APPENDIX G: MANUAL

Please refer to the following pages.

Operator's Manual

MM101332V1 R1A

P7100^{IP}
System/Scan Portable Radios

tyco Electronics

MA-COM

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SAFETY TRAINING INFORMATION

The M/A-COM P7100^{PI} portable radio generates RF electromagnetic energy during transmit mode. This radio is designed for and classified as "Occupational Use Only," meaning it must be used only during the course of employment by individuals aware of the hazards and the ways to minimize such hazards. This radio is NOT intended for use by the "General Population" in an uncontrolled environment.

The P7100^{PI} portable radio has been tested and complies with the FCC RF exposure limits for "Occupational Use Only." In addition, this M/A-COM radio complies with the following Standards and Guidelines with regard to RF energy and electromagnetic energy levels and evaluation of such levels for exposure to humans:

- FCC OET Bulletin 65 Edition 97-01 Supplement C, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
- American National Standards Institute (C95.1 – 1992), IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
- American National Standards Institute (C95.3 – 1992), IEEE Recommended Practice for the Measurement of

Potentially Hazardous Electromagnetic Fields – RF and Microwave.

To ensure that exposure to RF electromagnetic energy is within the FCC allowable limits for occupational use, always adhere to the following guidelines:

- DO NOT operate the radio without a proper antenna attached, as this may damage the radio and may also cause the FCC RF exposure limits to be exceeded. A proper antenna is the antenna supplied with this radio by M/A-COM or an antenna specifically authorized by M/A-COM for use with this radio.
- DO NOT transmit for more than 50% of total radio use time ("50% duty cycle"). Transmitting more than 50% of the time can cause FCC RF exposure compliance requirements to be exceeded. The radio is transmitting when the "TX" indicator appears in the display. The radio will transmit by pressing the "PTT" button.
- ALWAYS use M/A-COM authorized accessories (antennas, batteries, belt clips, speaker/mics, etc). Use of unauthorized accessories may cause the FCC Occupational/Controlled Exposure RF compliance requirements to be exceeded.

- ALWAYS keep the device and its antenna at least 2 cm (0.8 inches) from the body and at least 5 cm (2 inches) from the face when transmitting to ensure FCC RF exposure compliance requirements are not exceeded. This radio has been tested for RF exposure compliance at the distances listed in Table 1. However, to provide the recipients of your transmission the best sound quality, hold the antenna at least 5 cm (2 inches) from mouth, and slightly off to one side.

Table 1: RF Exposure Compliance Testing Distances

Radio Frequency	**Tested Distances** *(worst case scenario)*	
	Body	**Face**
800 MHz	1.6 cm	2.5 cm
VHF (MHz)	1.1 cm	2.5 cm

The information listed above provides the information needed to make the user aware of a RF exposure, and what to do to assure that this radio operates within the FCC RF exposure limits of this radio.

ELECTROMAGNETIC INTERFERENCE/COMPATIBILITY

During transmissions, this M/A-COM radio generates RF energy that can possibly cause interference with other devices or systems. To avoid such interference, turn off

the radio in areas where signs are posted to do so. DO NOT operate the transmitter in areas that are sensitive to electromagnetic radiation such as hospitals, aircraft, and blasting sites.

OPERATING RULES AND REGULATIONS

Two-way FM radio systems must be operated in accordance with the rules and regulations of the Federal Communications Commission (FCC). As an operator of two-way radio equipment, you must be thoroughly familiar with the rules that apply to your particular type of radio operation. Following these rules will help eliminate confusion and will assure the most efficient use of existing radio channels. This will provide a smooth operating radio network.

When using the radio, remember these rules:

1. It is a violation of FCC rules to interrupt any distress or emergency message. As the radio operates in much the same way as a telephone "party line" when in conventional mode, always listen and/or observe the absence of the “busy” display (refer to Table 2 – Three Line Display for display character) to make sure that the line is clear before sending any messages. If someone is sending an emergency message, such as reporting a fire or asking for help in an accident, KEEP OFF THE AIR! Emergency calls have priority over all other messages.
2. Use of profane or obscene language is prohibited by Federal Law.
3. It is against the law to send false call letters or a false distress or emergency message.

4. The FCC requires that conversations be brief and confined to business. To save time, use coded messages whenever possible.

5. Using the radio to send personal messages (except in an emergency) is a violation of FCC rules. Send only those messages essential for the business operation.

6. It is against Federal Law to repeat or otherwise make known anything overheard on the radio. Conversations between others sharing your channel must be regarded as confidential.

OPERATING TIPS

Antenna location and condition are important when operating a portable radio. Operating the radio in low lying areas or terrain, under power lines or bridges, inside of a vehicle or in a metal or steel framed building can severely reduce the range of the unit. Mountains can also reduce the range of the unit.

In areas where transmission or reception is poor, some improvement may be obtained by ensuring that the antenna is vertical. Moving a few yards in another direction or moving to a higher elevation may also improve communications. Vehicular operation can be aided with the use of an externally mounted antenna.

Battery condition is another important factor in the trouble free operation of a portable radio. Always properly charge the batteries.

EFFICIENT RADIO OPERATION

Hold the portable radio approximately three inches from your mouth and speak into the microphone at a normal voice level.

Keep the antenna in a vertical position when receiving or transmitting a message.

Do not hold the antenna when receiving a message and, especially, do not hold when transmitting a message.

Do NOT hold onto the antenna when transmitting.

Antenna Care and Replacement

Always keep the antenna at least 0.8 inches (2 cm.) away from the body and 2 inches (5 cm.) from the face when transmitting to ensure FCC RF exposure compliance requirements are not exceeded.

Do not use the portable radio with a damaged or missing antenna. A minor burn may result if a damaged antenna comes into contact with the skin. Replace a damaged antenna immediately. A missing antenna could damage your portable radio.

Use only the supplied or approved antenna. Unauthorized antennas, modifications or attachments could damage the radio unit and may violate FCC regulations.

Electronic Devices

RF energy from your portable radio may affect some electronic equipment. Most modern electronic equipment in cars, hospitals, homes, etc. are shielded from RF energy. However, in areas that instruct you to turn off two-way radio equipment, always observe the rules. ***If in doubt, turn it off!***

Aircraft

Always turn off your portable radio before boarding any aircraft!

- Use it on the ground only with crew permission.
- DO NOT use while in-flight!!

Blasting Areas

To avoid interfering with blasting operations, turn your radio OFF when in a "blasting area" or in areas posted "turn off two-way radio." Remote control RF devices are used by some construction crews to set off explosives.

Potentially Explosive Atmospheres

Areas with potentially explosive atmosphere are often, but not always, clearly marked. These may be fueling areas, such as gas stations, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles, such as grain, dust or metal powders.

Sparks in such areas could cause an explosion or fire resulting in bodily injury or even death.

Turn OFF your radio when in any area with a potentially explosive atmosphere. It is rare, but not impossible that the radio or its accessories could generate sparks.

BATTERY DISPOSAL

The P7100^{IP} portable radios use rechargeable, recyclable Nickel Cadmium (NiCd) or Nickel Metal Hydride (NiMH) batteries.

NICKEL CADMIUM BATTERY PACK DISPOSAL

At the end of its useful life, under various state and local laws, it may be illegal to dispose of the Nickel Cadmium batteries into the municipal waste stream. Check with local solid waste officials for details of recycling options or proper disposal. Call Toll Free 1-800-8BATTERY for information and/or procedures for returning rechargeable batteries in your state.

NICKEL METAL HYDRIDE BATTERY PACK DISPOSAL

There are no special requirements concerning the disposal of NiMH batteries. Batteries can be recycled. Call Toll Free 1-800-8BATTERY for information.

SCOPE OF THIS MANUAL

This manual describes the basic functions and operation of the P7100^{IP} System/Scan portable radios. For additional information about the features and operation refer to the appropriate Maintenance Manual or contact the System Administrator.

WATER RESISTANCE

The P7100^{IP} portable radios operate reliably even under adverse conditions. These radios meet MIL-STD-810F specifications for driven rain, humidity, and salt fog.

USER INTERFACE

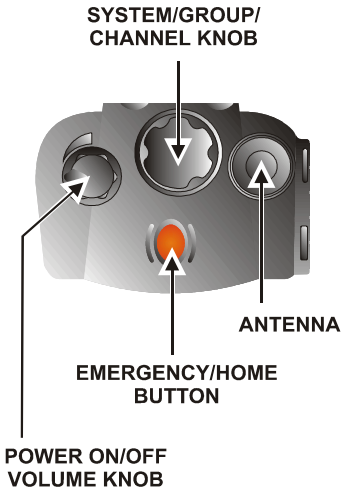

Figure 1 – Top View

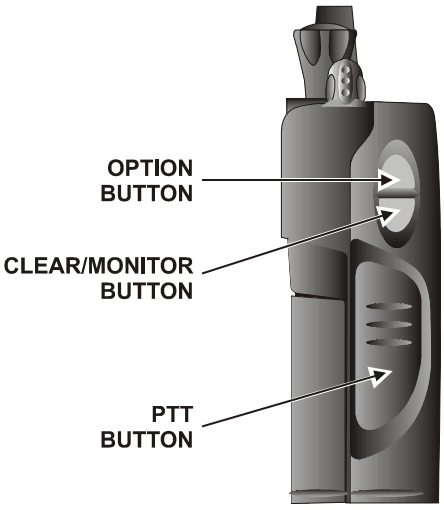

Figure 2 – Side View

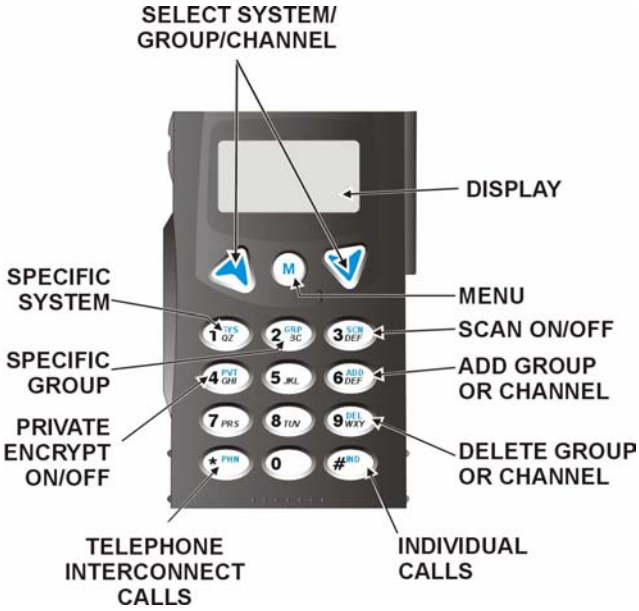

Figure 3 - System Keypad

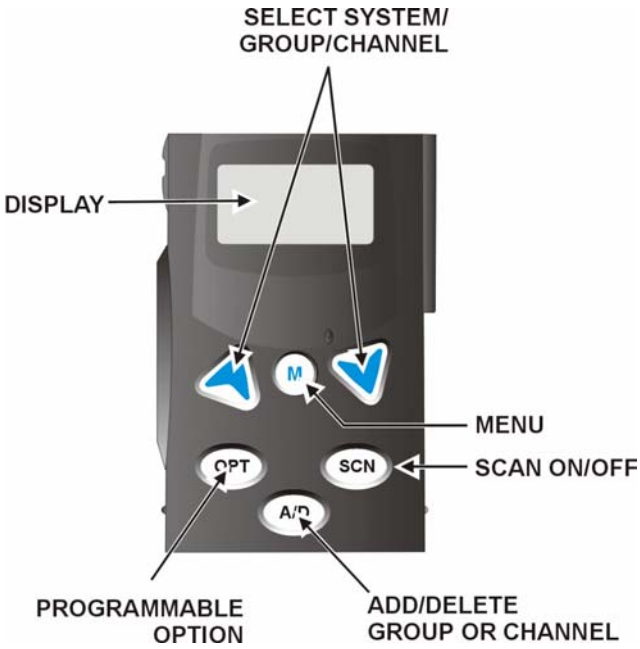

Figure 4 – Scan Keypad

Table 2 – Three Line Display

Icon Descriptions

 **Steady** – "Busy" transmitting or receiving **Flashing** – call queued	 **Steady** – special call mode (individual or telephone)
 **Steady** – during all radio transmissions	 **Steady** – transmit at low power **If icon is not visible** – transmit at high power
 **Steady** – low battery	 **Steady** – group or channel in scan list
 **Steady** – trunked system in **F**ailsoft mode	 **Steady** – priority 2 group or channel
 **Steady** – transmit in encrypt mode **Flashing** – receiving an encrypted call	**Steady** – priority 1 group or channel
 **Steady** – scan mode (*rotates clockwise*) **If icon is not visible** – scan disabled	 **Steady** – Channel Guard enabled **If icon is not visible** – Channel Guard disabled

STATUS MESSAGES

During radio operation, various radio status messages can be displayed. The messages are described below.

MESSAGE	NAME	DESCRIPTION
QUEUED	Call Queued	- Trunked mode only. Indicates the system has placed the call in a request queue.
SYS BUSY	System Busy	- Trunked mode only. Indicates the system is busy, no channels are currently available, the queue is full or an individual call is being attempted to a radio that is currently transmitting.
DENIED	Call Denied	- Trunked mode only. Indicates the radio or talkgroup is not authorized to operate on the selected system and/or talkgroup.
CC SCAN	Control Channel Scan	- Trunked mode only. Indicates the control channel is lost and the radio has entered the Control Channel Scan mode to search for the control channel. (Usually out of range indication.)

MESSAGE	NAME	DESCRIPTION
WA SCAN	Wide Area Scan	- Trunked mode only. Indicates the radio has entered the Wide Area Scan mode to search for a new system (if enabled through programming).
TALKARND	Talkaround	-Conventional mode only. Indicates the radio is operating on conventional channels in talkaround mode (no repeater).
SYSC ON	System Scan Features On	- Trunked mode only. Indicates the System Scan features are enabled.
SYSC OFF	System Scan Features Off	- Trunked mode only. Indicates the System Scan features are disabled.
LOW BATT	Low Battery	- Battery voltage has dropped below the point to where the radio is no longer able to transmit. The radio will still be able to receive calls until the battery is discharged beyond the point of operation upon which the radio will automatically shutdown.

MESSAGE	NAME	DESCRIPTION
RXEMER	Receive Emergency	- Trunked mode only. Indicates an emergency call is being received. This message will be flashing on line two.
TXEMER	Transmit Emergency	- Trunked mode only. Indicates an emergency call has been transmitted on this radio. This message will be flashing on line two.
VOL=31	Volume Level	- Indicates the current volume level. The volume level display ranges from OFF (silent) to 31 (loudest).
WHC	Who Has Called	- trunked mode only. Indicates an individual call has been received, but not responded to. The indicator turns OFF if the individual call mode is entered, the system is changed, or the radio is turned off and then back on.
UNKNOWN	Unknown ID	- Trunked mode only. Indicates an individual call is being received by an unknown radio ID.

BASIC OPERATION

SYSTEM SELECT – METHOD 1 (SYSTEM)

1. Press 1 SYS QZ to access system list.
2. Enter system ID number from keypad.
3. Press M to select desired system.

SYSTEM SELECT – METHOD 2

Rotate System/Group/Channel knob, or

If this knob is not programmed for systems, press the ◀ ▼ buttons to change systems.

GROUP SELECT – METHOD 1 (SYSTEM)

1. Press 2 GRP ABC to access group list.
2. Press ◀ ▼ to scroll through the list of groups.
3. Press M to select desired group.

GROUP SELECT – METHOD 2

1. Rotate System/Group/Channel knob.

If this knob is not programmed for groups:

2. Press the ◀ ▼ buttons to change groups.

CHANNEL SELECT

Rotate System/Group/Channel knob, or

If this knob is not programmed for channels, press the   buttons to change channels.

MODIFY SCAN LIST (SYSTEM)

1. Press 3 SCN DEF to toggle scan OFF and verify  is **not** displayed.
2. Select group or channel.
3. Press 9 DEL WXY once to remove group or channel from list.
4. Press 6 ADD DEF once to add as a normal group or channel.

   Press 6 ADD DEF twice to add as a Priority 2 group.

   Press 6 ADD DEF three times to add as a Priority 1 group.
5. Press 3 SCN DEF to re-start scanning.

NUISANCE DELETE (SYSTEM MODEL)

A channel can temporarily be deleted from the scan list if it is not the currently selected channel.

1. Turn Scan ON.
2. When the radio receives a call on the channel, press the 9 DEL WXY. The channel is removed from the scan list until the radio is power cycled.

MODIFY SCAN LIST (SCAN MODEL)

1. Press SCN to toggle scan OFF and verify  is **not** displayed.
2. Select group or channel.
3. Press A/D once to remove group or channel from the list.
4. Press A/D once to add as a normal group or channel.

   Press A/D twice to add as a Priority 2 group.

   Press A/D three times to add as a Priority 1 group.
5. Press SCN to re-start scanning.

BACKLIGHT ON/OFF

1. Press M to access the menu.
2. Press ◄ ▼ to scroll through menu until “BCKLGHT” appears.
3. Press M to select Backlight menu.
4. Press ◄ ▼ to toggle backlight ON and OFF.
5. Press M to select new backlight setting.

CONTRAST ADJUST

1. Press M to access the menu.
2. Press ◀ ▼ to scroll through menu until "CONTRAST" appears.
3. Press M to select Contrast menu.
4. Press ◀ ▼ to adjust contrast setting from 1 - 4.
5. Press M to select new contrast setting.

DECLARING AN EMERGENCY

1. Press and hold the red Emergency/Home button (the length of time is programmable; check with the system administrator).
2. ***TXEMER*** will flash in the display, plus  and  will be displayed. After 2-3 seconds the transmit icon  will turn off.
3. ***TXEMER*** and  will remain until the emergency is cleared.

4. Press the PTT and  will reappear.
5. Release PTT when the transmission is complete.

LOCKING/UNLOCKING KEYPAD

1. Press (M) button.
2. Within 1 second, press the Option button on the side of the radio.

ALERT TONES

Name	Tone	Description
Call Originate (B)	one short mid-pitched	*OK to talk after pressing the push-to-talk button*
Call Queued (T)	one high-pitched	*call in a queue for processing*
Autokey (T)	one mid-pitched	*queued call received channel assignment*
System Busy (T)	three low-pitched	*system busy or unable to complete call*
Call Denied (T)	one low-pitched	*radio is not authorized on the system or group*
Carrier Control Timer (B)	five high-pitched / one long low-pitched	*PTT depressed for maximum length of time*
Low Battery (B)	one low-pitched / one short mid-pitched	*low battery*
TX Low Battery Alert (B)	one low-pitched	*after PTT - battery too low to transmit*

(T) = trunked mode only (B) = both trunked and conventional modes

TRANSMITTING A CALL IN TRUNKED MODE

GROUP CALL

1. Select desired group.
2. Press Push-To-Talk button.
3. The  and  icons will appear.

INDIVIDUAL CALL (SYSTEM)

1. Press #IND to access the individual call list.
2. The  icon will appear.
3. Press ◄ ▼ to scroll through individual call list or Enter LID from keypad.
4. When the desired ID appears in the display press the Push-To-Talk button.
5. The  and  icons will appear.

PHONE CALL (SYSTEM)

1. Press * PHN to access the phone call list.
2. The  icon will appear.
3. Press ◄ ▼ to scroll through phone call list or Enter number from keypad.
4. When the desired phone number appears in the display press the Push-To-Talk button.
5. The  and  icons will appear.

RECEIVING A CALL IN TRUNKED MODE

GROUP CALLS

1. Select a group or turn scan ON and make sure group is in scan list.
2. The group name or “GR xxxxx” will appear to indicate a call.

PHONE CALLS

1. When the call is received, the receive audio sounds and the display reads: *PHONE*
2. Respond by pressing PTT. If you do not respond, radio will continue to ring to indicate an incoming call.

INDIVIDUAL CALLS

1. When the call is received, the receive audio sounds and the display reads : ID xxxxx
   INDV
2. Respond by pressing PTT. If you do not respond, radio will continue to ring to indicate an incoming call.
3. If the call is cleared with no response, the radio will store **W**ho **H**as **C**alled and display:
   WHC
4. Press the #IND key to display the ID.
5. Press the Push-To-Talk button to return the call or press the Clear/Monitor button to clear the *WHC*.

CONVENTIONAL OPERATION

RECEIVING A CALL

1. Select desired conventional system and channel or turn scan ON and make sure desired channel is in scan list.
2. When the radio receives a call, the radio will unmute and the channel name will appear in the display.

SENDING A CALL

1. Select desired system and channel.
2. Ensure the channel is not busy by pressing the **Monitor/Clear** button momentarily. If you hear audio or if the  icon is on, the channel is busy.
3. When you are sure the channel is not busy, press the Push-To-Talk button and speak into the microphone.

OPERATION FOLLOWING WATER CONTACT

If the P7100^{IP} model radio has been immersed in water or if the microphone air path or speaker grill become clogged with water, follow instructions under “Radio Microphone and Radio Speaker” to assure the highest quality transmitted and received messages.

RADIO MICROPHONE

In the event the P7100^{IP} microphone air path becomes clogged with water, blow two quick successive breaths of air directly into the radio microphone air hole. Refer to Figure 5. This will help to clear any water trapped in the microphone air path and allow the microphone to function properly.

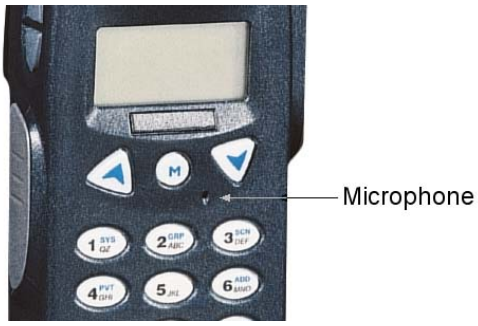

Figure 5 – Radio Microphone

RADIO SPEAKER

To assure the user receives the highest quality receive audio possible after the radio has contacted water or been immersed, it may be necessary to clear excess water from the speaker cavity and grill. The speaker grill has been designed for easy drainage. To facilitate maximum drainage and the highest quality speaker output, shake the radio vigorously with speaker grill face down.

CHANGING THE BATTERY PACK

REMOVING THE BATTERY PACK

Make sure the power to the radio is turned OFF.

1. Press the latch at the bottom of the battery pack.
2. Lift the battery pack from the bottom.
3. Remove the battery pack from the radio.

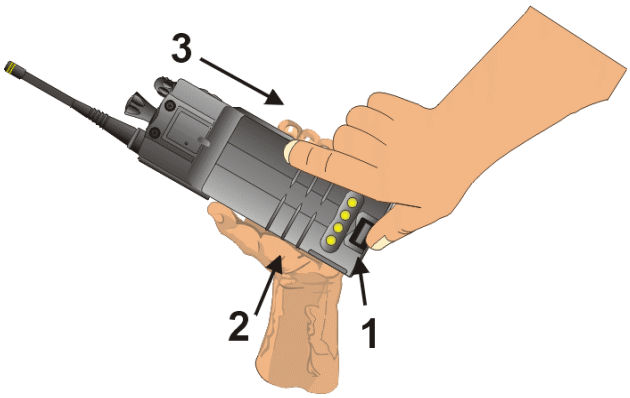

Figure 6 – Removing the Battery Pack

ATTACHING THE BATTERY PACK

Make sure the power to the radio is turned OFF.

1. Align the tab on the top of the battery pack with the slot at the top of the battery cavity.
2. Push the battery pack down to attach the battery to the radio.
3. Verify that the battery pack is properly latched to the radio.

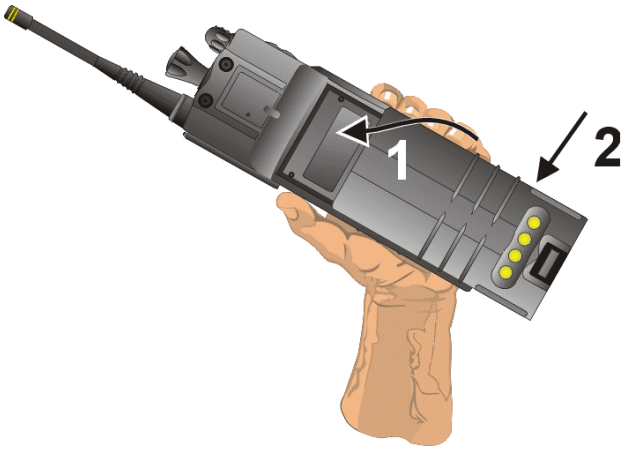

Figure 7 – Attaching the Battery Pack

BATTERY WARRANTY

A. M/A-COM Private Radio Systems, Inc. (hereinafter "Seller") warrants to the original purchaser for use (hereinafter "Buyer") that nickel-cadmium and nickel-metal hydride batteries supplied by Seller shall be free from defects in material and workmanship, and shall conform to its published specifications for a period of twelve (12) months from the date of purchase.

B. For purposes of this warranty, batteries shall be deemed defective if (1) the battery capacity is less than 80% rated capacity, or (2) the battery develops leakage.

C. If any battery fails to meet the foregoing warranty, Seller shall correct the failure by issuing a replacement battery upon receipt of the defective battery at an Authorized Service Center (ASC). To obtain the name and address of an ASC, ask your salesperson, consult the Yellow Pages, or call the number printed at the bottom of this page.

D. Replacement batteries shall be warranted only for the remaining unexpired warranty period of the original battery. This warranty becomes void if:

   1. The battery has been subjected to any kind of misuse, detrimental exposure, or has been involved in an accident.

   2. The battery is used in equipment or service other than the radio equipment for which it is specified.

E. The preceding paragraphs set forth the exclusive remedies for claims (except as to title) based upon defects in or non-conformity of any battery, whether the claim is in contract, warranty, tort (including negligence), strict liability or otherwise, and however instituted. Upon the expiration of the warranty period, all such liability shall terminate. The foregoing warranties are exclusive and in lieu of all other warranties, whether oral, written, expressed, implied or statutory. NO IMPLIED OR STATUTORY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE SHALL APPLY. IN NO EVENT SHALL THE COMPANY BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, INDIRECT OR EXEMPLARY DAMAGES.

This warranty applies only within the United States.

M/A-COM Private Radio Systems
3315 Old Forest Road
Lynchburg, Virginia 24501
1-800-528-7711

AE/LZT 123 3248/2 R4A

WARRANTY

A. M/A-COM Private Radio Systems, Inc. (hereinafter "Seller") warrants to the original purchaser for use (hereinafter "Buyer") that Equipment manufactured by or for the Seller shall be free from defects in material, workmanship and title, and shall conform to its published specifications. With respect to any Equipment not manufactured by or for the Seller (except for integral parts of Seller's Equipment to which the warranties set forth above shall apply), Seller gives no warranty, and only the warranty, if any, given by the manufacturer shall apply. Batteries are excluded from this warranty but are warranted under a separate Battery Warranty.

B. Seller's obligations set forth in Paragraph C below shall apply only to failures to meet the above warranties (except as to title) occurring within the following periods of time from date of sale to the Buyer and are conditioned on Buyer's giving written notice to Seller within thirty (30) days of such occurrence:

   1. for fuses and non-rechargeable batteries, operable on arrival only.
   2. for parts and accessories (except as noted in B.1) sold by Seller's Service Parts Operation, ninety (90) days.
   3. for PANTHER™ Series handportable and mobile radios, two (2) years.
   4. for Cougar™ Series handportable and mobile radios, two (2) years.
   5. for all other Equipment of Seller's manufacture, one (1) year.

C. If any Equipment fails to meet the foregoing warranties, Seller shall correct the failure at its option (i) by repairing any defective or damaged part or parts thereof, (ii) by making available at Seller's factory any necessary repaired or replacement parts, or (iii) by replacing the failed Equipment with equivalent new or refurbished Equipment. Any repaired or replacement part furnished hereunder shall be warranted for the remainder of the warranty period of the Equipment in which it is installed. Where such failure cannot be corrected by Seller's reasonable efforts, the parties will negotiate an equitable adjustment in price. Labor to perform warranty service will be provided at no charge during the warranty period only for the Equipment covered under Paragraph B.3. To be eligible for no-charge labor,

service must be performed by an Authorized Service Center (ASC) or other Servicer approved for these purposes either at its place of business during normal business hours, for mobile or personal equipment, or at the Buyer's location, for fixed location equipment. Service on fixed location equipment more than thirty (30) miles from the Service Center or other approved Servicer's place of business will include a charge for transportation.

D. Seller's obligations under Paragraph C shall not apply to any Equipment, or part thereof, which (i) has been modified or otherwise altered other than pursuant to Seller's written instructions or written approval or, (ii) is normally consumed in operation or, (iii) has a normal life inherently shorter than the warranty periods specified in Paragraph B, or (iv) is not properly stored, installed, used, maintained or repaired, or, (v) has been subjected to any other kind of misuse or detrimental exposure, or has been involved in an accident.

E. The preceding paragraphs set forth the exclusive remedies for claims (except as to title) based upon defects in or nonconformity of the Equipment, whether the claim is in contract, warranty, tort (including negligence), strict liability or otherwise, and however instituted. Upon the expiration of the warranty period, all such liability shall terminate. The foregoing warranties are exclusive and in lieu of all other warranties, whether oral, written, expressed, implied or statutory. NO IMPLIED OR STATUTORY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE SHALL APPLY. IN NO EVENT SHALL THE SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, INDIRECT OR EXEMPLARY DAMAGES.

This warranty applies only within the United States.

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NOTES

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www.macom-wireless.com *Printed in U.S.A.*

INSTRUCTION BOOK (DRAFT)

J725P VHF

1. Receiver Circuit

The FM dual-conversion super heterodyne receiver is designed for operation in the 136-174 MHz frequency range. The Receiver has intermediate frequencies (IF) of 115.65MHz and 450kHz. Adjacent channel selectivity is obtained by using two band pass filters, a 115.65MHz crystal filter and a 450kHz ceramic filter. The RX detector is the phase digitizer.

1-1 Receiver Front-end

A RF signal from antenna is coupled though the low pass filter/antenna switch, and band pass filter to the input of low noise amplifier Q101. The output of Q101 is coupled through band pass filter to input of 1'st Mixer Z101. Front End selectivity is provided by these band pass filter.

1-2 1'st Mixer

The 1'st Mixer is a Double-Balanced-Mixer Z101, that converts a RF signal the 136-174MHz range to 115.65MHz 1'st IF frequency. The signal on the output of Z101 is provided to the input of 1'st IF amplifier Q102.

1-3 1'st IF

The 1'st IF signal 115.65MHz from the output of the 1'st Mixer is coupled through 1'st IF amplifier Q102 to Crystal filter FL103. The highly-selective crystal filter FL103 provide the first portion of the receiver IF selectivity. The output of the filter is coupled through the impedance-matching net work to IF Receiver U101.

1-4 2nd Mixer, 2nd IF filter and 2nd IF amplifier

IF Receiver U101 is an one-chip IC for digital communication system. It includes 2'nd Mixer, 2'nd IF amplifier and Limiter amplifier. With the internal circuits of U101, The 1'st IF signal is amplified and applied to the input of 2'nd Mixer. The 2'nd local injection frequency 115.2MHz is applied from 2'nd local amplifier Q106 to another input of the 2'nd Mixer. The 2'nd Mixer converts a 1'st IF signal 115.65MHz to 2'nd IF frequency 450KHz. Then the 2'nd IF signal is applied to Ceramic Filter FL105(Wide Band) or FL106 (Narrow Band&C4FM), which provides the 450KHz selectivity. Those IF filters are controlled by IF.NARROW signal from the microcomputer (HILLARY:U700). The output of the 2'nd IF filter is applied through 2'nd IF

amplifier and Ceramic Filter FL104 or FL107 to Limiter amplifier. Those IF Filters are controlled by C4FM. DATA signal from the microcomputer (HILLARY:U700). This IF signal is amplified and balanced outputs, RXIF and $\overline{\text{RXIF}}$, are sent to HILLARY. These two lines, one positive and the other negative, are used to cancel out any noise that might get on the line. These balance outputs is applied to the phase digitizer on HILLARY and detected.

2, Transmitter Circuit

The Transmitter Circuit consists of Buffer Amplifier (U202 and Q202), PA Module (U201). Automatic Power Control Circuit (Q421, Q422 and U404), Antenna Switch Module (Z302).

The initial drive level for the transmitter is the Tx VCO. The VCO frequency range is 136 to 174MHz.

2-1 Buffer Amplifier

The output of VCO is applied to the Buffer Amplifier U202. The collector voltage for U202 is provided Switch circuit and is controlled by DPTT.

The output of U202 is applied to the Buffer Amplifier Q202 input that is amplified to +8dBm.

The output of U202 is applied to PA module input.

2-2 PA Module

The input of the PA Module is amplified to about 7W. B+ (7.5 V DC) is connected U201 through RF chokes L251. The PA Module consists of two stages RF amplifier. The first stage power supply voltage is supplied by power control circuit. The second RF amplifier operates in Class-C. This output can be regulated by power control circuit.

2-3 Automatic Power Control

The Automatic Power Control circuit samples the output power to the antenna to maintain a constant power level across the band. The Automatic Power Control circuit controls the Vcont voltage to PA Module U201.

Directional coupler is include of Antenna Switch Module(Z302). Directional coupler provides a sampled signal of transmit power for diode. Diode produce a positive DC voltage proportional to the transmitter circuit output power level, that is compared to a comparator (U404) from TX POWER CONT of control unit. The output of U404 is applied to DC amplifier Q422, then the output voltage of Q422 controls to the Vcont of PA Module for constant output power level.

2-4 Antenna Switch Module

The Antenna Switch Module consists of switch circuit and the Low Pass Filter.

During transmit, DPTT line from HILLARY is high level. Transistor Q403 turns on supply +7.2V to Antenna Switch Module Z302. When transmitting, the Antenna switch diode is low impedance.

3. Frequency Synthesizer Circuit

It consists of the Reference Oscillator, PLL Frequency Synthesizer chip U305, Loop filter, Rx VCO Z303, and Tx VCO Z304.

PLL Frequency Synthesizer chip receives PLL data, and control information from the microcomputer and from this generates the Tx/Rx RF frequencies. It also provides frequency lock status to the microcomputer.

Rx VCO and Tx VCO are locked to the Reference Oscillator by a single direct-divide synthesis loop consisting of the Feedback Buffer, Prescaler, and PLL Frequency Synthesizer chip.

The Tx VCO operates over a frequency range of 136-174MHz.

The Rx VCO operates over a frequency range of 251.65-289.65MHz.

3-1 Reference Oscillator

The reference oscillator consists of a 1.5ppm TCXO (Temperature Controlled Compensated Crystal Oscillator).

The standard of reference oscillator frequency is 19.2MHz.

The TCXO is enclosed in a RF shielded can. The TCXO is compensated by internal temperature compensated circuit for both low and high temperature. With no additional compensated the oscillator will provide 1.5 PPM stability from -30°C to +60°C.

3-2 Fractional-N Frequency Synthesizer chip

Fractional-N Frequency synthesizer chip U305 provides fractionality through the use of main ΔΣ modulators. The output from the modulators are combined with the main and auxiliary divider ratios through their respective Fractional Units.

The reference frequency 19.2MHz from the crystal oscillator is divided by a ratio of 1 to 32 to create the reference frequencies for the phase detectors.

The divide ratios can be programmed through the Reference Frequency Dividers Register.

The dividend is Desired VCO division ratio in fractional-N applications.

This number is a real number and can be interpreted as the reference frequency (F ref) multiplying factor such that the resulting frequency is equal to the desired VCO frequency.

When in 18-bit mode, 18-bit signed input value to the ΔΣ modulator, ranging from -131072 to +131071

providing 262144 steps, each of F div_ref / 2^{18} (Hz).

The divider is 262144 when the ΔΣ modulator is in 18-bit mode.

With the modulator in 18-bit mode, the value to be programmed in the Main Dividend register is programmed by the microcomputer.

This results in an error voltage when the phase differ and a constant output voltage when phase-detector input compare in frequency and phase. If a phase error is detected, an error voltage is developed and applied to the VCO DC offset and loop filter to reset the VCO frequency. The dividend is controlled by the frequency data received on the SC.CLK, SC.DATA - and SC.SYN1LE- line from the microcomputer.

When a different channel is selected or when changing to the transmit or receive mode an error voltage is generated and appears at the phase-detector output, causing the Phase Locked Loop to acquire the new frequency.

3-3 Loop filter

The Loop filter consists of R341 or R322 through R327 and C336 through C341and Analog SW (U304, U309). This filter controls the bandwidth and stability of the synthesizer loop.

When a different channel changing or changing to transmit or receive mode, analog switch is controlled by VCO RX/TX for PLL lock up first.

The output of the filter is applied to the variable capacitors in transmit and receive VCO to adjust and maintain the VCO frequency. The use of to VCO allows rapid independent selection of transmit and receive frequencies across the frequency split.

3-4 Rx VCO

The Rx VCO consists of low-noise silicon transistor oscillator, and followed by high-gain buffer.

The VCO is switched on and off VCO RX/TX line. When VCO RX/TX is low, the Rx VCO is turned on, transistor Q301 is on. The Rx VCO output is typically 0dBm. The output is applied to the PLL Frequency Synthesizer chip for VCO frequency control and as the Receiver frequency to Rx 1'st Mixer through the 1'st Local oscillator buffer amplifier. The VCO voltage need only be set once at some frequency of the band and split, after which it operates over the entire split with no additional tuning.

3-5 Tx VCO

The Tx VCO is basically the same as the Rx VCO. The Tx VCO has the modulation terminal for FM. The VCO consists of silicon transistor oscillator followed by high-gain buffer amplifier. When VCO RX/TX is high, the Tx VCO is turned on, transistor Q302 is on.

3-6 Lock Detect

The Lock Detect signal is outputted from synthesizer IC (U305-9). The LOCK(U305-9) is low if a large frequency error exist, and will carry unlock condition to the microcomputer.