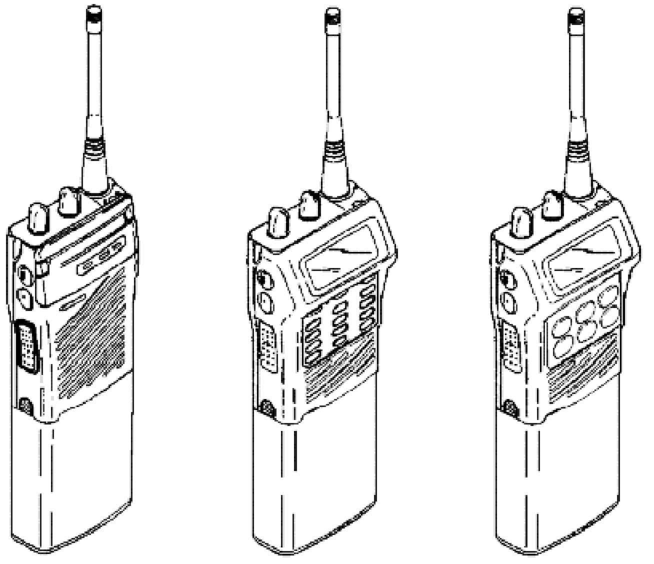
SECURITY POLICY
FOR THE
M-RK I AND M-RK II SYSTEM/SCAN (AEGIS/DES)
HANDHELD PERSONAL PORTABLE
TWO-WAY FM RADIO



MRK I

M-RK II
SYSTEM/SCAN

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1. Introduction

The M-RK II System/Scan *(AEGIS)* and M-RK I handheld personal portable two-way FM radio is a high-quality, high performance FM radio. The radio is synthesized and operates in both trunked *(Ericsson EDACS™)* and conventional communications systems. The trunked mode allows selection of either a communications group or an individual radio within a system. Both the selected group and the individual radio are secured through AEGIS digital signaling and DES encryption.

Trunked operation is where a set of radio frequency channels is used by multiple user groups. By using high speed digital data, the radio goes to an unused channel when a call is initiated and will only respond to calls in the same user group. In this way, conversation privacy between user groups is assured. This operation is very similar to a cellular phone call.

A conventional mode of operation is communicating on radio channels allocated for conventional use. Conventional use or operation is where a radio channel *(transmit/receive)* is allocated for conventional (non-trunked) use and may be manually selected by the operator. The user selects a channel and directly communicates on that channel. A channel is a transmit/receive radio frequency pair. Think of this mode as “Walkie-Talkie” mode.

A trunked group consists of several users with a common group identification *(GID)*. A radio may have several groups but the selected group determines whom the unit can call at any specific time. In trunked mode, a set of groups that communicate on a set of channels is called a system. In the conventional mode, a system is a set of channels. A system may consist of all trunking groups and channels, all conventional channels, or a mixture of both.

2. Scope

This document will define the security policy for the M-RK II System/Scan and M-RK I radio. This policy will define the cryptographic module, crypto-officer roles, user roles, and key management functions.

3. Module Description

The M-RK DES radio can be divided into three main modules; User, Crypto-Officer, and Processing. These are described in the following sections.

3.1. Module Interfaces

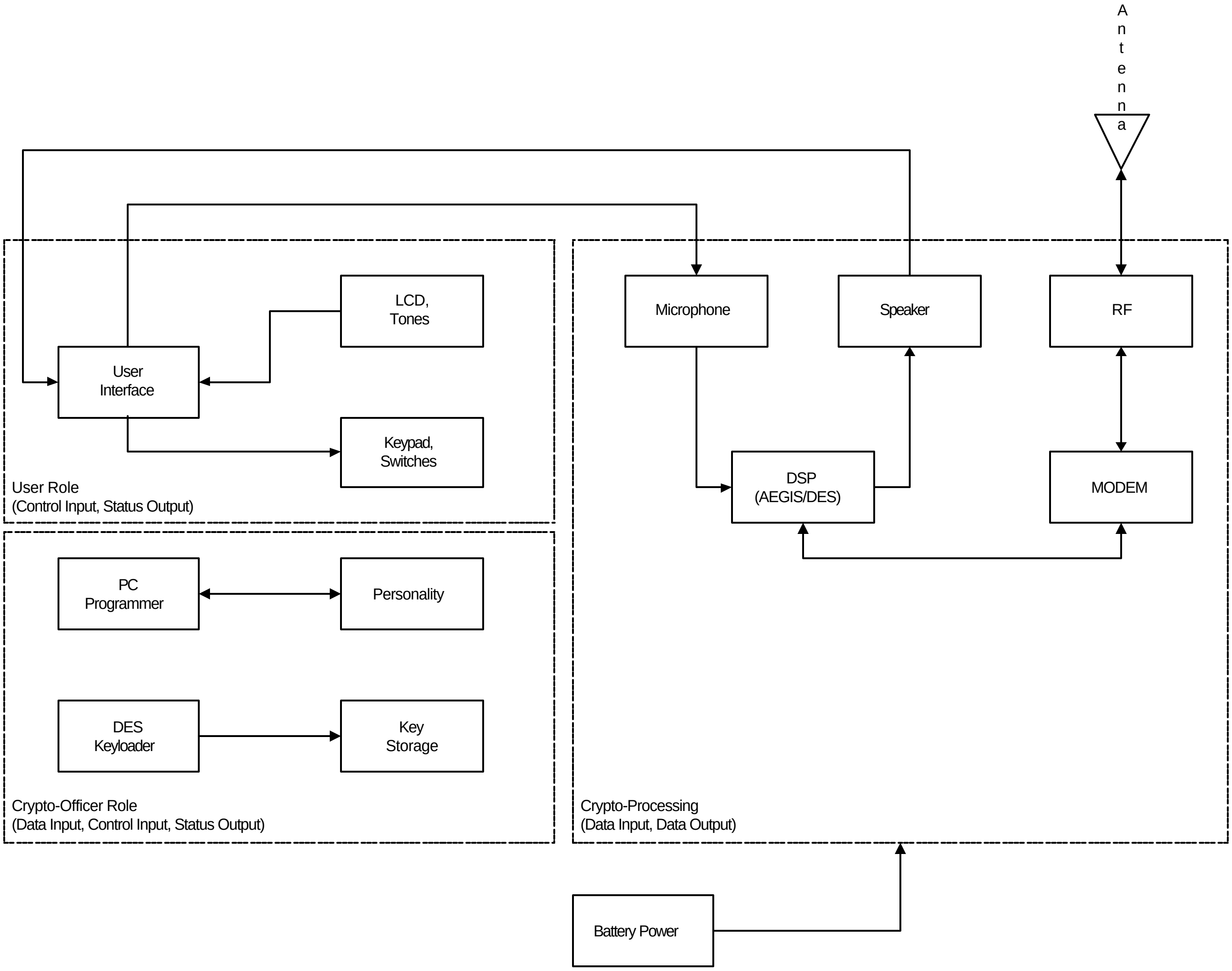

Figure 1 M-RK (AEGIS/DES) Radio Modules

3.2. Module Components

The User Role represents the user operating the radio. The user can input control data via the keypad and associated keys and switches. Status Output information is provided to the user by viewing the LCD, LED, and/or listening to the alert tones. This module is connected to the Processing module by the microphone and speaker. The user speaks into the microphone and listens to received speech from the speaker.

The Crypto-Officer Role allows the crypto-officer the ability to configure the radio's operation. The crypto-officer can input or output personality information using a PC. The personality configures the radio by specifying items such as trunked channels, conventional channels, DES talkgroups, clear talkgroups, etc. The crypto-officer can enter the DES encryption keys into the radio using a DES keyloader. These keys are scrambled and hidden into the radio's EEPROM memory. The crypto-officer can't read the keys out for security purposes. Status Output information is provided to the crypto-officer by viewing the LCD, LED, and/or listening to the alert tones.

The Crypto-Processing module represents the crypto-processing portion of the radio. This module samples speech from the microphone and digitizes it for processing. The DSP converts the speech to digital using the AEGIS algorithm. It then encrypts the AEGIS speech using the DES algorithm. The digital data is passed to the modem for transmission over an EDACS network or conventional system. Similarly, the reverse process receives a data transmission and passes the digital data to the modem. The DSP decrypts the DES speech into AEGIS speech and then converts it to an analog waveform to be played out the speaker. All of the DSP processing is performed in software.

4. Software/Firmware Capabilities

The M-RK contains numerous firmware and software components. All of the associated hardware can be found on the schematics.

4.1. Radio Control Processor (RCP)

The RCP S/W is the main M-RK S/W that resides both in ROM and FLASH memory. This S/W controls the entire operation of the radio. It is the master while all other S/W components are slaves. This S/W controls the User Interface, Transmitting and Receiving, Keyloading, Private Mode, Zeroizing Keys, and numerous other functions.

4.2. Interrupt Control Processor (ICP)

The ICP S/W is the slave S/W that responds to RCP commands. It controls such functions as read/write digital and analog I/O, serial port control, keyboard scanning, synthesizer loading, channel guard encode/decode, and UDC scanning. It is very low-level hardware control that notifies the RCP via interrupts whenever something happens. This S/W is not essential to the cryptographic module and its' operation.

4.3. AEGIS DSP (ADI)

The ADI S/W resides in the ADI DSP ROM and RCP FLASH memory. The FLASH portion is downloaded at power up to the ADI's RAM memory. This S/W, under the control of the RCP, performs A/D and D/A conversions on the user's voice for transmit and receive operations. The A/D and D/A conversion is performed using a proprietary algorithm known as AEGIS. Also, the ADI S/W executes the DES algorithm on the digital voice to encrypt or decrypt. It receives the encryption key from the RCP. The DES algorithm has already been certified and received FIPS approval.

4.4. Firmware

The ASIC (Modem), Audio Signal Processor (ASP), and Display Processor (DP) are considered firmware. The S/W in these devices is very low-level hardware control that is performed via latch, relay, and register reads and writes. This S/W is not essential to the cryptographic module and its' operation.

5. Roles & Services

There are two separate roles in the operation of the M-RK DES radio: Crypto-Officer and User. The M-RK DES radio can be used by anyone requiring secure two-way dispatch communications. This would include police officers, firemen, utility workers, etc. The group purchasing the radios would be the users and someone within the group would be designated as the technical liaison (Crypto-Officer). For example, the local police department buys 500 M-RK DES radios. The police would have a Crypto-Officer program all 500 radios and load the appropriate DES encryption keys. The radios would then be handed out to 500

Users. The Crypto-Officer may setup DES talkgroups for Undercover work, Narcotics, Traffic Control as well as a global DES talkgroup so everyone can communicate together.

5.1. Crypto-Officer Services

A Crypto-Officer can perform the following services:

Program Radio Personality
Program DES Encryption Keys

The M-RK DES Radio Personality is created on a PC using the program, *EDACS4* or *PC Programmer*. This personality contains numerous items including which talkgroups will be clear, AEGIS-clear, and AEGIS DES. It defines what encryption keys will be used on what systems and groups. Basically, it defines everything from the contrast settings to protocol timeouts. The personality can be read or written to the M-RK through the UDC connector.

The DES Encryption Keys are created and loaded into the radio using the DES Keyloader. This is a separate device that programs the keys into the M-RK's EEPROM through the UDC connector. The keys are 8 bytes long and must contain the correct parity. They can't be read out of the radio once they are programmed.

5.2. User Services

A User can perform the following services:

Transmit Conventional Clear/Private
Transmit EDACS Clear/Private
Zeroize Encryption Keys
Bypass Private Mode
Receive Conventional Clear/Private
Receive EDACS Clear/Private
Display Encryption Key Index

The User must first select the system they will be communicating on; conventional or EDACS trunked. Next, they select the talkgroup they will be communicating with. When a call on that group is received it will automatically be heard in the speaker. To transmit a call, the user presses PTT and speaks into the microphone. The communication will be in clear mode if the talkgroup is programmed for clear and the radio is in private mode. The communication will be in DES private mode if the talkgroup is programmed for private, the system is programmed for private, valid encryption keys for the system have been loaded, and the radio is in private mode.

Bypass Private Mode can be accomplished by the User by pressing the PVT button while in private mode. The PVT icon\LED will be turned off and an alert tone sounded. The radio personality has a lot to do with how this function works. Private Mode can be forced on which would negate bypass mode.

The user can Zeroize the encryption keys at anytime by pressing the two buttons on the side of the radio simultaneously. The user first hears a warning tone indicating the keys are about to be zeroized and then a solid tone is heard indicating the keys are now zero.

The user can Display the current encryption key index in use by the talkgroup and system on the M-RK II. The M-RK I assumes bank 1. The M-RK stores the DES encryption keys in banks. There are 8 banks possible with 7 keys per bank for a total of 56 DES keys that can be stored in the radio. The bank and key index are set via personality. For M-RK II, the user can display the current key index, 1-7, but not the actual key data.

5.3. Status Functions

Status information is displayed to both the Crypto-Officer and User via the LCD, LEDs, icons, and alert tones. The M-RK I has no display so it communicates status via LEDs and alert tones. The M-RK II communicates status via the LCD, which contains a 2x8 screen and icons along the border, and alert tones. Refer to the M-RK I and M-RK II User Manuals for details.

5.4. Key Management

As stated under the Crypto-Officer Role, the DES keys are loaded into the radio using a DES keyloader by the Crypto-Officer. The Crypto-Officer performs the following steps to load DES encryption keys:

- Connect the keyloader to the radio via the UDC connector and turn the radio on.
- The M-RK II will display KEYLOAD, BANK=1 on the LCD. Use the arrows keys to select bank 1-8. The M-RK I will assume BANK=1.
- The keyloader can transfer 1 key or all 7 keys to the selected bank.
- After the keys are loaded, disconnect the keyloader and radio will resume normal operation.

The keybanks provide additional security to the users. For example, the M-RK might be programmed with two EDACS trunked systems; EA and EB. EA could use bank 1 and EB could use bank 2. EA and EB are actually the same system on the same frequencies. The users could alternate between the two systems on a daily basis or permanently switch to EB if they felt EA was no longer secure.

The DES keys are 8 bytes long and are stored in EEPROM with a 2 byte CRC for a total length of 10 bytes per key. The keys are scrambled with a random pattern every time the keyloader is attached. This technique makes it very difficult to determine the exact location of the keys in EEPROM.

6. Secure Operation

6.1. AEGIS Clear, Digital, and DES Operation

Each system *(trunked or conventional)* is programmed for either AEGIS or Voice Guard (VG) communications. VG is an earlier generation algorithm that was replaced by AEGIS and will not be discussed in this document. AEGIS programmed systems have three different voice modes: clear *(analog)*, digital and private (*DES encrypted*). The voice modes are programmed on a per-group basis within each trunked system and on a per-channel basis within each conventional system.

6.1.1. Clear Mode

AEGIS clear mode is when the radio transmits and receives only clear *(analog)* voice signals. These analog signals are non-digitized and non-encrypted. Clear mode transmissions can be easily monitored by unauthorized persons. Groups or channels programmed for clear operation cannot transmit or receive AEGIS digital or private messages.

6.1.2. AEGIS Digital Mode

AEGIS Digital mode allows the radio to transmit and receive digitized voice signals. AEGIS digital signals provide improved weak signal performance and cannot be easily monitored with a standard receiver. Groups and channels programmed for AEGIS digital operation transmit only digital signals. Private calls cannot be received or transmitted when the radio is in the AEGIS digital mode because the radio does not know the cryptographic key used. Message trunked group calls and individual calls will be answered back on the mode they were received, assuming the call or hang time is still active. Individual, phone, broadcast, and emergency calls will be transmitted clear if digital mode is disabled or inoperative.

1. If receiving an analog message trunked call, the radio will respond in the analog mode during the hang time on the working channel.
2. If receiving an analog individual call (I-Call), the radio will respond in the analog mode during the hang time.

3. When using the “WHC” feature to respond to an I-Call (after the hang time has timed out), the call will be transmitted in the mode defined by the system mode as programmed for the current system if the ID being called is not in the I-Call list. If the ID is in the I-Call list, then the call will be transmitted as defined by the I-Call mode programmed in the list for that ID.

6.1.3. AEGIS Private Mode

AEGIS private mode allows the radio to transmit DES encrypted messages and receive clear or private transmissions. The radio will transmit private if the group/channel is programmed for private operation and forced operation is pre-programmed. If auto select operation was pre-programmed and the radio is in private mode, the radio will transmit in the mode of the received call if the hang time is active. If no hang time is active, the radio will transmit private.

DES Cryptographic keys are transferred to the radio using a DES Keyloader. Up to seven different cryptographic keys, numbered 1-7 can be transferred from a DES Keyloader and stored in the radio. An individual key is automatically selected on a per-group/channel basis according to the radio’s programming. Groups and channels within an AEGIS system can be programmed for keys 1-7. Up to 8 banks of 7 keys can be stored for Aegis DES systems and the bank is specified per system.

DES radios require a DES Keyloader (Option V4025 with software version 3.N or later). Keyloader cable 19B801971P18 is also required.

When operating on a group or channel programmed for private mode, all transmissions will be private transmissions and the radio will receive clear and private signals. For M-RK II, the PVT status flag in the display turns on when the private mode is enabled. For M-RK I, the OPT LED flashes Red. If the selected group or channel is programmed for autoselect capability, the mode may be toggled between private and clear with the PVT key. Radios programmed for forced private operation do not allow a change of the transmit mode.

6.1.4. Error Messages

The M-RK can generate errors at anytime. At radio power up, numerous tests are executed which can generate errors. During normal radio operation, error conditions are constantly checked. There are 2 types of error codes:

- Fatal errors - these errors will cause the radio to continuously reset and no operation is possible.
- Non-Fatal errors - these errors are indicated to the user but the radio will not reset. It will continue to operate.

The M-RK indicates to the user when an error has occurred by using the output device. For the M-RK II, an error message and code are displayed on the LCD. For the M-RK I, an error is indicated by the color of the OPT LED.

The errors are displayed on the radio as follows:

M-RK II:

message
ERR=xxxx

where xxx is the error code and message is one of the messages listed below

Error message	Description
HARDWARE	ROM errors
SOFTWARE	General software failure
TRACKING	Tracking data fatal error
NO LOCK	Synthesizer not locking

FREQDATA	Frequency data fatal error
PERSDATA	Personality errors
Non Fatal Errors	
UNKNOWN	
FEAT ERR	Feature encryption error
DSP ERR	DSP error

M-RK I:

- OPT LED is solid RED for fatal errors
- OPT LED flashes GREEN for non-fatal errors. It will flash the error code category. For example;

Error Code = 550, OPT LED flashes green 5 times to indicate a personality error code.

If either of the following error messages is indicated, the radio was either programmed incorrectly or needs servicing:

DSP ERR
ERR=XXXX

Power up only

DSP ERR

Run-Time

If the DSP H/W circuit is not responding, the following error message will be indicated and the radio needs servicing:

HARDWARE
ERR= 30