 minutes

9115 Timeout limit = 2 1/2 minutes

9116 Timeout limit = 3 minutes

9117 Timeout limit = 5 minutes

6.7 Function Timeout Limit

The following control operator commands allow selection of user telephone interconnect function timeout limits. In addition, these commands may affect the timeout limits of special user output functions. These commands do not affect the timeout limits of normal user function outputs.

9120 Unlimited (no timeout limit)

9121 Useage sensitive timeout limit

9122 Timeout limit = 1 minute

9123 Timeout limit = 2 minutes

9124 Timeout limit = 3 minutes

9125 Timeout limit = 5 minutes

9126 Timeout limit = 10 minutes

6.8 Reverse Autopatch Operation

The following commands are used to select the style of Reverse Autopatch operation. Styles of Reverse Autopatch operation are described in manual section 5.3.4.

9130 Reverse Autopatch alert signal sent after access code is entered (Style I - Code for Alert).

9131 Transmitter/ receiver connected to telephone line as soon as incoming call is answered (Style IV - Automatic Answer).

9132 Alert signal sent as soon as incoming call is answered (Style II - Automatic Alert).

9133 Autopatch originated from telephone line (Style III - Code for Autopatch)

9134 Autopatch originated from telephone line and sequential tone paging originated from telephone line

6.9 Tail Duration / Messages

The following commands determine the nature of the repeater tail which occurs after a transmission is made through the repeater:

9140 Tail is a 1-second interval, no messages are sent on the tail

9141 Tail is a 5-second interval with a courtesy tone

9142 Tail is a 5-second interval containing a programmed tail message

9143 Tail is a 1-second interval when no special messages are being sent. When messages are being sent the tail is extended to 5 seconds.

If the tail duration is set to a 1-second interval using command 9140, none of the message described in section 4 of this manual are sent as tail messages. Only non-tail messages (Identification, reverse autopatch alert, and alarm) are sent when this style of operation is selected.

6.10 Program Mode Enable

Certain control operator commands are accepted only when the KRP-5000 is placed in the Program Mode. This precaution is a extra level of safeguarding to prevent vital repeater characteristics from being changed accidentally. The following command places the repeater into the program mode. This command operates in a toggle fashion; that is, entering the command enable the Program Mode and entering the same

command a second time disables the Program Mode.

Because vital repeater characteristics can be changed when the repeater is in the Program Mode, it is recommended that the repeater be placed into the Program Mode only when it is specifically desired to change these characteristics. After the desired changes are made this command should be entered a second time to disable the Program Mode.

916 Program Mode Enable/ Disable

9161 Enable
9162 Disable

6.11 Changing Access Codes

The leading digits of all access codes recognized by the KRP-5000 may be changed by control opertor command. When the repeater is shipped from the factory these access code leading digits are set as follows:

5 User functions

9 Control operator commands

6 Extended Autodial, group 1

7 Extended Autodial, group 2

2 Sequential tones

As this listing shows, the KRP-5000 is programmed at the factory to have each access code begin with a single leading digit. For example, all control operator commands begin with the digit 9. By using the following commands, access code leading digits may be set to any combination of one or two digits.

(The KRP-5000 must be in the Program Mode to accept the following commands.)
lm-5

917 Change control operator command access code leading digits

918 Change user function access code leading digits

919 Change autodial group 1 access code leading digits

920 Change autodial group 2 access code leading digits

921 Change sequential tone access code leading digits

Example: To change control operator command access codes from the single digit 9 to the two digit combination 98 enter the following:

9 1 7 9 8 #

where,

917 is the command to change control operator command access codes leading digits,

98 is to be the new leading digit combination for control operator commands, and

informs the KRP-5000 that the command entry is complete.

Once this command sequence is entered all control operator commands will begin with the leading digits 98. For example, the Normal command becomes 9800, and the command to change control operator commands becomes 9817.

Changing user function access code leading digits also changes the Clear code as illustrated in the following example.

Example: User function access code leading digits may be changed from the single digit 5 to the two digit combination 54 by entering:

9 1 8 5 4 #

where,

918 is the control operator command to change user function access code leading digits,

54 is to be the new leading digit combination for user function access codes, and

informs the KRP-5000 that the command entry is complete

Once this command sequence is entered, all user functions will begin with leading digits 54. For example, the Autopatch access code becomes 5401.

The digit 5 in the Clear code is changed to the two digit combination 54 so the Clear code is now #540.

Caution: Different leading digit combinations must be selected for the different types of functions. That is, if a leading digit combination, say 54, is used for user functions then the same leading digit combination (54) cannot be used for

control operator commands.

923 - - DE - K7SYE/R
39 39 47 39 20 07 28 34 14 36 27 #

- - H I - 41 39 39
923 39 39 17 18 39 39 26 07 23 34 14 36 27 #

6.12 Programming Messages

Three messages sent by the KRP-5000 may be programmed in Morse code. The control operator commands for programming these messages are as follows:

922 Program Tail Message

923 Program Identification Message

924 Program Alarm Message

Morse letters and numbers to be programmed are identified to the KRP-5000 as a sequence of two DTMF digits. The DTMF digit sequence corresponding to each letter and number is given in Table 6.1. The procedure for programming a message is,

1. Enter the control operator command access code corresponding to the message to be programmed (922, 923, or 924),

2. Enter the two-digit DTMF digit sequence given in Table 6.1 for each letter and number to be contained in the Morse message,

3. Enter the # character to inform the KRP-5000 that the entry is complete.

Example: To program the Identification message to be KXC147, enter the following:

9 2 3 2 0 3 3 1 2 0 1 0 4 0 7 #

where,

923 is the control operator command to program the Identification message,

20 10 12 01 04 and 07 are the two-digit DTMF sequences corresponding to the Morse characters K X C 1 4 7 obtained from Table 6.1, and

informs the KRP-5000 that the command entry is complete

923 DE
~~1334~~
41 39 32 07 29 25 15 26 27
#

6.13 CW Speed Selection

The following control operator command selects the speed of all Morse and tone messages sent by the KRP-5000:

925X Select CW Speed,

where,
X is any digit from 0 through 9

Messages will be sent at the fastest speed (approximately 25 words-per minute for Morse messages) when digit X is zero. Messages will be sent at the slowest speed (approximately 10 words-per-minute for Morse messages) when digit X is nine. The KRP-5000 is shipped from the factory with the value of digit X set to 3; this produces a speed of approximately 18 words-per-minute for Morse messages.

Example: To set the speed of Morse messages to approximately 18 words-per-minute enter the command: 9253

6.14 Dial Pulse / DTMF Dialing Selection

The following control operator commands select whether dial pulse signaling or DTMF signaling is used by the KRP-5000 for originating Autopatch telephone calls.

9261 Use dial pulse signaling for Autopatch calls

9260 Use DTMF signaling for Autopatch calls

These commands affect only telephone calls originated using the Autopatch function; Autodial and Redial calls always use dial pulse signaling. When DTMF signaling is selected, DTMF digits entered by users are relayed directly to the telephone interface.

Some telephone central office equipment can accept either dial pulse of DTMF signaling, but it may not operate properly when dial pulses and DTMF tones are intermixed. In these applications DTMF signaling should be used to originate Autopatch calls.

6.15 Auotdial Prefix Digit Programming <929>

This feature allows a control operator to program telephone dialing digits which are to be sent at the begining of all Autodial telephone numbers. Some PBX telephone systems require that a special digit sequence be entered to access an 'outside line.' This feature allows the special 'outside line' digit sequence to be programmed into the KRP-5000 so the 'outside line' digits do not need to be programmed as part of each individual Autodial telephone number.

The KRP-5000 must be in the Programming mode to program Autodial Prefix Digits.

To program Autodial Prefix Digits enter the access code 929 followed by the prefix digits to be sent at the beginning of all Autodial telephone numbers followed by the # character.

Example: If the KRP-5000 is to be used with a PBX telephone system which requires that the digit 9 be sent to access an 'outside line,' enter the following digit sequence:

9 2 9 9 * #

where, 929 is the access code for programming prefix digits,

9 is the 'outside line' prefix digits,

* causes a pause in dialing while the PBX connects the 'outside line,'

informs the KRP-5000 that the access code entry is complete.

Entering the * character as part of the Autodial prefix causes a 1.2 second pause in dialing. The * character may also be used when programming Autodial telephone numbers to cause a pause in dialing.

6.16 Fault Recovery

6.16.1 Special Diagnostic Program

During normal operation the KRP-5000 microprocessor executes diagnostic routines to continuously monitor the 'health' of the repeater. It is possible that a severe power transient might alter the operation of the repeater in manner which is not detected by

the diagnostic routines. If this condition were to occur the repeater might not respond to user function access or other control operator commands. Although this possibility is extremely unlikely, a special diagnostic program is provided in the KRP-5000 to recover from his condition. The following control operator command causes the repeater to run a special diagnostic program. Run time for the special diagnostic program approximately 10 seconds; normal repeater operation is suspended while the diagnostic program is running.

927 Execute Special Diagnostic Program

6.16.2 Select Original Operating Characteristics

Management of repeater operation is important in systems having more than one control operator. Poor management caused by various control operators entering conflicting commands can lead to a situation where no one knows all the commands which have been entered into the KRP-5000; therefore, no one knows the operating characteristics of the repeater. This condition can be corrected by the following command. This single command restores all operating characteristics to the original factory programmed values. A listing of the factory programmed operating characteristics is given in Table 6.2.

This command affects only those repeater operating characteristics shown in Table 6.2 and does not affect access code leading digits, programmed messages, or programmed autodial telephone numbers.

928 Set repeater operating characteristics to original factory programmed values

6.16.3 Access Code Recovery

One control operator error cannot be corrected by remotely entered control operator commands: if a control operator accidentally changes command access code leading digits to an unknown combination of digits then subsequent commands will not be accepted by the repeater.

Capability is provided in the KRP-5000 to recover from this unlikely error. The following procedure allows all repeater operating characteristics and access code leading digits to be restored to their original factory programmed values. The procedure does not alter programmed messages or autodial telephone

numbers.

1. Remove power from the repeater (Rotate the front panel PWR/SQUELCH controll fully counterclockwise. Disconnect emergency DC power from rear panel binding posts.)

2. Remove any connection to rear panel terminal 11 (Alarm input).

3. Remove the unit top cover to gain access to the processor circuit board.

4. Locate test terminals TP1 and TP2 on the processor circuit board.

5. Connect a cliplead from TP1 to TP2. (Be certain the cliplead does not touch any other components.)

6. Apply power to the unit (Rotate the PWR/SQUELCH control clockwise.)

7. Wait approximately 10-seconds then remove the cliplead from terminals TP1 and TP2.

8. Momentarily apply received signal to the repeater and observe that the Morse message 'START' is sent on the repeater tail.

9. Enter the command access code 900 to remove the START message from the repeater tail.

This completes the access code restoration procedure. All access code leading digits and repeater operating characteristics are now restored to their original factory programmed values, e.g. all command access codes now begin with the digit 9.

Replace the unit top cover. Restore connections to rear panel terminal 11 and DC power binding posts. Set the PWR/SQUELCH control for normal operation.

7.0 CIRCUIT DESCRIPTIONS

7.1 Audio Circuit Board Description

Audio combining circuits, DTMF detection circuits, and telephone interconnect circuits are contained on the audio circuit board. All standard connections to the audio circuit board are made through two plug-in connectors: 16-pin socket J3 connects via a ribbon cable to the backplane circuit board, and 16-pin socket J1 connects via ribbon cable to the Processor circuit board. J1 is loacated on the underside of the audio circuit board. A third socket, J2, is used only in special applications.

Audio from the repeater receiver is routed through preamplifier U1 to two analog switches (U5). Shunt transistor switch Q2, under control of the processor, mutes receiver squelch noise when no received signal is present. The two sections of analog switch U5 are also controlled by the processor to route receiver audio to the transmitter via summing amplifier U1, or to the telephone interconnect. The repeat audio level routed to the transmitter is adjustable by potentiometer R5. A second auxiliary audio output is also available from summing amplifier U1. Both U1 outputs are high impedance.

Other signals fed to summing amplifier U1 are derived from the CW tone oscillator, the telephone interconect, and an auxiliary link input. The audio level fed through the summing amplifier to the repeater transmitter from each of these inputs may be adjusted independently using potentiometers R4, R3, and R1 respectively.

Ocillator U4 generates the audio frequency tone used for creating Morse and tone messages. Audio tone pitch can be adjusted using potentiometer R2.
The oscillator output is lowpass filtered to reduce harmonic content and then routed to analog switch U5. The oscillator operates continuously and the analog switch is gated by the processor to create messages.

The two sections of amplifier U2 deliver signals to and receive signals from the telephone line interface. The audio level applied to the telephone line is controllable with potentiometer R6 and the audio level to the repeater transmitter from the telephone line is controllable with potentiometer R4. Transmformer T1 couples audio from the repeater to the telephone line and provides DC isolation. Relay K1 serves as the loop closure and dial pulsing relay. The relay is driven by transistor Q1 under control of the processor. Optoisolator U3 and its associated components detect ringing voltages on the telephone line.

Audio from the output of U2 is also routed to DTMF filter U6. A second input to U6 allows DTMF command codes to be applied from an external command receiver. U6 is a crystal controlled digital filter which separates high and low frequency DTMF tones. Tone detection is done by U7 and logic signal outputs from U7 are passed to the processor.

7.1.1 Audio Board Adjustments

Potentiometers are provided on the audio circuit board to enable adjustment of the following audio levels:

R2 - Pitch of CW tone used for Morse and tone messages.

R3 - Audio level from telephone line applied to repeater transmitter.

R4 - Level of CW tone used for Morse and tone messages.

R5 - Repeat audio level (repeater receiver to repeater transmitter.)

R6 - Audio level applied to telephone line.

Potentiometer R6 is factory adjusted to provide a proper level to the telephone line through telephone loops having nominal loss. Field adjustment is not normally required.

CAUTION: Potentiometer R6 also affects the DTMF tone level applied to filter U6. Improper adjustment of R6 may overload the tone filter causing distortion and unreliable detection of DTMF access codes.

7.1.2 Audio Board Troubleshooting

Operation of the audio circuit board may be observed by applying a modulated signal at the repeater receiver input and tracing the path of audio through the circuit board using an oscilloscope. The audio signal should be observable at the output of amplifiers U1 (pins 1 and 7) and U2 (pins 1 and 7). It is not possible to measure the audio signal directly at the amplifier inputs.

When a signal is applied to the repeater receiver input, audio gates U5 should pass audio from pin 1 to pin 2 and from pin 4 to pin 3. The audio gates are controlled by the processor and pass audio when their control voltages (pins 13 and 5 respectively) are at +12 volts. Audio is blocked when the gate control voltages are at ground potential.

When messages are not being sent by the repeater, signal from the tone oscillator (U4) should be present at audio gate U5 pin 9 and not present at pin 8. The control voltage at pin 6 should be at ground potential.

Telephone interconnect audio operates in half-duplex manner. When a telephone interconnect function is active, audio gates U5 are controlled by the presence of received signal as follows:

	Gate pin 1 to 2	Gate pins 11 to 10
Received signal present	Conducting	Blocked
No received signal present	Blocked	Conducting

DTMF is extracted from received signals by sampling audio at pin 7 of amplifier U1. Proper operation of DTMF decoding circuitry can be determined by observing front panel status lamp 3. This lamp is lighted whenever a DTMF signal is detected. Improper operation of the DTMF decoder may be caused by distortion. Apply a signal to the repeater receiver input and modulate the received signal with a DTMF tone. Observe the DTMF tone at amplifier U1 pin 1. If the tone is distorted at this point the cause of the distortion is likely to be at the transmitter and cannot be corrected by adjusting the KRP-5000. Transmitter distortion is generally caused by excessive tone levels becoming clipped by the transmitter limiters. Tone levels should be adjusted or approximately 3.5 KHZ peak deviation to avoid limiter distorton.

If DTMF tones show no distortion at pin 1 of U1 then observe the tones at pin 7 of U2. Distortion seen at this point is due to an incorrect setting of potentiometer R6. The potentiometer should be readjusted to eliminate the distortion.

7.2 Processor Circuit Board Description

Processor circuit board activity is governed by microprocessor U1. The microprocessor opertes with an instruction cycle time of 1.1 microseconds determined by the clock (895 KHz) obtained from divider U5. The clcok divider input fed from oscillator gates U7 and is controlled by crystal Y1.

Periheral devices driven directly by the microprocessor address and data buses include ROM memory (U2), EEPROM memory (U3), and periheral interface adapters (U12 and U13). Address decoder U6 is driven by the microprocessor high-order address lines and generates enabling signals for the four devices driven by the microprocessor bus.

All instructions executed by the microprocessor are contained in ROM program memory U2. Data is stored in non-volatile EEPROM memory U3. Gates U10 and transistor Q2 disable the EEPROM during power-up and power-down to prevent the memory from being disturbed by power transients.

Each peripheral interface adapter, PIA, contains RAM memory, a software controlled timer, and two input/output ports. The RAM memory is used as temporary scratchpad and stack memory by the processor. Timer intervals are derived directly from the microprocessor clock and give precise timing of events which must be monitored or generated by the processor. Each PIA has 16 software controlled input/output lines. Communication from the processor circuit board to other repeater circuits is through these input/ output lines.

PIA U12 drives addressable decoders U14 and U15 which serve as latched expanders to generate user and command settable outputs. Buffers U18, U19, and U20 convert from TTL levels at the decoder outputs to high-voltage open-collector outputs. These outputs are routed directly to the repeater rear panel.

RECEIVED SIGNAL PRESENT

Four inputs (Command signal, CTCSS, Emergency power, and COS) are buffered by exclusive-or gates U16. The second input to each exclusive-or gate may be set to +5 volts or ground by a section of rocker switch S1. The rocker switch settings allow the gates to function as inverting (rocker switch section open) or non-inverting (rocker switch section closed) buffers. Thus, the processor can accomodate inputs having either positive or negative logic senses.

Four outputs of PIA U12 (pins 9-12) are routed to open-collector buffer U11 which performs a digital-to-analog conversion function to synthesize sequential tones. Sequential tone output level may be adjusted with potentiometer R25.

During normal operation, PIA U12 generates a continuous signal on output pin 14. This signal is rectified and used to keep transistor Q1 turned on. Q1, in turn, prevents astable multivibrator U4 from oscillating and causes the output of U4 (pin 3) to be held high. In the event of a processor fault Q1 turns off thereby allowing U4 to begin oscillating. U4 oscillates at a low frequency rate and causes repeated reset pulses to be applied to the microprocessor. Reset pulses continue to be applied to the microprocessor until proper operation is restored and the output signal re-appears at U12 pin 14.

All input/output connections appearing on the repeater rear panel,

plus processor board power and ground, are routed to the backplane board via a 40-pin jack, J2. Interconnections to the audio circuit board are routed via 16-pin jack J1. Jack J1 is located on the underside of the processor circuit board.

7.2.1 Processor Board Adjustments

Rocker switch positions may be set to accomodate input sources having positive or negative logic as follows:

INPUT	SWITCH SECTION
CTCSS	1
COS	2
Command Signal	3
Emergency Power	4

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New Software Release H 2.4

KRP-5000 NEW TIMING FILTER COMMAND

Command Code	
9311	Timing Filter ON
9310	Timing Filter OFF

Timing Filter should be "ON" for normal operation.
Timing Filter may be turned OFF for packet-syyle data operation.

#51 New Auto Patch Clear Code (Standard)
#52 New Auto Patch Clear Code (Special)

This keeps the repeater transmitter on. It would be used if another user function is on so it wouldn't clear other functions when the patch is cleared. (#52)

REMOTE CONTROL OF SQUELCH

Command Function	1 TB-9
9021	Normal squelch
9020	Tight squelch

When repeater is turned on, 9021 should be entered and squelch adjusted from the front panel.

GENERAL DESCRIPTION

The MT4-V1 transmitter is a single-frequency, crystal-controlled FM transmitter designed for operation in the 132-174 and 215-250 megahertz band. All transmitter circuitry is contained in a single 6-inch (15.2 mm.) X 6-inch (15.2 mm.) X 2-inch (5 mm.) aluminum enclosure. All input leads, and non-RF output leads, enter the transmitter enclosure via individual feed-through bypass capacitors. RF output energy is delivered through an enclosure-mounted SO-239 type coaxial connector.

The MT4-V1 is a completely solid-state transmitter and features a TMOS FET output power amplifier for low noise and fail-free operation in the event of antenna faults. Transmitter power output is adjustable from 15 to aprox 35 watts, slightly less in the 220 MHz band. The transmitter is engineered for continuous duty operation and can be expected to provide reliable, long-life operation in repeater and base station applications.

Transmitter circuitry is contained on two printed circuit boards mounted within the enclosure. One circuit board contains audio, modulator, oscillator, multiplier, and driver stages. The second circuit board contains the TMOS FET power transistor amplifier stage and harmonic filter.

SPECIFICATIONS

Frequency range:	132-174 220-250MHz
Power Output:	15-35 watts
Stability:	.0005% (-30 to +50 C) (with optional oven)
Harmonic and spurious output:	Minimum 70 dB below rated output
Modulation:	Frequency Modulation, Deviation adjustable 0-5 kHz with instantaneous peak limiting
Audio Response:	Within +2 to -3 dB of EIA standard 6dB/octave pre-emphasis response from 300Hz to 2800Hz
Audio Input:	Limiting occurs with 180 millivolt peak-to-peak input from a 600-Ohm, 1 KHz audio source
Audio Distortion:	Less than 5%
Duty Cycle:	Continuous
Emission designator:	15F3

CIRCUIT DESCRIPTION

AUDIO AND LIMITER CIRCUITS

Audio from a low-impedance (600-Ohm) external source is applied to the transmitter at terminal TB4. RF decoupling is provided by C2, as well as by enclosure mounted feed-through capacitor C1. Capacitor C3 and resistor R1 provide 6 dB/ octave pre-emphasis shaping when the transmitter is driven from a 600 Ohm audio source.

Amplifier U1A provides audio preamplification of 20 dB. Amplifier U1B provides an additional 20 dB of amplification and also performs the audio limiting function. Both sections of amplifier U1 are DC coupled and both sections are from a common reference voltage established by R3 and R4. The reference voltage is established at one-half of the supply voltage applied to the amplifier. This circuit arrangement enables U1B to limit the audio in a highly symmetric manner which minimizes intermodulation distortion.,

POST-LIMITER FILTER AND AMPLIFIER

The limited audio signal is fed through deviation adjustment potentiometer R8 to the post-limiter filter. The filter consists of capacitors C6, C7, C8, and C11, and resistors R9, R10, and R11. The filter attenuates all audio frequency components greater than 3 KHz. Output of the audio filter is applied to class A voltage amplifier transistor Q1. The output of Q1 is fed to modulating varactor diode VC1 through capacitor C13 and resistor R11. Bias voltage for the varactor diode is derived from the regulated +8 volt supply through resistors R17 and R18. The bias voltage maintains VC1 in a reverse biased condition at all times and prevents distortion on audio signal peaks.

OSCILLATOR / MODULATOR

The transmitter oscillator consists of transistor Q2 and its associated components which are connected in a Colpitts arrangement with feedback provided by capacitors C18 and C19. Transmitter frequency is determined principally by crystal Y1 and may be adjusted to precise cystal resonance with trimmer capacitor C16. Modulation of the oscillator frequency occurs by the application of an audio frequency signal from voltage amplifier Q1 to varactor diode VC1. The audio voltage adds to the bias voltage of the varactor diode and thus alters the capacitance afforded by the diode. This change in diode capacitance causes a resulting change in transmitter frequency.

Crystal Y1 is enclosed in a proportionally controlled temperature envelope (option) to maintain exceedingly high frequency stability. The crystal heater is a solid-state unit which maintains crystal temperature typically within 1 degree C over the operating temperature range of the transmitter. Unlike older thermostatic ovens, the proportional heater used in the MT4 does not cycle on and off; therefore, crystal units are not subjected to thermal shocks. This results both in higher freqency stability and longer crystal unit life.

Frequency stability is controlled further through the use of silver mica capacitors in locations C17, C18, and C20. Capacitor C19 is a mica capacitor having a temperature coefficient which is especially selected to compensate for thermal characteristics of varactor diode VC1.

Oscillator output is taken from the emitter of Q2 through capacitor C20 and fed to the first multiplier stage. Because the oscillator output is taken from a low impedance point, oscillator frequency stability is not affecte by tuning of the subsequent multiplier stages.

Voltage regulator VR1 provides a constant 8-volt supply voltage for the oscillator and crystal heater unit. The use of an internal voltage regulator minimizes the effects of supply voltage variations on transmitter frequency stability.

MULTIPLIERS

Three multiplier stages are used to obtain the final transmitter output frequency: Q3 is used as a frequency tripler, Q4 is used as a frequency doubler, and Q5 is used as a frequency doubler (tripler in 220 units)Thus, the tranmsitter output frequency is 12-times (18-times 220 units) the crystal frequency. Double-tuned interstage networks are used at the output of all multiplier stages to give excellent rejection of unwanted mulitples. The interstage network at the output of Q3, consisting of L1/C23 and L2/C25, is tuned to 3-times the crystal frequency. The interstage network at the output of doubler Q4, consisting of L3/C28 and L4/C30 is tuned to 6-times the crystal frequency. The tuned circuit, consisting of L5/C35 and L6/C37, at the output of doubler stage Q5 is tuned to 12-times the crystal frequency. All double-tuned interstage networks operate as high-Q circuits with low value coupling capacitors (C24, C29, and C34). Values of certain capacitors in the multiplier circuits depend upon the sub-band frequency of the transmitter and are factory selected. These capacitrs are designated F.S. on te schematic drawing. Test points TP1 and TP2 are provided at the emitters of the doubler stages to aid in alignment.

DRIVER STAGES

Three power amplifying driver stages consisting of transistors

to the operating frequency by a T-matching network consisting of L103, C104, and C105. The output signal is then passed through a two-section harmonic reduction filter consisting of L104/C118, C108, L15/C120 and C109. RF power output is taken from J101.

Output power is sampled by capacitor C106 and rectified to provide an indication of relative power output at TB6.

The power amplifier operates from a supply voltage of 24 VDC. This supply is applied to the FET drain through decoupling inductor L101. Gate bias for the FET is also developed from the 24 volt supply through a regulated divider network. Potentiometer R103 sets the quiescent drain current of transistor Q101 and is used to compensate for manufacturing variations among devices.

INSTALLATION

MOUNTING

The MT4-V1 transmitter may be mounted in any position. The unit should be installed in a location where it will not be subjected moisture or a corrosive atmosphere. Although the transmitter is designed for operation over a temperature range from -30 to +50 degrees C, the reliability of components will be extended by selecting a location where the unit will not be subjected to temperature extremes or rapid temperature changes. The transmitter may be held in position with the four mounting screws on the bottom side of the enclosure. Mounting should be done in a manner which allows access to internal adjustments by removal of the top cover.

CONNECTIONS

All non-RF connections to the transmitter should be made by soldering to the feedthrough capacitor terminals extending from the side panel of the enclosure. In making these connections care should be taken to not exert excessive bending stress on the capacitor terminals as this may result in cracking the capacitor insulators. Audio connections to terminals TB4 and TB5 should be made using shielded wire.

RF output is taken from enclosure mounted coaxial connector J101. Connection should be made using coaxial cable terminated in a PL-259, or compatible, coaxial plug.

POWER SUPPLIES

Three power supplies are required. Connections for these power supplies, and their current capacities are as follows:

Connection to	Voltage	Current
TB1	+18 to +24 VDC	500 mA
TB2	+12VDC	500 mA
TB3	+24VDC	2 A

The power supply connected to TB1 powers the transmitter oscillator and proportional crystal heater. The nominal current drain from this power supply is approximately 50 mA; however, the current drain approaches 500 mA for a period of about one-minute following the initial application of power until the crystal heater temperature stabilizes. The supply connected to TB2 powers the excitier multipliers and drivers. This source is typically switched to cause transmitter keying.

ALIGNMENT

The MT4-V1 transmitter is factory aligned and tuned prior to shipment; however, the following procedure should be used to verify proper alignment upon initial installation and as required to compensate for normal component ageing. Following the alignment, transmitter frequency and deviation should be set as described in following sections. If the transmitter frequency is to be changed then the procedure given below for changing crystals should be followed prior to alignment.

Test equipment needed for alignment is as follows:

- 1- DC current meter, 0-1 Ampere
- 1- DC current meter, 0-5 Amperes
- 1- DC voltmeter, 0-5 volts, 20000 Ohms/volt
- 1- RF wattmeter, Bird model 43, or equivalent, arranged to measure 25 watts in the frequency range 134-174 MHz
- 1- Spectrum analyzer capable of measuring in the frequency range 110-550 MHz and having a dynamic range of 60dB
- 1- 50 Ohm resistive dummy load having a power rating of at least 25 watts

1. Remove the four mounting screws holding the enclosure top cover and remove the cover to gain access to the two transmitter

circuit boards.

2. Connect the transmitter through an RF wattmeter to a dummy load.

3. Connect a +18 volt power source to terminal TB1 and a +24 volt power source through a 0-5 Ampere current meter to terminal TB3.

4. Connect the DC voltmeter to the junction of resistor R101 and capacitor C117 on the power amplifier circuit board and adjust potentiometer R103 to obtain a voltage of 3.0 volts.

5. Allow a period of two-minutes for the crystal heater temperature to stabilize.

6. Connect a +12 volt source through a 0-1 Ampere current meter to terminal TB2.

7. Connect a 0-5 VDC meter to test point TP1 and adjust inductors L1 and L2 to obtain a maximum indication on the meter.

8. Move the 0-5 VDC meter to test point TP2 and adjust inductors L3 and L4 to obtain a maximum indication on the meter. Disconnect the meter from TP2.

9. Rotate potentiometer R34 to maximum its maximum clockwise position.

10. Adjust inductors L5, L6, and L7 to obtain a maximum indication on the current meter connected to TB2.

11. Adjust capacitors C45, C48, and C49 to obtain a maximum indication on the current meter connected to terminal TB2. The current indicated on the meter should not exceed 400 mA. If the current exceeds 400 mA rotate potentiometer R34 to reduce the current to 400 mA.

12. Adjust capacitors C101 and C102 to obtain an indication of approximately 500 mA on the current meter connected to terminal TB3.

13. Adjust capacitors C104 and C105 to obtain maximum power output as indicated on the wattmeter.

14. Re-adjust capacitors C101 and C102 to obtain maximum power output as indicated on the wattmeter.

15. Retune capacitors C104 and C105 to obtain maximum amplifier efficiency. This adjustment is made by simultaneously observing the wattmeter and the current meter connected to terminal TB3 and adjusting for maximum power output with minimum current input.

16. Loosely couple a link from the spectrum analyzer to the

transmitter amplifier and verify that the second and third harmonic signals are at least 60dB below the fundamental output signal.

17. Rotate potentiometer R31 as necessary to obtain a power output of 15, 20, or 25 watts in accordance with the licensed authorization.

18. This completes the transmitter alignment. Proceed to set the transmitter deviation and frequency as described below.

TYPICAL OPERATING CHARACTERISTICS

When adjusted in accordance with the alignment procedure given above, the transmitter operating parameters should be approximately as follows:

Power Output (watts)	Exciter Current (mA)	Amplifier Current (A)	Efficiency (%)
15	225	1.0	62
20	310	1.4	60
25	400	1.7	61

MODULATION LEVEL ADJUSTMENT

The deviation level is adjusted prior to shipment; however it is suggested that the level be checked upon initial installation of the unit and periodically thereafter as necessary to compensate for normal component ageing.

Test equipment required:

1- Audio oscillator capable of providing a 1 Khz output at a level of 70 mv rms.
1- Modulation meter, Wavetek model 4200, or equivalent
1- 50 Ohm resistive dummy load having a 25 watt, or greater, power rating

1. Remove the four screws holding the transmitter top cover and remove the top cover.

2. Connect the transmitter output the dummy load and apply power to transmitter input terminals TB1 (+18V), TB2 (+12V), TB3 (+24V). Allow about 2-minutes for component temperature

stabilization.

3. Connect the audio oscillator to transmitter input terminals TB4 (high) and TB5 (low). Adjust the oscillator to provide 70 mv rms at a frequency of 1 KHz.

4. Adjust DEVIATION ADJ (potentiometer R8 on the exciter board) to obtain a 4.5 KHz peak deviation with the polarity which gives the highest reading as indicated on the modulation meter.

5. Verify that the peak deviation level of the opposite polarity is greater than 4.0 KHz.

6. This completes the modulation level adjustment. If no other adjustments are required then replace the unit top cover and secure the cover with screws.

FREQUENCY ADJUSTMENT

Tranmsitter frequency is adjusted prior to shipment; however, it is suggested that the frequency accuracy be checked upon initial adjustment and periodically thereafter to compensate for normal component ageing.

Equipment needed:

1- 50 Ohm resistive dummy load having a power rating of at least 25 watts
1- Frequency counter having an accuracy better than 2 ppm and capable of measuring to 200 MHz

1. Remove the four screws holding the unit top cover and remove the top cover.

2. Connect the transmitter output to the dummy load and apply power to terminals TB1 (+18V), TB2 (+12V), and TB3 (+24V).

3. Wait at least 2-minutes for the crystal heater and other circuit components to temperature stabilize.

4. Loosely couple a link from the frequency counter to the transmitter output circuit. Adjust capacitor C16 on the exciter circuit board to set the transmitter frequency.

5. This completes the frequency adjustment. If no other adjustments are to be made replace the unit top cover and secure with screws.

CRYSTAL REPLACEMENT

The MT4-V1 is shipped from the factory with the frequency controlling crystal unit installed and with the unit tuned to frequency. If the ooperating frequency of the transmitter is to be changed or if the crystal unit must be replaced the procedure given below should be followed. Replacement crystal units should conform to the following specification:

Crystal Frequency = (Operating frequency)/12

Crystal Mode: Series resonant, 22 pf load capacity

Grade: High Accuracy, 60 degree C turnover

Holder: HC/25-u

CRYSTAL REPLACEMENT

Caution: Soldering and unsoldering should be done using a fine pointed, temperature controlled soldering iron. DO NOT use a soldering gun or iron greater than 50 watts as this may cause damage to the circuit board. De-soldering should be done with the aid of a wick or desoldering tool. Apply the minimum heat necessary and do not exert excessive pressure on the components being removed.

1. Disconnect all power from the unit.
2. Remove the four screws holding the unit top cover and remove the cover.
3. Remove the four screws holding the exciter circuit board and carefully lift the circuit board to gain access to the foil side of the board.
4. Locate the crystal heater unit and observe the orientation of the unit. Unsolder the two wire leads holding the heater unit to the circuit board and remove the heater.
5. Unsolder the two wire leads holding the crystal unit to the circuit board and remove the crystal unit.
6. Solder the new crystal unit in place, and then solder the crystal heater in place. Be sure to position the crystal heater in its original orientation.
7. If crystal replacement is being done to change the transmitter frequency it may be necessary to change certain

capacitors in the exciter multiplier stages to allow proper tuning. Appropriate values for these frequency sensitive components is given in the table below.

8. Replace the exciter circuit board into the enclosure and secure it in place with screws.

9. This completes the crystal unit replacement. Follow the procedure given above for setting the transmitter frequency.

FREQUENCY DEPENDENT COMPONENTS

Certain capacitors in the exciter multiplier stages have values which are selected to provide proper tuning of the stages in different frequency sub-bands. If the transmitter frequency is to be changed to a different sub-band the capacitors should be changed to correspond to the following capacitance values (in pf):

Capacitor	Frequency sub-band in MHz	
	132-150	150-174
C23	62	47
C25	62	47
C28	20	15
C30	20	
15		
C34	1	1
C37	22	22
C39	12	12
C40	22	22

TROUBLE SHOOTING

Voltage readings given in the following table are intended as an aid for troubleshooting. Actual voltage reading may vary 15% from values given in the table. Meaurements should be taken with the transmitter operating (key down) into a dummy load and with a 90 mv rms, 1 KHz signal applied to the audio input.

Test equipment needed for trouble shooting:

DC voltmeter 0-25 volts, 20000 Ohms/volt
AC voltmeter or oscilloscope
RF voltmeter
50 Ohm resistive dummy load having a power rating of at least 25 watts

Circuit Location	DC Voltage
Q2 Emitter	0.9 V
Q3 Emitter	2.0 V
TP 1	1.0 V
TP 2	1.6 V

Circuit Description

The receiver RF input circuit consists of seven high-Q helical resonators (H1-H7), two amplifier transistors (Q1, Q2) and associated components. The gain of this circuitry at the RF input frequency is nominally 20 dB. Superior intermodulation performance is obtained by passing input signals through two helical resonators (H1, H2) to reject out-of-band energy before amplification. Both amplifier transistors use high bias current for maximum overload capability and minimum distortion. Feedback is used to stailize amplifier operation against temperature variations, and two sections of power supply decoupling per stage further insure stable operaion. The RF circuit output connects to the input of double balanced mixer SBL-1.

Mixer injection voltage is generated by oscillator and multiplier stages consisting of transistors Q3 through Q6 and associated components. Q3 fucntions as a fundamental frequency oscillator at a frequency determined by crystals Y1 through Y4. In single frequency receivers, diode CR2 is replaced by a strap to cause crystal Y2 to be selected as the frequency determining element. Y2 may be enclosed by an optional proportional crystal oven in applications at UHF frequencies where the receiver is subject to wide temperature variations. In multi-frequency receivers, oscillator frequency is determined by providing a ground on terminal E5, E8, E11, or E14 to select the associated crystal. The multiplication ratios of Q4 through Q6 depend upon the frequency range of the receiver as follows:

Frequency Range in MHz	Multiplier Q4	Q5	Q6
136 - 151	Doubler	Amplifier	Not used
151 - 174	Tripler	Amplifier	Not used
216 - 250	Doubler	Doubler	Not used
420 - 512	Doubler	Doubler	Doubler

High frequency crystal are used in the MR4 receiver to minimize the number of possible image frequencies by reducing the total multiplication ratio needed to obtain the required injection frequency. To further reduce image levels, double-tuned filters are used between all multiplier stages.

The double balanced mixer output is fed to the high-IF amplifier section which consists of two transistors (Q7, Q8), eight crystal filter sections, and associated components ('B' version command receivers use four filter sections.) The high-IF operates at a frequency of 21.4 MHz. Both amplifier stage outputs include broadly

tuned resonant circuits (L24, C60 and L27, C66 respectively) to reject signals at frequencies beyond the skirts of the ceramic filters. Generous feedback and decoupling desensitize the amplifiers to temperature and power supply effects.

Conversion from high to low IF frequencies, amplification at the low IF frequency, limiting, and detection is done by integrated circuit U1 (squelch circuitry in U1 is not used). Frequency conversion is controlled by crystal Y5 which operates in conjuction with oscillator circuitry contained in U1. Four pole ceramic filter FL-9 operates at the low IF frequency of 455 KHz to provide additional filtering. Seven amplifier stages contained in U1 provide excellent limiting before detection. Detection is done by discriminator circuitry contained in U1 operating in conjunction with coil L28.

Wideband demodulated audio from U1 is detected by diodes CR5 and CR6 to provide the primary voltage reference for squelch operation. This detected voltage is fed to a Schmitt trigger circuit consisting of transistors Q15 and Q16. Hysteresis in the Schmitt trigger produces positive squelch action by requiring a change of about 6 dB in noise level before receiver audio is switched from off to on. The detected reference voltage is applied to the Schmitt trigger through squelch control R84 (R84 is external to the MR4.) Action of the Schmitt trigger can also be controlled by an external CTCSS decoder to disable receiver audio when no CTCSS signal is present. In applications where CTCSS operation in used, the CTCSS decoder output connects to terminal E33 to contol Schmitt trigger operation.

Squelch operation is further enhanced in the MR4 by automatically adjusting the squelch threshold in accordance with received signal level. Received signal at the low IF frequency is amplified by linear amplifier U2. detected by CR13/ CR14, level shifted by U3A, and fed to fast/slow squelch switch transistor Q14. When weak signals, less than 1 uV, are applied to the receiver transistor Q14 is turned on and applies a ground at terminal E30 to produce normal squelch action. When strong signals, greater than 1 uV, are applied to the receiver transistor Q14 is switched off. With Q14 turned off the reference voltage at the Schmitt trigger input is increased causing the squelch to be 'tightened.' 'Tightening' the squelch causes faster operation in response to signal changes and virtually eliminates squelch tail noise. Thus, the MR4 provides high squelch sensitivity to weak signals and noise-free operation for strong signals.

Output from the Schmitt trigger gates the audio output of U1. When a received signal is present audio from U1 is passed to amplifier U3C. Line audio is taken from the output of U3C at terminal E22. Audio from U3C is also routed to power amplifier U4 for driving a local speaker.

Metering circuits are provided to monitor signal strength, discriminator centering, and received signal peak deviation (Metering is not provided in version 'B' command receivers). All metering circuits are designed to drive 0-1 mA, 2200 Ohm panel meters. Signal strength metering is available at terminal E27 which is driven by DC amplifier transistor Q13. The signal strength meter indication is

calibrated using potentiometer R66. DC amplifier transistor Q11 drives terminal E20 to provide discriminator metering. Potentimeter R54 allows the discriminator meter to be set to mid-scale when registering an on-frequency signal. The discriminator meter negative terminal should be returned to ground through two series connected diodes. Diodes CR7 and CR8 are provided external to the receiver module for this purpose when the MR4 is factory installed in a repeater or rack panel. Audio is amplified, rectified by CR)/ CR10, and level shifted by Q12 to drive peak deivation metering outut terminal E26. Metering calibration is done using poteniometer R64.

Switched outputs indicating the presence of received signal are available from Q9 or Q10. .Q10 provides a ground at terminal E16 when received signal is present and an open when no signal is present. An inverted output can be obtained by connecting a strap from terminal E16 to terminal E17 and taking the output from terminal E15.

Installation

The following describes connections which may be made to MR4 receivers furnished in modular form. Receivers furnished in repeaters are completely connected and require no field installation.

1. Connect to receiver terminals E34 (positive) and E35 (ground) from a DC power source having the following characteristics:

Nominal voltage	12 VDC
Regulation	+/- 5%
Ripple	< 100 mV
Current	250 mA

CAUTION: The MR4 uses negative ground and must be powered from a negative ground or floating power supply. DO NOT connect a positive ground power source to the receiver.

2. To obtain a fixed-level audio output (line audio) connect to terminals E22 (signal) and E23 (ground). This output provides a level of approximately 0.4 vrms and a source impedance of 1000 Ohms. Shielded wire should be used for making this connection.

3. To obtain power amplifier audio output for driving a loudspeaker connect to terminals E24 (signal) and E25 (ground). This output provides a fixed level of approximately 3 vrms. An external 100 Ohm potentiometer may be connected between this output and the loudspeaker, as shown in the receiver schematic drawing, to adjust loudspeaker volume.

4. Connect a strap from terminal E28 to terminal E29. (Input terminal E28 is used for remote squelch control in repeater

applications and is not normally used in other applications.)

5. Connect a 50 KOhm potentiometer to terminals E30, E31, and E32 as shown in the receiver schematic diagram. This potentiometer is used for setting the receiver squelch threshold. Shielded wire should be used for making these connections.

6. To obtain a logic output signal indicating the presence of received signal connect to terminal E16. Output E16 provided a ground when received signal is present and an open when no received signal is present.

If an inverted logic signal is desired, connect a strap from terminal E16 to terminal E17 and take the output from terminal E15. Terminal E15 provides a open when received signal is present and a ground when no received signal is present.

7. If CTCSS operation is to be used, connect from terminals E18 (signal) and E19 (ground) to the CTCSS decoder input. Connect from the CTCSS decoder output to terminal E33. The logic signal connected to terminal E33 should provide a ground when a CTCSS signal is detected by the decoder and an open when no CTCSS signal is detected.

8. If metering is to be used, connect 0-1 mA meters having internal resistances of 2200 Ohms to the following terminals:

	Meter + Terminal	Meter - Terminal
Signal Strength	E27	Ground
Peak Deviation	E26	Ground
Discriminator	E20	Ground through series connected diodes

Adjust the signal strength meter by applying a strong (10,000 uV) signal to the receiver input and setting potentiometer R66 until compression begins (further rotation of the potentiometer causes no further change in the meter indication).

Set the discriminator meter by applying an on freqency signal to the receiver and adjusting potentiometer R54 for a center scale meter reading.

Set the peak deviation meter by applying a signal having 5KHz deviation to the receiver and adjusting potentiometer R64 for a center scale reading. Meter indication is directly proportional to deviation, i.e. 0.5 mA meter indication corresponds to 5 KHz deivation.

Alignment

All MR4 receivers are factory aligned prior to shipment and require no initial alignment. The information given below is intended to aid readjustment following component replacement; it is not a step-by-step alignment procedure. Perform only the adjustments pertaining to the receiver section having the replaced component.

1. The RF section may be aligned by applying a signal to the receiver input and connecting a selective RF monitor to terminal E1. Adjust helical resonator capacitors and coupling capacitors C4 and C15 to obtain a maximum indication on the monitor. Some interaction will be found between resonator H2 and capacitor C4 and between resonator H6 and capactior C15 so these adjustments should be repeated as necessary until no further increase in gain is obtained.

As adjustments are made, reduce the applied signal level to avoid saturating the amplifier transistors or the RF meter. When properly aligned the RF section will exhibit a gain of approximately 20 dB.

2. IF amplifier resonant circuits have a low Q so inductors L24 and L27 should not require adjustment in the field. The IF frequency can be set by loosely coupling a frequency counter to U1 terminal 1 and adjusting C107 to obtain a reading of 21.855 MHz.

3. The discriminator may be adjusted by applying an on-frequency, deviated signal to the receiver input and adjusting L28 for maximum output audio. The adjustment of L28 is not critical and will be found to have a broad maximum.

4. Receiver frequency may be set by applying an on-frequency signal to the receiver and adjusting capacitor C24 to obtain a center scale reading on the discriminator meter. In multi-frequency receivers, apply a ground to terminals E14, E11, E5, and E8 in turn to select the appropriate crystal and sdjust capacitors C28, C26, C22, and C24 respectively.

5. Multiplier stages may be adjusted by connecting a selective RF monitor to test point TP4 and adjusting the tuning components (inductors and capactiors) for a maximum indication on the monitor. When the multipliers are operating properly, the injection voltage at TP4 should be greater than 300 mv.

MR4 Receiver Parts List-1
Rev A

CAPACITORS

C 1	Part of Helical Resonator
C 2	Part of Helical Resonator
C 3	Part of Helical Resonator
C 4	5-25 pf Trim Cap
C 5	.001 Disc
C 6	.001 Disc
C 7	.001 Disc
C 8	.001 Disc
C 9	Part of Helical Resonator
C 10	Part of Helical Resonator
C 11	Part of Helical Resonator
C 12	Part of Helical Resonator
C 13	Part of Helical Resonator
C 14	Part of Helical Resonator
C 15	5-25 pf Trim Cap
C 16	.001 Disc
C 17	.001 Disc
C 18	.001 Disc
C 19	.001 Disc
C 20	Part of Helical Resonator
C 21	.001 Disc
C 22	5-25 pf Trim Cap
C 23	.001 Disc
C 24	5-25 pf Trim Cap
C 25	.001 Disc
C 26	5-25 pf Trim Cap
C 27	.001 Disc
C 28	5-25 pf Trim Cap
C 29	.001 Disc
C 30	100 pf Siver Mica
C 31	4.7Mfd 16v.
C 32	.01 Disc
C 33	F.S. 8 pf SM (135-174 Mhz) 8 pf SM (420-512 Mhz) 12 pf SM (216-250 MHZ)
C 34	F.S. 56 pf NPO (135-151 MHz) 47 pf NPO (151-158 MHz) 36 pf NPO (158-174 MHz) 39 pf NPO (215-250 MHz) 20 pf NPO (420-512 MHz)
C 35	.001 Disc
C 36	.001 Disc
C 37	F.S. 1 pf tubular
C 38	F.S 10 pf NPO (135-151 MHz) 12 pf NPO (151-158 MHz)

RESISTORS

R 1	1K
R 2	1.8K
R 3	220 Ohm with F.Bead
R 4	100 Ohm
R 5	1K
R 6	1.8K
R 7	220 ohm with F.Bead
R 8	100 Ohm
R 9	10K *
R 10	10K *
R 11	10K *
R 12	10K *
R 13	15K
R 14	3.3K
R 15	220 Ohm
R 16	39 Ohm with F.Bead
R 17	1.5K
R 18	6.8K
R 19	1.8K
R 20	220 Ohm
R 21	47 Ohm with F.Bead
R 22	6.8K
R 23	1.8K
R 24	220 Ohm
R 25	47 Ohm with F Bead
R 26	6.8K
R 27	1.8K
R 28	220 Ohm
R 29	47 Ohm with F. Bead
R 30	1K
R 31	2.7K
R 32	1K
R 33	47 Ohm with F. Bead
R 34	75 Ohm
R 35	2K
R 36	2K
R 37	47 Ohm With F. Bead
R 38	1K
R 39	2.7K
R 40	1 K
R 41	75 Ohm
R 42	2.2K
R 43	100K
R 44	4.7K
R 45	1K
R 46	47K
R 47	4.7K
R 48	390K

MR4 Receiver Parts List-2
Rev A3

CAPACTORS

	10 pf NPO (158-250 MHz)
	15 pf NPO (420-512 MHz)
C 39	F.S.
	10pf NPO (135-151 MHz)
	10 pf NPO (151-158 MHz)
	8 pf NPO (158-174 MHz)
	12 pf NPO (215-512 MHz)
C 40	1 pf (5 pf 220 Mhz only)
C 41	.001 Disc
C 42	.01 Disc
C 43	F.S. 1 pf tubular
C 44	F.S.
	22 pf (135-151Mhz)
	(151-158Mhz)
	(158-174Mhz)
	(215-250Mhz
	(420-512Mhz)
C 45	6.8 NPO Disc
C 46	F.S. 1 pf
C 47	.001 Disc
C 48	.01 Disc **
C 49	3-15 pf Trim Cap **
C 50	1 pf tubular
C 51	3-15 pf Trim Cap **
C 52	3-15 pf Trim Cap **
C 53	3-15 pf Trim Cap **
C 54	1 pf tubular **
C 55	33 pf NPO
C 56	10 pf NPO
C 57	27 pf NPO
C 58	.01 Disc
C 59	.01 Disc
C 60	33 pf NPO
C 61	.01 Disc
C 62	10 pf NPO
C 63	.01 Disc
C 64	.01 Disc
C 65	.001 Disc
C 66	33 pf NPO
C 67	.01 Disc
C 68	100 pf S.M.
C 69	17 pf S.M.
C 70	.01 Disc
C 71	100 pf NPO
C 72	.1 Disc
C 73	.1 Disc
C 74	100 pf S.M.
C 75	100 pf NPO

RESISTORS

R 49	10K
R 50	20K
R 51	7.5K
R 52	4.7K
R 53	390 Ohm
R 54	10K Pot
R 55	20K
R 56	47K
R 57	20K
R 58	1K
R 59	200K
R 60	39 K F.S.
R 61	470K
R 62	1 Meg
R 63	470K
R 64	10K Pot
R 65	1 Meg
R 66	5k Pot
R 67	22 Meg
R 68	150 Ohm with F. Bead
R 69	22 Meg
R 70	3.9K
R 71	2.2K
R 72	470K
R 73	10K
R 74	1 Meg
R 75	10K
R 76	20K
R 77	4.7K
R 78	100K
R 79	10K
R 80	10K
R 81	10K
R 82	150 Ohm
R 83	3.9K
R 84	50K pot (Squelch)

SEMI-CONDUCTOR DEVICES

Q 1	MRF 901

C 76	100 pf NPO
C 77	4.7 Mfd 16 v.
C 78	4.7 MFD 16v.
C 79	.047 Mylar
C 80	.01 Mylar
C 81	2.2 MFD
C 82	2.2 MFD 16v.
C 83	4.7 MFD 16v.
C 84	220 MFD 35v.
C 85	.1
C 86	33 MFD 35v.
C 87	.1 MFD Disc
C 88	220 MFD 35v.
C 89	.1 MFD Disc
C 90	.1 MFD Disc
C 91	.1 MFD Disc.
C 92	100 pf NPO
C 93	100 pf NPO
C 94	4.7 MFD 16v.
C 95	100 pf NPO
C 96	100 pf NPO
C 97	2.2 MFD 16v.
C 98	.1 MFD Disc
C 99	.1 MFD Disc
C 100	.1 MFD Disc
C 101	.1 MFD Disc
C 102	2.2 MFD 16v.
C 103	33 MFD 35v.
C 104	.1 MFD Disc
C 105	.01 Mylar
C 106	
C 107	5-25 pf Trim Cap

CRYSTALS and FILTERS

Y1-Y4

136-151 Fx=(F0-21.4Mhz)/2
151-174 Fx=(Fo-21.4Mhz)/3
216-250 Fx=(Fo-21.4Mhz)/4
420-512 Fx=(
Parallel resonant,third overtone,resistance 30 Ohm max 12 pf load capacity,HC-25/U case

Q 2	MRF 901
Q 3	2N4123
Q 4	2N3563
Q 5	2N3563
Q 6	2N5179
Q 7	2N3563
Q 8	2N3563
Q 9	2N4123
Q 10	2N4123
Q 11	2N4123
Q 12	2N4123
Q 13	2N4123
Q 14	2N4123
Q 15	2N4123
Q 16	2N4123
U 1	MC 3359
U 2	CD4007
U 3	LM3900
U 4	LM380
U 5	7808
CR 1	1N1448 *
CR 2	1N1448 *
CR 3	1N1448 *
CR 4	1N1448 *
CR 5-14	1N1448

COILS and INDUCTORS

L1	Part of Hel.Resonator
L2	Part of Hel.Resonator
L3	Part of Hel.Resonator
L4	6T2518 (135-174 Mhz)
L5	Part of Hel.Resonator
L6	Part of Hel.Resonator
L7	Part of Hel.Resonator
L8	Part of Hel.Rersonator
L9	Part of Hel.Resonator
L10	6T2528 (135-174 Mhz) 5T2518 (216-250 Mhz)
L11	5T2518
L12	Part of Hel.Resonator
L13	Part Hel.Resonator