



**800 MHz M5300**

**700/800 MHz M7300**

**Front and Remote-Mount Mobile Radios**

**RU-144750-061**



## MANUAL REVISION HISTORY

REV.	DATE	REASON FOR CHANGE
B	May/10	Updated drawings, parts lists, and specifications. Added VIDA Device Manager section and keypad lock/unlock for ECP mode.
C	May/12	Updated specifications, introduction, related publications, lists of service parts, disassembly and reassembly procedures, parts lists, production changes, schematic diagrams, and assembly diagrams. Added programming and configuration information, test procedures, and alignment procedures.

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## 1. SAFETY SYMBOL CONVENTIONS

The following conventions are used to alert the user to general safety precautions that must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere violates safety standards of design, manufacture, and intended use of the product. Harris Corporation assumes no liability for the customer's failure to comply with these standards.



The **WARNING** symbol calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** symbol until the conditions identified are fully understood or met.



The **CAUTION** symbol calls attention to an operating procedure, practice, or the like, which, if not performed correctly or adhered to, could result in a risk of danger, damage to the equipment, or severely degrade the equipment performance.



The **NOTE** symbol calls attention to supplemental information, which may improve system performance or clarify a process or procedure.



The **ESD** symbol calls attention to procedures, practices, or the like, which could expose equipment to the effects of Electro-Static Discharge. Proper precautions must be taken to prevent ESD when handling circuit modules.



The **electrical hazard** symbol is a **WARNING** indicating there may be an electrical shock hazard present.

## 2. OPERATIONAL SAFETY RECOMMENDATIONS

### 2.1 TRANSMITTER HAZARDS



**The operator of any mobile radio should be aware of certain hazards common to the operation of vehicular radio transmitters. A list of several possible hazards is given:**

- **Explosive Atmospheres** – Just as it is dangerous to fuel a vehicle with the motor running, similar hazards exist when operating a mobile radio. Be sure to turn the radio off while fueling a vehicle. Do not carry containers of fuel in the trunk of a vehicle if the radio is mounted in the trunk.  
  
Areas with potentially explosive atmosphere are often, but not always, clearly marked. 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.
- **Interference to Vehicular Electronics Systems** – Electronic fuel injection systems, electronic anti-skid braking systems, electronic cruise control systems, etc., are typical electronic systems that can malfunction due to the lack of protection from radio frequency energy present when transmitting. If the vehicle contains such equipment, consult the dealer and enlist their aid in determining the expected performance of electronic circuits when the radio is transmitting.
- **Electric Blasting Caps** – To prevent accidental detonation of electric blasting caps, **DO NOT** use two-way radios within 1000 feet of blasting operations. Always obey the “**Turn off Two-Way Radios**” signs posted where electric blasting caps are being used. (OSHA Standard: 1926-900)
- **Liquefied Petroleum (LP) Gas Powered Vehicles** – Mobile radio installations in vehicles powered by liquefied petroleum gas with the LP gas container in the trunk or other sealed-off space within the interior of the vehicle must conform to the National Fire Protection Association standard **NFPA 58** requiring:
  - The LP gas container and its fittings.
  - Outside filling connections shall be used for the LP gas container.
  - The LP gas container shall be vented to the outside of the vehicle.

### 2.2 SAFE DRIVING RECOMMENDATIONS

The American Automobile Association (AAA) advocates the following key safe driving recommendations:

- Read the literature on the safe operation of the radio.
- Keep both hands on the steering wheel and the microphone in its hanger whenever the vehicle is in motion.
- Place calls only when the vehicle is stopped.
- When talking from a moving vehicle is unavoidable, drive in the slower lane. Keep conversations brief.
- If a conversation requires taking notes or complex thought, stop the vehicle in a safe place and continue the call.
- Whenever using a mobile radio, exercise caution.

## 2.3 OPERATING RULES AND REGULATIONS

Two-way FM radio systems must be operated in accordance with the rules and regulations of the local, regional, or national government.

In the United States, the M5300 mobile radio 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 helps eliminate confusion, assures the most efficient use of the existing radio channels, and results in a smoothly functioning radio network.

When using your two-way radio, remember these rules:

- It is a violation of FCC rules to interrupt any distress or emergency message. As your radio operates in much the same way as a telephone “**party line**,” always listen to make sure that the channel is clear before transmitting. Emergency calls have priority over all other messages. If someone is sending an emergency message – such as reporting a fire or asking for help in an accident – **KEEP OFF THE AIR!**
- The use of profane or obscene language is prohibited by Federal law.
- It is against the law to send false call letters or false distress or emergency messages. The FCC requires that you keep conversations brief and confine them to business. To save time, use coded messages whenever possible.
- Using your radio to send personal messages (except in an emergency) is a violation of FCC rules. You may send only those messages that are essential for the operation of your business.
- It is against Federal law to repeat or otherwise make known anything you overhear on your radio. Conversations between others sharing your channel must be regarded as confidential.
- The FCC requires that you identify yourself at certain specific times by means of your call letters. Refer to the rules that apply to your particular type of operation for the proper procedure.
- No changes or adjustments shall be made to the equipment except by an authorized or certified electronics technician.



**NOTE**

Under U.S. law, operation of an unlicensed radio transmitter within the jurisdiction of the United States may be punishable by a fine of up to \$10,000, imprisonment for up to two (2) years, or both.

## 2.4 OPERATING TIPS

The following conditions tend to reduce the effective range of two-way radios and should be avoided whenever possible:

- Operating the radio in areas of low terrain, or while under power lines or bridges.
- Obstructions such as mountains and buildings.
- In areas where transmission or reception is poor, some improvement can be obtained by moving a few yards in another direction or moving to a higher elevation.

## 3. SPECIFICATIONS<sup>1</sup>

### 3.1 GENERAL

<b>Dimensions, Front-Mount Mobile Radio:</b> (Height x Width x Depth)	2.4 x 6.9 x 11.3 inches (6.1 x 17.5 x 28.7 centimeters) (Includes knobs but not space required for mounting bracket and cables at rear of radio)
<b>Dimensions, Remote-Mount Mobile Radio:</b> (Height x Width x Depth)	2.0 x 6.9 x 9.2 inches (5.1 x 17.5 x 23.4 centimeters) (Does not include space required for mounting bracket and cables at rear of radio)
<b>Dimensions, Control Head:</b> (Height x Width x Depth)	2.4 x 6.9 x 3.9 inches (6 x 17.5 x 10 centimeters) (Does not include bracket and mounting screws)
<b>Weight, Front-Mount Mobile Radio:</b>	5.9 pounds (2.68 kilograms), less bracket
<b>Weight, Remote-Mount Mobile Radio:</b>	5.25 pounds (3.69 kilograms), less bracket
<b>Weight, Control Head:</b>	1.25 pounds (0.57 kilograms), less bracket
<b>Operating Ambient Temperature Range:</b>	-22 to +140° Fahrenheit (-30 to +60° Celsius)
<b>Storage Temperature Range:</b>	-40 to +185° Fahrenheit (-40 to +85° Celsius)
<b>Altitude:</b>	15,000 feet (4,572 meters) maximum
<b>DC Supply Voltage Operating Range:</b>	+13.6 Vdc ±10% (Normal range per TIA-603)
<b>DC Supply Current Requirements:</b>	
Receive (includes control head):	
With Speaker Muted:	1.1 amps maximum
With 0.5-Watt Speaker Output Power:	1.5 amps maximum
With 10-Watt Speaker Output Power:	3.5 amps maximum
With 15-Watt Speaker Output Power:	4.0 amps maximum
Transmit:	(See tables in Section 3.2)
Quiescent/Off Current:	
Mobile Radio:	100 microamps maximum
Control Head:	100 microamps maximum

<sup>1</sup> These specifications are primarily intended for the use of the installation technician. See the appropriate Specifications Sheet for the complete specifications.

## 3.2 TRANSCEIVER

### Frequency Ranges:

#### Receive:

700 MHz Operation:	764 to 767 MHz, 769 to 775 MHz and 773 to 776 MHz (repeater and talk-around operations) [See footnote <sup>2</sup> ]
800 MHz Operation:	851 to 869 MHz (repeater and talk-around operations)

#### Transmit:

700 MHz Talk-Around Operation:	764 to 767 MHz, 769 to 775 MHz and 773 to 776 MHz
700 MHz Repeater Operation:	794 to 797 MHz, 799 to 805 MHz and 803 to 806 MHz [See footnote <sup>3</sup> ]
800 MHz Talk-Around Operation:	851 to 869 MHz
800 MHz Repeater Operation:	806 to 824 MHz



NOTE

700 MHz band frequency ranges listed above do not apply to the M5300 mobile radio. The M5300 mobile radio covered by this maintenance manual is a single-band 800 MHz radio.

### Transmit Output Power

#### OpenSky<sup>®</sup> Trunking Protocol (OTP) Mode:

TX Power Setting (dBm)	TX Power Setting (Watts)	2-Slot Current (Amps)	4-Slot Current (Amps)
41	12.59	4.3	2.8
42	15.85	4.6	3.0
43	19.95	5.1	3.2
44	25.12	5.6	3.5
45 (max)	31.62	6.2	3.8

#### EDACS/Conventional/P25 Mode:

Power Output (Watts)	Current Draw for 800 MHz at 13.8 V (Amperes)
5	5.5
35	11.6

#### Channel Spacing:

12.5 kHz or 25 kHz (mode dependent)

#### Voice and Data Communications Modes:

Half-Duplex

#### Frequency Stability:

±1.5 ppm (AFC disabled); ±0.5 ppm (AFC)

#### Receiver Sensitivity:

700 MHz OTP Mode:	-111 dBm minimum at 1% BER (static)
800 MHz OTP Mode:	-111 dBm minimum at 1% BER (static)
700 MHz P25 Mode (TIA-102 Method):	-116 dBm minimum at 5% BER (static)
800 MHz P25 Mode (TIA-102 Method):	-116 dBm minimum at 5% BER (static)
700 MHz EDACS/Analog Conv. Mode:	-119 dBm minimum at 12 dB SINAD

<sup>2</sup> 764 to 767 MHz and 773 to 776 MHz per old FCC 700 MHz band plan. 769 to 775 MHz added August 30, 2007 by new FCC 700 MHz band plan.

<sup>3</sup> 764 to 767 MHz, 773 to 776 MHz, 794 to 797 MHz and 803 to 806 MHz per old FCC 700 MHz band plan. 769 to 775 MHz and 799 to 805 MHz added August 30, 2007 by new FCC 700 MHz band plan.

800 MHz EDACS/Analog Conv. Mode:	-118 dBm minimum at 12 dB SINAD
<b>Receiver Intermodulation Rejection:</b>	77 dB minimum at 12.5 kHz
<b>Audio Frequency Response:</b>	300 to 3000 Hz
<b>Audio Output Power (Control Head):</b>	15 W RMS max into 4-ohm external speaker; 1 watt into 4-ohm headset
<b>Voice-Coding Method:</b>	
OTP Mode:	AMBE®
EDACS, ProVoice™ and P25 Modes:	IMBE™
P25 Phase 1 Mode:	AMBE+™
<b>OpenSky Data Rate:</b>	9.6 kbps
<b>OpenSky Compressed Voice Relative Data Rate:</b>	2400 bps

### 3.3 REGULATORY

#### 3.3.1 General

<b>FCC Type Acceptance:</b>	OWDTR-0060-E (formerly OWDTR-0051-E)
<b>Applicable FCC Rules:</b>	Part 15 and Part 90
<b>Industry Canada Certification:</b>	3636B-0051
<b>Applicable Industry Canada Rules:</b>	RSS-119

#### 3.3.2 FCC Part 15 Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

#### 3.3.3 Industry Canada RSS Statement

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

## 4. INTRODUCTION

The M5300 and M7300 mobile radios are multi-mode digital mobile radios designed to meet the critical demands of radio users. The M5300 is a single-band 800 MHz mobile radio and the M7300 is a dual-band 700 and 800 MHz mobile radio. Each radio can provide 35-watts of transmit output power. Refer to Section 3 for detailed specifications.

These radios support multiple operating modes including OpenSky, Project 25 (P25) trunked, P25 conventional, Enhanced Digital Access Communications System (EDACS) trunked, ProVoice trunked, and analog conventional modes. OpenSky operating mode is provided by radio firmware/software called OpenSky Trunking Protocol, or “OTP” for short. EDACS and ProVoice trunked, analog conventional, and P25 trunked and conventional operating modes are provided by radio firmware/software commonly called EDACS, Conventional and P25, or “ECP” for short. The radio can be quickly switched between OTP and ECP modes via a “system” change at the radio control head.

Several voice/data encryption options are available. For OpenSky, P25 trunked, and P25 conventional modes, the Advanced Encryption Standard (AES) software feature option provides 256-bit AES encryption. In OpenSky and P25 radio systems, encryption keys are sent to the radio via Over-The-Air Rekeying (OTAR) methods. In addition, a Data Encryption Standard (DES) software feature option is available for the ECP operating mode, providing 64-bit DES encryption.

M5300 and M7300 radios can be optionally equipped with a Global Positioning System (GPS) receiver module. This module can provide standard GPS-formatted over-the-air data for vehicle tracking systems. It can also provide NMEA-formatted data to a locally-connected computer via a serial data link between the radio and the local computer. At the radio, the respective serial interface port is provided at the 44-pin connector on the radio’s rear panel.

The M5300 and M7300 radios are designed to operate in a mobile environment, typically within a motor vehicle. A radio must be connected to an external transmit/receive antenna such as one mounted to the vehicle’s rooftop or trunk lid. Several different types of external-mount antennas are approved and available for use with the radio, as listed in the radio’s *Installation and Product Safety Manual*. Publication numbers are listed in Section 5 on page 18.

Front-mount and remote-mount radio configurations are available, as illustrated in Figure 4-1 below. In the front-mount configuration, the control head is an integral part of the mobile radio. In the remote-mount configuration, the control head is located near the radio operator’s position and the radio is mounted remotely from the control head, typically in the vehicle’s trunk. In addition, a hand-held controller can be connected to a remote-mount radio in place of the control head.



**Figure 4-1: Front-Mount and Remote-Mount M5300 and M7300 Mobile Radios**

Control heads used with the M5300 and M7300 radios include the CH-721 Scan and the CH-721 System model control heads. See Figure 4-3 and Figure 4-4. Both heads feature a large 3-line graphical vacuum-fluorescent display, front panel controls and buttons/keys for user control of the mobile radio, an internal high-power audio amplifier to drive an externally-connected speaker, and a front panel microphone connector. The CH-721 System control head also has a 12-button numeric keypad that provides Dual-Tone Multi-Frequency (DTMF) functionality and easier operator system/group selection control at the control head's front panel.

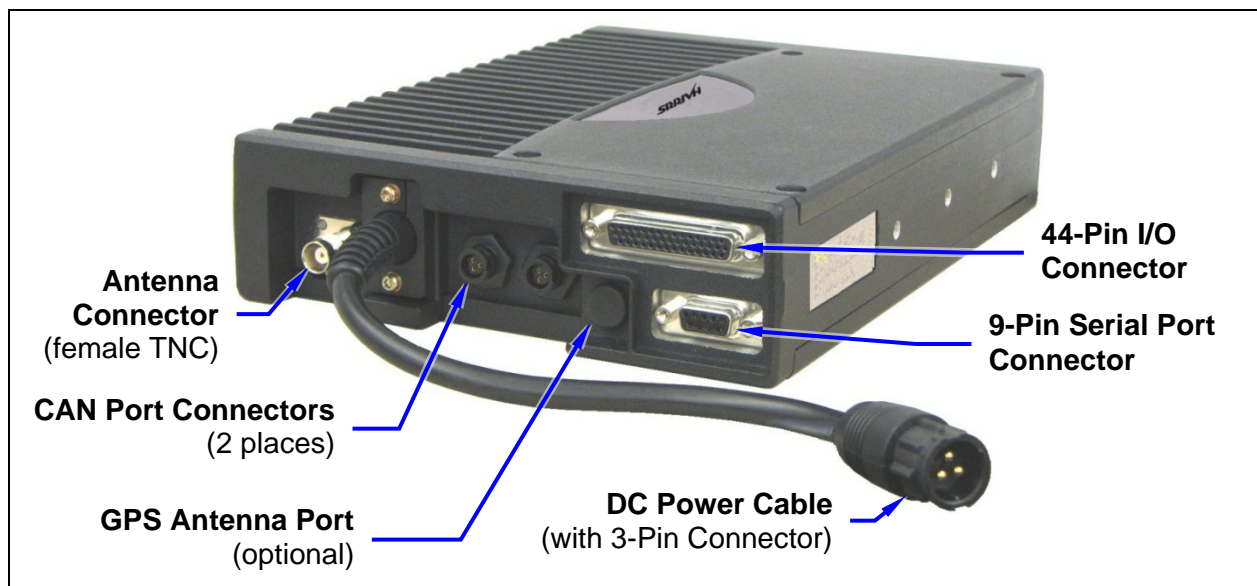


Figure 4-2: M5300 and M7300 Mobile Radios (Rear View)

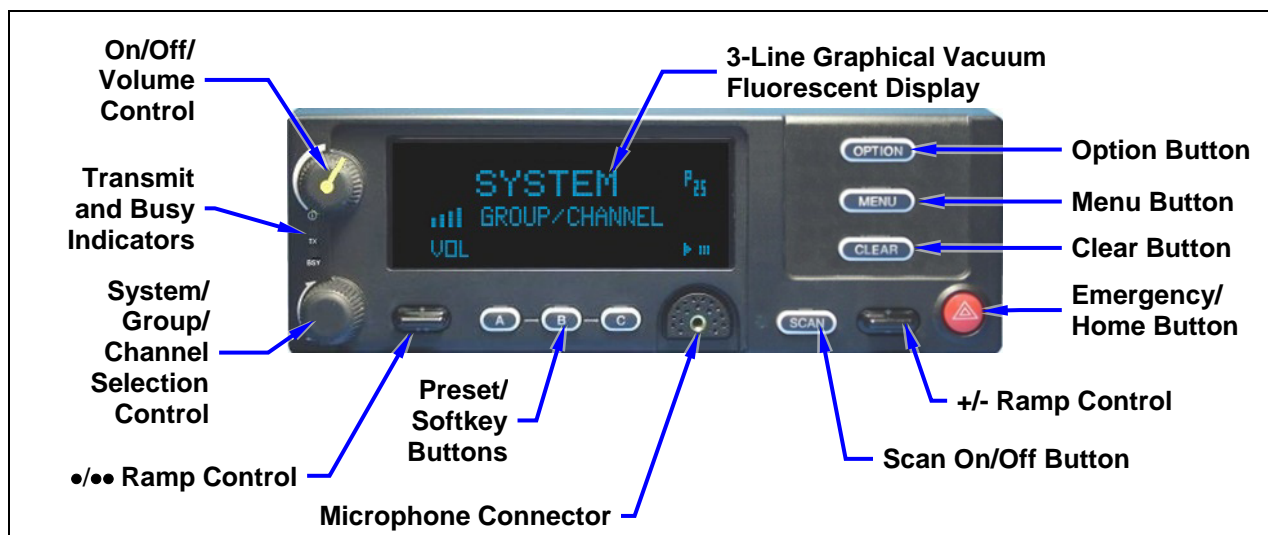
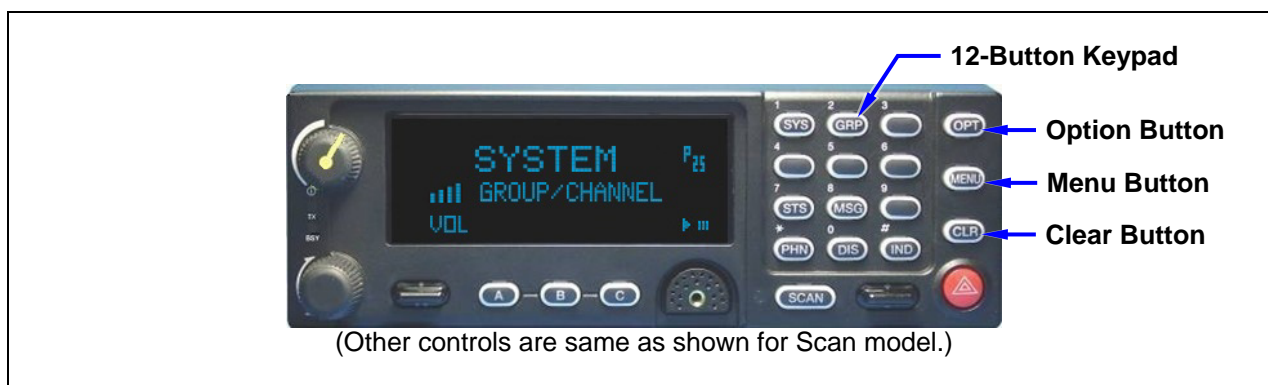
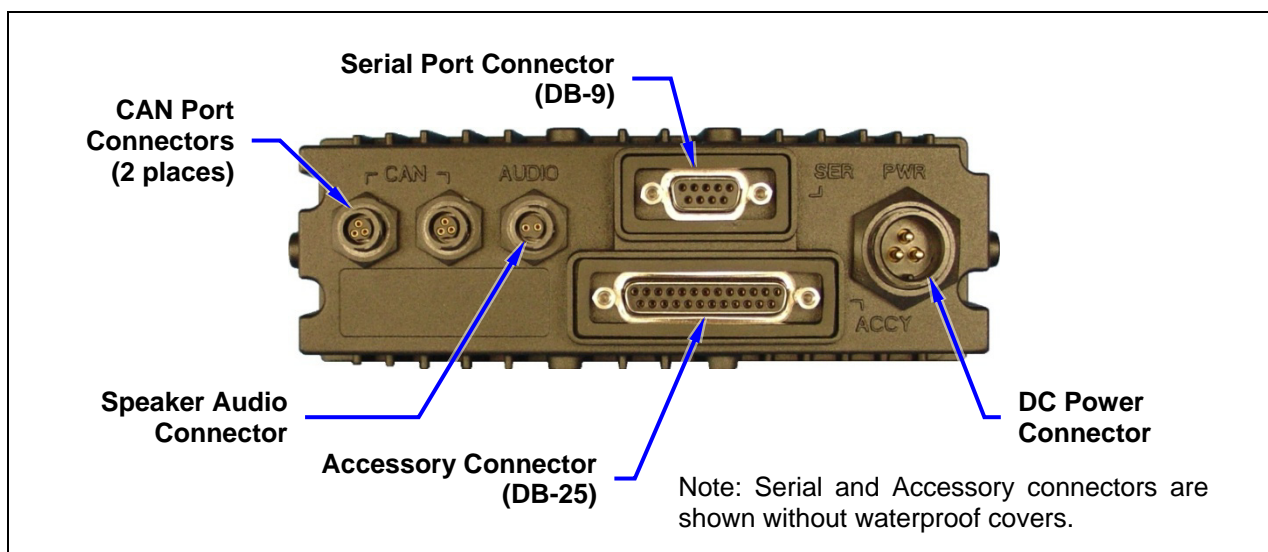


Figure 4-3: CH-721 Scan Model Control Head Front Panel



**Figure 4-4: CH-721 System Model Control Head Front Panel**



**Figure 4-5: CH-721 Rear Panel (Both Control Head Models)**

In a remote-mount radio installation, the HHC-731 hand-held controller can be employed in place of the CH-721 control head. This easy-to-use hand-held mobile radio controller is primarily designed for use in harsh environments such as maritime (i.e., boating) applications and All-Terrain Vehicle (ATV) applications. The HHC-731 hand-held controller has easy-to-use buttons, a tough liquid-crystal display (LCD), and a built-in microphone. As of the publication of this manual, only one (1) HHC-731 hand-held controller can be connected to a radio, and without any connected CH-721 control heads. The front of the HHC-731 hand-held controller is shown in Figure 4-6.

The remote-mount M5300/M7300 radio is designed for remote mounting in a motor vehicle's trunk, or some other preferably unoccupied section in a vehicle, such as a fire truck's equipment shelf. EDACS Conventional P25 (ECP) mode supports dual control heads. OpenSky supports multiple control heads. For a front-mount radio, this includes the head in the radio.

An intercom feature is available for multi-head installations. This licensed option gives radio users at multiple control heads connected to the same radio the ability communicate with each other without transmitting over-the-air. When activated, incoming network radio calls are still scanned and heard at each control heads.

The radio is remotely controlled by a control head(s) connected to it via 3-wire Controller Area Network (CAN) cables. Between the radio and control head(s), the CAN link carries digitized microphone and speaker audio, controlling data such as button presses and radio messages, and user data such as that for a

mobile data terminal connected to the serial port of the radio or control head. For proper operation, the CAN link must be terminated appropriately on each end. In multiple control head installations, heads are interconnected to the mobile radio in a series (“daisy-chain”) fashion via CAN link cables. CAN port connectors are located on the rear of the radio and control heads, as illustrated in Figure 4-2 and Figure 4-5.



**Figure 4-6: HHC-731 Hand-Held Controller Front View**

The 44-pin D-subminiature connector on the rear panel of the radio provides a connection point for various types of optional equipment. For example, with a front-mount radio, this connector can provide connections for an optional siren/light control system via an optional interconnect cable.

As shown in Figure 4-5, the CH-721 Scan and System model control heads used in remote-mount radio installations have several connectors located on the head's rear panel. These connectors include a DC power connector, two (2) CAN port connectors used for CAN link interconnections, an external speaker connector, a 9-pin serial port connector for connecting optional equipment such as a mobile data terminal, and a 25-pin accessory connector. Both CH-721 models can interface to an optional Federal Signal Electronic siren/light control system for broadcasting via a public address (PA) speaker.

The radio and control head or hand-held controller must be powered by an external +13.6-volt (nominal) DC power source. In mobile applications, the motor vehicle's electrical system is utilized as the source of DC power. In a remote-mount radio installation, the CH-721 control head(s) or the HHC-731 hand-held controller connected to the radio is also powered by the same DC power source, but separately fused. When the control head or hand-held controller is powered-up by the operator, it “wakes up” the radio by transmitting data to the radio via the CAN link.

The radio provides half-duplex voice and data communications. Voice communications are accomplished via a “push-to-talk” (PTT) type microphone and an external speaker connected to the control head. The HHC-731 hand-held controller has an integrated microphone and PTT button/key. When a control head is

employed in a mobile radio installation, an audio amplifier in the head drives the speaker. When the hand-held controller is employed, an audio amplifier in the remote-mounted mobile radio drives the speaker.

For data communications, the radio has an industry-standard 9-pin serial interface port for connecting optional data-type equipment, such as a Mobile Data Terminal (MDT), a laptop PC, an external display, or a key-entry device. This port works seamlessly with equipment from popular manufacturers and off-the-shelf applications.

The M5300/M7300 mobile radio, the CH-721 control head and the HHC-731 hand-held controller exceed tough environmental specifications included within military standard MIL-STD-810F, the radio industry standard TIA/EIA-603, and the radio standard established by the U.S. Forest Service.

The M5300/M7300 mobile radio supports operation on APCO Project 25 phase I compliant Common Air Interface (P25 CAI) trunked radio networks, and operation in a talk-around mode in accordance with the APCO Project 25 phase I standard. P25 radio systems utilize Improved Multi-Band Excitation (IMBE) speech and data compression technology, developed by Digital Voice Systems, Inc.

EDACS and ProVoice trunked radio networks employ analog FM and 2-level Gaussian Frequency-Shift Keying (GFSK) modulation techniques on the RF channels. Data is transmitted on an RF channel at a 9600 bits-per-second rate. ProVoice also employs IMBE technology.

For over-the-air secure radio communications, the radio may be equipped for 64-bit DES (Data Encryption Standard) encryption or 128/256-bit AES (Advanced Encryption Standard) encryption. With encryption, voice and/or user data signals transmitted and received by the radio on an RF channel are digitally encrypted ("scrambled") to virtually eliminate unauthorized monitoring via the RF channel.



**Harris recommends the buyer use only an authorized representative to install and service this product.** The warranties provided to the buyer under the terms of sale shall be null and void if this product is installed or serviced improperly, and Harris shall have no further obligation to the buyer for any damage caused to the product or to any person or personal property.

## 5. RELATED PUBLICATIONS

The following publications contain additional information about the M5300 and M7300 mobile radios:

- M5300 Installation and Product Safety Manual (800 and 900 MHz): MM-012137-001
- M7300 Installation and Product Safety Manual (700 and 800 MHz): MM-014763-001
- M5300 OpenSky Quick Guide for CH-721: MM-012997-001
- M7300 OpenSky Quick Guide for CH-721: MM-014368-001
- M5300 ECP Quick Guide for CH-721: MM-013232-001
- M7300 ECP Quick Guide for CH-721: MM-014369-001
- M5300 Operator's Manual for CH-721: MM-012125-001
- M7300 Operator's Manual for CH-721: MM-014716-001
- HHC-731 Hand-Held Controller Operator's Manual (includes OpenSky and ECP Modes): MM-018321-001
- CH-721 Scan and System Control Heads Maintenance Manual: MM-008918-001  
(included with this manual)
- HHC-731 Hand-Held Controller Maintenance Manual: MM-018323-001  
(included with this manual)
- Installation Manual for GPS Receiver Field Upgrade Kit MM-015617-001
- M5300/M7300 OpenSky Software Release Notes  
(for SK-012724-016 R16G and SK-015406-016 R16H): MS-018990-001
- M5300/M7300 OpenSky Software Release Notes  
(for SK-015406-016 R18C and later): MS-018835-001
- M5300/M7300 ECP Software Release Notes: MS-010366-001
- OpenSky Mobile-End System (MES) AT Commands for OpenSky  
Mobile and Portable Radios: MM-016649-001

A Quick Guide is included with each mobile radio equipment package when it ships from the factory. Quick Guides and the Operator's Manuals are available at [www.pspc.harris.com](http://www.pspc.harris.com) without a login. Obtaining other manuals/release notes from that web site requires an Information Center log-in, then browsing to Tech-Link's Technical Manual Library.

## **6. TECHNICAL ASSISTANCE**

The Technical Assistance Center's (TAC) resources are available to help with overall system operation, maintenance, upgrades and product support. TAC is the point of contact when answers are needed to technical questions.

Product specialists, with detailed knowledge of product operation, maintenance and repair provide technical support via a toll-free (in North America) telephone number. Support is also available through mail, fax and e-mail.

For more information about technical assistance services, contact your sales representative, or contact the Technical Assistance Center directly at:

United States and Canada:	1-800-528-7711
International:	1-434-385-2400
Fax:	1-434-455-6712
E-mail:	<a href="mailto:PSPC-tac@harris.com">PSPC-tac@harris.com</a>

In addition, our Tech-Link service is available at <https://premier.pspc.harris.com/>.

Tech-Link is a one-stop link to technical documents (i.e., downloadable PDFs), software revisions information, feature encryption information, service parts and accessories pictorials, and other information pertaining to Harris PSPC radio products.

## **7. CATALOG AND PART NUMBERS**

### **7.1 RADIOS AND CONTROL HEADS**

**Table 7-1: Radio Catalog and Part Numbers**

CATALOG NUMBER	PART NUMBER	DESCRIPTION
MAHK-S8MDX*	RU-144750-061	35-Watt 800 MHz M5300 Mobile Radio
MAMW-SDMXX*	RU-144750-061	35-Watt 700/800 MHz M7300 Mobile Radio

\* Catalog package also includes installation and product safety manual and quick-reference operating guide.

Table 7-2: Control Head Catalog and Part Numbers

CATALOG NUMBER (FOR M5300)	CATALOG NUMBER (FOR M7300)	PART NUMBER	DESCRIPTION
MAHK-NCP9G	MAMW-NCP9G	CU23218-0001	CH-721 Scan Control Head, Local-Control; for Use on a Front- Mount Mobile Radio
MAHK-NCP9E	MAMW-NCP9E	CU23218-0002	CH-721 Scan Control Head, Remote-Control; for Use with a Remote-Mount Mobile Radio
MAHK-NCP9H	MAMW-NCP9H	CU23218-0003	CH-721 System Control Head, Local-Control; for Use on a Front- Mount Mobile Radio
MAHK-NCP9F	MAMW-NCP9F	CU23218-0004	CH-721 System Control Head, Remote-Control; for Use with a Remote-Mount Mobile Radio

## 7.2 INSTALLATION-RELATED COMPONENTS

For detailed information on installation-related components for the M5300, refer to the *Installation and Product Safety Manual*, publication MM-012137-001.

For detailed information on installation-related components for the M7300, refer to the *Installation and Product Safety Manual*, publication MM-014763-001.



For information about service parts available for the M7300 mobile radio, see Section 16.1 on page 124.

## 8. OPERATION

This section provides some basic operating information. For detailed operating instructions, refer to the respective operator's manual listed in Section 5 on page 18.

### 8.1 CH-721 FRONT PANEL COMPONENTS

The front panel of the CH-721 Scan and System model control heads are shown in Figure 4-3 (page 14) and Figure 4-4 (page 15) respectively. The front panel includes a display, controls for menu navigation, an emergency button, three pre-set buttons, a power on/off/volume control, and a microphone connector. In addition, the system model control head features a DTMF keypad. Table 8-1 and Table 8-2 list all front panel controls and their default functions.

The buttons on the front panel are backlit for operation in a low ambient light level such as nighttime operation. Some buttons also flash to provide feedback of various operating conditions. Display brightness and button backlighting can be manually dimmed via a control head menu.



Button function may vary depending upon programming, radio hardware, and optional configurations.






**Table 8-1: Front Panel Controls and Default Functions for OpenSky Operating Mode**

CONTROL	FUNCTION
	Power On/Off/Volume Control Turn clockwise to power on the radio and increase volume. Turn counter-clockwise to decrease volume and power off the radio.
Mic Connection	Connection for hand-held, hands-free, speaker-mic, or headset.
	If enabled through programming, the emergency button sends an emergency and opens voice communication on the currently selected talk group or the default emergency talk group (depending upon how the system is defined).
	While in the dwell display, scrolls through available talk groups. Scrolls through selections within the active menu (available talk groups, pre-programmed speed dial numbers, canned alert messages, etc.).
	<b>IF ENABLED VIA PROGRAMMING</b> , while in the dwell display, scrolls through available talk group. Scrolls through selections within the active menu (available talk groups, pre-programmed speed dial numbers, canned alert messages, etc.). <u>Or</u> Increases and decreases the display brightness.
	<b>IF ENABLED VIA PROGRAMMING</b> , scrolls through available menu items.
OPT/OPTION	Scrolls through available menu items.
CLR/CLEAR	
MENU	Press to activate the current selection. In some cases, this is not necessary as the last selection will automatically activate after a short period. Also exits Stealth Mode.

Table 8-1: Front Panel Controls and Default Functions for OpenSky Operating Mode

CONTROL	FUNCTION
Display Area	Menu selections and messages. Network Connectivity icon. Current Volume Level icon. Volume represented numerically within the display (0 = Muted, 40 = Loudest). User may select which one of several dwell displays the radio uses.
Pre-Set Buttons A, B, C	These buttons are used to store and recall user-selectable parameters such as scan mode, selected profile, selected talk group, and priority talk group. Different parameters can be stored at each of the three different pre-set buttons. Preset button C can be configured via programming to reboot the radio into a particular application mode. Contact your system administrator to determine if this feature is enabled in your radio.
SCAN	Toggles the Scan Mode on and off. <ul style="list-style-type: none"> <li>If the Scan Mode is Normal and the Scan Mode is toggled Off, when the Scan Mode is toggled On the Scan Mode will be set to Normal.</li> <li>If the Scan Mode is Fixed and the Scan Mode is toggled Off when the Scan Mode is toggled On the Scan Mode will be set to Fixed .</li> <li>If the Scan Mode is Off when the radio boots up when the Scan Mode is toggled On the Scan Mode will be set to Normal.</li> </ul>

Table 8-2: Front Panel Controls and Default Functions for EDACS/Conventional/P25 Operating Mode

CONTROL	FUNCTION
	Power On/Off/Volume Control Turn clockwise to power on the radio and increase volume. Turn counter-clockwise to decrease volume and power off the radio.
Mic Connection	Connection for speaker-mic or headset.
	The Emergency button declares an emergency if enabled through programming.
	This rotary switch selects the systems or groups/channels, depending upon programming.
	This rocker type button is used to display the current SCAN status for a group/channel and then add or delete the group/channel from the system scan list. Pressing the add/delete button twice while the radio is actively receiving or three times when the radio is not receiving selects the last scanned channel (Last Scanned Channel Recall).
	The primary function of this rocker type button is to scroll through the System list or the Group/Channel list depending upon programming. The secondary function is to increment or decrement items within a list (phone list for example).
OPT/OPTION	Toggle a PC programmable feature on and off.
CLR/CLEAR	<b>EDACS:</b> Exits the current operation and removes all displays associated with it. The radio and display then return to the group receive state. <b>Conventional:</b> Unmutes the receiver so activity on the selected channel can be monitored. When pressed and held for approximately 3 seconds, this button toggles conventional channel decoding (Channel Guard, Digital Channel Guard, T99) ON and OFF if programmed for the selected channel.



**Table 8-2: Front Panel Controls and Default Functions for EDACS/Conventional/P25 Operating Mode**

CONTROL	FUNCTION
<b>MENU</b>	Primary function - access the menu list. This is a list of additional features that are not available directly from the keypad. Secondary function - activate a selected item within a list, similar to an enter key.
<b>SCAN</b>	Primary function - toggle scan operation on and OFF. Secondary function - toggle the keypad buttons between their primary function and their secondary function.
Pre-Set buttons	Used to store and recall user-selectable parameters.
<b>SYS</b>	Used to enter the System select mode.
<b>GRP</b>	Used to enter the Group select mode.
<b>STS</b>	Permits the transmission of a pre-programmed status message to an EDACS site.
<b>MSG</b>	Permits the transmission of a pre-programmed message to an EDACS site.
<b>PHN</b>	Used to place telephone calls through the radio by selecting the interconnect special call function.
<b>DIS</b>	Used to adjust the current display intensity and the keypad backlight level.
<b>IND</b>	Used to call an individual or make an all-call by selecting the individual call function.







## 8.2 RADIO STATUS ICONS

Status icons indicate the various operating characteristics of the radio. The icons show operating modes and conditions. See Table 8-3 and Table 8-4.







**Table 8-3: Radio Status Icons for OpenSky Operating Mode**

ICON	DESCRIPTION
	Indicates data registration.
	Volume bars – indicates relative volume level.

**Table 8-4: Radio Status Icons for EDACS/Conventional/P25 Operating Mode**

ICON	DESCRIPTION
	Indicates the EDACS system is in Failsoft™ mode (if enabled through programming).
	Indicates selected group or channel is in scan list.
	Indicates selected group or channel is programmed as Priority 1 in scan list.
	Indicates selected group or channel is programmed as Priority 2 in scan list.
	Scan mode enabled.
	Volume bars – indicates relative volume level.

**Table 8-4: Radio Status Icons for EDACS/Conventional/P25 Operating Mode**

ICON	DESCRIPTION
	Indicates the current channel is set up as an analog channel.
	Indicates the current channel is set up as a ProVoice channel.
	Special call mode (individual or telephone).
	Transmitting or receiving in encrypted mode.
	Indicates the current channel is set up as a Project 25 (P25) channel.
	Indicates a conventional channel enabled with Channel Guard Function.

### 8.3 ALERT TONES

The M7300 and M5300 mobile radios also provide audible Alert Tones or “beeps” to indicate the various operating conditions. Refer to Table 8-5 and Table 8-6 for detailed information on these tones.

**Table 8-5: Alert Tones for OpenSky Operating Mode**

NAME	TOPE	DESCRIPTION
Call Queued	1 low tone/2 high tones	Call queued for processing.
Call Denied	3 short beeps	Radio is out of coverage area or requested talk group is active.
Grant (or Go-Ahead)	1 short beep	Sounds when resources become available for a call request placed in the queue (if enabled) upon channel access. If the radio roams to another site while transmitting, then it will auto rekey and begin transmitting on that tower. It gives a second grant tone to let the user know they have roamed.
Priority Bump	1 short tone	Stopped current incoming call in favor of higher-priority incoming call.
Call Removed	1 long low-pitched tone	Notifies the user access to the channel has been lost (out of coverage area or pre-empted by higher-priority call).
Selective Alert Received	1 short tone, 2 short beeps, 1 short tone	Only played once to indicate a selective alert has been received.
Emergency Tone	3 long tones	Sounds when an emergency is declared.
Emergency Cleared	1 long low-pitched tone	Sounds when an emergency is cleared.
Volume	1 short tone	Reflects current volume level.

Table 8-5: Alert Tones for OpenSky Operating Mode

NAME	tone	DESCRIPTION
Selective Call Ring	a ringing tone similar to a telephone	Ringling is repeated every four seconds until the call is accepted or rejected by the radio being called or until the network drops the call if unanswered after one minute.
PSTN Ring	1 medium-pitch repeating tone	Two ring tone - one generated by the radio when there is an incoming telephone call or an outgoing telephone call attempt is waiting for the telephone interconnect gateway equipment to dial the Public Switched Telephone Network (PSTN). The second ring tone sounds when the gateway equipment has dialed the number.
Roam	2 short tones, 1 high-pitched and 1 low-pitched	Sounds when the radio transitions from one radio base station site to another.
Out of Range	Tri-tone beep	If enabled via programming, sounds when the radio is not within operational range with base station.

Table 8-6: Alert Tones for EDACS/Conventional/P25 Operating Mode

NAME	tone	DESCRIPTION
Call Originate	1 short mid-pitched tone	Sounds after keying the radio (Push-To-Talk button is pressed). Indicates the radio has been assigned a working channel
Autokey	1 mid-pitched tone	After being placed in a queue or releasing the PTT button prior to a working channel assignment, the site calls the radio when a channel becomes available. At this point, the radio automatically keys the transmitter (autokey) for a short period to hold the channel. The radio sounds a mid-pitched tone when it is clear to talk. Immediately press the PTT button to keep the assigned channel.
Call Queued	1 high-pitched tone	Sounds after pressing the PTT button indicating the system has placed the call request in the queue. The receiving unit(s) also sound(s) the tones to indicate they will receive a call shortly.
System Busy	3 low-pitched tones	Sounds if the radio is keyed when the system is busy, if no channels are available for sending the message, if the call queue is full, or if an individual call is being attempted to a radio that is transmitting.
Call Denied	1 low-pitched tone	Indicates the radio is not authorized on the system that has been selected.
Carrier Control Timer	5 short high-pitched warning tones followed by a long low-pitched tone	Sounds if the programmed time for continuous transmission is exceeded. The transmitter will shut down shortly after the alert, interrupting communications. Release and re-key the PTT button to maintain communications. This will reset the carrier control timer and turn the transmitter back on.



Table 8-6: Alert Tones for EDACS/Conventional/P25 Operating Mode

NAME	tone	DESCRIPTION
Key Press Alert	1 short tone	Indicates a key has been pressed. A short low-pitched tone indicates no action was taken because the key is not active in the current mode.

## 8.4 CHANGING THE OPERATING MODE

### 8.4.1 Changing from OTP Mode to ECP Mode

To change from OpenSky Trunking Protocol (OTP) operating mode to EDACS/Conventional/P25 (ECP) mode:

1. Cycle through the menu until the “App Mode” appears in the bottom line of the display.
2. Use  to choose an available mode. Press **MENU** and confirm (Y/N) with  and press **MENU** again.
3. Press the **MENU** button to confirm.


Or

Preset button C can be configured via programming to reboot the radio into a particular application mode.

Or

Quick Button command 1# transitions the radio to ECP mode. If ECP mode is not loaded in the radio, the radio displays “No App.”

### 8.4.2 Changing from ECP Mode to OTP Mode

1. Use  to scroll through available systems until “OpenSky” is displayed.
2. The radio transitions to OpenSky Trunking Protocol (OTP) mode.

## 8.5 OPENSky KEYPAD COMMANDS (DTMF KEYPAD REQUIRED)

To perform a command from the keypad, press the \* key followed by one of the pre-set function keys as follows:

Table 8-7: Keypad Commands and Functions (OpenSky Only)

KEYPAD COMMAND	FUNCTION
*0	<b>Log off command:</b> *0## (logs the user off the system).
*1	<b>Login command:</b> *1<User ID> # <Password> ## (required for encryption).
*4	<b>Enter Scene of Incident Mode (SOI) on specified channel and band:</b> *4#<ccc>#<bb># where <i>ccc</i> is the SOI channel number and <i>bb</i> is the number assigned to each frequency band. <b>Press *40# to exit SOI mode.</b>
*7	<b>Initiate Selective Alert command:</b> *7<Target ID>#[Choose Message]#.
*8	<b>Radio-to-Radio Call command:</b> *8<Selective call number># (PTT to dial).
*9	<b>Public Switched Telephone Network (PSTN) Call command:</b> *9 <telephone number># (PTT to dial).

Table 8-7: Keypad Commands and Functions (OpenSky Only)

KEYPAD COMMAND	FUNCTION
*32	<b>Begin Manual Encryption command:</b> *32<Pre-Determined Encryption Key ># 1 – 16 digit encryption key for 128 bit encryption; 17 – 32 digit encryption key for 256 bit encryption.
*33	<b>End Manual Encryption command:</b> *33#

### 8.5.1 Quick Buttons (System Model Only)

Quick Buttons are a two-button sequence that gives the radio user quick access to certain menu items. Most Quick Buttons act as a toggle function.

Table 8-8: Quick Buttons and Functions

QUICK KEY	FUNCTION
1#	<b>Transition to ECP mode.</b> If ECP is not loaded in the radio, the radio displays “No App.”
2#	<b>Stealth Mode On/Off.</b>
3#	<b>Scan Mode On/Off.</b> <ul style="list-style-type: none"> <li>If the Scan Mode is Normal when the Scan Mode is toggled Off, the Scan Mode will be Normal when toggled On again.</li> <li>If the Scan Mode is Fixed when the Scan Mode is toggled Off, the Scan Mode will be Fixed when scan mode is toggled On again.</li> <li>If the Scan Mode is Off when the radio boots up, the Scan Mode will be Normal when Scan Mode is toggled On.</li> </ul>
4#	<b>Lights/Tones On/Off.</b> This turns the TX/RX LEDs and Side Tones On/Off. If the radio is in Stealth mode, this quick button is disabled since the user is not able to turn on the light/tones in stealth mode.

## 8.6 LOCKING AND UNLOCKING THE KEYPAD

### 8.6.1 OpenSky Mode

1. Press and hold the **MENU** button.
2. While holding the **MENU** button, press the **OPTION** button within one second

### 8.6.2 ECP Mode

1. Scroll through the menu until “keylock” is displayed.
2. Press **MENU**.

Press **MENU** and **CLEAR** to unlock the keypad.

## 9. CONFIGURATION

### 9.1 GENERAL INFORMATION FOR OPENSky

An M7300 or M5300 mobile radio must be initially configured (programmed) with customer-specific parameters before it can operate on any radio system. For an OpenSky trunked radio system, these parameters include but are not limited to:

- The radio's main Internet Protocol (IP) address
- The radio's broadcast IP address
- The radio's Electronic Serial Number (ESN)
- The Wide Area Communications Network (WACN) number assigned to the OpenSky radio system upon which the radio will log into
- At least one base station channel upon which the radio will initially log into the OpenSky radio system

These and other parameters are initially loaded from a locally-connected Personal Computer (PC) connected to the radio's serial port. Typically, a configuration file is supplied by network administration personnel, edited as needed for a specific radio, and then loaded into the radio from a locally-connected personal computer via the radio's serial port.

### 9.2 CONFIGURING THE RADIO FOR OPENSky

#### 9.2.1 Using VIDA® Device Manager

VIDA Device Manager is a Microsoft® Windows®-based application that facilitates the loading of firmware code updates to numerous devices throughout the VIDA network. The VIDA Device Manager centralizes and provides a common interface for this function. Code loading must be performed with caution. Refer to Device Manager's online help and user's manual MM-016371-001 for detailed instructions on using VIDA Device Manager.

#### 9.2.2 Using the Remote Device Configuration (RDC) Application

The Remote Device Configuration (RDC) software application can be used to remotely or locally load customer-specific configuration parameters into the radio. Parameters such as the radio's initial set of RF channels, user ID number, and IP address, can be easily loaded via a serial link between the RDC computer and the radio. Other parameters, including higher-level parameters which more uniquely configure a radio, can be remotely loaded over-the-air from the RDC. For complete details on using this application, refer to the RDC's user manual, publication number MM23020. The RDC's Media Kit part number is SK22444-0001, and its Distribution Kit part number is MATQ-S3423 (previously ST23516-0001). RDC software release notes are provided in publication number MS231234-0001.

#### 9.2.3 Using a Terminal Application

The following procedure is recommended to load the initial configuration into the radio for OpenSky mode operations via a terminal application such as Microsoft Windows HyperTerminal®:

1. Obtain the proper radio configuration file from the network administration personnel. Typically, this file is supplied via disk, email, etc. Command lines from a sample configuration file are shown in Table 9-1.
2. Copy the configuration file to the PC's hard disk drive (or a network drive if available).

3. Open the configuration file with a text editor such as Windows Notepad.
4. Using the text editor, edit required parameters. Typically, only the radio's IP address, user ID number and password will require changing. Refer to Table 9-1 on page 29 as necessary. The radio will not process/accept configuration commands that also include comments, so do not include any comments on the same line as a command.
5. Double-check/verify all parameters for the particular radio.
6. Save this text file in an ANSI® format with a new name that is unique to the particular radio (e.g., using the text editor's Save As command).

**Or**

7. Select all text in the configuration file and copy it to the system's clipboard.
8. Connect a service PC's serial port to the radio's rear serial connector using serial programming cable CA-104861 (5 feet long) or CA-013671-020 (20 feet long).
9. At the service PC, start a terminal application such as Microsoft Windows HyperTerminal.
10. Configure the terminal application to use the respective PC serial port (COM1 for example), VT100 terminal emulation, a data rate of 19,200 bps, 8 data bits, 1 stop bit, no parity, and no flow control.
11. Power-up the control head and radio.
12. Send the configuration text to the radio by using the terminal application's paste function or by loading the saved file from disk.
13. From the terminal application, verify the radio processed all commands successfully by, after each command, checking for the presence of an "OK" response and for the absence of an "Error" response.



NOTE

**Information in Table 9-1 below is for reference only. See the respective Software Release Notes for additional information.**

**Table 9-1: Sample of Command Lines from an OpenSky M7300/M5300 Configuration File**

COMMAND LINES IN CONFIGURATION FILE	NOTES
	<b>Typically, only the information in the next five (5) command lines changes on a per-radio basis:</b>
<code>at@u2057770302</code>	Sets user ID number to "2057770302". 10 characters maximum.
<code>at@password1234</code>	Sets password to "1234". Used along with the user ID to register with the voice system. 8 characters maximum.
<code>at\s10.205.21.2</code>	Sets IP address of the radio to 10.205.21.2.
<code>at\b10.205.21.254</code>	Sets broadcast IP address of the radio to 10.205.21.254. Used for transmitting to multiple radios.
<code>at@h200</code>	Sets site ID number that the radio will give preference to when channel scanning. Set to 200 in this example.
	<b>Miscellaneous Settings Section 1:</b>
<code>at@esc+</code>	Sets the modem's escape character to "+".
<code>at@b2</code>	Sets button press sidetone volume to medium. Use 0 to mute sidetones, 3 for maximum volume.
<code>ate1</code>	Enables echo character to serial port/terminal. Use <code>ate0</code> to disable echo.
<code>atv1</code>	Interprets results of AT commands as text (e.g., "OK") instead of numerically (e.g., "0").

Table 9-1: Sample of Command Lines from an OpenSky M7300/M5300 Configuration File

COMMAND LINES IN CONFIGURATION FILE	NOTES
<code>at@r*</code>	Removes all channels from the radio's Licensed Channel List (LCL).
	<b>Mutual Authentication Parameters:</b>
<code>at@wacn 783836</code>	Sets Wide Area Communications Network (WACN) number to "783836". Range = 1 to 1048574.
<code>at**smepolicy 0x020</code>	Sets bit mask used to define the Security Management Entity (SME) Policy to 20 hexadecimal. See Section 9.3 for additional information.
<code>at@encrypt_data1</code>	Enables data encryption. Use <code>...data0</code> to disable.
	<b>700 &amp; 800 MHz Channel Frequency List. Use <code>at@c?</code> to list all channels in the radio's LCL:</b>
<code>at@c8,245,0,4</code>	Adds 800 MHz SMR channel 245 to the radio's LCL.
<code>at@c8,285,0,4</code>	Adds 800 MHz SMR channel 285 to the radio's LCL.
<code>at@c8,384,0,4</code>	Adds 800 MHz SMR channel 384 to the radio's LCL.
<code>at@c4,140,0,4</code>	Adds 700 MHz channel 140 to the radio's LCL.
<code>at@c4,603,0,4</code>	Adds 700 MHz channel 603 to the radio's LCL.
<code>at@c3,476,0,4</code>	Adds 700 MHz channel 476 to the radio's LCL.
<code>at@c3,1,0,4</code>	Adds 700 MHz channel 1 to the radio's LCL.
	<b>Service IP Address and Port:</b>
<code>at\u199.81.106.100</code>	Sets IP address of the radio for access to services to 199.81.106.100.
<code>at\p6425</code>	Sets service port of the radio to 6425.
	<b>Miscellaneous Settings Section 2:</b>
<code>at**vpolicy1</code>	Sets the radio's VNIC security policy to require VNIC authentication.
<code>at@sreg1</code>	Enables secondary registration. Use <code>at@sreg0</code> to disable it.
<code>at&amp;dtr1</code>	Directs radio to use data terminal ready (DTR) line to determine whether to go online.
<code>at&amp;ao0</code>	Sets Rx audio output destination to the normal speaker port. Use <code>at&amp;ao1</code> to send to secondary port.
<code>atchanscan1</code>	Enables channel scanning for best server analysis.
<code>at@scanmode0</code>	Sets initial scan mode to No Scan. Use <code>at@scanmode1</code> for Normal Scan or <code>at@scanmode2</code> for Fixed Scan.
<code>at@vreg1</code>	Enables voice registration on power-up.
<code>at@ar1</code>	Enables auto registration on power-up.
<code>at@ao ato</code>	If auto registration is enabled, the radio automatically data and voice registers at power-up.
<code>at@q0</code>	Disables auto shutdown timer. Use <code>at@q3600</code> to set to 3600 minutes (default). Range = 0 (off) to 32767 minutes.
<code>atgt11</code>	Sets grant tone volume level to 1. Range = 0 (mute) to 5.
<code>atrt11</code>	Sets roam tone volume level to 1. Range = 0 (mute) to 5.
<code>atst11</code>	Sets button press sidetone volume to 1 (low). Use 0 to mute sidetones, 5 for maximum volume.
<code>at@spni116</code>	Sets Set Service Provider Network ID (SPNI) number to 116. Range = 0 to 32767.
<code>at@wasil</code>	Sets initial Set Wide Area Service Identifier (WASI) number. Range = 0 to 65535. Use -1 to clear WASI list.

Table 9-1: Sample of Command Lines from an OpenSky M7300/M5300 Configuration File

COMMAND LINES IN CONFIGURATION FILE	NOTES
at*grant_tone1	Turns grant tones on. Use at*grant_tone0 to turn off.
at*emerg_tone 3	Sets emergency tone level to 3 (medium). Range = 0 (mute) to 5 (loudest).
atqueue_timer5	Sets transmit duration of a queue-granted call to 5 seconds. Range = 0 to 30 seconds.
at@emerg_timer10	Sets transmit duration after an emergency is started to 10 seconds. Range = 1 to 30 seconds.
at@start_profile0	Sets initial profile to the first profile stored in the radio.
at@pwd_entry_type0	Allows alpha-numeric passwords. Use at@pwd_entry_type1 for numeric-only passwords.
at@se_enable0	Disables silent emergency capability. Use at@se_enable1 to enable.
at@se_prefixEBA	Sets prefix of display text for a silent emergency to "EBA" (default).
at***** 40	Sets maximum transmit power level to 10 watts (40 dBm). A space is required after at*****. Valid range = 30 to 43. Use at***** 42 for 15 watts.
	<b>Alert Messages Definitions:</b>
at*alertmsgsr0	Deletes all existing alert messages from radio. Use at*alertmsgsr1 for example to delete only the first alert message.
at*alertmsga CALL ME, Call me ASAP	Adds alert message "CALL ME" abbreviation and "Call me ASAP" trailing text. 100 characters maximum.
at*alertmsga ON DUTY, I am on duty	Adds alert message "ON DUTY" abbreviation and "I am on duty" trailing text. 100 characters maximum.
at*alertmsga OFF DUTY, I am off duty	Adds alert message "OFF DUTY" abbreviation and "I am off duty" trailing text. 100 characters maximum.
	<b>Save and Reboot Commands:</b>
at&w3	Saves all parameters to non-volatile memory. Use at&w0 to save user parameters only. Use at&w2 to save user parameters and personality.
atz	Reboots radio to current mode. Use atz9 to reboot to OTP mode.

## 9.3 MUTUAL AUTHENTICATION FOR OPENSky



NOTE

This section includes procedures necessary to perform an M7300/M5300 radio's initial data and voice mutual authentication for operation on an OpenSky trunked radio network. Completion of these procedures is only necessary if radio system network administration personnel require mutual authentication to gain access to the radio system. These procedures need to be performed only once, to establish a "shared secret" between the radio and the Mobile Data Intermediate System (MDIS).

### 9.3.1 Data Mutual Authentication Preparation Procedure

The data mutual authentication procedure included in this section is typically performed by administration personnel before the radio is deployed for field installation into a motor vehicle. Commands sent to the radio via its serial port may be scripted according to system policy (from a file named CONFIG.TXT file, for example).

Voice and data mutual authentication are independent functions. Completion of the voice mutual authentication procedure (presented in the next section) is not required to perform data mutual authentication.

1. Obtain the OpenSky radio system's Wide Area Communications Network (WACN) number from radio system administration personnel.
2. Connect a service PC's serial port to the radio's rear serial connector using serial programming cable CA-104861 (5 feet long) or CA-013671-020 (20 feet long).
3. At the service PC, start a terminal application such as Microsoft Windows HyperTerminal.
4. Configure the terminal application to use the respective PC serial port (COM1 for example), VT100 terminal emulation, a data rate of 19,200 bps, 8 data bits, 1 stop bit, no parity, and no flow control.
5. Power-up the control head and radio.
6. Send the following command to the radio via the terminal application. This command is not required for system software releases R8A and later:

**at@encrypt\_data\_1**

7. Send the following command to the radio via the terminal application:

**at@wacn xxxxxx** (where xxxxxx = the radio system's WACN number obtained in step 1)



**NOTE**

To display the WACN number currently stored in the radio, send the following command to the radio: **at@wacn?**.

8. Send the following command to the radio via the terminal application:

**at\*\*smepolicy 0x3f** (or see below for another value)

- Use 0x3f to allow all authentication types. Use for radios operating on networks (i.e., WACNs) that require mutual authentication, and on networks that do not support mutual authentication.
- Use 0x20 to specify only V4AE-authenticated encrypted data can be used. In this case, the MDIS must execute mutual authentication to validate the radio. If it fails, the radio will roam and look for a different site on a known network (i.e., WACN).
- The utilized value must be greater than 0x03 to allow the radio to voice-register using release R7 protocol. If a value of 0x03 or less is used, during voice registration with the VNIC, the radio will voice-register using release R6 protocol.

9. Reboot the radio and save the configuration by sending it the following command:

**atz**

10. After the radio reboots, take it offline by sending it the following command:

**+++**

### **9.3.2 Data Mutual Authentication Public Key Initialization Procedure**

This procedure initializes the public key for data mutual authentication:

1. Connect a known-good antenna to the radio so it can access the OpenSky radio network with the respective UAS and MDIS (or multiple MDIS equipment).
2. Obtain the OpenSky radio's "nonce" number from radio system administration personnel. This number is generated by the Unified Administration System (UAS) application.

3. Send the nonce number to the radio by sending it the following command via the terminal application:  
**at\*keyinit <nonce>** (where <nonce> = nonce number obtained in step 2)
4. Verify a 'key exchange successful' message appears in the terminal application's display, and the radio data-registers on the network. Data registration can be verified by the presence of the antenna icon in the display. If not, see Table 9-2 for troubleshooting information. If successful, this authentication procedure will not need to be performed on the radio again unless its configuration is lost, or if its nonce number is regenerated at the UAS.
5. If the radio requires voice mutual authentication and it has not already been performed, continue with the procedure presented in the next section.

**Table 9-2: Troubleshooting Data Mutual Authentication Problems**

DISPLAYED ERROR MESSAGE	CORRESPONDING TRAP MESSAGE AT RNM APPLICATION*	POSSIBLE CAUSE & SOLUTION
"NOAUTH01"	"KeyInit Failed (Used NONCE)"	Nonce number has already been used. Regenerated nonce and try again.
"NOAUTH01"	"NONCE Mismatch"	Nonce number was most likely mistyped when issuing the "at*keyinit <nonce>" command. Resend command with correct nonce number.
(none)	"Auth Failure"	WACN mismatch between radio and region. Verify WACN number received from radio system administration personnel.
"UNK MES"	"KeyInit Failed (MES <sup>4</sup> Not Configured)"	IP address/ESN pair does not match configuration in UAS. Consult with radio system administration personnel.
"BADEKEY"	"Key Exchange Failed - No KeyInit"	The radio's nonce number has been regenerated at the UAS, but the radio has not been reinitialized with it. Resend nonce number to radio.
(none)	"SME: BAD IDR: IPKSN=0 NONCE=0 - EID 0x..."	The radio has lost its key. Perform/Repeat the data mutual authentication procedure.

\* For trapped RNM messages, consult with radio system administration personnel.

### 9.3.3 Voice Mutual Authentication Procedure

Voice and data mutual authentication are independent functions. Completion of the data mutual authentication procedure (presented in the previous section) is not required to perform voice mutual authentication.

1. Connect a service PC's serial port to the radio's rear serial connector using serial programming cable CA-104861 (5 feet long) or CA-013671-020 (20 feet long).
2. At the service PC, start a terminal application such as Microsoft Windows HyperTerminal.
3. Configure the terminal application to use the respective PC serial port (COM1 for example), VT100 terminal emulation, a data rate of 19,200 bps, 8 data bits, 1 stop bit, no parity, and no flow control.
4. Connect a known-good antenna to the radio so it can access the OpenSky radio network.
5. Power-up the control head and radio.

<sup>4</sup> MES = Mobile End System (i.e., any mobile or portable radio)

6. Enable 256-bit AES voice encryption by sending the following command to the radio via the terminal application:  
**at@spoe 2**
7. Send the following command to the radio via the terminal application:  
**at\*\*smepolicy 0x3f** (or see below for another value)
  - Use 0x3f to allow all authentication types. Use for radios operating on networks (i.e., WACNs) that require mutual authentication, and on networks that do not support mutual authentication.
  - Use 0x20 to specify only V4AE-authenticated encrypted data can be used. In this case, the MDIS must execute mutual authentication to validate the radio, and if it fails, the radio will roam and look for a different site on a known network (i.e., WACN).
  - The utilized value must be greater than 0x03 to allow the radio to voice-register using release R7 protocol. If a value of 0x03 or less is used, during voice registration with the VNIC, the radio will voice-register using release R6 protocol.
8. Send the following command to the radio so it can verify if the VNIC is authentic: **at\*\*vpolicy 1**
9. If the radio determines the VNIC is not authentic, it will display “NOAUTHV” and roam for another site. In this case, see Table 9-3 for troubleshooting information.
10. Reboot the radio and save the configuration by sending it the following command: **atz**

**Table 9-3: Troubleshooting Voice Mutual Authentication Problems**

DISPLAYED ERROR MESSAGE	CORRESPONDING TRAP MESSAGE AT RNM APPLICATION*	POSSIBLE CAUSE AND SOLUTION
“NOAUTHV”	(none)	The radio determined the VNIC was not authentic. This can occur if at**vpolicy is 1 and at**smepolicy is 3 or less. Also see Table 11-3.
“NOAUTHM”	“Invalid MCRes”	The VNIC determined the radio was not authentic based on its R7 challenge response. Receiving this trapped message at the RNM could be an indication of an unauthorized radio attempting to access the system. If a valid radio displays this error, contact TAC (See Section 6). Also see Table 11-3.
“BAD PWD”	“Invalid Credential”	The VNIC determined the radio was not authentic based on its R5 credential. This is normally caused by mistyping the user’s password at the radio or the UAS.
“NOSUPRT”	(none)	The user is provisioned with 256-bit voice encryption keys at the UAS, but the radio is configured to register with R6 protocol (at**smepolicy is 3 or less), or the radio is configured to disallow 256-bit encryption (at@spoe is 0).
“NOSUPRT”	“Rejected by Sec Policy”	The VNIC Security Policy at the UAS is set to “Credential & Challenge/Response Methods” but the radio is configured to register with R6 protocol (at**smepolicy is 3 or less).

\* For trapped RNM messages, consult with radio system administration personnel.

## 9.4 EDACS, CONVENTIONAL AND P25 CONFIGURATION

### 9.4.1 Radio Personality Manager (RPM) TQS3385 and TQS3389

Radio Personality Manager (RPM) software application TQS3385 (part number SK-104768-001) is used to program the M5300/M7300 mobile radio for operations in EDACS, ProVoice, and P25 trunked radio systems. TQS3385 can also be used to program the radio for analog conventional and P25 conventional operations. For additional information, refer to RPM's built-in help and/or RPM Software Release Notes, publication number MS-012550-001.

Conventional RPM software application TQS3389 (part number SK-012177-001) is used to program the M5300/M7300 mobile radio for analog conventional and P25 conventional operations. Trunking mode programming is disabled in TQS3389. For additional information, refer to RPM's built-in help and/or Conventional RPM Software Release Notes, publication number MS-012761-001.

Both RPM applications also support other radios such as the M7100, M7200, and Unity XG-100M mobile radios, and the P7200, P7300, and Unity XG-100P portable radios.



NOTE

Use the information and procedures in this section and RPM's built-in help as a guideline for programming and configuring an M5300/M7300 mobile radio. **Additional configurations not covered in this manual must be applied to meet specific customer requirements.**

### 9.4.2 Loading New ECP Code ("Flashing" the Radio)

EDACS Conventional P25 (ECP) application firmware code is loaded into the radio before it ships from the factory. Therefore, typically this procedure can be bypassed. However in some cases, before the mobile radio is deployed for use, the ECP code must be updated by loading new ECP code.



CAUTION

Before loading new ECP code into the radio, consult with the Harris Technical Assistance Center (TAC) and/or respective Software Release Notes as necessary. TAC contact information is included on page 6 of this manual. Software Release Notes are available at [www.pspc.harris.com](http://www.pspc.harris.com) via an Information Center login and Tech-Link account.

Follow this procedure to load ECP code into the M5300/M7300 mobile radio:

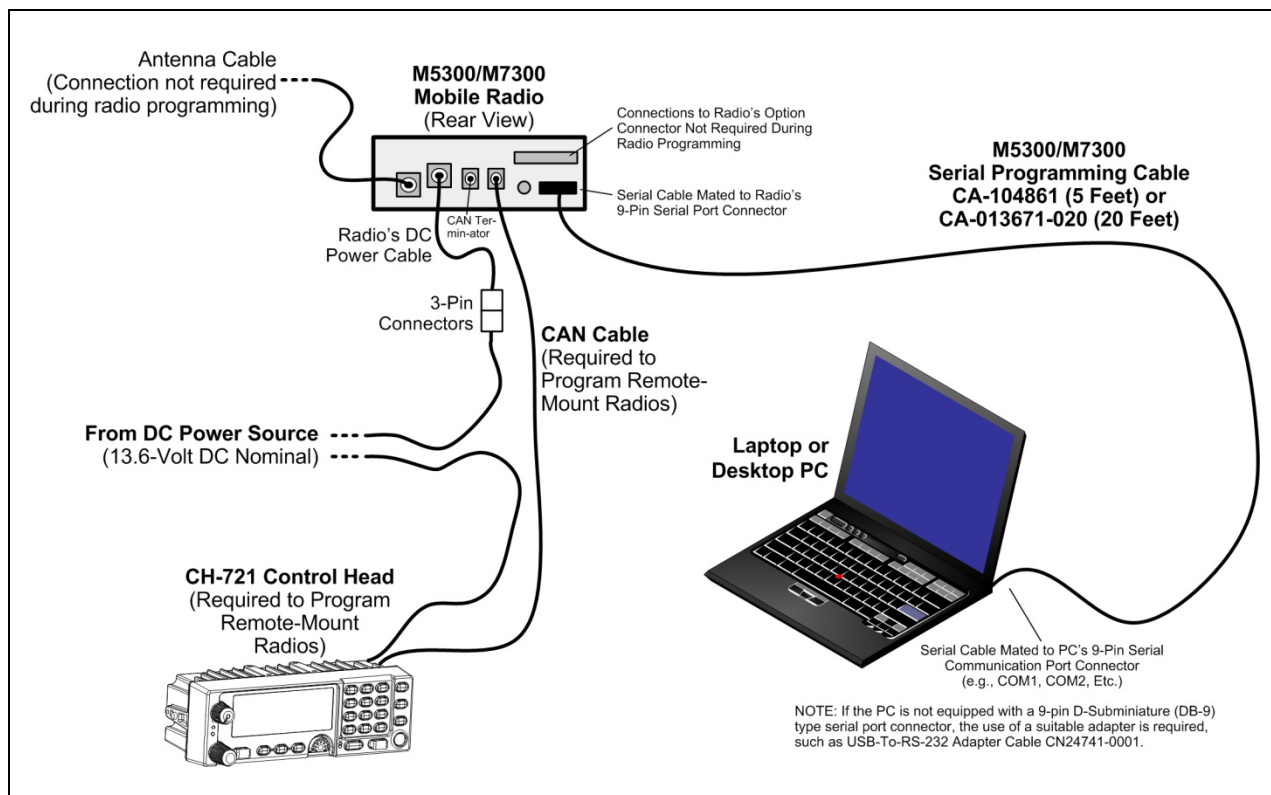
1. As illustrated in Figure 9-1, connect the radio to a personal computer with the Radio Personality Manager (RPM) programming software installed on it. Use Serial Programming Cable CA-104861 (5 feet long), CA-013671-020 (20 feet long), or equivalent, to connect the computer's serial port to the 9-pin (DB-9) connector on the rear of the radio.



NOTE

If the utilized PC is not equipped with a DB-9 type serial port connector, the use of a suitable adapter is required, such as USB-to-RS-232 Adapter Cable CN24741-0001. As of the publication of this manual, CN24741-0001 is available via the Harris Customer Care center.

2. Power-up the PC that has the RPM programming software installed on it, and start Windows.
3. Start the RPM programming software.



**Figure 9-1: Cable Connections for Radio Programming**

4. Optional: Turn the radio and control head off via the on/off/volume control on the control head.
5. Optional: While depressing both the A and C preset buttons on the control head, turn the radio and the control head on. "PROGRAM" should appear in the control head's display.



Cycling power (with the A and C preset buttons depressed at power-up) is not necessary. RPM will automatically place the radio into program mode before loading ECP code to it.

6. In RPM, click the Radio menu, and then click Standard Serial Connection > Load Compressed Code.
7. In the Load Compressed Code dialog box, click the ECP Code's button and then select the location of the compressed M5300/M7300 mobile radio ECP code, named **m7200\_ecp\_RxxXxx.cmp** (where **RxxXxx** is the required software version). After selecting the correct code file, click the Open button in the Open dialog box, and then click the OK button in the Load Compressed Code dialog box.



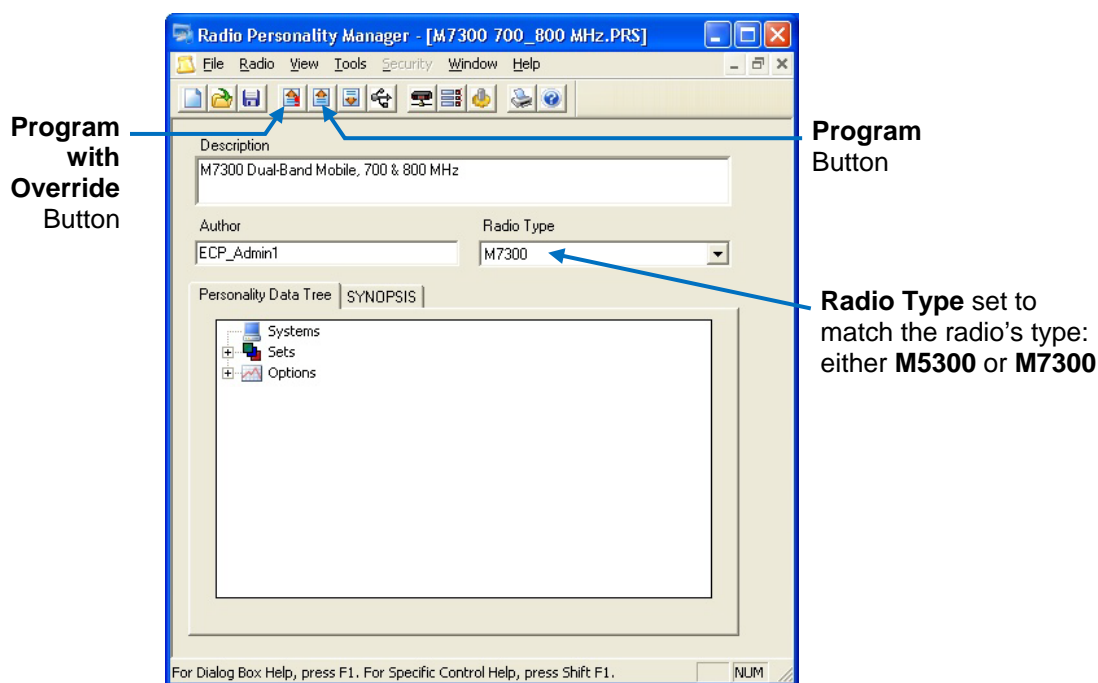
The M7300 mobile radio requires release R14A (or later) code. The compressed code (file named **m7200\_ecp\_RxxXxx.cmp**) is included with Media Kit SK-011983-001. That Media Kit is included with Software Distribution Kit ST-011986-001. For additional information, refer to Software Release Notes MS-010366-001.

8. RPM will begin loading the selected code to the mobile radio, with load status displayed in the Serial I/O Status box. The code is loaded successfully when the Serial I/O Status box disappears.

9. When the Serial I/O Status box disappears, continue with radio personality programming, as presented in the following section.

### 9.4.3 Radio Personality Programming

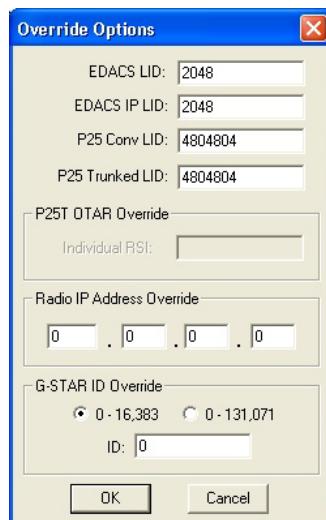
1. Connect the radio to a personal computer with the Radio Personality Manager (RPM) programming software installed on it. Use Serial Programming Cable CA-104861 (5 feet long) or CA-013671-020 (20 feet long), or equivalent, to connect the computer's serial port to the 9-pin (DB-9) connector on the rear of the radio. Connections are illustrated in Figure 9-1.
2. Power-up the PC that has the RPM programming software installed on it, and start Windows.
3. Start the RPM programming software.
4. Open an existing 700/800 MHz band split personality, or start a new M5300/M7300 personality, or read the existing personality from the radio. Consult RPM's built-in help as necessary.
5. As illustrated in Figure 9-2, in RPM's main dialog box, verify the Radio Type is set to match the radio's type, either M5300 or M7300. If it is not, make this change.



**Figure 9-2: RPM's Program and Program with Override Buttons (Example Main Dialog Box)**

6. Complete the personality programming as required for the radio. Consult with the radio system(s) network administration personnel and/or RPM's built-in help as necessary.
7. Save the personality, using a unique filename if necessary.
8. If logical ID (LID) values and the radio's IP address (if required) currently in the personality are correct for this radio, click on the Program button in the RPM toolbar.

Otherwise, in RPM's toolbar, click the Program with Override button and in the Override Options dialog box, enter the radio's LID number(s) and other relative information as required for the respective radio. Consult with radio network administration personnel as necessary. The following figure shows example LID numbers only:



**Figure 9-3: RPM's Override Options Dialog Box (with Example LID Numbers)**

9. Click the OK button to start the personality write operation. After it is completely written, the radio automatically reboots.
10. Disconnect cables and check for proper radio operation.

#### **9.4.4 Adding Software Feature Packages To The Radio**

##### **9.4.4.1 Displaying the Currently Enabled Software Feature Packages**

To display the radio's software feature packages which are currently enabled:

1. If not already, use RPM to add the FEATURES programmable menu function to the radio's menu(s). Do this by modifying the personality. In RPM, access the respective dialog box by double-clicking on Programmable Menus the Options limb of RPM's Personality Data Tree. There is one menu used during trunked operations and one menu used during conventional operations.
2. Program/Write the modified personality to the radio.
3. At the CH-721 control head, press the MENU button, then use the ●/●● ramp control to scroll through the menu until FEATURES appears in the middle line of the display.
4. Press the MENU button again.
5. Use the ●/●● ramp control through the features list, as necessary.
6. Press the MENU or CLR (Clear) button to exit the features list.

##### **9.4.4.2 Enabling Software Feature Packages**

To enable software feature packages:

1. Contact the Harris Technical Assistance Center (TAC) to obtain a new software feature data string for new (and existing) features. Be prepared to report the radio's serial number, new feature(s) needed, and the respective customer information.
2. If it is running, exit the RPM programming software.
3. Connect the radio to a personal computer with the RPM programming software installed on it. Use Serial Programming Cable CA-104861 (5 feet long) or CA-013671-020 (20 feet long), or equivalent,

to connect the computer's serial port to the 9-pin (DB-9) connector on the rear of the radio. Connections are illustrated in Figure 9-1.

4. Start RPM's Radio Maintenance Utility application by clicking **Start > (All) Programs > Harris Radio Personality Manager > Radio Maintenance Utility**.
5. On the utility's **Radio** menu, select **Read > Feature Data from Radio** to read the existing feature data string from the radio.
6. Select the **P5x00/P7x00/M5300/M7x00/XG100M** tab.
7. Click the **Feature Data Edit** button and replace the existing feature data string with the new feature data string supplied by TAC. If necessary, refer to the application's built-in help for additional information.
8. Click the **OK** button.
9. On the utility's **Radio** menu, select **Write > Feature Data to Radio** function to send the new feature data string to the radio. The radio briefly displays an "install" prompt and the utility displays a **Command Response** dialog box.
10. Verify the dialog box reports the feature data transfer is complete.
11. Click the dialog box's **OK** button, and exit the utility.

## 10. CIRCUIT ANALYSIS

### 10.1 PROCESSING KERNEL BOARD

The Processing Kernel Board contains the majority of the microprocessor and digital signal processing circuitry in the radio.

#### 10.1.1 Logic Circuit

The main microcomputer circuit in the radio consists of the OMAP processor (IC801), Flash ROM (IC802), and SDRAM (IC822). This circuit is synchronized by the 14.4 MHz TCXO located on the RF Processor board.

OMAP processor IC801 handles modulation, de-modulation, and audio coder-decoder (CODEC). The RS-232 (IC821 and IC823) and CAN interface (IC808 and IC809) provide the external man-machine interface. Reset Circuit (IC819) handles resetting the radio at power ramped up timing.

##### 10.1.1.1 **OMAP IC801**

OMAP processor IC801 is a highly-integrated, dual-core microprocessor. The OMAP has a built-in TI925T 32-bit Reduced Instruction Set Computer (RISC) core and a TMS320C55x Digital Signal Processor (DSP) core.

Functions performed by IC801 include:

- FLASH ROM, SDRAM, and SRAM control
- TRX/Synthesizer control
- External interface control for the radio data (e.g., channel number and signaling)

##### 10.1.1.2 **Flash ROM IC802**

The Flash ROM (IC802) is a 128 Mb simultaneous Read/Write, Burst Mode Flash memory device. IC802 stores the firmware executed by OMAP processor IC801. This firmware includes the “BurnApp” flash software code used to copy the application software and the application software itself. Operating power is provided from the 1.8 V switched supply line, +1V8\_SW.

IC802 interfaces to OMAP IC801 via the external memory interface-slow (EMIFS) traffic controller. Data transfers between IC802 and IC801 via the 16-bit bi-directional data bus identified FLASH\_D(15:0). Twenty-four bit address bus FLASH\_A(24:1) addresses both flash memory IC802 and SRAM IC803.

##### 10.1.1.3 **Static RAM IC803**

SRAM IC803 is a high-performance CMOS static RAM organized as 1024 K words by 16 bits. Operating power is provided by the 1.8-volt switched supply line, +1V8\_SW. Like flash memory IC802, SRAM IC803 interfaces to OMAP IC801 via the EMIFS traffic controller. Data transfers between IC803 and IC801 via the 16-bit bi-directional data bus identified FLASH\_D(15:0). Twenty-four bit address bus FLASH\_A(24:1) addresses both flash memory IC802 and static RAM IC803; however, only the lower twenty lines are utilized for SRAM addressing. Byte-wide vs. word-wide reads/writes are controlled by the two byte-enable logic lines identified FLASH\_BE0 and FLASH\_BE1 from IC801’s J5 and J1 respectively.

#### **10.1.1.4 Synchronous Dynamic RAM IC822**

SDRAM IC822 is a high-speed CMOS synchronous DRAM containing 16 Mb. It is internally configured as a dual 512K word x 16 DRAM with a synchronous interface. IC822 is rated for clock frequencies up to 143 MHz.

OMAP IC801 addresses SDRAM IC822 via the address bus identified SDRAM\_A(10:0), together with row buffer, column buffer, and command decoder logic within IC822, and the respective active-low control lines from IC801 to IC822. These active-low control lines include write-enable SDRAM\_WE, column-address SDRAM\_CAS, and row-address SDRAM\_RAS. SDRAM\_WE also provides read/write directional control. Bank selection is accomplished via the SDRAM\_BA0 logic line from IC801 which controls IC822's bank-select address line, A11.

Data transfers between IC801 and IC822 via the 16-bit bi-directional data bus identified SDRAM\_D(15:0). Directional control is determined by SDRAM\_WE.

SDRAM\_CLK is the clock line from OMAP IC801 to IC822. All data and commands are registered on the positive edge of the clock signal, SDRAM\_CLK. SDRAM\_CKE from IC801 to IC822 is an active-high clock enable line. When the clock-enable line is high, data and commands transfer between IC801 and IC822. When it is low, no data transfers and IC822 enters either a power-down mode or a self-refresh mode.

#### **10.1.1.5 CAN Controller and Transceiver (IC808 & IC809)**

The Stand Alone Can Controller IC808 is one of the two main ICs in the PK Board's CAN link interface circuit which meets the requirements of the CAN 2.0 specification. It interfaces to IC801's Multi-channel Buffered Serial Port 2 (McBSP2) which handles CAN link data for the radio. SACC IC808 is a 5-volt device, as shown by the +5V power supply connection at pin 20.

SACC IC808 has an internal oscillator that, together with crystal X803 between IC808 pins 8 and 9, generates a 40 MHz crystal-timebase reference clock for IC808. The clock output from IC808 pin 3 is not utilized (test point TP815).

CAN-formatted data transfers between SACC IC808 and CAN link transceiver IC809 occur over the two 5-volt logic lines between IC808 pins 1 and 2 and IC809 pins 1 and 4. 5-volt level CAN transmit data from SACC IC808 pin 1 is buffered by 3-state buffer IC812-1 and applied to IC809 pin 1. Likewise, 5-volt level CAN receive data from CAN link transceiver IC809, pin 4 is buffered by 3-state buffer IC812-2 and applied to SACC IC808 pin 2.

CAN link transceiver IC809 transfers and converts SACC IC808's separate single-ended receive and transmit 5-volt level CAN logic signals onto the common 2-wire differential CAN link. The 2-wire differential connections at U32 pins 6 and 7 are identified CANH (for CAN high) and CANL (for CAN low) on the schematic.

#### **10.1.1.6 RS-232 Serial Port Converters (IC821 and IC823)**

Integrated circuits IC821 and IC823 of the PK Board provide 3.3-volt to RS-232 level conversion for the radio's two serial ports. These are EIA/TIA-232-compliant serial level converters.

IC821 supports the serial port of the radio's rear panel 9-pin connector (DB-9). This is serial port A of the PK Board. This serial port is used for radio programming. It can also be used to interface to optional equipment such as a computer running Mobile Data Terminal (MDT) or similar software. Refer to Section 12.1 on page 108 for additional information.

IC823 supports the serial port of the radio's rear panel 44-pin connector (DB-44). This is serial port B of the PK Board. This serial port is not normally not used.

#### **10.1.1.7 Reset Circuit (IC819)**

IC819 is a low voltage detector with output delay used to reset the radio. The reset signal is generated when the +5V\_SW level is greater than 4.4 volts. The delay time is set by C831. The generated reset signal is then injected in IC801 at pin 12.

#### **10.1.1.8 Control and Status Register (CSR)**

The PK board's CSR functions as a 16-bit, 3.3V logic output port by providing sixteen latched logic outputs to various other logic circuits on the PK Board. It is formed by 16-bit transceiver and register IC804, 16-bit dual supply bus transceiver IC805, dual input OR gate IC807, buffer IC806, and associated resistors and capacitors. IC804 latches a 16-bit word sent to it via processor IC801's flash data bus, identified FLASH\_D(15:0) on the schematic. This 16-bit word is applied to IC805 for 1.8-volt to 3.3-volt logic level conversion via a secondary bus between the two transceivers identified CSR\_D(15:0). Circuit control originates from OMAP IC801's EMIFS traffic controller, IC801-1.

### **10.1.2 Audio Circuit**

The Audio Circuit provides the audio output to the speaker and is comprised of the Audio CODEC IC901, Audio Amplifiers IC903 and IC905, and the analog switch IC904.

#### **10.1.2.1 Audio CODEC (IC901)**

Audio CODEC IC901 converts digital audio to analog audio for RX and analog audio to digital audio for TX. IC901 is a high-performance audio codec with 16/20/24/32-bit, 97-dBA stereo playback, mono record functionality at up to 48 kbps. A microphone input includes a built-in preamp and hardware automatic gain control, with single-ended or fully-differential input capability.

Digitized audio signals transfer between IC901's digital audio processing circuits and OMAP processor IC801 via IC801's second Multichannel Serial Interface (MCSI2). A Serial Peripheral Interface (SPI) link interface between IC801 and IC901 is utilized to transfer control information from IC801's subsection 5 to IC901's internal control registers. This allows IC801 to set various IC901 operating parameters such as the reference voltage at IC901 pin 14, CODEC audio levels, and audio routing paths inside IC901.

#### **10.1.2.2 Audio Amplifier (IC903 and IC905)**

The Audio Amplifiers IC903 and IC905 are located between the CODEC and speaker amplifier. They amplify the output signal from the CODEC (IC901) to the adequate level for driving the speaker.

#### **10.1.2.3 Analog Switch (IC904)**

The Analog Switch (IC904) is used to mute the voice line. When the control signal on pin 4 is high, the voice line is active.

### **10.1.3 Voltage Regulators**

Voltage regulators IC907 and IC908 provide 5 volts DC for primary system control. Voltage regulator IC909 provides 1.6 volts DC for the OMAP core (IC801), FLASH (IC802), SRAM (IC803), and CODEC (IC901). Voltage regulator IC911 provides 3.3 volts DC for the OMAP (IC801) and SDRAM (IC822).

#### **10.1.4 GPS Receiver Unit (Optional)**

The optional GPS unit connects to J901 on the PK board.

## **10.2 RF PROCESSOR BOARD**

### **10.2.1 Receiver Circuit**

The RF Processor Board's receiver is a super-heterodyne receiver that operates in the 764 to 776 MHz range and the 851 to 870 MHz range in the 700 and 800 MHz receive band. The board employs an 82.2 MHz first intermediate frequency (IF) and a 2.16 MHz second IF. A receiver backend integrated circuit (IC) converts the 2.16 MHz second IF signal into a complex pair of I/Q baseband digital signals. The I/Q baseband digital signals are then transferred by a Synchronous Serial Interface (SSI) to the Digital Signal Processing (DSP) circuits on the radio's PK Board for digital filtering and demodulation. Final RF channel selectivity filtering for the different radio modes is performed by the DSP circuits on the PK Board.

The IF block consist of two 1st IF filter, 3 stages of IF amplifiers, RX IF level Limiter, and 2nd Mixer/2nd IF amp/ADC within IC301.

This block's function is filtering of the 1st IF signal and conversion from the 1st IF signal to the 2nd IF signal and conversion from 2nd IF signal to digital baseband signals by the Analog Digital Converter.

#### **10.2.1.1 Receiver Front-End**

The RF signal from the antenna is fed to the low-pass filters and switch (IC201). The RF signal is switched by IC201 to select the appropriate frequency band and is fed to the 1st band pass filter (FL201 or FL202). In the 700 MHz band, the RF signal passes through FL201, TR201, and FL203. In the 800 MHz band, the RF signal passes through FL202, TR202, and FL204. The low noise amplifier (TR201 and TR202) power source is switched by a transistor switch (TR203-TR206) for 700 MHz and 800 MHz respectively. The output of each amplifier is fed to the switch (IC202) and fed to the input of the 1st Mixer (IC203). These band pass filters reject noise or undesired out of band signals.

#### **10.2.1.2 First Mixer**

The 1st Mixer is an IC-Mixer (IC203) that converts an RF signal from the 764 MHz to 870 MHz frequency, to the 1st IF frequency (82.2 MHz).

To produce the 82.2 MHz intermediate frequency (IF), the 1st Local Oscillator signal is injected to the Mixer's lower side frequency (681.8 - 693.8 MHz) for the 700 MHz band and upper side frequency (933.2 - 952.2 MHz) for the 800 MHz band.

#### **10.2.1.3 First IF Amplifier and First IF Filter**

The 1st IF signal from the 1st Mixer output is input to the 1st IF Amplifier. The IF signal is filtered by the IF filters (FL301 and FL302) and it is amplified by the IF amplifier stage (TR301, TR302, TR311, and TR312). TR313 is not used. The filtered and amplified IF signal is applied to the IF Level Limiter.

#### **10.2.1.4 RX IF Level Limiter**

An automatic IF signal level limiter circuit is included between the output of the 1st IF amplifier (TR312) and the input of the IF IC (IC301). This closed-loop circuit employs a variable attenuator, a wide-band power detector, and an inverting op-amp buffer stage. The variable attenuator is installed in the path between the IF amp's output and the input of the IF IC (IC301). The power detector senses the power level of the IF signal applied to IF IC's input and the attenuator is adjusted via the op-amp buffer when the limiting point is reached. The limiting point is approximately -32 dBm at the input port of the IF IC.

### **10.2.1.5 Second Mixer, Second IF Amplifier, Second Local PLL**

The IF Receiver IC (IC301) is a one-chip IC for radio communication system. This IC includes the 2nd Mixer, the Analog Digital Converter, and the PLL synthesizer for the 2nd Local signal. The 1st IF signal is fed to the input port of the 2nd Mixer in IC301. The 2nd Mixer converts the 1st IF signal (82.2 MHz) to the 2nd IF frequency (2.16 MHz) with the synthesized 84.36 MHz 2nd Local signal.

An Analog-to-Digital Converter (ADC) circuit converts the receiver's 2.16 MHz 2nd IF signal to a complex pair of I/Q baseband digital signals. The I/Q baseband digital signals are then transferred by a Synchronous Serial Interface (SSI) to the Digital Signal Processing (DSP) circuits on the radio's PK Board for digital filtering and demodulation.

### **10.2.1.6 Second Local VCO**

The 2nd Local Oscillator signal is generated by the PLL synthesizer in the IF IC (IC301). The 2nd local VCO (TR321) generates the 2nd Local Oscillator signal (80.04 MHz or 84.36 MHz) which is injected to the 2nd Mixer through the 2nd Local amplifier (TR322, TR303). The 2nd PLL circuit controls the frequency of the 2nd Local Oscillator signal with high stability.

## **10.2.2 Transmitter Circuit**

### **10.2.2.1 IQ Modulator Circuit**

The RF Board has an IQ modulator IC (IC401) and related circuitry. The baseband signal is generated by the DAC (IC506) and switched by the switching IC (IC512). The switched baseband signal for the IQ modulator is fed to OP amps (IC402 to IC 404). Then the filtered signal is fed to IQ modulator (IC401) as I and Q signal.

#### **10.2.2.1.1 Baseband Signal Generator**

The baseband signal is generated in the DAC IC (IC506). The baseband signal contains the modulation signal and DC components. This DAC is common for direct FM modulation. In case of IQ modulation, the baseband signals are fed to the OP amp filters via the switch IC (IC512) as I and Q signal.

#### **10.2.2.1.2 Baseband Filter**

The baseband signals are filtered in the OP amp (IC402 to IC404). These filter circuits generate inverse signals for each I and Q to convert balanced signals. The balanced I and Q signals are fed to the IQ modulator IC (IC401).

#### **10.2.2.1.3 IQ Modulator**

The IQ modulator IC (IC401) has two functions. For IQ modulation, IC401 works as an IQ modulator. The modulated output frequency of the IQ modulator is half of its input frequency. For direct FM modulation, IC401 works as a frequency divider. The output of the IQ modulator is fed to TX mixer via a low-pass filter circuit.

### **10.2.2.2 TX IF LO Mixer**

The RF Board's transmit IF LO mixer stage mixes the output of the RF synthesizer's output with the transmit IF LO signal (112.2 MHz or 127.2 MHz). The Transmit IF LO frequency is selected by the radio operating frequency. The mixed signal is then bandpass filtered, amplified, and applied to the PA circuit. The mixer stage is formed by IC601 and the associated components.

### **10.2.2.3 TX Bandpass Filter**

The TX RF signal from the output of the transmit IF LO mixer is filtered by the switchable transmit bandpass filter. This circuit includes six RF switches (IC602 - IC607), low-pass filter, high-pass filter, and four RF bandpass filters (FL601 - FL 604).

The appropriate filter is selected by the control signal to reject spurious and out-of-band noise.

### **10.2.2.4 RF Amplifier**

The RF input signal is input to the TX Amplifier (TR101) from the TX bandpass filter. Input frequency ranges are 764 to 776 MHz, 794 to 806 MHz, 806 to 825 MHz, and 851 to 870 MHz.

The RF signal is amplified to about +1 dBm. The output of TX AMP1 is input to the 1 dB attenuator and that output signal is input to TX AMP2 (TR111). The RF signal is amplified to about +9 dBm at TX AMP2. The output of TX AMP2 is input to the 1 dB attenuator and that output signal is input to TX AMP3 (TR121). The output signal level of TX AMP3 is approximately +16 dBm. TX AMP1 (TR101) and TX AMP2 (TR111) are controlled by TXENB2+. TX AMP3 (TR121) is controlled by TXENB+.

### **10.2.2.5 Driver Amplifier**

The RF signal output from TX AMP3 (TR121) is input to the 4 dB attenuator. That RF signal is input to the driver amplifier (TR131). The RF signal is amplified to approximately +20 dBm at the driver amplifier. The driver amplifier (TR131) is controlled by TXENB+.

That output of the driver amplifier is input to the variable attenuator and that output signal is input to the PA module. The minimum loss of the variable attenuator is approximately 2 dB and the PA module input signal is approximately +17 dBm.

### **10.2.2.6 PA Module**

The RF output of TR131 is input to the PA module (IC141). The RF signal is amplified to approximately 30 watts by the PA module. The power control circuit controls the gain control voltage of the PA Module. The PA module power supply voltage is supplied from A+. The PA module is a Class-AB 2-stage FET amplifier.

### **10.2.2.7 Automatic Power Control**

The Automatic-Power-Control circuit (APC) controls the output power to the antenna to maintain a constant power level. The APC circuit controls the gate voltage (V<sub>gg</sub>) of the second stage to control the gain of the PA module (IC141) and the variable attenuator (CD101 and CD102).

The directional coupler picks up TX power and the picked up power is supplied to diode CD142 for rectifying. Diode CD142 produces positive DC voltage proportional to the TX-power level. Also, when the RF-load is mismatched, the directional coupler picks up the reflected power from antenna port. That reflected power is rectified in diode CD141 (the rectifying circuit).

Each rectified signal is summed in the adder circuit (R159, R160, and R161). The added signal is compared to "HPA\_BIAS" by TR261. "HPA\_BIAS" is produced from the DAC in MCU IC701. The collector of TR261 is connected to the DC amplifier (TR262 and TR263) via IC261. The output signal of TR262 and TR263 is connected to the V<sub>gg</sub> terminal of IC141 and the variable attenuator (CD101 and CD102). The V<sub>gg</sub> is the control port for TX power and the TX power is controlled with the compared signal in TR261.

The temperature monitor circuit (RT101 and TR171) performs thermal monitoring and detection for PA module protection. When the temperature of the PA module heat sink is higher than +90° C, this circuit senses the temperature of the PA heat sink and reduces TX output power.

### 10.2.2.8 Antenna Switch and Low-Pass Filter

The antenna switch consists of CD147, CD148, CD161, CD162, IC181, and TR161. The low-pass filter consists of the micro-strip line and C162 - C171. During TX operation, the “TXENB+” signal is switched high level.

The “TXENB+” signal from the Micro Controller Unit (MCU) is connected to the base of TR253, TR255, TR258, and TR268. The status of TR253, TR255, TR258, and TR268 are ON while “TXENB+” is high level.

The +9V\_TX2 line becomes 9 volts. Then the switch (IC181) and diode impedance for the antenna switch are produced low and the output power from the PA module passes to the low-pass filter. The TX power feed through into the receiver is reduced by diodes and switch CD161, CD162, and IC181.

During RX operation, the “TXENB+” signal level is low and the transistor TR161 is OFF. The bias current for the switching diodes is zero and the impedance of antenna switch diode becomes high. The receiver RF signal from the antenna port is input to L161 circuit through the low-pass filter.

### 10.2.3 Synthesizer Circuit

The RF Processor Board employs RF Local synthesizers for transmit and receive, a transmit IF synthesizer, and a 2nd Local synthesizer in the Rx IF IC (IC301). Each synthesizer's operating frequency is determined by data received from MCU IC701 based upon the radio's current operating mode and programming channel. The PLL frequency synthesizer IC (IC501) integrates RF fractional frequency synthesizer with IF Integer-N frequency synthesizer.

### 10.2.4 Reference Oscillator

The reference oscillator is a VC-TCXO (Voltage Control Temperature Controlled Compensated Crystal Oscillator). The standard reference oscillator frequency is 14.4 MHz.

The VC-TCXO is enclosed in a shielded can for RF guard. The VC-TCXO frequency is compensated by an internal temperature compensated circuit against both low and high temperatures. The VC-TCXO frequency is compensated within +/-1.5 ppm frequency range under temperatures from -30° C to +60° C. The TCXO control terminal has +/-7.5 to 12.5 ppm of tuning range and is used for AFC (Automatic Frequency Control).

#### 10.2.4.1 RF Local Synthesizer Circuit

The RF Local Synthesizer circuit receives PLL data and control information from the MCU based on the synthesizer data from the OMAP. This circuit generates RF Local frequency for the TX/RX RF frequencies.

The synthesizer circuit consists of the reference oscillator, the PLL frequency synthesizer IC, the loop filter, the RF VCO, and the feedback buffer amplifier. The RF VCO is locked on the divided frequency of the reference oscillator by a single synthesis loop consisting of the feedback buffer and the PLL frequency synthesizer IC that has internal divider and pre-scalars.

There are two RF VCOs; one is for the 700 MHz band and the other is for the 800 MHz band. Both RF VCOs generate the RX 1st local signal and the transmit local signal. The circuit provides lock/unlock information to the MCU.

##### 10.2.4.1.1 PLL Frequency Synthesizer IC

The RF synthesizer IC (IC501) consists of a pre-scalar, programmable reference oscillator divider (that uses “R” counter), phase detector, and programmable VCO dividers that use “+N” and “A” counters. R

fixed integer number divides the reference frequency (14.4 MHz) of the reference oscillator to obtain a channel reference (200 kHz) for the synthesizer.

The VCO output frequency is divided by the pre-scalar. The pre-scalar output is divided by the “+N” and “A” counter. The “+N” and “A” counter are programmed by the MCU to divide the VCO frequency to 200 kHz.

The internal phase detector compares the output from the reference divider with the output from internal “+N”, “A” counter. The “+N”, “A” counter receive the divided signal, whose source is the VCO output signal, by Pre-scalar. The counters are programmed by the MCU.

#### **10.2.4.1.2 Loop Filter**

The loop-filter consists of IC503, IC504, TR501 through TR506, and some passive devices. This filter controls the bandwidth and stability of the synthesizer loop. The FET-switches (TR505 and TR506) in the loop filter circuit are controlled by “PLLST2-” for the speeding up of PLL-lock-time. The output signal of the loop filter is fed to the varactor diodes in the RF local VCOs and TRX frequency is controlled and maintained.

#### **10.2.4.1.3 RF Local VCO**

There are two RF Local VCOs. VCO1 is for the 700 MHz band and VCO2 is for the 800 MHz band.

The 700MHz Local VCO consists of bipolar transistor oscillator TR404 and the associated components. Oscillation frequency is determined by the dielectric resonator (L411), varactor diodes (CD410 - CD413), and trimmer capacitor CV402. Its oscillation frequency is 651.8 MHz to 693.8 MHz. The oscillator transistor power is controlled by the transistor switch (TR405). TR405 is turned ON for the 700 MHz band.

The 800 MHz Local VCO consists of bipolar transistor oscillator TR408 and the associated components. Oscillation frequency is determined by the dielectric resonator (L412), varactor diodes (CD420 - CD423), and trimmer capacitor CV403. Its oscillation frequency is 933.2 MHz to 982.2 MHz. The oscillator transistor power is controlled by the transistor switch (TR409). TR409 is turned ON for the 800 MHz band.

The Local VCOs output are connected to input port of the high gain buffer amplifier (TR410). The buffer amplifier output is divided to three by R444, R445, R447, and C494 and connected to the PLL feed back amplifier, RX\_Lo\_Amp, and the local port of the TX mixer.

#### **10.2.4.1.4 Feedback Buffer Amplifier**

The divided signal after the local VCO buffer (TR410) for PLL feedback is amplified to -5 dBm by feedback amplifier TR514 and fed to the PLL frequency synthesizer IC.

#### **10.2.4.1.5 Dual-Modulus Pre-Scalar**

The Dual-Modulus Pre-scalar is included in the PLL frequency synthesizer IC (IC501).

The Pre-scalar divides the RF frequency. The output of the Pre-scalar is supplied to the internal “+N”, “A” counter for division down to 200 kHz. The phase is compared between the divided-down frequency and the internal reference oscillator. The result of this comparison is current of detected phase error that is used to lock on frequency. The “+N”, “A” counter value is provided from the MCU.

#### **10.2.4.1.6 Lock Detect**

The “Lock Detect” signal is output from IC501. In case of an unlock condition, lock detect signal SYNTH1\_LOCK goes to “L.”

#### **10.2.4.2 TX IF Local Synthesizer Circuit**

The TX IF LO synthesizer generates a local oscillator (LO) transmit IF signal (112.2 MHz or 127.2 MHz). The oscillation frequency depends on the radio operation band. For 806 to 825 MHz transmitting, the frequency is 127.2 MHz. For 700 MHz transmitting, the frequency is 112.2 MHz. The synthesizer's output is phase-locked to the board's 14.4 MHz reference oscillator. The synthesizer only requires a comparison frequency (tuning resolution) of 25 kHz. The intermediate frequency LO signal is mixed with the RF LO signal from the output of the RF local synthesizer (651.8 MHz – 693.8 MHz, 933.2 - 982.2 MHz) to produce a transmit RF signal.

##### **10.2.4.2.1 PLL Frequency Synthesizer IC**

Same as Section 10.2.4.1.1.

##### **10.2.4.2.2 Loop Filter**

The PLL active loop filter is formed by op-amp IC511 and associated components. This circuit filters the charge-pump output signal (CPOUTIF) from IC501 to generate the VCONT\_IF tuning voltage.

##### **10.2.4.2.3 Feedback Buffer Amplifier**

The output signal of the local VCO is divided by R411, R412, and R413. The divided signal for PLL feedback is amplified to -5 dBm by feedback amplifier TR507.

##### **10.2.4.2.4 Modulation Circuit**

The modulation circuit is formed by op-amp IC505 for PM modulation, D/A converter IC506 to generate Voice and Data, and logic components IC507 - IC510, IC1501 to provide master clock to DAC. The output signal from the DAC is injected to the modulation varactor diode (CD402) in the TX VCO for FM Modulation via IC512 in case of direct FM. The output of the DAC is fed to the op-amp (IC505) and it is integrated at IC505 for PM modulation. The output signal from the DAC is injected to the active filter (IC402, IC403, and IC404) for IQ modulator via IC512 in case of IQ modulation.

##### **10.2.4.2.5 TX IF VCO**

The TX IF VCO is an oscillator with a tank circuit that consists of various capacitors and coils. This is a Colpitts type oscillator. The IF VCO consists of bipolar transistor oscillator TR401, varactor diode CD401 for tuning, varactor diode CD402 for modulation, and switching diodes CD403 and CD404 for band switching. The oscillation frequency is 224.4 MHz or 254.4 MHz. This frequency is switched according to the transmit frequency band.

The output level of the VCO is typically -10 dBm for coupled buffer amplifier inputs. The IF VCO output is fed to the high gain buffer amplifier (TR403). The output of the buffer amplifier is divided into two outputs; one is fed to the PLL IC and the other is fed to the IQ modulator TX MIXER.

##### **10.2.4.2.6 Active Filter**

The op amp (IC402, IC403, and IC404) consists of an active filter. This filter rejects noise in the IQ baseband signal. DC bias voltage is summed at the OP amps. The I and Q signal is inverted at IC402 and IC403 to change for complemented signal.

##### **10.2.4.2.7 IQ Modulator**

The IQ modulator (IC401) modulates the TX IF carrier. The injected frequency is divided by 2 at the IQ modulator. The output frequency is 112.2 or 127.2 MHz.

### **10.2.5 Micro Controller Unit (MCU)**

The Micro Controller Unit (IC701) performs all setup and local control functions for the RF Processor Board. This mixed signal microcontroller has an 8051-type 8-bit core that can perform up to twenty-five million-instructions-per second (25 MIPS at 25 MHz clock rate).

Other circuits integrated into IC701 and used by the RF Processor Board include:

- **64K Bytes of Flash Memory** - This memory stores the RF Processor Board's operating firmware. It is flash programmed at the factory.
- **4K Bytes of Random-Access Memory (RAM)** - The operating firmware uses this memory for "scratch pad" functions. No external RAM is required on the RF Processor Board.
- **I2C Communications Port** - A 2-wire I2C-type serial inter-board communications link between IC701 and the OMAP processor on the PK Board passes commands and status messages back-and-forth between the two boards. All commands originate from the OMAP processor on the PK Board and all status messages originate from IC701. This type of interface is sometimes referred to as a "System Management Bus."
- **Serial Peripheral Interface (SPI) Bus** - Internal SPI bus is used to load the frequency programming data into the on-board phase-lock-loop RF/IF synthesizer IC, to load the configuration data into the receiver's IF IC.
- **Twenty-Three Digital Output Bits** - These digital output lines provide logic control for various circuits on the RF Processor Board, such as those for 700/800 MHz RF band switching, talkaround/non-talk-around mode switching, and gating control for the SPI logic signals during loads of the on-board phase-lock-loop RF/IF synthesizer IC.
- **Seven Digital Input Bits** - IC701 uses these digital input lines to monitor various conditions such as the state of the radio's vehicle ignition sense input and the phase-lock status of the on-board RF/IF synthesizers.
- **Two 12-Bit Digital-to-Analog Converter (DAC) Channels** - One IC701 DAC channel output is used during factory calibration of the board's 14.4 MHz reference oscillator, and to implement automatic frequency control (AFC) of this oscillator during 700/800 MHz RF band operations. This oscillator provides the 14.4 MHz reference clock for the entire radio (for the RF Processor Board and the PK Board). The other IC701 DAC channel output provides the reference voltage in the transmitter to support the radio's Automatic Power-level Control (APC) loop function.
- **Five 10-Bit Analog-to-Digital Converter (ADC) Channels** - IC701 uses these ADC channel inputs to detect various conditions such as the transmitter power and the frequency band type of the RF Processor Board.

## 11. MAINTENANCE

### 11.1 GENERAL INFORMATION

Performance test procedures for a complete radio installation are included in the radio's installation manual.



**Improper radio service may void the radio's RF integrity and cause it to violate FCC rules and regulations. Do not return the radio to field use until it is fully tested to ensure proper operation.**

**The PK Board and the RF Processor Board are serialized during final testing and tuning procedures at the factory. If a board is replaced, always successfully complete all applicable test and alignment procedures presented in this manual before returning the radio to the customer. The radio should also be fully tested and (where necessary) aligned if any component in an RF signal path is replaced, retuned, or disturbed in any way.**

### 11.2 PREVENTIVE MAINTENANCE

Preventive maintenance on the radio installation should be performed periodically. Harris Corporation recommends performing preventive maintenance on an annual basis, or more often in harsh environments such as an installation in a fire truck. Preventive maintenance should include:

- Inspecting all mobile radio related hardware to verify it is in place and secure. Any missing or loose hardware should be replaced and/or tightened as necessary.
- Inspecting all control head related hardware to verify it is in place and secure. Any missing or loose hardware should be replaced and/or tightened as necessary.
- Inspecting all cabling to verify it is not damaged, it is securely tied-and-stowed, and all related cable connectors are tight. Repair as necessary.
- Performing radio and antenna system performance test as described in the radio's installation manual. Repair as necessary.
- Verifying overall radio operation by performing an operations check.

### 11.3 STATUS AND ERROR CODES DISPLAYED AT CONTROL HEAD

#### 11.3.1 Status Codes for OpenSky Mode

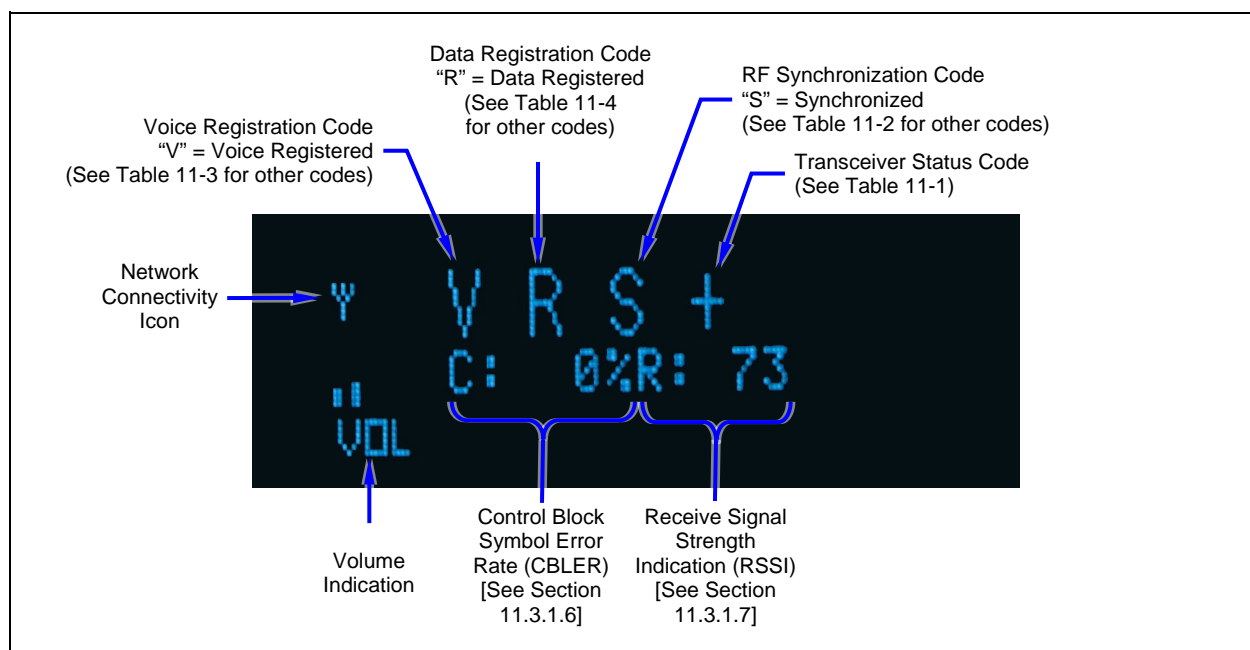
Tables in this section list OpenSky mode status codes that may be displayed at the control head if the "Engineering Display" is available. A typical Engineering Display is shown in Figure 11-1. A radio does not have access to this display if the Engineering Display menu selection is disabled per radio's menu configuration. In this case, use the following procedure to enable the Engineering Display menu selection. Before returning the radio to the customer/operation, use the subsequent procedure to disable the menu selection.

##### 11.3.1.1 To Enable and Access the Engineering Display

Use this procedure to enable the Engineering Display menu selection and access the Engineering Display:

1. Connect a PC running a terminal application such as Microsoft Windows HyperTerminal to the radio using an appropriate serial cable connection.

2. Configure the terminal application to use the respective PC serial port (COM1 for example), VT100 terminal emulation, a data rate of 19,200 bps, 8 data bits, 1 stop bit, no parity, and no flow control.
3. Power-up the radio.
4. From the terminal application, send the following command to the radio:  
**at\*\*menuon 14**
5. At the control head, scroll through the menu until Engineering Display is appears. A typical display is shown in Figure 11-1.



**Figure 11-1: Typical Engineering Display (OpenSky Mode Only)**



**NOTE**

The menu structure can be displayed by querying the radio with an **at\*\*menu ??** command followed by an **at\*\*menu ?** command.

### 11.3.1.2 To Disable the Engineering Display

Use this procedure to disable the Engineering Display menu selection:

1. Connect a PC running a terminal application such as Microsoft® Windows HyperTerminal to the radio using an appropriate serial cable connection.
2. Configure the terminal application to use the respective PC serial port (COM1 for example), VT100 terminal emulation, a data rate of 19,200 bps, 8 data bits, 1 stop bit, no parity, and no flow control.
3. Power-up the radio.
4. From the terminal application, send the following command to the radio:  
**at\*\*menuoff 14**
5. At the control head, scroll through the menu to verify the Engineering Display menu selection is not available.

### 11.3.1.3 Transceiver Status Codes

The Engineering Display's transceiver status code is a plus symbol (“+”) during normal operation of the transceiver-related circuits in the radio. Other transceiver status codes are listed in Table 11-1.

**Table 11-1: Transceiver Status Codes for OpenSky Mode**

DISPLAYED CODE	MEANING
+	No transceiver problems detected.
C	Transceiver has a problem in its RF combiner circuits.
O	Transceiver is too hot (over-temperature).
P	Transceiver has a problem in its RF synthesizer circuits.

### 11.3.1.4 RF Synchronization Codes

The Engineering Display's RF synchronization code is an “S” during normal OpenSky RF channel operation. Other codes related to RF synchronization are listed in Table 11-2.

**Table 11-2: RF Synchronization Codes for OpenSky Mode**

DISPLAYED CODE	MEANING
*	No signal.
P	Training progressing.
S	Forward RF Channel Synchronization.
Z	Persistent deactivation.

### 11.3.1.5 Voice and Data Registration Codes

The Engineering Display's voice and data registration codes identify the current registered operational status of the radio on the OpenSky network. Voice registration is granted by the VNIC (Voice Network Interface Controller) computer and data registration is granted by the MDIS (Mobile Data Intermediate System) computer. The codes are listed in Table 11-3 and Table 11-4 respectively. To enable the Engineering Display, see Section 11.3.1.1.

**Table 11-3: Voice Registration Codes for OpenSky Mode**

DISPLAYED CODE ENGINEERING DISPLAY	DISPLAYED TEXT DWELL DISPLAY	RETRY	MEANING
–	(none)	No	Idle (not registering)
a	VDENIED	Yes	Voice denied: Unknown error per VNIC.
b	BAD VID	No	Voice denied: Invalid voice user ID. Check user ID number.
c	(none)	No	Duplicate user ID
d	(none)	No	Unknown IP address
e	(none)	No	Duplicate IP address

Table 11-3: Voice Registration Codes for OpenSky Mode

DISPLAYED CODE ENGINEERING DISPLAY	DISPLAYED TEXT DWELL DISPLAY	RETRY	MEANING
f	BAD PWD	No	Voice denied: Missing password.
g	BAD PWD	No	Voice denied: Invalid password received by the VNIC.
h	HOM DWN	Yes	Voice denied: Home VNIC down/unreachable.
i	SRV BSY	Yes	Voice denied: Serving VNIC busy/congested.
j	(none)	Yes	Voice denied: Aged registration sequence number.
k	MAX USR	Yes	Voice denied: Too many login instances for specified user ID. OpenSky allows one user ID to log onto the radio network at up to three (3) different radios. Use *0## command or power down one of the other radios to de-register it.
l	NAS BSY	Yes	Voice denied: The system cannot provision the radio. NAS changing talk group or administrative update currently in progress.
m	(none)	No	VNIC does not support the specified protocol version.
n	NOAUTHM	No	Radio failed voice mutual authentication by the network; its response was incorrect.
o	NOSUPRT	No	Radio does not support required provisions. It may be using old/incompatible software.
R	(none)	Yes	Registration paused. The last registration attempts failed possibly due to network congestion. Registration will restart after a brief delay.
V	(none)	No	Radio is voice registered.
v	(none)	No	Radio's voice registration pending.
x	NOAUTHV	No	VNIC failed voice mutual authentication. VNIC response was incorrect.
1	(none)	No	Radio sent an authentication challenge or response message to the network.
2	(none)	No	Radio received an authentication challenge or response message from the network (VNIC).

Table 11-4: Data Registration Codes for OpenSky Mode

DISPLAYED CODE ENGINEERING DISPLAY	DISPLAYED TEXT DWELL DISPLAY	RETRY	MEANING
–	(none)	Yes	Idle (not registering)
A	(none)	Yes	Authenticated
a	UNK ALG	No	Unknown/Unsupported encryption algorithm.
b	MDISBSY	Yes	MDIS currently cannot handle request.
B	(none)	Yes	MDIS currently cannot handle request.

Table 11-4: Data Registration Codes for OpenSky Mode

DISPLAYED CODE ENGINEERING DISPLAY	DISPLAYED TEXT DWELL DISPLAY	RETRY	MEANING
c	NOAUT12 <sup>5</sup> NOREPLY <sup>6</sup>	Yes	No response from MDIS. If condition persists in strong signal conditions, contact the system administrator.
d	(none)	No	Awaiting de-registration response
d	UNK DOM	No	Unknown home domain. Radio's data registration is pending. If condition persists in strong signal conditions, contact the system administrator.
E	(none)	Yes	Data link established
e	BADEKEY	No	Invalid end-system public key sequence number (EPKSN).
f	NOAUT05 <sup>5</sup> BADMDIS <sup>6</sup>	No	MDIS failed mutual authentication. If condition persists in strong signal conditions, contact the system administrator.
i	BADIKEY	No	Invalid infrastructure public key sequence number (IPKSN).
k	NOAUT11 <sup>5</sup> NOAUTHM <sup>6</sup>	No	Radio failed data mutual authentication. If condition persists in strong signal conditions, contact the system administrator.
m	UNK MES	No	Unknown Mobile End System (radio). If condition persists in strong signal conditions, contact the system administrator.
n	(none)	Yes	No status yet. Security Management Entity (SME) not attempted.
p	(none)	No	Awaiting registration response
P	DUP IP <sup>7</sup>	No	IP address is already in use.
R	(none)	No	Radio is data registered.
r	(none)	No	Releasing TEI
s	(none)	Yes	Public key initialized
T	(none)	No	Temporary Equipment Identifier (TEI) assigned from MDIS.
t	(none)	No	Awaiting TEI assignment
u	MDENIED	Yes	Unspecified error
U	UNK ERR <sup>7</sup>	Yes	Unknown error.
w	SMEWAIT <sup>5</sup>	No	Awaiting authentication confirmation
y	KEYSYNC	No	Mismatched encryption key sequence number.
z	BADSIZE	No	Unsupported MDIS encryption key size.
1	NOAUT01 <sup>5</sup> MDENIED <sup>6</sup>	Yes	Unspecified MDIS error. If condition persists in strong signal conditions, contact the system administrator.

<sup>5</sup> Prior to OTP version R14B.<sup>6</sup> OTP version R14B and later.<sup>7</sup> OTP version R15A and later.

Table 11-4: Data Registration Codes for OpenSky Mode

DISPLAYED CODE ENGINEERING DISPLAY	DISPLAYED TEXT DWELL DISPLAY	RETRY	MEANING
2	MDISBSY <sup>7</sup>	Yes	MDIS currently cannot handle request. If condition persists in strong signal conditions, contact the system administrator.
3	UNAUTH3	No	Network ID not authorized. Check radio's IP address.
4	UNAUTH4	No	Bad authentication.
5	UNAUTH5	No	Unsupported authentication.
6	MDISBSY <sup>8</sup> MAX NEI <sup>7</sup>	Yes	NEI has exceeded usage limitations.
7	DUP IP <sup>8</sup> MDENIED <sup>7</sup>	No	Unspecified error.
8	IPBCAST <sup>7</sup>	No	NEI is identical to broadcast.
9	NOREPLY <sup>7</sup>	Yes	Home MDIS is unreachable.

### 11.3.1.6 Control Block Symbol Error Rate (CBLER)

As illustrated in Figure 11-1, the Engineering Display's CBSER value indicates data distortion or interference on the RF channel currently being used by the radio. A zero (0) represents no errors. When operating in RF fringe areas, this number may increase as interference in the received data signals increases.

### 11.3.1.7 Receive Signal Strength Indication (RSSI)

As illustrated in Figure 11-1, the Engineering Display's RSSI number represents, in absolute value, the dBm level of the signal received from the OpenSky's base station transmitter. It represents a negative unit of measure; however, a negative/minus sign does not precede the number in the display. Because the displayed number represents a negative value, higher/increasing numbers represent lower/decreasing received signal strengths.

- Values lower than -110 (125 for example) indicate a possible antenna problem, or radio operation in a fringe or no-coverage area.
- Higher RSSI values, -73 for example (displayed 73), with CBSER values greater than zero (0) generally indicate RF interference is being induced into the radio's antenna system along with the received signal.

It is not uncommon for an OpenSky signal with low RSSI and degraded CBSER to be decoded by the radio and heard at the speaker without any problem.

## 11.3.2 Error Codes for EDACS, Conventional and P25 (ECP) Modes

The following table lists and defines error codes for EDACS, conventional, and P25 modes. Fatal errors typically cause the radio to automatically reset after a short delay. For non-fatal errors, the radio will typically resume operation after a short delay.

<sup>8</sup> Prior to OTP version R15A.

Table 11-5: Error Codes for EDACS, Conventional and P25 (ECP) Modes

DISPLAYED CODE	MEANING
<b>FATAL SYSTEM ERROR CODES:</b>	
<b>Startup Errors</b>	
(0x0001)	Non-maskable interrupt occurred outside of sleep routine
(0x0002)	32k RAM test error
(0x0003)	Not used
(0x0004)	Flash memory checksum test error
(0x0005)	Flash memory part is unknown
(0x0006)	FIPS random IV test error
(0x0007)	FIPS bypass test error
(0x0008)	FIPS no voice keys error
(0x0009)	Flash memory write error
(0x0010)	Timing generator driver failed initialization
(0x0011)	DSP driver failed initialization
(0x0012)	Abbie driver failed initialization
(0x0013)	EEPROM memory driver failed initialization
(0x0014)	ICP digital failed initialization
(0x0015)	INTOUT driver failed initialization
(0x0016)	INTIN driver failed initialization
(0x0017)	RADIO driver failed initialization
(0x0018)	MODEM driver failed initialization
(0x0019)	EXTIO driver failed initialization
(0x0020)	SCI driver failed initialization
(0x0021)	ICP PROM checksum error
(0x0022)	I2C driver initialization error
(0x0023)	I2C driver mode change error
(0x0024)	I2C driver write error
(0x0025)	UART driver failed initialization
(0x0026)	Timer failed initialization
<b>ADI Driver Fatal Error Codes</b>	
(0x0030)	ADI did not respond to command
(0x0039)	FIPS DES self test had incorrect result
<b>LCD Driver Fatal Error Codes</b>	
(0x0040)	LCD did not acknowledge message
(0x0041)	LCD hardware is invalid
<b>SCI Driver Fatal Error Codes</b>	
(0x0050)	SCI out of heap space
<b>CAN Driver Fatal Error Codes</b>	
(0x0060)	CAN server semaphore initialization failure
<b>IPC DSP Driver Fatal Error Codes</b>	
(0x0070)	DSP did not read a message within 500 milliseconds

Table 11-5: Error Codes for EDACS, Conventional and P25 (ECP) Modes

DISPLAYED CODE	MEANING
(0x0071)	DSP gave a response longer than buffer
(0x0072)	DSP did not read stream data within 500 milliseconds
(0x0073)	ARM tried to write more data than DSP could store
(0x0074)	ARM tried to write DSP code and failed
(0x0075)	ARM did not get an acknowledgement of a command to the DSP
<b>Radio Driver Fatal Error Codes</b>	
(0x0080)	Transceiver failed to program synthesizer due to data collision(s)
(0x0081)	Transceiver failed to program MCU
(0x0082)	Transceiver failed to find proper calibration data
(0x0083)	Transceiver MCU failed to program receiver ADC
<b>Boot Loader Fatal Error Codes</b>	
(0x0090)	No memory space for ROM task
(0x0091)	No memory space for BL task
(0x0092)	Boot loader could not attach to SCI
<b>MCBSP Fatal Error Codes</b>	
(0x0093)	McBSP configuration error
<b>RXSIF Primitive Fatal Error Codes</b>	
(0x0098)	RXSIF fatal error
<b>Operating System Fatal Error Codes</b>	
(0x0100)	Interrupt had no handler
(0x0101)	Pre-fetch abort handler
(0x0102)	Data abort handler
(0x0103)	Reserved interrupt handler
(0x0104)	Unexpected interrupt handler
(0x0105)	Interrupt handler failed to set-up the IRQ
(0x0106)	OS fork creation process failed
(0x0107)	OS pipe creation process failed
(0x0108)	OS task creation process failed
(0x0109)	Task stack overflowed
(0x0110)	OS timer task creation failed
(0x0111)	OS returned fatal error
(0x0112)	OS fork stack overflowed
(0x0113)	OS priority fork stack overflowed
(0x0114)	GPIO config was wrong - check radio config
(0x0115)	MPUIO config was wrong - check radio config
(0x0116)	Could not set radio type right using sector 0
(0x0117)	Failure in download system
(0x0118)	Memory allocation failed
(0x0119)	Semaphore pending error
(0x0120)	Semaphore post operation error
(0x0121)	OS fork stack had nucleus error

Table 11-5: Error Codes for EDACS, Conventional and P25 (ECP) Modes

DISPLAYED CODE	MEANING
(0x0122)	OS priority fork stack had nucleus error
<b>FATAL APPLICATION ERROR CODES:</b>	
<b>RADC Fatal System Error Codes</b>	
(0x2200)	PERS tracking data error
(0x5201)	PERS hardware data error
(0x4202)	PERS frequency data error
(0x1203)	PERS tracking data memory error
(0x1204)	PERS tracking data checksum error
(0x1205)	Hardware revision could not be determined
<b>DACS Fatal System Error Codes</b>	
(0x3300)	No lock message
(0x1301)	Unable to correctly configure modem for EDACS operation
(0x1302)	ProSound scan failed
(0x1303)	CISYS message buffer not enabled
(0x1304)	Failure in Tx frequency load
(0x1305)	Failure in Rx frequency load
(0x1306)	Failure to transmit CC header data
(0x1307)	Failure to set up CC receiver
(0x1308)	Failure to set up WC receiver
(0x1309)	Failure to set up WC LSD receiver
(0x1310)	Failure to set up WC HSD receiver
(0x1311)	Failure to transmit body of CC message
(0x1312)	Failure to idle transmitter
(0x1313)	Failure to transmit body of WC message
(0x1314)	Failure in RADC speaker function
(0x1315)	Failure to transmit WC HSD
(0x1316)	Failure to select TX hardware path
(0x1317)	Failure to transmit DTMF digit
(0x1318)	Failure to transmit LSD
(0x1319)	Failure of HSD sync setup
<b>EA Fatal System Error Codes</b>	
(0x1350)	Memory failure message
<b>Conventional Fatal System Error Codes</b>	
(0x1400)	Error calling RADC function
(0x3401)	Synthesizer became unlocked
(0x1402)	UI message buffer not enabled
(0x1403)	Conventional digital voice modem overflow
(0x1404)	Conventional digital voice modem underflow
(0x1405)	Unable to correctly configure the modem for conventional digital voice operation
(0x5407)	Conventional personality error

**Table 11-5: Error Codes for EDACS, Conventional and P25 (ECP) Modes**

DISPLAYED CODE	MEANING
(0x1408)	Error calling RADC function in ECP1 scan
(0x1409)	Error calling RADC function in CHANUTIL - channelized
(0x1410)	Error calling RADC function in CHANUTIL - absolute frequency
(0x1411)	Error calling RADC function in CONVTX – channelized
(0x1412)	Error calling RADC function in CONVTX - absolute frequency
(0x1413)	Error calling RADC function in CONVTX - idle mode
(0x1450)	Error calling RADC function in CONVTX - idle mode
(0x1451)	Error calling RADC function in trunked P25
(0x1452)	Error reading serial number
(0x1453)	Bad message type requested
<b>Personality Interface Fatal System Error Codes</b>	
(0x5500)	Personality data is not present
(0x5501)	Flash personality Cyclic Redundancy Check (CRC) did not match EEPROM's CRC
(0x5502)	Personality descriptor table CRC error
(0x1503)	Descriptor table memory error
(0x5504)	Custom frequency set table error
<b>User Interface Fatal System Error Codes</b>	
(0x5600)	Input/Output device error
(0x1601)	Out of memory
(0x1602)	Maximum number of timers exceeded
(0x1603)	Too many open windows
(0x1604)	Out of memory
(0x1605)	Invalid parameter
(0x1606)	RI BBOS message buffer full error
(0x1607)	RI System (EDACSBOS message buffer full error)
(0x1608)	CI BBOS message buffer full error
(0x5609)	I/O device type from personality not supported
(0x1610)	No more memory
(0x5611)	Network I/O device error
(0x6612)	Control head ID is invalid
(0x5613)	No tone data is available in personality
(0x1614)	UI IBBOS message buffer full error
(0x1615)	No more memory
(0x1616)	No more memory
(0x1617)	UI message received error
<b>Test Unit Fatal System Error Codes</b>	
(0x1701)	Rx message buffer memory failed
(0x1702)	Tx message buffer memory failed
(0x1703)	BB message to UI task failed
(0x1704)	BB message to RISYS task failed
(0x1705)	BIOS call for voter monitor failed

Table 11-5: Error Codes for EDACS, Conventional and P25 (ECP) Modes

DISPLAYED CODE	MEANING
<b>FIPS 140 Fatal System Error Codes</b>	
(0x1902)	Invalid DESMAC key
(0x1903)	DESMAC checksum failed
(0x1904)	DESMAC DSP attach failed
<b>RI Fatal System Error Codes</b>	
(0x6901)	Multi-radio devices stopped communicating
<b>NON-FATAL APPLICATION ERROR CODES:</b>	
<b>Common Error Messages</b>	
(1)	Feature encryption error message
(2)	Synthesizer unlocked
(3)	No key banks allocated in personality
(5)	Tracking data was in error; using default
(6)	Dual personality recoverable error message
(7)	G-STAR error
(8)	Tone encode error
(9)	Traffic encryption keys Cyclic Redundancy Check (CRC) error
(10)	DSP did not respond to key query
(11)	AES configuration error
(12)	DES configuration error
<b>Flags to Set Persistent Error Messages</b>	
(0x8000)	Set persisting error condition, error will be cleared with another call
(0x1000)	Clear persisting error condition
<b>Personality Interface Non-Fatal System Error Codes (Feature Encryption Errors)</b>	
(0x0550)	Cannot read SROM
(0x0551)	Personalities sizes don't match
(0x0552)	Decryption failure
(0x0553)	Tracking data failure
<b>Dual Personality Errors</b>	
(0x0580)	Personality failure
(0x0581)	Tracking data failure
(0x0582)	Feature data failure
(0x0583)	Image failure
<b>Calibration Parameter Error Codes</b>	
(0x0560)	ECP calibration data missing; data updated to current defaults
(0x0561)	Calibration data update failed
(0x0562)	ECP calibration data older than current revision; data updated to current defaults
(0x0563)	ECP calibration data newer than current revision
(0x0590)	TestApp calibration data missing; data updated
(0x0591)	TestApp calibration data update failed
(0x0592)	TestApp calibration data older than current revision; data updated to current defaults

**Table 11-5: Error Codes for EDACS, Conventional and P25 (ECP) Modes**

<b>DISPLAYED CODE</b>	<b>MEANING</b>
(0x0593)	TestApp calibration data newer than current revision
<b>USER INTERFACE NON-FATAL SYSTEM ERROR CODES:</b>	
(0x0880)	Group is set to digital but system vocoder is set to analog
(0x0883)	IMBE is not supported by DSP
(0x0885)	Attempt to use IMBE vocoder with IMBE feature turned off
(0x0886)	Attempt to use encryption but DSP doesn't support encryption
(0x0887)	Attempt to use encryption but encryption is turned off
(0x0890)	Hardware revision could not be determined
(0x0891)	No G-STAR response from DSP
(0x0892)	No tone encode response from DSP
(0x0894)	DSP did not respond to key query

## 11.4 RF PERFORMANCE TESTS

### 11.4.1 General Information

This section includes RF performance test procedures for the radio. Basic receiver and transmitter RF performance test procedures are included, along with details on the configuration of a recommended conventional test personality, and a list of recommended test equipment. Unless otherwise stated, all test procedures in this section are performed in analog conventional mode.

Performance test procedures for a complete radio installation are included in the radio's installation manual. These test procedures test basic aspects of the radio and control head installation, including the installation's antenna system.



**Improper radio service may void the radio's RF integrity and cause it to violate FCC rules and regulations. Do not return the radio to field use until it is fully tested to ensure proper operation.**

**The PK Board and the RF Processor Board are serialized during final testing and tuning procedures at the factory. If a board is replaced, always successfully complete all applicable test and alignment procedures presented in this manual before returning the radio to the customer. The radio should also be fully tested and (where necessary) aligned if any component in an RF signal path is replaced, retuned, or disturbed in any way.**



Observe precautions for damage due to **Electro-Static Discharge (ESD)**. Always use proper grounding techniques (wrist or waist straps with grounding cords, grounded table-top mats, etc.) and other approved methods in order to minimize the chance of damage from ESD.

For technical assistance, contact the Technical Assistance Center using the contact information listed in Section 6

### 11.4.2 Test Equipment

Table 11-6 lists test equipment required for mobile radio RF performance tests included in this manual.

**Table 11-6: Test Equipment for RF Performance Tests and Alignments**

EQUIPMENT	RECOMMENDED TYPES / MODEL NUMBERS
RF Communications Test Set	Any RF Communications Test Set capable of generating a standard P25 1011 Test Pattern, such as an Aeroflex IFR 2975 or Aeroflex 3920
RF Cable, 50-Ohm: TNC Male to Type-N Male	Pasternack Enterprises PE3661-36 or equivalent
RF Cable, 50-Ohm: Type-N Male to Type-N Male*	Pasternack Enterprises PE3441-36 or equivalent
RF Attenuator, 50-Ohm: 30 dB, Type-N Female*	Bird Tenuline® 100-SA-FFN-30 or 100-A-FFN-30 or equivalent
Modified Microphone**	Harris Part Number MC-101616-041 modified similar to Tech Tips modification instructions in the Technical Training Toolbox on the Tech Link web site. ( <a href="https://premier.pspc.harris.com/infocenter/TechLink">https://premier.pspc.harris.com/infocenter/TechLink</a> )
Modified Speaker**	Harris Part Number LS102824V10 modified similar to Tech Tips modifications instructions in the Technical Training Toolbox on the Tech Link web site. ( <a href="https://premier.pspc.harris.com/infocenter/TechLink">https://premier.pspc.harris.com/infocenter/TechLink</a> )
Personal Computer (PC) with Radio Personality Manager (RPM) Programming Software	Laptop PC recommended with RPM Release R8B or later (See Section 9.4 on page 35 and/or Table 12-6 on page 75 for additional information).
Serial Programming Cable***	CA-104861 (5 feet long) <u>or</u> CA-013671-020 (20 feet long) <u>or</u> equivalent
DC Power Cable with Fuses (for Powering Radio)	Harris Part Number CA-012365-001
DC Power Cable with Fuses (for Powering Control Head)****	Harris Part Number CA-012616-001
CAN Cable****	Harris Part Number CA-009562-030
CAN Terminators (2)	Harris Part Number CD-014027-001
Speaker Cable	Harris Part Number MAMROS0034-NN006
Option Cable	Harris Part Number CA-012349-001
Power Supply	Adjustable Regulated DC-Output Power Supply capable of adjustment from 12 to 15 Vdc (minimum) and 20-ampere output current (minimum)

- \* An RF attenuator is required if the utilized RF Communications Test Set does not have a high-power input port capable of at least 50 watts of continuous RF input power.
- \*\* Not Required for Transmitter/TCXO Error Test and Transmitter Power Test.
- \*\*\* If the utilized PC is not equipped with a DB-9 type serial port connector, the use of a suitable adapter is required, such as USB-to-RS-232 Adapter Cable CN24741-0001.
- \*\*\*\* DC Power Cable CA-012616-001 (with fuses) and CAN Cable CA-009562-030 are not required for testing a front-mount radio.


**NOTE**

The RF Communications Test Set should have a frequency accuracy equal to or better than 0.15 ppm. If not, an appropriate external timebase reference which meets or exceeds this specification must be applied to the test set's external timebase reference input, and the test set must be configured to use this external reference.



NOTE

Test procedures included in this section can be performed on customer frequencies/channels, if possible. This will prevent unnecessary radio personality reprogramming operations.

However, if customer frequencies/channels are not available and/or the utilized test equipment does not allow testing on these frequencies/channels or radio operating mode, a conventional test personality should be created and used as described in Section 11.4.3 that follows.

### 11.4.3 Recommended Conventional Test Personality

Use RPM to create the following conventional test personality and program it into the radio. Refer to Section 9.4.3 and/or RPM's built-in help as necessary:

1. If the personality currently in the radio is not available on computer storage media, use RPM's read function to read it from the radio and store it for later restoration.

#### Create the Analog Conventional Test System

2. Create a new conventional system using RPM's Add New System button. This button is located on the System Setup dialog box's General tab.
3. Configure this new conventional system with the analog conventional test channels listed in Table 11-7. Achieve this by creating a new conventional (channel) set with the listed channels and assigning the set to the new system.



NOTE

For the 800 MHz M5300, enter only the four (4) 800 MHz band channels listed in Table 11-7. For this radio, 700 MHz band channels should be ignored (i.e., not be entered).

4. Verify each channel's Voice Mode is set to Analog. If not, make this change.
5. In the System Setup dialog box, click the General tab and select the test system.
6. Verify MAX is present in the Power Level text box. If not, enter MAX so the radio will transmit at full-power when set to high-power transmit level via the control head. Exit this dialog box and save changes by clicking the OK button.

**Table 11-7: Analog Conventional and P25 Conventional Test Channels**

TX FREQ. (MHz)	RX FREQ. (MHz)	RECOMMENDED NAME FOR ANALOG CONV. SYSTEM	RECOMMENDED NAME FOR P25 CONV. SYSTEM	BANDWIDTH	RX CG (Hz)	TX CG (Hz)	OTHER SETTINGS
764.025	764.025	764TRA	764TRP	"Wide" (25 kHz) for Analog Conv.; "C4FM" (12.5 kHz) for P25 Conv.	156.7	156.7	Leave at RPM Defaults
805.975	775.975	805T75RA	805T75RP				
806.025	851.025	806T51RA	806T51RP				
823.975	868.975	824T69RA	824T69RP				
851.025	851.025	851TRA	851TRP				
868.975	868.975	868TRA	868TRP				



Within RPM, a period (.) can be entered into the Name field of the Conventional Frequency Sets dialog box using a right-click and paste action. This assumes a period or the complete frequency in MHz has been previously copied to the Windows clipboard.

7. In the Personality Data Tree, double-click on Programmable Menus and use that dialog box to set the TX POWER function as a selection on the conventional menu. This menu is necessary for the transceiver performance test procedures in Section 11.4.4.
8. Add the SQUELCH function as a selection on the conventional menu. This menu is necessary for the receiver performance test procedures in Section 11.4.5.
9. Add the FCC MENU function as a selection on the conventional menu. This menu is necessary for P25-related test procedures in Sections 11.4.4 and 11.4.5.
10. Continue by creating a new P25 test system.

### Create the P25 Conventional Test System

11. Create a new P25 conventional system using RPM's Add New System button.
12. Configure this new P25 conventional system with the P25 conventional test channels listed in Table 11-7. Achieve this by creating a new P25 conventional (channel) set with the listed channels and assigning the set to the new system.
13. Set each P25 test channel's Voice Mode to P25 and Bandwidth to C4FM.
14. Set each channel's Tx NAC and Rx NAC as desired, or leave them at the default values of 293.
15. In the System Setup dialog box's Project 25 Conventional tab, set the radio's Unit ID number as required (range = 1 to 9,999,999 decimal).
16. Save this personality and program it to the radio. Refer to Section 9.4.3 and/or RPM's built-in help as necessary.

## 11.4.4 Transmitter Performance Tests

### 11.4.4.1 Tx Frequency Test

Use the procedure in this section to check the accuracy of the radio's Temperature-Compensated Crystal Oscillator (TCXO) frequency and transmitter frequency. TCXO performance affects both transmitter and receiver performance.



The radio's TCXO is a highly accurate and stable crystal reference oscillator. The use of a recently-calibrated RF Communications Test Set and/or Frequency Counter is recommended. **The utilized test equipment should have a specified frequency accuracy equal to or better than 0.15 ppm.**



This test should be performed with the radio and test equipment at room temperature between 68 and 77° Fahrenheit (20 to 25°C).

1. With the DC power supply output **off**, connect the radio and control head to the supply. To make these connections, use standard DC power installation cables with fuses.

To connect the radio to the power supply, use cable CA-012365-001 with a 15-amp fuse in its red wire (main power) to the power supply's positive (+) output terminal. Connect the cable's black wire to the power supply's negative (-) output terminal. For a remote-mount radio, leave the cable's white

wire unconnected and insulated. For a front-mount radio, connect the white wire via a 3-amp fuse to the power supply's positive (+) output terminal or to a switched power source.

To connect the control head to the power supply, use cable CA-012616-001 with a 5-amp fuse in the red wire (main power) to the power supply's positive (+) output terminal. Connect the cable's black wire to the power supply's negative (-) output terminal. Connect the cable's white wire to the power supply's positive output terminal with a 3-amp fuse in the white wire (switched power).



**Always observe polarity when making connections to the power supply!**

2. For a remote-mount radio, connect the control head to the radio via the CAN cable.
3. Terminate both ends of the CAN link by installing a CAN terminator onto each unterminated CAN port connector.
4. For a remote-mount radio, connect the modified speaker to the control head via speaker cable MAMROS0034-NN006. One end of this 6-inch speaker cable mates to the 2-pin circular connector on the rear of the control head, and the other end mates to the 2-pin rectangular connector of the modified speaker's cable.

For a front-mount radio, connect the modified speaker to the radio via option cable CA-012349-001. The option cable mates to the 44-pin connector on the rear of the radio. The 2-pin rectangular connector of the modified speaker's cable mates to the 2-pin rectangular connector of the option cable.

5. Connect the radio's TNC antenna port connector to the RF Communications Test Set's high-power RF input port. To make this connection, use only high-quality RF coax cable(s). If the utilized test set does not have a high-power input port capable of at least 50 watts of continuous RF power, use an external RF attenuator between the radio and test set. The attenuator should have a minimum power rating of 60 watts.
6. Set the DC power supply's output voltage to 13.6 Vdc with a current limit between 15 and 20 amps.
7. **Power-up the radio and the control head and allow at least a 15-minute warm-up period.**
8. At the control head, select the analog conventional test system and then select one of the test channels listed in Table 11-8.
9. Configure the test set's frequency counter for an in-band frequency count.
10. Temporarily disable receive and transmit CTCSS operation (i.e., Channel Guard) by depressing the control head's CLR button for approximately two (2) seconds. The display's  $\text{C}_\text{G}$  icon remains off when CTCSS operation is disabled.
11. Key the radio by depressing the microphone's PTT button and verify the radio is transmitting per an illuminated red Tx (transmit) indicator at the control head.
12. Use the test set's frequency counter function to accurately measure the transmit frequency.
13. Unkey the radio.
14. Change channels at the control head and repeat the transmit frequency measurements for the other test channels listed in Table 11-8. (For the 800 MHz M5300, ignore the 700 MHz band channels.) After changing channels, be sure to disable CTCSS operation. Always unkey the radio before making a channel change.

15. Verify each measured transmit frequency is within the respective error limits listed in Table 11-8. Any error outside of the listed limits indicates TCXO reference oscillator alignment is needed or there is a TCXO reference oscillator or transceiver synthesizer circuit problem in the radio. Record the overall pass/fail result in the table.



TCXO reference oscillator alignment procedures are included in Section 11.5.5.2 which begins on page 91. This alignment is sometimes referred to as “Automatic Frequency Control” (AFC) alignment.

16. Unkey the radio.
17. If no other tests are required at this time, disconnect all test equipment and remove the conventional test personality from the radio. The test personality **must** be removed from the radio and the original personality restored before the radio is returned to normal service.

**Table 11-8: Maximum Transmit Frequency Errors for Recommended Test Channels**

RF BAND	TEST TX FREQUENCY (MHz)	MAXIMUM TRANSMIT FREQUENCY ERROR ( $\pm 1.5$ ppm)	MINIMUM TX FREQUENCY (MHz)	MAXIMUM TX FREQUENCY (MHz)	MEASURED FREQUENCY (MHz)	PASS/ FAIL
700 MHz	764.025	$\pm 1146$	764.023854	764.026146		
	805.975	$\pm 1209$	805.973791	805.976209		
800 MHz	806.025	$\pm 1209$	806.023791	806.026209		
	868.975	$\pm 1303$	868.973697	868.976303		

Radio:	Radio Part Number:	Radio Serial Number:	PASS/ FAIL	Test Date:	Technician's Initials:
<input type="checkbox"/> 800 MHz M5300 <input type="checkbox"/> 700/800 MHz M7300	RU-144750-061				



For the 800 MHz M5300, ignore the 700 MHz band channels.



Do **not** return the radio to service if frequency error exceeds TIA-603 limits.

## 11.4.4.2 Tx Power Levels Test

Follow this procedure to check the radio's transmitter output power levels:

1. If the transmitter frequency test procedure has not been performed per Section 11.4.4.1, do that now. Leave the radio and test equipment connected and configured as described in that procedure.
2. Zero out (i.e., account for) all RF loss in utilized test cable(s), attenuator, adapter(s), etc. Refer to the RF Communications Test Set's documentation and the equipment's RF loss data as necessary.

- While in high-power transmit level, select each respective test frequency listed in Table 11-8, key the radio by depressing the microphone's PTT button, and verify the power level is within the respective range listed in the table. If not, check cable connections, etc., and re-test if necessary.
- At the control head, switch the radio to low-power transmit level.



NOTE

To switch between high-power and low-power transmit level, press the control head's MENU button, then use the  $\bullet/\bullet$  ramp control to scroll through the menu until TX POWER appears in the middle line of the display. Finally, toggle to the other power level by pressing the MENU button again.

- While in low-power transmit level, select each respective test frequency listed in Table 11-8, key the radio by depressing the microphone's PTT button, and verify the transmit power level is within the respective range listed in the Table 11-9. If not, check cable connections, etc., and re-test if necessary. Unkey the radio before making a channel change.

Table 11-9: Transmitter Power Test—Maximum Errors

TX POWER LEVEL SETTING	TOLERANCE (dB)	LIMITS		MEASURED TX POWER (Watts)	PASS/FAIL
		MINIMUM TX POWER (Watts)	MAXIMUM TX POWER (Watts)		
Low (5 watts)	$\pm 0.5$	4.4	5.6		
High (35 watts)	$\pm 0.25$	33.0	37.1		

Radio:	Radio Part Number:	Radio Serial Number:	PASS/FAIL	Test Date:	Technician's Initials:
<input type="checkbox"/> 800 MHz M5300	RU-144750-061				
<input type="checkbox"/> 700/800 MHz M7300					



NOTE

Transmit power level alignment information is included in Section 11.5.5.3 (page 93).

- Unkey the radio.
- If no additional tests are to be performed, disconnect all test equipment and remove the conventional test personality from the radio. The test personality **must** be removed from the radio and the original personality restored before the radio is returned to normal service.



CAUTION

Do **not** return the radio to service if any measured transmit power level is outside of the respective limits listed in Table 11-9.

#### 11.4.4.3 Conventional Tx Modulation Limiting Tests

Follow this test procedure to check the radio's analog conventional modulation limiting and symmetry:

- If the transmitter frequency test procedure has not been performed per Section 11.4.4.1, do that now. Leave the radio and test equipment connected and configured as described in that procedure.

2. Adjust the RF Communication Test Set's audio signal generator output for a 1 kHz audio signal at a level of 200 mV rms.
3. Connect this 1 kHz signal to the control head's microphone input. To make this connection, use a modified microphone (see Table 11-6 for additional information) along with a BNC cable and an adapter(s) appropriate for the test set. Apply the signal to the modified microphone's mic audio BNC input connector.
4. Select the analog conventional test system and select any test channel within that system.
5. Switch the radio to high-power transmit level via the control head.
6. Configure the test set for an on-frequency transmitter FM deviation measurement.
7. Temporarily disable receive and transmit CTCSS operation (i.e., Channel Guard) by depressing the control head's CLR button for approximately two (2) seconds. The display's  $\text{C}_G$  icon remains off when CTCSS operation is disabled.
8. Key the radio via the modified microphone and verify it is transmitting per an illuminated red Tx (transmit) indicator at the control head.
9. Measure FM deviation and verify it is between 4.3 and 5.0 kHz. Record the pass/fail result in the following table:

Radio:	Radio Part Number:	Radio Serial Number:	PASS/ FAIL	Test Date:	Technician's Initials:
<input type="checkbox"/> 800 MHz M5300 <input type="checkbox"/> 700/800 MHz M7300	RU-144750-061				



CAUTION

FM deviation in excess of 5.0 kHz on a wideband (25 kHz) channel may violate FCC rules on wideband RF channels.



NOTE

FM deviation alignment information is included in Section 11.5.5.5 which begins on page 101.

10. Unkey the radio.
11. If no additional tests are to be performed, disconnect all test equipment and remove the conventional test personality from the radio. The test personality **must** be removed from the radio and the original personality restored before the radio is returned to normal service.



CAUTION

Do **not** return the radio to service if any measured parameter exceeds the respective limits.

#### 11.4.4.4 P25 (C4FM) Tx Modulation Test

Follow this procedure to test radio transmitter's P25 modulation performance:

1. If the transmitter frequency test procedure has not been performed per Section 11.4.4.1, do that now. Leave the radio and test equipment connected and configured as described in that procedure.

2. Select the P25 conventional test system and select any test channel within that system.
3. Configure the test set for an on-frequency transmitter peak-positive FM deviation measurement.
4. Configure the test set deviation meter's audio bandwidth response with a high-pass frequency at  $\leq 15$  Hz and a low-pass frequency at  $\geq 3$  kHz.
5. Disable the deviation meter's de-emphasis function.
6. Press the control head's MENU button, then use the ●/●● ramp control to scroll through the menu until FCC Menu appears in the middle line of the display, and then press the MENU button again.
7. Use the ●/●● ramp control to scroll through the FCC menu until P25 HIGH appears, and select that function by pressing the MENU button again. The radio will begin transmitting a standard C4FM symbol rate pattern.
8. Measure the deviation at the test set. It should be between 2544 and 3111 Hz. Record the pass/fail result in the following table:

Radio:	Radio Part Number:	Radio Serial Number:	PASS/FAIL	Test Date:	Technician's Initials:
<input type="checkbox"/> 800 MHz M5300	RU-144750-061				
<input type="checkbox"/> 700/800 MHz M7300					



For related alignment information, refer to the I/Q Data Modulation Alignment procedure in Section 11.5.5.4 (page 98). This alignment is performed in a single side-band mode.

9. Press the MENU button again to unkey the radio.
10. If no additional tests are to be performed, disconnect all test equipment and remove the conventional test personality from the radio. The test personality **must** be removed from the radio and the original personality restored before the radio is returned to normal service.

### 11.4.5 Receiver Performance Tests

Unless otherwise stated, all receiver performance test procedures presented in this section should be performed in the order presented.

#### 11.4.5.1 Audio Output and Distortion Levels Tests

Receiver audio output and distortion levels should always be verified as being good **before** performing a receiver sensitivity test, or other receiver-related tests. This ensures the respective audio circuits in the control head have sufficient output capability and minimal distortion, and that other related circuits are operating properly. Follow this procedure to check the audio output and distortion levels:

1. With the DC power supply output off, connect the radio and control head to the supply. To make these connections, use standard DC power installation cables with fuses. **Always observe polarity when making connections to the power supply!**
2. For a remote-mount radio, connect the control head to the radio via the CAN cable.
3. Terminate both ends of the CAN link by installing a CAN terminator onto each unterminated CAN port connector.

4. For a remote-mount radio, connect the modified speaker to the control head via speaker cable MAMROS0034-NN006. One end of this 6-inch speaker cable mates to the 2-pin circular connector on the rear of the control head, and the other end mates to the 2-pin rectangular connector of the modified speaker's cable.

For a front-mount radio, connect the modified speaker to the radio via option cable CA-012349-001. The option cable mates to the 44-pin connector on the rear of the radio. The 2-pin rectangular connector of the modified speaker's cable mates to the 2-pin rectangular connector of the option cable.

5. Connect the speaker output of the control head/radio to the RF Communication Test Set's audio input measurement port. Make this connection at the 4-ohm load resistor in the modified speaker (see Table 11-6 for additional information).



The modified speaker contains a 1:1 audio coupling transformer to couple the radio's/control head's differential-type speaker output to the modified speaker's unbalanced test port output (BNC connector or banana plug). This output **must** only be connected to a high-impedance load (of any test equipment). Loading this output with a speaker could damage the transformer.

6. Switch the modified speaker's double-pole switch to the load position (i.e., speaker off).
7. Set the DC power supply's output voltage at 13.6 Vdc at a current limit between 6 and 8 amps.
8. Turn the power supply's output on, if it is not already.
9. **Power-up the radio and the control head and allow at least a 5-minute warm-up period.**



Do **not** key the radio during this test. Doing so could damage to the RF Communication Test Set.

Using an external 20 or 30 dB attenuator between the radio's antenna port and the test set's generator/low-power RF output port can help to prevent damage to the test set if the radio is accidentally keyed. If an external attenuator is used, all RF signal level measurements must be adjusted accordingly when making RF signal level measurements.

10. Set the control head's volume control to a mid-range position.
11. Select the analog conventional test system.
12. Select any analog conventional test channel listed in Table 11-7. (For the 800 MHz M5300, ignore the 700 MHz band channels.) Make a system and channel change as necessary.

Alternately, select any customer channel that can be used for radio testing.

13. Temporarily disable receive and transmit CTCSS operation (i.e., Channel Guard) by depressing the control head's CLR button for approximately two (2) seconds. The display's  $\text{C}_\text{G}$  icon remains off when CTCSS operation is disabled.
14. Connect the radio's TNC antenna port connector to the RF Communications Test Set's signal generator/low-power RF output port. To make this connection, use only high-quality RF coax cable(s).
15. Set the RF Communication Test Set on-frequency with an RF output level of -47 dBm (1000  $\mu$ V). Modulate the RF output with a 1 kHz tone with a 3 kHz deviation (60% rated system deviation for wideband channel). This is considered a full-quieting RF signal for a wideband channel.
16. Verify the radio is receiving the full-quieting RF signal. If not, recheck connections and/or radio and test equipment configurations.

17. While monitoring the test set's audio analyzer or AC voltmeter, adjust the control head's volume control for a speaker output audio level of 7.745 Vrms. This is 15 watts into the 4-ohm speaker load.
18. Using the test set's audio analyzer, measure the distortion level of the 1 kHz tone from the radio/control head. It should be less than 5%.
19. Reduce the volume control to a relatively low setting.
20. Switch the modified speaker's double-pole switch to the speaker position.
21. Adjust the volume control to at least a mid-range setting to verify the 1 kHz tone from the speaker is loud and clear.

Radio:	Radio Part Number:	Radio Serial Number:	PASS/FAIL	Test Date:	Technician's Initials:
<input type="checkbox"/> 800 MHz M5300 <input type="checkbox"/> 700/800 MHz M7300	RU-144750-061				

22. If no additional tests are to be performed, disconnect all test equipment and remove the test personality from the radio. The test personality **must** be removed from the radio and the original personality restored before the radio is returned to normal service.

#### 11.4.5.2 12 dB SINAD Rx Sensitivity Test

Use this test procedure to determine the radio's 12 dB SINAD receiver sensitivity level:

1. Complete the Audio Output and Distortion Levels Tests presented in Section 11.4.5.1. Leave the radio and all test equipment interconnected and configured per that procedure.



NOTE

Receiver audio output and distortion levels should always be verified as being good **before** performing a receiver sensitivity test, or other receiver-related tests. This ensures the respective audio circuits in the control head have sufficient output capability and minimal distortion, and that other related circuits are operating properly.

2. If using the recommended test channels, select the first test channel listed in Table 11-7. (For the 800 MHz M5300, ignore the 700 MHz band channels.) Make a system and channel change as necessary.

If using the customer's channels, select the channel with the lowest frequency.

3. Disable squelch by adjusting it to a minimum setting. Refer to the following NOTE as necessary.



NOTE

Before squelch can be disabled/adjusted, the SQUELCH programmable menu function must be programmed to the conventional menu as described in Section 11.4.3. In this case, disable squelch as follows:

- Press the control head's MENU button.
- Press the ●/●● ramp control to scroll through the conventional menu until SQUELCH appears in the middle line of the display.
- Press the MENU button again.
- Press the ●/●● ramp control **down** until SQUELCH=1 appears in the top line of the display. At this point, squelch is at a minimum setting and essentially disabled.

4. Set the RF Communication Test Set on frequency with an initial RF output level of approximately -100 dBm (2.25  $\mu$ V), and verify the radio is receiving the RF signal from the test set. If not, recheck connections and/or radio and test equipment configurations.
5. Configure the RF Communication Test Set for a 12 dB SINAD level measurement. Modulate its RF output with a 1 kHz tone at 3 kHz deviation (60% rated system deviation for wideband channel). Reduce/Adjust the test set's RF output level as necessary to obtain a 12 dB SINAD level reading. Control head volume control adjustments may also be necessary.
6. Verify the 12 dB SINAD level measurement against specifications listed in Section 3.2 of this manual. If the 12 dB SINAD level measurement is worse than (i.e., RF signal level greater than) the respective specification, first recheck connections and test set configuration. If the problem cannot be resolved, verify RF channel programming before contacting the Harris Technical Assistance Center (TAC) for assistance. The channel must be programmed for wideband operation.
7. If using the recommended test channels, select the next test channel listed in the table, change the test set to the corresponding frequency, and measure the 12 dB SINAD level on the channel. (For the 800 MHz M5300, ignore the 700 MHz band channels.) Verify the measured value against the respective specification.

If using the customer's channels, select the channel with the highest frequency.

8. Repeat until all test channels have been measured. (For the 800 MHz M5300, ignore the 700 MHz band channels.) Record the overall pass/fail result in the following table:

Radio:	Radio Part Number:	Radio Serial Number:	PASS/ FAIL	Test Date:	Technician's Initials:
<input type="checkbox"/> 800 MHz M5300	RU-144750-061				
<input type="checkbox"/> 700/800 MHz M7300					

9. Using the SQUELCH menu, re-enable squelch by returning its level to the original setting.
10. If no additional tests are to be performed, disconnect all test equipment and remove the conventional test personality from the radio. The test personality **must** be removed from the radio and the original personality restored before the radio is returned to normal service.

### 11.4.5.3 P25 (C4FM) Rx Sensitivity Test

Follow this test procedure to check P25 (C4FM) receiver sensitivity:

1. Complete the Audio Output and Distortion Levels Tests presented in Section 11.4.5.1. Leave the radio and all test equipment interconnected and configured per that procedure.
2. Select the P25 conventional test system and a test channel within that system.
3. Set the RF Communication Test Set on frequency at an RF output level of -116 dBm (0.35  $\mu$ V).
4. Modulate the test set with a standard 1011 P25 (C5FM) test pattern.
5. Press the control head's MENU button, then use the  $\bullet/\bullet\bullet$  ramp control to scroll through the menu until FCC Menu appears in the middle line of the display, and then press the MENU button again.
6. Use the  $\bullet/\bullet\bullet$  ramp control to scroll through the FCC menu until IBERC4FM appears, and select that function by pressing the MENU button again. The radio displays the internally calculated Bit Error Rate (BER) of the received test pattern.
7. Press the MENU button again to toggle the display from fast BER to slow (averaging) BER.

8. Verify the displayed BER is not 0%, but less than 5%. If a 0% is displayed, the radio is not receiving an on-channel RF signal from the test set.
9. Repeat BER measurements on the other test channels. Record the overall pass/fail result in the following table:

Radio:	Radio Part Number:	Radio Serial Number:	PASS/ FAIL	Test Date:	Technician's Initials:
<input type="checkbox"/> 800 MHz M5300	RU-144750-061				
<input type="checkbox"/> 700/800 MHz M7300					

10. If no additional tests are to be performed, disconnect all test equipment and remove the conventional test personality from the radio. The test personality must be removed from the radio and the original personality restored before the radio is returned to normal service.

## 11.5 RADIO ALIGNMENT

Programming, alignment, and servicing aspects of maintaining a mobile radio rely on Harris RPM programming software. A software-based Radio Maintenance Utility is included with the RPM software. This tool is installed on the personal computer (PC) when RPM is installed. It is used for various radio alignment and restoration activities, as described in the following subsections.

### 11.5.1 Required RPM Programming Software, Radio Code and Test Equipment

Prerequisites required to perform the radio alignment procedures presented in this manual include:

- The minimum version of the RPM programming software, as listed in Table 11-10, must be installed and operating on the technician's PC.
- The minimum version of ECP radio firmware codes, as listed in Table 11-11, must be installed into the radio.
- Test equipment as listed in Table 11-6 (page 63) is necessary to complete the alignment procedures.

This section also assumes the technician is familiar with the general operation of RPM and that the COM port assigned to the programming cable is properly configured in RPM.

The instructions in this manual are based on the RPM software revisions listed in Table 11-10 which are required when programming, aligning, and servicing the radios.

**Table 11-10: Minimum RPM Programming Software Versions**

RPM RADIO SOFTWARE	PART NUMBER	VERSION
RPM for EDACS, ProVoice and P25 Trunked Systems	TQS3385	R08B or later
RPM for Conventional and P25 Conventional Systems	TQS3389	R08B or later

The minimum version of radio ECP firmware codes listed in Table 11-11 must be loaded into the radio. Otherwise, the Radio Maintenance Utility will not function properly with the radio. Determining if a radio has the minimum code versions installed is accomplished by using the Radio Maintenance Utility to read the calibration data from the radio. A pop-up message will appear when the radio does not meet the required minimum ECP firmware code versions.

**Table 11-11: Minimum Versions of ECP Radio Firmware Codes for M5300/M7300 Radios**

OMAP RADIO SOFTWARE	VERSION
BootApp	R12A or later
LoaderApp	R12B or later
BurnApp	R10A or later
ECP Radio Code	R15A or later

### 11.5.2 Overview of the Radio Maintenance Utility

As previously stated, the software-based Radio Maintenance Utility is included with the RPM programming software. It is installed on the PC along with the RPM programming software. This utility may be used to align many Harris mobile and mobile products, including the M5300 and M7300 mobile radios.

The Radio Maintenance Utility is primarily used with the radio operating from a test personality in analog conventional mode. Test systems and frequency sets must be added to the radio's existing personality to complete the tests. Alternately, a "shop" test personality which includes the test system and frequency sets may be developed and used to align the radio.

Within the Radio Maintenance Utility, most transmitter (Tx) and receiver (Rx) alignment fields contain multiple data points within each alignment test. Some tests use up to forty (40) data points. Each data point sets alignment of a specific function at different frequencies spread across the radio's entire operating frequency range.

Since a radio's RF performance can change over a wide frequency range, this multi-point alignment procedure assures the best possible radio performance at all programmed operating frequencies. Alignment values for frequencies between the specific alignment data points are interpolated from the data points above and below the programmed operating frequency. Therefore, precision alignment at each specific operating frequency is obtained.

### 11.5.3 Reading and Saving Feature License Data, Calibration Data, and Personality Files

M5300 and M7300 mobile radios depend upon feature license data and calibration data for its proper and legal performance. These data sets are specific to an individual radio. Without these data sets, the radio will not function. Should anything happen to the radio resulting in the corruption or loss of this data, a previously saved feature data file can be used to restore corrupted or lost data.



Feature license data and calibration data is very important because **the data sets are specific to each individual radio.** In other words, every radio is different and has different data sets!



Use caution when selecting and loading a calibration data file into a radio. Loading an incorrect calibration data file into a radio may prevent the radio from functioning properly.

Radio Maintenance Utility is used to read, write, update, and save feature and calibration data files. This procedure focuses on reading feature and calibration data files from a radio.

Each radio's feature license and calibration data can be backed up locally (i.e., on the PC hard disk or other storage media). Then, if the radio's data becomes corrupt or lost, it may be restored via the Radio Maintenance Utility.



It is highly recommended to read each radio's feature license data and calibration data and save these data sets to local files. This is in preparation of radio repairs which may require data reloads. The following sub-sections provide instruction for preparing the radio for the various data acquisitions and updates required to maintain M5300 and M7300 radios.

#### 11.5.3.1 Entering Programming Mode

##### Automatically Entering Programming Mode:

Perform these steps to automatically place the radio into programming mode:

1. As illustrated in Figure 9-1 on page 36, connect the control head to the radio and connect the control head and radio to a DC power source.

2. Turn off the radio and control head via the control head's on/off/volume control.
3. Power-up the PC that has the RPM programming software installed on it, and start Windows.
4. Start the RPM programming software.
5. Using a serial programming cable, connect the radio to the PC with the RPM programming software. See Figure 9-1 on page 36.
6. Turn on the radio and control head. After RPM communicates with the radio, "PROGRAM" appears in the control head's display, indicating the radio has automatically entered program mode.
7. Continue with personality programming or calibration procedures as described elsewhere in this manual.
8. Turn the radio off and disconnect the programming cable after programming is complete.

If at any time this automatic method fails, retry the procedure or try one of the manual methods that follow.

**Manually Enter Programming Mode via A and C Preset Buttons:**

1. Connect the equipment as illustrated in Figure 9-1 on page 36.
2. Turn off the radio and control head via the control head's on/off/volume control.
3. While simultaneously depressing the control head's A and C preset buttons, turn the radio and control head on via the head's on/off/volume control, then release both buttons. After the "Booting" message clears, a "PROGRAM Please Wait..." message should appear in the control head's display. This indicates the radio is in programming mode.
4. Continue with personality programming or calibration procedures as described elsewhere in this manual.
5. Turn the radio off and disconnect the programming cable after programming is complete.

**Manually Enter Programming Mode via Program Menu:**

If the existing personality in the radio has the Program menu enabled, the programming mode can be manually entered by selecting this menu.

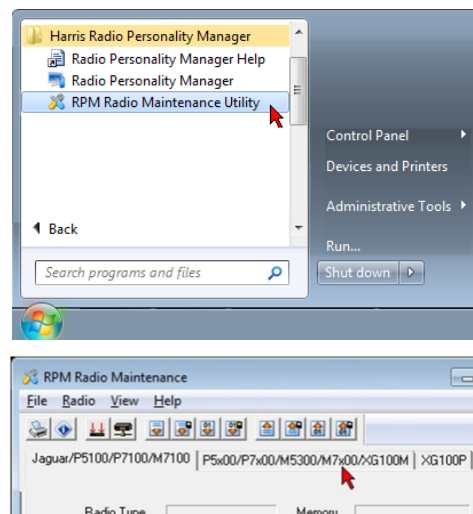
### 11.5.3.2 Reading and Saving Feature License Data

Follow this procedure to read and save a radio's feature license data:

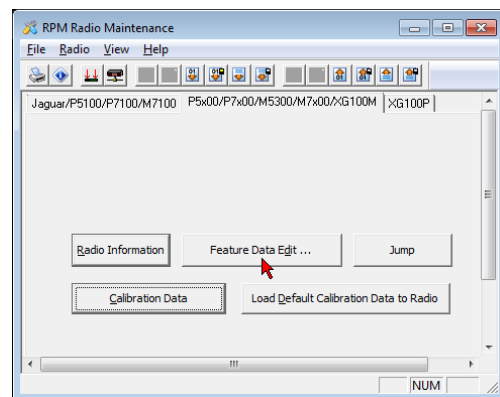
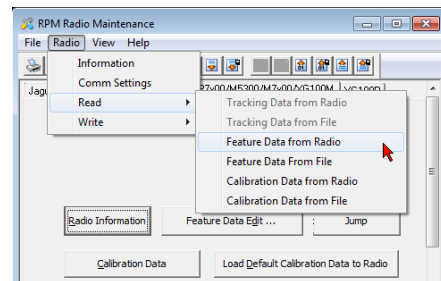
1. Enter programming mode as described in Section 11.5.3.1.
2. At the PC with the RPM programming software, start the Radio Maintenance Utility:

Click: **Start > Programs > Harris Radio Personality Manager > RPM Radio Maintenance Utility**

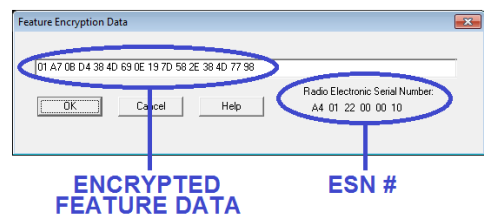
3. Within the utility, click on the tab that includes **M7x00** (for the M5300, M7300, and other radios).



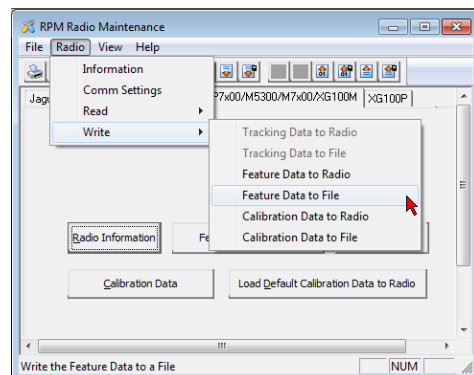
4. From the utility's menu:  
Select: **Radio > Read > Feature Data from Radio**
5. When the Read Feature Data Complete message box appears:  
Click: **OK**
6. In the tab that includes **M7x00**:  
Click: **Feature Data Edit**



7. The Feature Encryption Data dialog box opens. This dialog box includes the radio's Electronic Serial Number (ESN). Record the ESN for later use. Click **OK** or **Cancel** to exit the box.

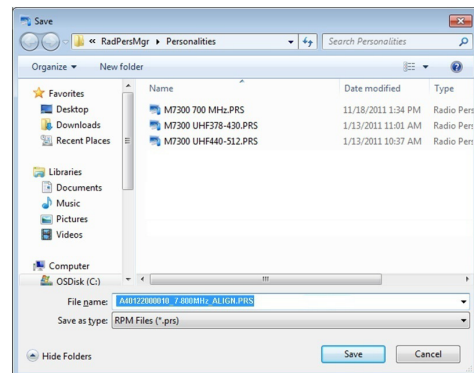


8. From the utility's menu:  
Select: **Radio > Write > Feature Data to File**  
  
This action opens up the "Save As" dialog box to the default calibration and feature data folder. If desired, the folder/path may be changed.



9. Enter a unique file name which clearly identifies the radio (such as the serial number of the radio or a property tag number) and the electronic serial number, found on the Feature Encryption Data dialog box.

Select: **Save**



## 11.5.3.3 Reading and Saving Calibration Data

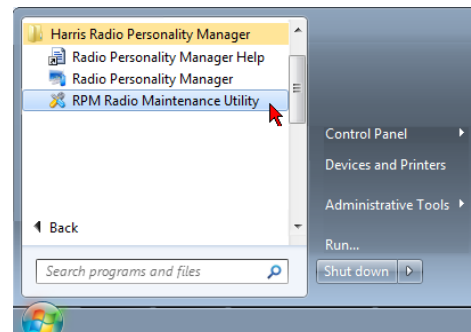
Follow this procedure to read and save a radio's calibration data:



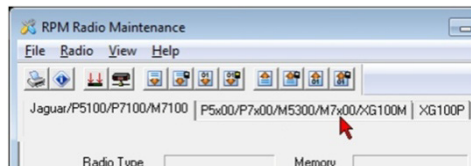
The radio must have R15A or later code before calibration data can be read from or written to it. See Section 11.5.1 on page 75 for details.

1. Enter programming mode as described in Section 11.5.3.1.
2. At the PC with the RPM programming software, start the Radio Maintenance Utility:

Click: **Start > Programs > Harris Radio Personality Manager > RPM Radio Maintenance Utility**



3. Click on the tab that includes **M7x00** (for the M5300, M7300, and other radios).

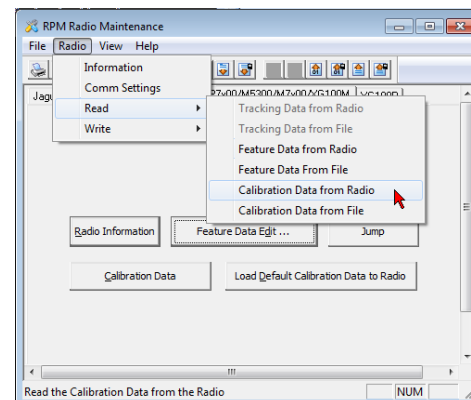


4. From the utility's menu:

Select: **Radio > Read > Calibration Data from Radio**

5. When the Calibration Data Complete dialog box opens:

Click: **OK**



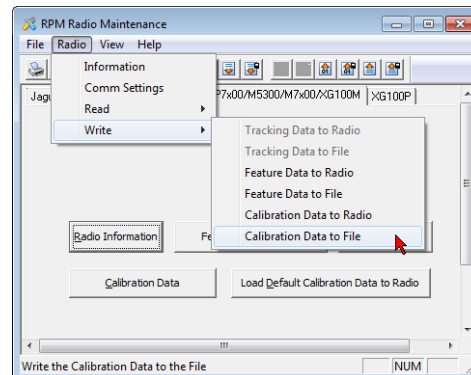
6. From the utility's menu:

Select: **Radio > Write > Calibration Data to File**

This action opens up the "Save As" dialog box to the default calibration and feature data folder. If desired, the folder/path may be changed.

7. Enter a unique file name which clearly identifies the radio (such as the serial number of the radio or a property tag number) and the electronic serial number, found on the Feature Encryption Data dialog box.

Select: **Save**

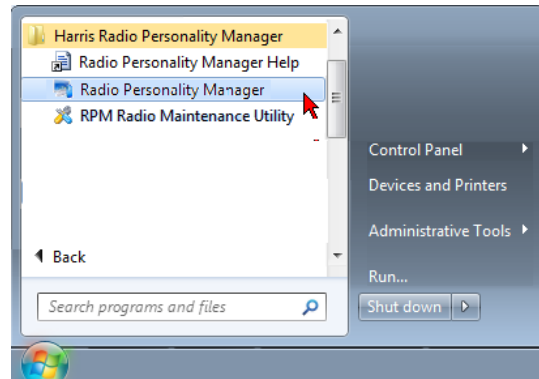


### 11.5.3.4 Reading and Saving the Radio Personality

A *personality* file is a computer file created within RPM. It contains the operating characteristics and frequencies for the radio. The personality file is downloaded and stored in the radio. Before beginning any alignment or test procedures, it is highly recommended to save a copy of the personality file to local archive (i.e., on the PC hard disk or other storage media).

1. Enter programming mode as described in Section 11.5.3.1.
2. At the PC with the RPM programming software, start this software:

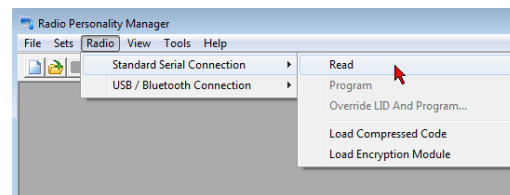
Click: **Start > Programs > Harris Radio Personality Manager > Radio Personality Manager**



3. From RPM's main menu:

Select: **Radio > Standard Serial Connection > Read**

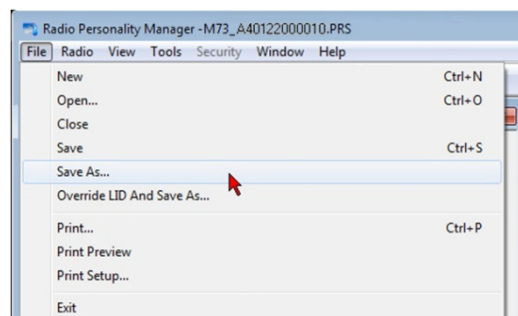
After the radio personality is read, the Personality window will appear.



4. Within the personality window, information may be entered in the "Description" and "Author" fields.
5. On the RPM's main menu:

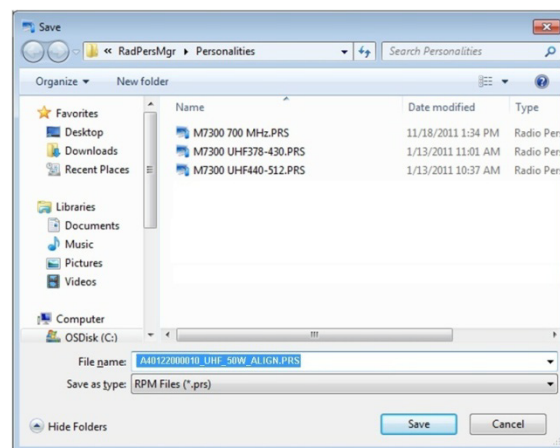
Click: **File > Save As**

When reading and saving a radio's personality, always use the Save As feature to prevent overwriting any existing file. RPM can determine the last known personality file name from the radio's personality. Avoid using the Save icon so a previously saved personality is not overwritten.



6. Enter a unique file name which clearly identifies the radio (such as the serial number of the radio, a unit number, a person's name, etc.).

Select: **Save**



## 11.5.4 Adding and Removing Radio Alignment Test Systems to Personalities

Radio alignment is performed at specific frequencies across the entire RF operating range of the radio. Performing a full radio alignment requires multiple conventional test systems with specific test channels to be added to a personality. The following procedure adds conventional test systems to an existing personality. However, this procedure may be adapted to the creation of a new “shop” test personality specific to each RF band of the M5300/M7300 mobile radio series.

### 11.5.4.1 Adding Radio Alignment Test Systems to the Personality

1. Connect the radio to the PC with the RPM programming software and enter programming mode. Refer to Section 11.5.3.1 as necessary.
2. Verify the feature and calibration data files have been saved to local disk. Refer to Sections 11.5.3.2 and 11.5.3.3 as necessary.
3. Read and save the radio’s personality. Be sure to save a copy of the original personality to a local file before making changes to the personality. Refer to Section 11.5.3.4 as necessary.

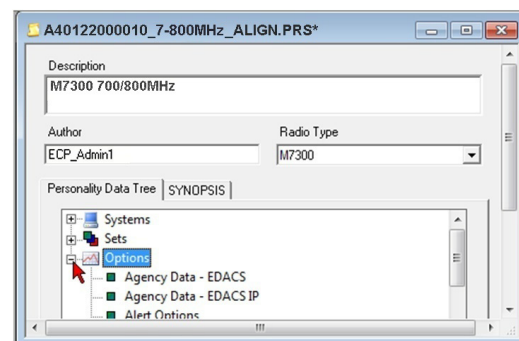


NOTE

Instead of modifying the customer’s personality each time a radio is serviced, it is recommended that a “shop” test personality for the radio be developed and used when radio service is required. Always be sure to save the radio’s original personality before loading any test personality. After tests/alignments are complete, be sure to re-load the original personality back into the radio.

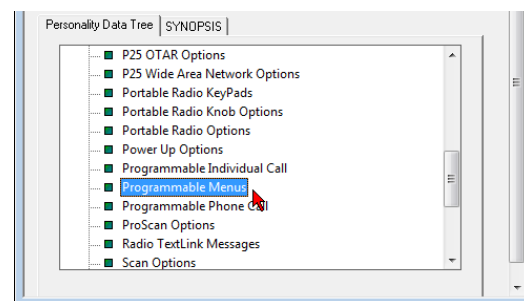
4. In the Personality Data Tree:

Click: **Options**



5. Scroll down the Options limb:

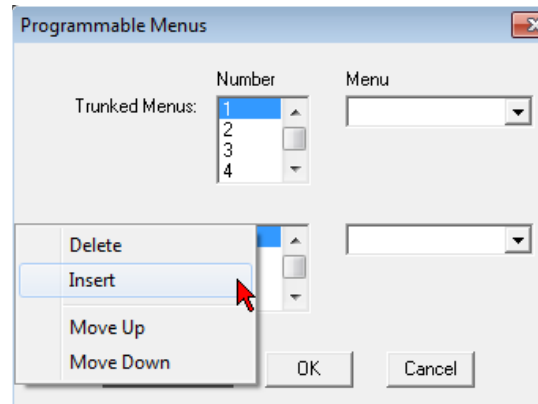
Double-click: **Programmable Menus**



6. Within the Conventional Menus Number box:

Double-click: **1**

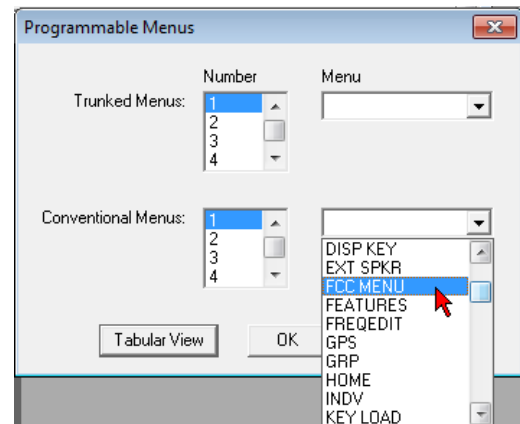
Click: **Insert**



7. Within the dropdown menu choices:

Select: **FCC MENU**

Click: **OK**



**NOTE**

To support radio alignment and testing, the FCC Menu and several additional conventional frequency sets must be added to the radio's personality. This facilitates proper alignment of the radio.

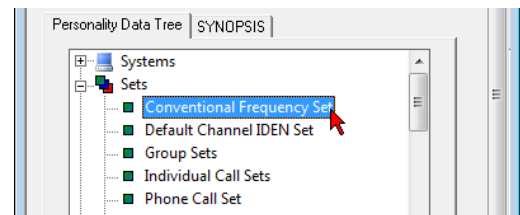
8. In the Personality Data Tree:

Double-click: **Sets**

The Sets limb expands.

Double-click: **Conventional Frequency Set**

The Conventional Frequency Sets dialog box opens.



**NOTE**

In the steps that follow, several unique frequency sets will be created and later used to perform alignment test. These sets provide access to various features being tested and the correct test points (frequencies) spread across the radio's RF operating range.

9. In the Conventional Frequency Sets tab of the Conventional Frequency Sets dialog box, add a new set to the existing personality as follows:

Click: **New Conv Set**

Type: **M73DB TX**

Click: **OK**

Use the illustration to the right, or reference Table 11-12, and enter for each channel, the channel name, TX and RX frequencies, select High Power, and set any other features as indicated by the outlined boxes. Enter all 20 channels.

This set is used to align the radio's reference oscillator (TCXO), and its high, mid, and low TX power.

10. In the Conventional Frequency Sets tab of the Conventional Frequency Sets dialog box, add a new set to the existing personality as follows:

Click: **New Conv Set**

Type: **M73DB IQ**

Click: **OK**

Use the illustration to the right, or reference Table 11-13, and enter the channel name, TX and RX frequencies, select High Power, and set any other features as indicated by the outlined boxes. Enter both channels. Enter 770.00625 for the channel 1 receiver frequency.

This set is used to align the radio's IQ modulation.

11. In the Conventional Frequency Sets tab of the Conventional Frequency Sets dialog box, add a new set to the existing personality as follows:

Click: **New Conv Set**

Type: **M73DB SQ**

Click: **OK**

Use the illustration to the right, or reference Table 11-14, and enter the channel name, frequency, and set any other features as indicated by the outlined boxes. Enter all 5 channels.

This set is used to align analog squelch and RSSI functions.

12. To exit the Conventional Frequency Sets dialog box, click: **OK**
13. In the Personality Data Tree, assign these newly-created frequency sets to new systems:

Double-click: **Systems**

14. In the General tab of the System Setup dialog box:

Click: **Add New System**

15. In the New System box:

Type: **M73DB HP**

Select: **Conventional**

Click: **OK**

Set Power Level to: **MAX**  
(Using "MAX" forces the radio to use the high power alignment values for each channel in this system, refer to Section 11.5.5.3)

16. Repeat steps 14 and 15, except create a new system for each of the following previously-created frequency sets:

**M73DB MP**

**M73DB LP**

**M73DB IQ**

**M73DB SQ**

17. In the System Setup window, assign a frequency set to each system:

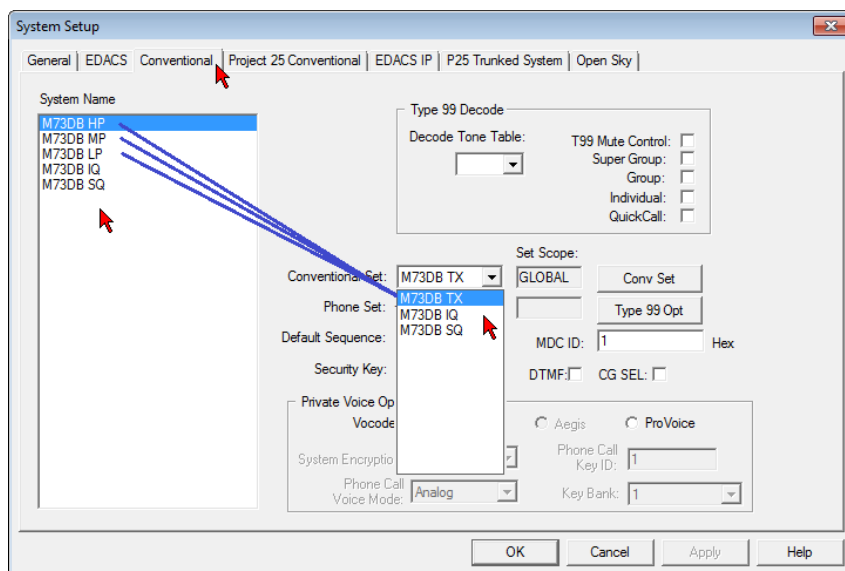
Click: **Conventional** tab

18. In the System Name field:

Select: **M73DB HP**

19. In the Conventional Set dropdown:

Type: **M73DB TX**



20. Click the **General** tab and set the **Power Level** to **MAX** (35 watts).

(Using “MAX” forces the radio to use the high power alignment values for each channel in this system.)

21. Repeat steps 18 and 19, except create a new system for each of the following previously-created frequency sets:

<u>System Name</u>	<u>Conv. Freq. Set</u>	<u>Power Level (Watts)</u>
<b>M73DB MP</b>	<b>M73DB TX</b>	<b>15</b> (see NOTE)
<b>M73DB LP</b>	<b>M73DB TX</b>	<b>5</b>
<b>M73DB IQ</b>	<b>M73DB IQ</b>	<b>5</b>
<b>M73DB SQ</b>	<b>M73DB SQ</b>	<b>5</b>



If the radio is used in a motorcycle application, set the medium-power system to 10 (for 10 watts) instead of 15.

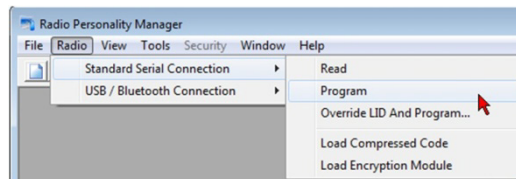
The numeric value entered in the **Power Level** box is used to set the TX power in Watts. Only whole numbers may be entered. Entering a value that is outside the High or Low Power reference levels range entered during alignment results in the radio defaulting to the high or low alignment value. See Section 11.5.5.3 on page 93 for additional information).

The value used for aligning the mid power level is not critical, as long as the measured transmitter power output matches the reference value shown in the mid power “Tx Power” field.

22. From RPM's main menu:

Select: **Radio > Standard Serial Connection > Program**

23. After the radio personality is programmed, it is recommended to save the updated personality file to a different name for future reference as a test personality for the radio.



**Table 11-12: Frequencies for Conventional Frequency Set M73DB TX**

CHANNEL NUMBER	700 MHz BAND FREQUENCY IN MHz (TX and RX)	CHANNEL NUMBER	800 MHz BAND FREQUENCY IN MHz (TX and RX)
1	764.00625	13	806.0125
2	766.99375	14	812.3125
3	769.08125	15	818.6875
4	771.40625	16	824.9875
5	773.00625	17	851.0125
6	774.92500	18	857.3125
7	794.00625 (Rx = 764.00625)	19	863.6875
8	796.00625 (Rx = 766.00625)	20	869.9875
9	799.08125 (Rx = 769.08125)		
10	801.40625 (Rx = 771.40625)		
11	803.00625 (Rx = 773.00625)		
12	804.92500 (Rx = 774.92500)		

**Table 11-13: Frequencies for I/Q Modulation Frequency Set M73DB IQ**

CHANNEL NUMBER	FREQUENCY IN MHz (TX and RX)
1	800.00625 (Rx = 770.00625)
2	860.5125

**Table 11-14: Frequencies for Receiver Frequency Set M73DB SQ**

CHANNEL NUMBER	FREQUENCY IN MHz (TX and RX)	CHANNEL NUMBER	FREQUENCY IN MHz (TX and RX)
1	764.00625	4	851.0125
2	769.00625	5	869.9875
3	774.99375		

### 11.5.4.2 Removing Radio Alignment Test Systems from the Personality



**CAUTION**

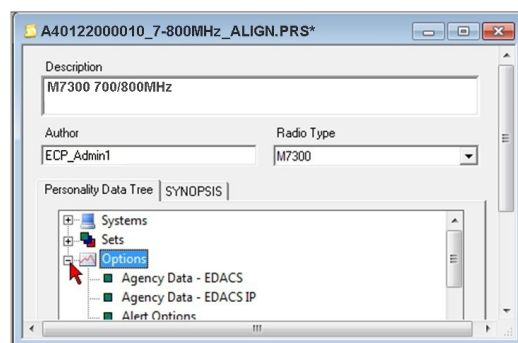
#### \*\*\*IMPORTANT\*\*\*

The systems added to the radio for accessing the test conventional frequency sets must **not** be accessible to the end radio user. When testing is completed, reload the radio's original personality, or remove the test systems as described in this section.

In general, deleting the new frequency sets created for radio testing from the radio's personality is not necessary. Simply deleting the test Systems from the System Setup's General tab in RPM and re-programming the radio with this modified personality removes radio user access to the frequency sets used for testing. The respective steps are presented in this procedure:

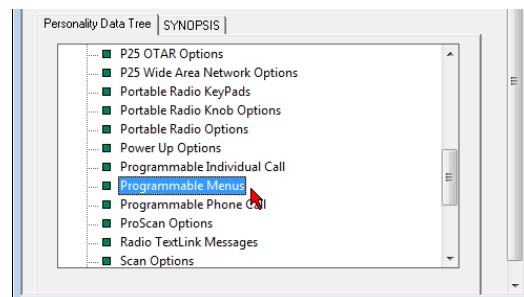
1. Connect the radio to the PC with the RPM programming software and enter programming mode. Refer to Section 11.5.3.1 as necessary.
2. Verify the feature and calibration data files have been saved to local disk. Refer to Sections 11.5.3.2 and 11.5.3.3 as necessary.
3. Read the radio's personality. Refer to Section 11.5.3.4 as necessary.
4. In the Personality Data Tree tab:

Click: **Options**



5. Scroll down the Options limb:

Double-click: **Programmable Menus**

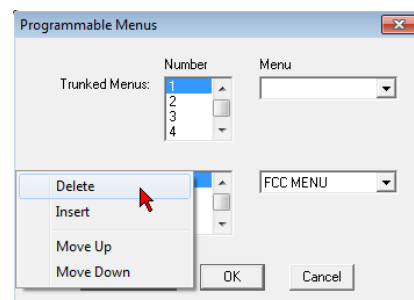


6. Within the Conventional Menus Number box:

Double-click: **1** ("FCC Menu")

Click: **Delete**

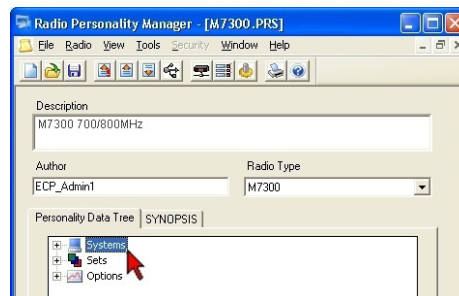
Click: **OK**



7. In the Personality Data Tree tab:

Double-click: **Systems**

The System Setup dialog box opens.



8. In the General tab of the System Setup dialog box:

Double-click: **M73DB HP**

Click: **Delete System**

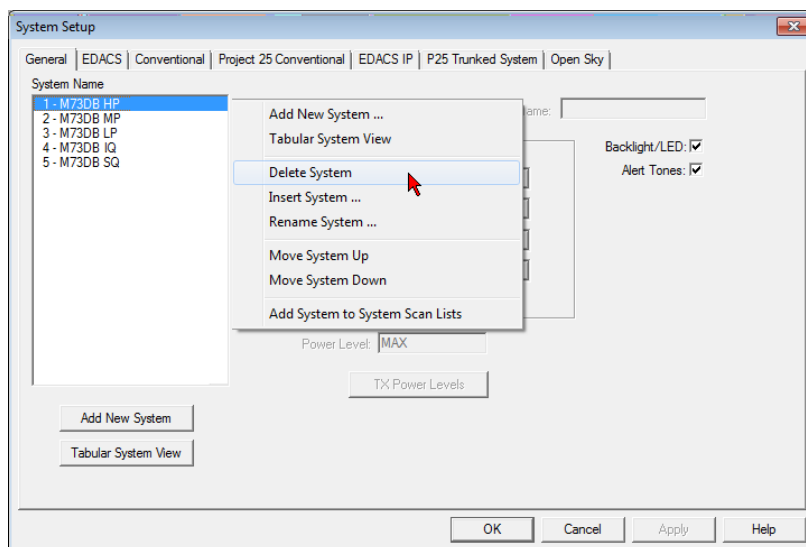
9. Repeat to delete each of the other systems previously added for testing:

**M73DB MP**

**M73DB LP**

**M73DB IQ**

**M73DBSQ**



#### NOTE

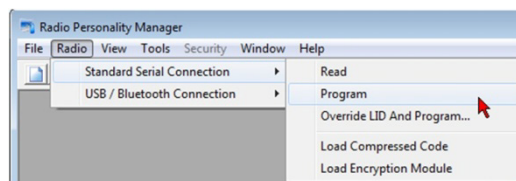
In general, deleting the new frequency sets created for radio testing from the radio's personality is not necessary. Simply deleting the test Systems from the System Setup's General tab in RPM and re-programming the radio with this modified personality removes radio user access to the frequency sets used for testing.

10. When all new conventional systems created for testing are deleted, click **OK**.

11. From RPM's main menu:

Select: **Radio > Standard Serial Connection > Program**

12. Wait for the re-programming operation to complete.



## 11.5.5 Radio Alignment Procedures

### 11.5.5.1 General Information

Before beginning any radio alignment procedure, a careful review of Sections 11.5.3.1 through 11.5.3.4 is recommended. The minimum radio firmware code versions and RPM version listed in Section 11.5.1 (page 75), and the required test equipment must be in place. Unless otherwise stated, each alignment procedure is written as a standalone procedure; in other words, it may be performed without performing the full battery of procedures.

The following flow of events should be performed before beginning radio alignment:

- Read and save the original feature data, calibration data, and personality data files before making any changes. Refer to Section 11.5.3 (page 76) as necessary.
- Update the existing personality in the radio with conventional test frequency sets. Refer to Section 11.5.4 (page 81) as necessary.
- Test the radio per the alignment procedures in this manual and align with updated calibration data as necessary.
- Save the final calibration data to a local file. Refer to Section 11.5.3.3 (page 79) as necessary.
- Reload the radio's original personality and verify operation.



#### \*\*\*IMPORTANT\*\*\*

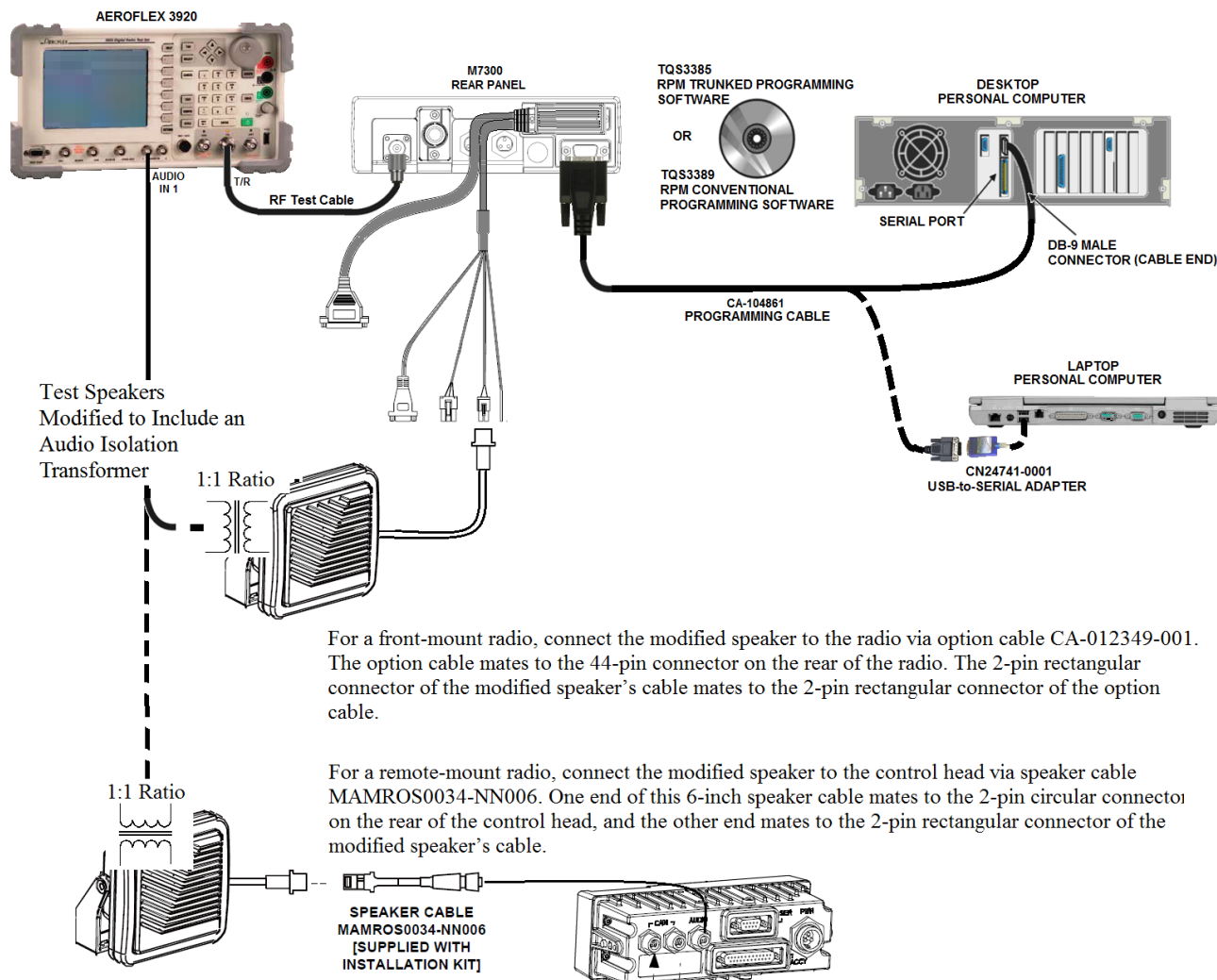
The systems added to the radio for accessing the test conventional frequency sets must **not** be accessible to the end radio user. When testing is completed, reload the radio's original personality, **or** remove the test systems as described in Section 11.5.4.2 (page 87).



RF test cables used to connect the radio to the RF Communications Test Set will affect RF power by adding losses. The longer the cable, the greater the loss. For optimum results, connect the radio to the RF test equipment using only high-quality cables as listed in Table 11-6 (page 63).



The use of an RF attenuator between the radio and the test equipment is recommended, and it may be required for some test equipment. Consult the test equipment's specifications as necessary. An attenuator is not shown in the following figure. When an attenuator is used, be sure to compensate all measurements accordingly.



**Figure 11-2: Test Equipment Connections for Radio Alignment**

### 11.5.5.2 Automatic Frequency Control (TCXO Reference Oscillator) Alignment



NOTE

The radio's TCXO reference oscillator is a highly accurate and stable crystal reference oscillator which should **not** normally require re-alignment. The use of a recently-calibrated RF Communications Test Set or Frequency Counter is recommended. **The utilized test equipment should have a specified frequency accuracy/stability equal to or better than 0.15 ppm.** If not, an appropriate external timebase reference which meets or exceeds this specification must be applied to the external timebase reference input of the test set/frequency counter, and the test set/frequency counter must be configured to use this external reference.



NOTE

This alignment should be performed with the radio and test equipment at a room temperature between 68 and 77° Fahrenheit (20 to 25° Celsius). After radio power-up, always wait at least 15 minutes before taking a measurement. This warm-up time will allow the temperature of the radio's circuits to properly stabilize.



NOTE

If frequency alignment is necessary, maximum errors less than or equal to  $\pm 80$  Hz should be obtained.

#### **DO NOT attempt AFC alignment while in trunked mode!**



CAUTION

Only align the AFC value in analog conventional mode. During trunked mode, an additional AFC compensation value is applied to the radio's reference oscillator frequency control.

The additional compensation value is temporary and refreshed each time the radio locks onto a Control Channel. While locked on a Control Channel, the radio's reference oscillator is precision-aligned to match the Control Channel base station's true frequency.

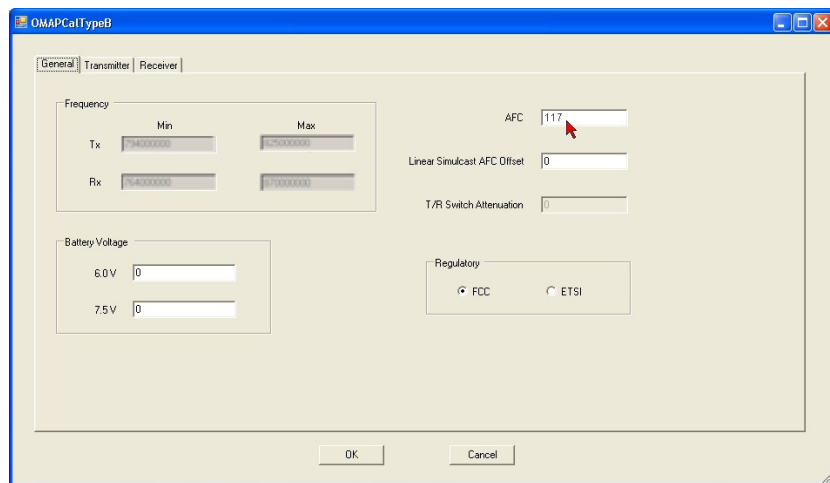
The Automatic Frequency Control (AFC) adjusts the frequency of the radio's TCXO reference oscillator. Follow this procedure to align this oscillator:

1. Setup and power-up the radio, control head, and test equipment as described in the Tx Frequency Test procedure, Section 11.4.4.1 (do steps 1 through 7 of that procedure). Also see Figure 11-2.
2. Add the conventional test systems to the radio personality. Refer to Section 11.5.4 as necessary.
3. Select the low-power test system **M73DB LP**.
4. Select **Channel 20** (869.9875 MHz). See Table 11-12 on page 86 for all channels/frequencies used in this procedure.
5. Configure the RF Communications Test Set's frequency counter for an in-band frequency count.
6. **If at least 15 minutes has passed since the radio was powered-up, continue to the next step. Otherwise, wait until this period has passed, to allow the frequency of the radio's TCXO reference oscillator to stabilize.**
7. Key the radio by depressing the microphone's PTT button, and measure the radio's transmit frequency.
8. If the measured frequency is within  $\pm 80$  Hz, unkey the radio and advance to step 22.  
If the measured frequency is not within this range, unkey the radio and go to step 9.
9. Turn off the radio and the control head.

10. Using a serial programming cable, connect the radio to the PC with the RPM programming software. See Figure 9-1 on page 36.
11. Turn on the radio and control head.
12. At the PC with the RPM programming software, start the Radio Maintenance Utility:  
Click: **Start > Programs > Harris Radio Personality Manager > RPM Radio Maintenance Utility**
13. In the utility, click on the tab that includes **M7x00** (for the M5300, M7300, and other radios).
14. From utility's main menu:  
Select: **Radio > Read > Calibration Data from Radio**
15. When the Calibration Data Complete dialog box opens:  
Click: **OK**
16. In the tab that includes **M7x00**:  
Click: **Calibration Data**

17. In the General tab, adjust the AFC value up or down. The TX frequency is proportional to the change in AFC value: Increasing the value increases the TX frequency while decreasing the value decreases the TX Frequency.

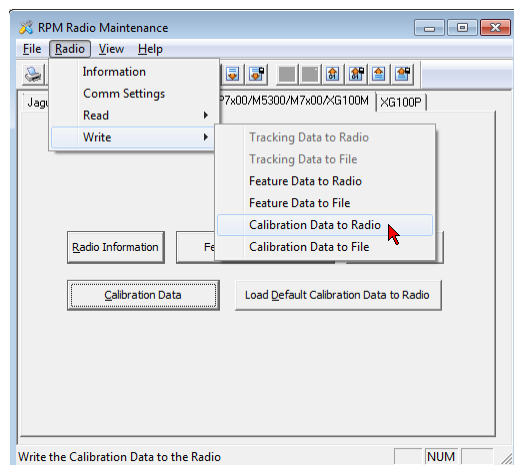
Click: **OK**



**CAUTION**

Do not change any of the other fields in the General tab.

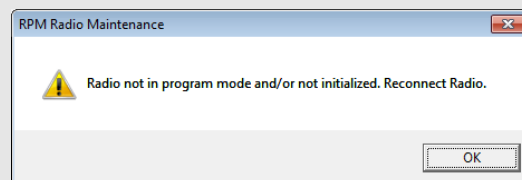
18. From the utility's main menu:  
Select: **Radio > Write > Calibration Data to Radio**
19. When the Calibration Data Write Complete dialog box appears:  
Click: **OK**
20. Cycle power to the radio or click the **JUMP** button to reset the radio after programming. Power cycling the control head is not necessary.





NOTE

If an error message box appears similar to the one shown at the right, try re-writing the calibration data. If a second write does not resolve the issue, first verify serial programming cable connections. Next, within the utility, verify serial port settings by clicking **Radio > Comm Settings** on the utility's main menu.



21. Repeat from step 3 until the measured transmit frequency is within  $\pm 80$  Hz. Step resolution of the AFC increment/decrement value may not allow setting to the exact frequency. In that case, use a value which results in a transmit frequency as close as possible, and within the respective range. When performing alignment, do **not** use the maximum frequency errors listed in Table 11-8, as they are based on  $\pm 1.5$  ppm across the entire operating temperature range of the radio.
22. If no other alignment or testing will be performed, do the following:
  - a. Save the final calibration data to a local file.
  - b. If a “shop” test personality was used to test the radio, reload the original personality and verify radio operation.
  - c. If conventional test systems were added to the original personality, remove the test systems, and verify radio operation. Refer to Section 11.5.4.2 on page 87 as necessary.

### 11.5.5.3 TX Power Alignment

The Radio Maintenance Utility's Calibration Data button accesses several tabs that can be used for aligning radio transmit power output levels. These levels include:

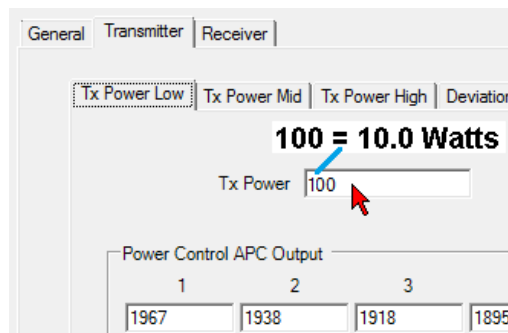
- TX Power Low
- TX Power Mid
- TX Power High

Each power level tab includes the following three (3) types of compensation factors:

- TX Power Reference
- Power Control APC Output
- Power Sense APC Input

Field alignment of the RF power output is performed at the high (maximum) and low (minimum) power levels. In each Tx Power tab, the value entered in the Tx Power box represents the RF output level which the radio is aligned to in deciwatts (i.e., divide by 10 for watts). For example, an entry of “350” equals an RF power output of 35 watts, and an entry of “100” equals 10 watts.

There are 2 sets of 20 data values, each representing a different frequency and spread across the combined 700/800 MHz bands. Each point is used to align the transmitter RF output power level at the assigned frequency, as specified in Table 11-12. Increasing the data values increases the power output at each reference point.



Power Control APC Output																			
	1	2	3	4	5	6	7	8	9	10									
For 764.00625 MHz	1265	1260	1254	1249	1244	1238	1233	1228	1223	1217									
	11	12	13	14	15	16	17	18	19	20									
For 803.00625 MHz	1212	1208	1204	1200	1196	1192	1188	1184	1180	1176									
	11	12	13	14	15	16	17	18	19	20									
	1	2	3	4	5	6	7	8	9	10									
For 764.00625 MHz	247	246	245	243	242	241	240	239	237	236									
	11	12	13	14	15	16	17	18	19	20									
For 803.00625 MHz	235	234	233	232	231	230	229	228	227	226									
	11	12	13	14	15	16	17	18	19	20									

See Table 11-12 for a Complete List of Frequencies Vs. Channels/Alignment Data Points

For the Power Control APC Output and Power Sense APC Input alignment data points, increasing a data point value increases the power output at the corresponding test frequency. Values for frequencies between the 20 specific alignment data points/frequencies are interpolated from the 20 data point values.

Power Control APC Output values prevent the radio from producing excessive RF during initial transmit key-up. Power Sense APC Input values set the radio's steady state power after being keyed for a short period of time (i.e., settling time).



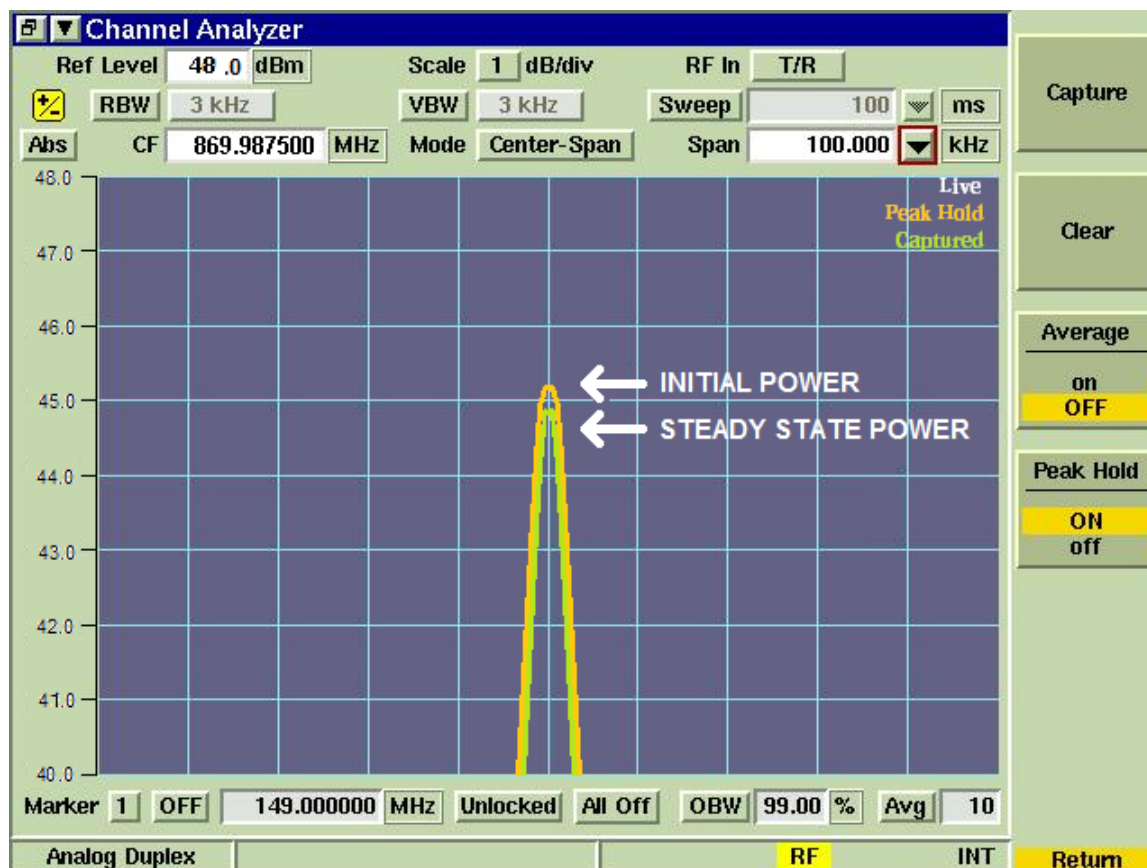
TX power levels are factory aligned. Factory alignment establishes the appropriate transmit power levels for the radio. New values should not be entered unless original values are lost, corrupted, or associated hardware is replaced (e.g., TX Power Amplifier module).



For optimum performance, minimum DC current drain, TX power amplifier protection, and to assure compliance with FCC requirements, DO NOT exceed nominal RF power output settings.

Perform the following to align the transmit RF power output of the radio:

1. Setup and power-up the radio, control head, and test equipment as described in the Tx Frequency Test procedure, Section 11.4.4.1 (do steps 1 through 7 of that procedure). Also see Figure 11-2.
2. Add the conventional test systems to the radio's personality. Refer to Section 11.5.4 as necessary.
3. Select the low-power test system **M73DB LP**.
4. Select **Channel 20** (869.9875 MHz), the next test channel, or the channel being aligned. See Table 11-12 on page 86 for all channels/frequencies used in this procedure.
5. Key the radio by depressing the microphone's PTT button, and wait for the transmit power to stabilize (typically one to two seconds).
6. Measure the steady-state transmit power. Figure 11-3 shows the Channel Analyzer function of the Aeroflex 3920.



**Figure 11-3: Measuring and Aligning APC Input and Output Power with Aeroflex 3920**

7. Unkey radio.
8. Turn on the test set's Peak Hold function.
9. Rekey the radio and measure the initial transmit power. Typically, this measurement is higher than this channel's steady-state transmit power. See Figure 11-3 for an example display.
10. Unkey the radio:
11. Use the applicable case below to continue:
  - a. If the difference between the initial transmit power and the steady-state transmit power is greater than 0.8 dB, or the steady-state power measurement is outside of the respective High Power, Mid Power, or Low Power specifications shown in Table 11-15, then advance to step 12 and align the power settings for the channel being tested.
  - b. If the difference between the initial transmit power and the steady-state transmit power is less than 0.8 dB, and the steady-state transmit power is within  $\pm 0.25$  dB of the set power level:
    - i. Select the next lower test frequency in the selected system.
    - ii. Repeat the test and alignment process, beginning with step 4, until all channels in the selected system have been tested and aligned.
  - c. If all data points are aligned in the low power system:
    - i. Select the high-power system, **M73DB HP**.
    - ii. Repeat the test and alignment process beginning with step 4, until all channels in the selected system have been tested and aligned for high power.

- d. If all data points are aligned in the high power system:
  - i. Select the mid-power system, **M73DB MP**.
  - ii. Repeat the test and alignment process beginning with step 4, until all channels in the selected system have been tested and aligned for mid power.
- e. If high, mid, and low power testing has been completed for all test channels, advance to step 27.

**Table 11-15: Transmitter RF Power Output Requirements**

<b>BAND (MHz)</b>	<b>LOW POWER (WATTS)</b> (± 0.25 dB)	<b>MID POWER (WATTS)</b> (± 0.25 dB)	<b>HIGH POWER (WATTS)</b> (± 0.25 dB)
700 MHz	1.5	15	35 (or 20, see NOTES)
800 MHz	5.0	15	35 (or 20, see NOTES)

**NOTE**

The radio is aligned for a maximum of 35 watts across the entire 700/800 MHz frequency band. For FCC licensed systems, make sure that customer personalities which contain 700 MHz frequencies are limited to 30 Watts via the personality programming, not the alignment.

**NOTE**

To meet Maximum Permissible Exposure (MPE) requirements, mobile radios used in motorcycle applications are factory-set in radio code to limit RF power output to 20 watts. In this case, realign all high power settings for 20 watts, and all mid power settings for 15 watts.

MODIFIED AND POWER TURNED DOWN  
FOR MOTORCYCLE APPLICATIONS

12. Turn off the radio and control head.
13. Using a serial programming cable, connect the radio to the PC with the RPM programming software. See Figure 9-1 on page 36,
14. Turn on the radio and control head.
15. At the PC with the RPM programming software, start the Radio Maintenance Utility:
 

Click: **Start > Programs > Harris Radio Personality Manager > RPM Radio Maintenance Utility**
16. In the utility, click on the tab that includes **M7x00** (for the M5300, M7300, and other radios).
17. From the utility's main menu:
 

Select: **Radio > Read > Calibration Data from Radio**
18. When the Calibration Data Complete dialog box opens:
 

Click: **OK**
19. In the tab that includes **M7x00**:
 

Click: **Calibration Data**

20. In the Transmitter tab, review the TX Power Low, Mid, and High tabs and verify the Tx Power and the 700 MHz (M7300 Only) input boxes show the correct values:

For Low Power: **50** (see Figure 11-4)

For 700 MHz Low Power: **15**

For Mid Power: **150** (see the following **NOTE**)

For High Power: **350** (however, if re-aligning a motorcycle radio, enter **200**)



**NOTE**

The Tx Power input box values represent the transmit power output level associated to each Tx Power Tab (High, Mid, and Low) in deciwatts. Divide by 10 for watts. For example, “350” equals an RF power output of 35 watts, and “200” equals 20 watts.



**NOTE**

The value used for aligning the mid power level is not critical, as long as the measured transmitter power output matches the reference value shown in the mid power Tx Power field.

If a different Tx Mid Power level value is present in the input box, it is acceptable to reprogram the channel set **M73DB MP** for the same power level and retest the radio; refer to Section 11.5.4.1, step 16. This will save realignment time.

OMA PCalTypeB

General | Transmitter | Receiver

Tx Power Low | Tx Power Mid | Tx Power High | Deviation Wideband | Deviation Narrowband | I/Q Data

Tx Power 50 700 MHz (M7300 Only) 15

Power Control APC Output

1	2	3	4	5	6	7	8	9	10
540	540	540	540	540	540	518	514	511	507
11	12	13	14	15	16	17	18	19	20
504	500	972	965	957	950	933	933	933	933

Power Sense APC Input

1	2	3	4	5	6	7	8	9	10
144	144	144	144	144	144	140	139	138	138
11	12	13	14	15	16	17	18	19	20
137	136	238	237	235	234	230	230	231	231

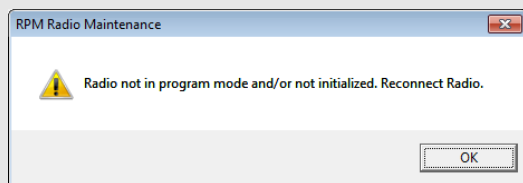
OK Cancel

**Figure 11-4: Example of TX Power Low APC Input and Output Power Settings**

21. Adjust the Power Control APC Output and Power Sense APC Input values accordingly for the frequency (test channel) being tested. Increasing the values increases transmit power output.
22. Click **OK**.
23. From the utility’s main menu:  
Select: **Radio > Write > Calibration Data to Radio**

**NOTE**

If an error message box appears similar to the one shown at the right, try re-writing the calibration data. If a second write does not resolve the issue, first verify serial programming cable connections. Next, within the utility, verify serial port settings by clicking **Radio > Comm Settings** on the utility's main menu.



24. When the Calibration Data Write Complete dialog box appears, click **OK**.
25. Cycle power to the radio or click the **JUMP** button to reset the radio after programming. Power cycling the control head is not necessary.
26. Return to step 4 and retest the channel.
27. Save the final calibration data to a local file.
28. If no other alignment or testing will be performed, do the following:
  - a. If a “shop” test personality was used to test the radio, reload the original personality and verify operation.
  - b. If test systems were added to the original personality, refer to Section 11.5.4.2 (page 87), remove the systems, and verify radio operation.

#### 11.5.5.4 I/Q Data Modulation Alignment

The Radio Maintenance Utility can be used to align the following I and Q data modulation parameters: DC offset, amplitude, and vector arrays. This alignment affects radio transmissions when operating on a channel programmed for C4FM mode.

**CAUTION**

I/Q data modulation alignment should only be necessary if hardware components affecting transmitter performance have been replaced or the radio has reset to default factory data. Under any other circumstances where I/Q misalignment is suspected, it is recommended to first verify the test setup, and then determine and correct the cause of radio failure before proceeding with an alignment.

Follow this procedure to verify and align I and Q data modulation:

1. Setup and power-up the radio, control head, and test equipment as described in the Tx Frequency Test procedure, Section 11.4.4.1 (do steps 1 through 7 of that procedure). Also see Figure 11-2.
2. Add the conventional test systems to the radio's personality. Refer to Section 11.5.4 as necessary.
3. At the control head, select conventional test system **M73DB IQ**.
4. At the control head, select **Channel 2** (860.5125 MHz). See Table 11-13 on page 86 for all channels/frequencies used in this procedure.
5. Setup the RF Communications Test Set's RF spectrum analyzer for on-frequency measurements. Refer to Figure 11-5.
6. Press the control head's **MENU** button, then use the **•/••** ramp control to scroll through the menu until **FCC Menu** appears in the middle line of the display, and then press the **MENU** button again. The second line of the display now alternates between the selected RX frequency and the present RF input level (in dBm) applied to the radio.

7. Press the ●/● ramp control down to select **SSB MODE** (single side-band mode).



While in the FCC Menu's SSB MODE submenu, use the **MENU** button to key and unkey the radio. This is a latching PTT function. The control head's transmit indicator will illuminate red when the radio is transmitting.

8. Press the **MENU** button to key the radio.
9. Using the spectrum analyzer display, measure the difference between the RF carrier and any carrier leakage or sidebands. See Figure 11-5 for an example analyzer display. Record the suppressed carrier leakage and sidebands on this channel/frequency. Each must be at least -45 dBc (i.e., at least 45 dB below the carrier).
10. Press the **MENU** button to unkey the radio.

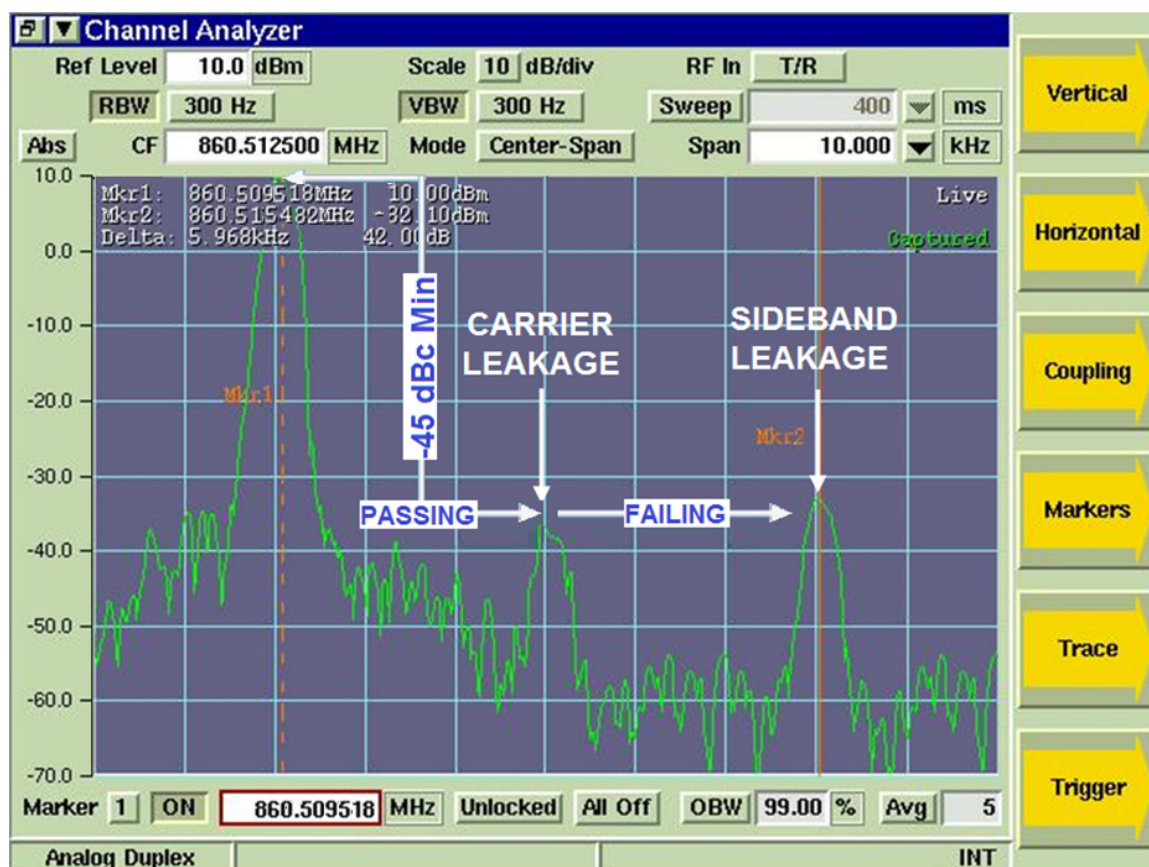


Figure 11-5: I and Q Alignment using FCC Menu's SSB MODE with Aeroflex 3920

11. Select the next lowest channel/frequency and repeat steps 5 through 10 until carrier leakage and sideband measurements have been recorded for all four (4) test channels/frequencies.
12. If carrier leakage or sideband leakage on any test frequency exceeded the -45 dBc limit, go to step 13. Otherwise, advance to step 27 and save data.
13. Turn off the radio and control head.
14. Using a serial programming cable, connect the radio to the PC with the RPM programming software. See Figure 9-1 on page 36.
15. Turn on the radio and control head.

16. At the PC with the RPM programming software, start the Radio Maintenance Utility:

Click: **Start > Programs > Harris Radio Personality Manager > RPM Radio Maintenance Utility**

17. In the utility, click on the tab that includes **M7x00** (for the M5300, M7300, and other radios).

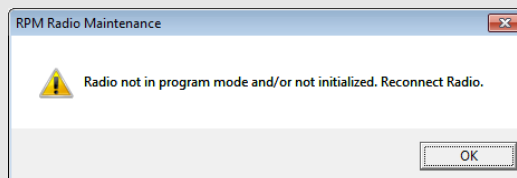
18. From the utility's main menu:

Select: **Radio > Read > Calibration Data from Radio**



**NOTE**

If an error message box appears similar to the one shown at the right, try re-reading the calibration data. If a second read does not resolve the issue, first verify serial programming cable connections. Next, within the utility, verify serial port settings by clicking **Radio > Comm Settings** on the utility's main menu.



19. When the Calibration Data Complete dialog box opens:

Click: **OK**

20. In the tab that includes **M7x00**:

Click: **Calibration Data**



**NOTE**

Adjusting I and Q values is an iterative (manual) and time-consuming process. The values interact with each other. Start by adjusting the "I" DC Offset up or down and retesting the channel. If an improvement in carrier and sideband suppression is noted, continue updating the value until the improvement ends.

When starting out, it may be helpful to update the values in steps of 50 and note the changes to the RF signal. Once several stepped updates seem to pass by a null, go back and update the values in steps of 5 or 10 until the best (or a passing) result is achieved.

Continue alignment by systematically adjusting, Q DC Offset, I Amplitude, Q Amplitude, I Vector, and Q Vector until the best (or a passing) result is achieved, adjust only one value at a time. However, all failing channels may be adjusted at the same time (or just one at a time), whichever is least confusing and the most efficient.

21. Within the Transmitter tab, select a test channel requiring alignment.
22. Adjust the fields, one at a time, and retest until the best (or a passing) result is achieved.

Adjust the fields in the following order, making sure to retest each change before moving onto the next field:

- “I” DC Offset
- “Q” DC Offset
- “I” Amplitude
- “Q” Amplitude
- “I” Vector
- “Q” Vector

Channels:	DCOffset - I	DCOffset - Q	Amplitude - I	Amplitude - Q	Vector - I	Vector - Q
1	280	200	32767	32767	-180	32767
2	0	0	0	0	0	0
3	600	200	32767	32767	230	32767
4	0	0	0	0	0	0

23. From the utility's main menu:  
Select: **Radio > Write > Calibration Data to Radio**
24. When the Calibration Data Write Complete dialog box appears:  
Click: **OK**
25. Cycle power to the radio or click the **JUMP** button to reset the radio after programming. Power cycling the control head is not necessary.
26. Return to step 3 and repeat the procedure until all channels are correctly aligned.
27. Save the final calibration data to a local file.
28. If no other testing is to be performed, do the following:
  - a. If a “shop” test personality was used to test the radio, reload the original personality into the radio and verify operation.
  - b. If conventional test frequency sets were added to the original personality, refer to Section 11.5.4.2, remove the test sets, and verify radio operation.

### 11.5.5.5 FM Deviation Alignment (Not Required)

While the Radio Maintenance Utility's user interface is generically written for most OMAP radios, it provides alignment tabs for the wide-band and narrowband deviation alignment. However, these tabs only apply to portable radios and to the 900 MHz M5300 mobile radio.



Changing values within the Deviation Wideband tab or Deviation Narrowband tab will **not** affect radio alignment for VHF, UHF, 700 or 800 MHz M5300/M7300 mobile radios.

### 11.5.5.6 RSSI Alignment

The Radio Maintenance Utility's Receiver tab includes input fields for aligning the Receive Signal Strength Indication (RSSI) detection. This alignment is based on weak, medium, and strong input RF signal levels as measured on five (5) test frequencies spread across the entire RF operating range of the

radio. Correct alignment ensures the proper values are displayed in the FCC menu, and that received signal strength reports sent over-the-air from the radio are accurate.

Follow this procedure to test and align RSSI values:

1. Connect and power-up the radio, control head, and test equipment as described in the Audio Output and Distortion Levels Tests presented in Section 11.4.5.1 (do steps 1 through 9 of that procedure). Also see Figure 11-2. Distortion levels do not need to be tested (i.e., do not need to be verified as good) before performing this procedure.
2. Add the conventional test systems to the radio's personality. Refer to Section 11.5.4 as necessary.
3. Connect the radio's TNC antenna port connector to the RF Communications Test Set's signal generator/low-power RF output port. To make this connection, use only high-quality RF coax cable(s).
4. At the control head, select test system **M73DB SQ**.
5. At the control head, select **Channel 1** (764.00625 MHz). However, if aligning an 800 MHz M5300 radio, select **Channel 4** (851.0125 MHz). See Table 11-14 on page 86 for all channels/frequencies used in this procedure.
6. Press the control head's **MENU** button, then use the **•/••** ramp control to scroll through the menu until **FCC Menu** appears in the middle line of the display, and then press the **MENU** button again. The second line of the display now alternates between the selected RX frequency and the present RF input level (in dBm) applied to the radio.
7. Configure the test set to generate an on-frequency FM carrier at a -110 dBm RF output level. This RF level is a reference level for verifying "weak" RSSI alignment values.
8. Record the displayed RSSI level.
9. Change the test set's RF output level to -85 dBm. This RF level is a reference level for verifying "medium" RSSI alignment values.
10. Record the displayed RSSI level.
11. Change the test set's RF output level to -60 dBm. This RF level is a reference level for verifying "strong" RSSI alignment values.
12. Record the displayed RSSI level.
13. At the control head, change the channel to the next higher channel/frequency and repeat steps 6 through 12 until weak, medium and strong RSSI measurements are done on all receive frequencies. For the 800 MHz M5300, only the two 800 MHz band frequencies need to be measured. For the 700/800 MHz M7300, measure all five (5) frequencies. The five channels/frequencies are listed in Table 11-14.
14. If any of the measured RSSI level measurement is more than  $\pm 1.0$  dB from the test set's RF output level, continue with step 15 to align the radio. Otherwise, advance to step 29 and save data.
15. Turn off the radio and control head.
16. Using a serial programming cable, connect the radio to the PC with the RPM programming software. See Figure 9-1 on page 36.
17. Turn on the radio and control head.
18. At the PC with the RPM programming software, start the Radio Maintenance Utility:

Click: **Start > Programs > Harris Radio Personality Manager > RPM Radio Maintenance Utility**

19. In the utility, click on the tab that includes **M7x00** (for the M5300, M7300, and other radios).

20. From the utility's main menu:

Select: **Radio > Read > Calibration Data from Radio**

21. When the Calibration Data Complete dialog box opens:

Click: **OK**

22. In the tab that includes **M7x00**:

Click: **Calibration Data**

23. Select: **Receiver** tab.

Refer to step 14 and adjust the Strong, Medium, and Weak RSSI values as necessary.

Do **not** change the Signal Strength values in the first column.

24. Click: **OK**

Squelch Open Levels					
	1	2	3	4	5
Wideband	1750	1750	1750	1750	1750
Narrowband	720	720	720	1400	1400
C4FM	720	720	720	1400	1400
XNB	600	600	600	600	600

Squelch Close Levels					
	1	2	3	4	5
Wideband	2550	2550	2550	2550	2550
Narrowband	1500	1500	1500	2250	2250
C4FM	1500	1500	1500	2250	2250
XNB	1600	1600	1600	1600	1600

RSSI					
Signal Strength	1	2	3	4	5
Strong	60	2714	2721	2690	2658
Medium	85	2035	2042	2004	1983
Weak	110	1257	1275	1245	1228

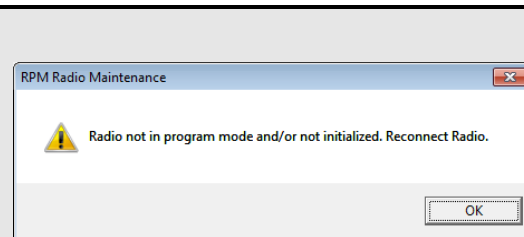
25. From the utility's main menu:

Select: **Radio > Write > Calibration Data to Radio**



NOTE

If an error message box appears similar to the one shown at the right, try re-writing the calibration data. If a second write does not resolve the issue, first verify serial programming cable connections. Next, within the utility, verify serial port settings by clicking **Radio > Comm Settings** on the utility's main menu.



26. When the Calibration Data Write Complete dialog box appears:

Click: **OK**

27. Cycle power to the radio or click the **JUMP** button to reset the radio after programming. Power cycling the control head is not necessary.

28. Return to step 4 and repeat the test and alignment procedure until all RSSI values are correctly aligned.

29. Save the final calibration data to a local file.

30. If no other testing is to be performed, do the following:

- If a "shop" test personality was used to test the radio, reload the original personality and verify operation.
- If conventional test systems were added to the original personality, refer to Section 11.5.4.2, remove the test systems, and verify radio operation.

### 11.5.5.7 Squelch Open and Close Alignment

The Radio Maintenance Utility's Receiver tab includes input fields for Squelch Open Levels and Squelch Close Levels. Values entered into these fields determine the received signal level required to unsquelch the receiver. A higher value equates to a weaker RF signal required to unsquelch the radio on the respective channel/frequency.

Radios like the M5300 and M7300 that support multiple modes of operation and wide and narrow bandwidths require different squelch levels for each mode. Squelch Open Levels and Squelch Close Levels input fields are provided for wide-band, narrowband, C4FM, and XNB operations. Values for wideband and narrowband operation are aligned for squelch open and squelch close at five (5) frequencies spread across the entire RF operating range of the radio.



The C4FM Squelch Open Levels and C4FM Squelch Closed Levels values are not used with an 800 MHz M5300 radio or with a 700/800 MHz M7300 radio. These values are only used with a 110-Watt VHF radio. Do not change these values in a 700/800 MHz radio.

Likewise, the XNB Squelch Open Levels and XNB Squelch Close Levels values are not used with an 800 MHz M5300 radio or with a 700/800 MHz M7300 radio. These values only apply to a 900 MHz radio. Do not change these values in a 700/800 MHz radio.

Each compliment of Squelch Open Level and Squelch Close Level values are set such that a stronger signal is required to open the squelch (Squelch Open Levels) and it doesn't close until the signal level weakens (Squelch Close Levels). This is squelch hysteresis. Without hysteresis, squelch response to weak signals would result in broken-up receive audio in the speaker.

Squelch alignment is based on the industry-standard Signal, Noise, And Distortion (SINAD) ratio. This is a comparison of no signal (all noise) to the desired signal being received. A hysteresis value of between 1.5 and 3.0 dB in SINAD is considered optimal. Factory alignment sets the Squelch Open Level for 8 dB  $\pm$  2 dB SINAD.

Follow this procedure to test and align squelch open and close levels:

1. Connect and power-up the radio, control head, and test equipment as described in the Audio Output and Distortion Levels Tests presented in Section 11.4.5.1 (do steps 1 through 9 of that procedure). Also see Figure 11-2. Distortion levels do not need to be tested (i.e., do not need to be verified as good) before performing this procedure.
2. Add the conventional test systems to the radio's personality. Refer to Section 11.5.4 as necessary.
3. Connect the radio's TNC antenna port connector to the RF Communications Test Set's signal generator/low-power RF output port.
4. At the control head, select test system **M73DB SQ**.
5. At the control head, select **Channel 1** (764.00625 MHz). However, if aligning an 800 MHz M5300 radio, select **Channel 4** (851.0125 MHz). See Table 11-14 on page 86 for all channels/frequencies used in this procedure.
6. Configure the test set to generate an on-frequency FM carrier at a minimum RF output level (-125 dBm or lower) and modulated with a 1 kHz tone at a deviation level per the respective operating mode in Table 11-16.

**Table 11-16: FM Deviation Levels for Aligning Squelch**

FREQUENCY BAND	MODE	1 kHz TONE DEVIATION (NO CG OR DCG)
700 MHz	Narrowband (Analog)	1.35 kHz $\pm$ 100 Hz
800 MHz	NPSPAC	2.16 kHz $\pm$ 100 Hz
800 MHz	Wideband (Analog)	2.7 kHz $\pm$ 200 Hz

7. Also prepare the test set for a SINAD measurement.



While it may be desirable to perform SINAD testing simply by listening to the audio heard from the speaker, it is highly recommended to set-up the test equipment for a SINAD measurement, and let it make accurate and repeatable measurements.

8. Press the control head's **MENU** button, then use the **•/••** ramp control to scroll through the menu until **FCC Menu** appears in the middle line of the display, and then press the **MENU** button again. The second line of the display now alternates between the selected channel's RX frequency and the RF input level (in dBm) currently applied to the radio. Typically, the displayed RF input level will be -125 dBm or less. It is important to verify the frequency is clear (no undesired receive signals).
9. Press the **•/••** ramp control down to select: **SQ #####**, where ##### represents a randomly changing number, typically between 1000 and 4000. This is the Squelch Reference value. It represents the received noise level currently being detected by the receiver's squelch circuit.
10. Record the Squelch Reference value displayed for this channel/frequency.
11. While monitoring the SINAD level, slowly increase the test set's RF output level until the squelch just opens. Record the measured SINAD level at this RF level for this channel/frequency.
12. While monitoring the SINAD level, slowly decrease the test set's RF output level until the squelch closes. Record the measured SINAD level just before squelch closing for this channel/frequency.
13. At the control head, select the next higher channel/frequency, then return to step 6 and repeat measurements on this frequency. Repeat this until the SINAD levels are measured and recorded on all five (5) wide-band channels/frequencies. Table 11-14 on page 86 lists the channels/frequencies.



C4FM squelch operation works as a conventional analog squelch and thus C4FM squelch is aligned as analog squelch. When a P25 signal's RF signal strength satisfies the C4FM Squelch Open Level value (RF signal quality), the radio then verifies P25 synchronization. If synchronization is present, the audio path opens in P25 mode. Otherwise, if a valid CG is detected (or if the channel is programmed for carrier squelch), the audio path is opened in analog voice mode.

14. If any channel opens at a level of 9 dB SINAD or greater, or closes at a value 5 dB SINAD or less, then continue with step 15 to realign the Squelch Open Level and Squelch Close Level values. Otherwise, advance to step 29 and save data.
15. Turn off the radio and control head.
16. Using a serial programming cable, connect the radio to the PC with the RPM programming software. See Figure 9-1 on page 36.
17. Turn on the radio and control head.

18. At the PC with the RPM programming software, start the Radio Maintenance Utility:  
Click: **Start > Programs > Harris Radio Personality Manager > RPM Radio Maintenance Utility**
19. In the utility, click on the tab that includes **M7x00** (for the M5300, M7300, and other radios).
20. From the utility's main menu:  
Select: **Radio > Read > Calibration Data from Radio**
21. When the Calibration Data Complete dialog box opens:  
Click: **OK**
22. In the tab that includes **M7x00**:  
Click: **Calibration Data**

23. Select: **Receiver** tab

Refer to steps 11 and 12 to adjust the values for any of the channels where the squelch did not open or close as expected. Decreasing the input value tightens the squelch function.

The screenshot shows the 'Receiver' tab in the RPM Radio Maintenance Utility. It contains three tables:

Squelch Open Levels					
	1	2	3	4	5
Wideband	1750	1750	1750	1750	1750
Narrowband	720	720	720	1400	1400
C4FM	720	720	720	1400	1400
XNB	600	600	600	600	600

Squelch Close Levels					
	1	2	3	4	5
Wideband	2550	2550	2550	2550	2550
Narrowband	1500	1500	1500	2250	2250
C4FM	1500	1500	1500	2250	2250
XNB	1600	1600	1600	1600	1600

RSSI					
Signal Strength	1	2	3	4	5
Strong	60	2714	2721	2690	2658
Medium	85	2035	2042	2004	1983
Weak	110	1257	1275	1245	1228

24. Click: **OK**



NOTE

A Squelch Open Level value must always be lower than the respective Squelch Close Level value.



NOTE

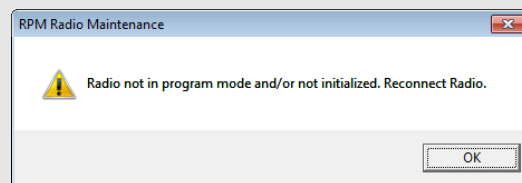
It may be advantageous to initially set each Squelch Open Level value 200 to 300 points lower than the displayed no-carrier **SQ #####** value, and then set the respective Squelch Close Level value 100 to 200 points lower than the displayed no-carrier **SQ #####** value.

This allows the radio's audio path to open with a very weak RF input signal and prevent the squelch from closing too soon. This allows the **SQ #####** value to be monitored while varying the RF generator's signal strength to near 0 dB SINAD. Afterward, the **SQ #####** values seen when 8 dB SINAD (Squelch Open) and 6 dB SINAD (Squelch Close) signal levels are achieved may be used to program the Squelch Open Levels and Squelch Close Levels values for each test channel/frequency, thus achieving alignment in a simplified test.

25. From the menu:  
Select: **Radio > Write > Calibration Data to Radio**

**NOTE**

If an error message box appears similar to the one shown at the right, try re-writing the calibration data. If a second write does not resolve the issue, first verify serial programming cable connections. Next, within the utility, verify serial port settings by clicking **Radio > Comm Settings** on the utility's main menu.



26. When the Calibration Data Write Complete dialog box appears:  
Click: **OK**
27. Cycle power to the radio or click the **JUMP** button to reset the radio after programming. Power cycling the control head is not necessary.
28. Return to step 6 and repeat the test and alignment procedure until all squelch level values are correctly aligned.
29. Save the final calibration data to a local file.
30. If no other testing is to be performed, do the following:
  - a. If a “shop” test personality was used to test the radio, reload the original personality and verify operation.
  - b. If conventional test systems were added to the original personality, refer to Section 11.5.4.2, remove the test systems, and verify radio operation.

## 12. RADIO CONNECTOR PIN-OUTS

### 12.1 9-PIN I/O CONNECTOR (SERIAL PORT CONNECTOR)

The 9-pin D-subminiature (DB-9) connector on the rear panel of the radio is a multi-purpose TIA/EIA/RS-232C serial port. Its pin-out is included in Table 13-1 below. It is also shown in the radio's internal interconnection diagram on page 175.

This serial port is used during radio programming operations. In this manual, see Sections 10.2 and 10.3 for details. Radio programming information, including cable hook-up diagrams, is also included in RPM's built-in help.

This serial port can also be used for connection to optional serially-interfaced equipment such as a computer/laptop running Mobile Data Terminal (MDT) software. For connections details, refer to the radio's *Installation and Product Safety Manual*, publication MM-014763-001.

In addition, this port is used for diagnostic testing performed at the factory.

**Table 13-1: 9-Pin Serial Port I/O Connector Pin-Out**

PIN	SIGNAL NAME	DESCRIPTION
1	DCD_A	RS-232 Data-Carrier-Detect output
2	TD_A	RS-232 Transmit-Data output
3	RD_A	RS-232 Receive-Data input
4	DSR_A	RS-232 Data-Set-Ready input
5	GND	RS-232 signal ground/reference
6	DTR_A	RS-232 Data-Terminal Ready output
7	CTS_A	RS-232 Clear-To-Send input
8	RTS_A	RS-232 Ready-To-Send output
9	RI_A	RS-232 Ring Indicator output

## 12.2 44-PIN I/O CONNECTOR (OPTION/ACCESSORY CONNECTOR)

The 44-pin D-subminiature (DB-44) connector of the rear panel of the radio is a connection point for optional inputs and outputs. The pin-out for this connector and the respective connectors of Option Cable 14002-0174-01 (formerly CA-012349-001) are included in the following table. The pin-out for the 44-pin connector is also shown in the radio's internal interconnection diagram on page 175.

**Table 12-2: 44-Pin Option/Accessory Connector Pin-Out**

44-PIN I/O CABLE CONNECTOR P1 PIN	SIGNAL NAME	OPTION CABLE 14002-0174-01 (or CA-012349-001)	DESCRIPTION
19	SPKR1	P2 pin 1	Speaker Audio Outputs 1 and 2. This differential speaker output is not used in a remote-mount radio installation with a CH-721 control head. However, in a front-mount radio installation, and in a remote-mount radio installation with an HHC-731 hand-held controller, this output drives the radio installation's external speaker.
20			
21	SPKR2	P2 pin 2	
22			
10	OUT2	P3 pin 1	Digital Output 2 (open-collector, 100 mA / 17 V maximum). External pull-up resistor needed if required by the external device's input during the high/off state. Use P3 pin 2 or 4 for ground. For ECP, configure via the "External Output Control Line 2" in Radio Personality Manager's (RPM's) External I/O dialog box. For example, an external logging recorder's record enable/disable input can be controlled by setting "External Output Control Line 2" to "Extern. Tx Indicator." With this example configuration, OUT2 will remain in the high/off (inactive) state during a radio trunked control channel transmission.
7	GND	P3 pins 2 & 4	Chassis Ground. Over-current-protected by a fuse on radio's PK Board.
26	HKSW	P3 pin 3	Digital Input for Hookswitch (default) or for radio PTT. Active = Ground. Inactive = Open. For use as a PTT input with OpenSky (see footnote <sup>9</sup> ), send the following AT command to the radio: AT@PTT_INPUT2. Also see P4 pin 21.

<sup>9</sup> This OpenSky AT command applies only to M5300/M7300 "rear panel software" release R15A (and later), and to M5300/M7300 radio software release R15C (and later).

Table 12-2: 44-Pin Option/Accessory Connector Pin-Out

44-PIN I/O CABLE CONNECTOR P1 PIN	SIGNAL NAME	OPTION CABLE 14002-0174-01 (or CA-012349-001)	DESCRIPTION
25	INP2	P3 pin 5	<p>Digital Input 2. Active = Ground. Inactive = Open. Use P3 pin 2 or 4 for ground.</p> <p>For ECP, configure via the “Auxiliary Input 2” in Radio Personality Manager’s (RPM’s) External I/O dialog Box.</p> <p>For OpenSky running OTP software R18C or earlier, send AT@PTT_INPUT2 to the radio to select this input for external PTT control.</p> <p>For OpenSky running OTP software R18D or later, send AT@AUXIO0,1,0,1,4 to the radio to set this input for non-emergency external PTT control. Using a “4” as the last digit of this command pairs this input as PTT control for the external mic input at P4 pin 27. Send AT@AUXIO1,0 to disable this input. Additional addressable OpenSky functions are available, such as defining this input as an emergency function input. Refer to the OpenSky MES Command Manual MM-016649-001 or contact the Harris Technical Assistance Center.</p>
28	SWA+	P3 pin 6	Switched A+ (DC Power) Output.
8	GND	P4 pin 1	Chassis Ground. Over-current-protected by a fuse on radio’s PK Board.
30	DGPS_ DATA	P4 pin 4	GPS Receiver Module DGPS Correction Data Serial Data Input (NMEA-Formatted).
4	EXTRX	P4 pin 5	External Rx Audio Input (from external/2 <sup>nd</sup> receiver; summed).
9	EXTMOD	P4 pin 7	External Tx Audio Input (typically not used).
3	SDATA	P4 pin 8	In a front-mount M5300/M7300 radio installation, this pin for the siren/PA interface is the siren serial data output (open-collector/open-drain) from the radio’s mounted (local) CH-721. It serially transfers siren and light control data from the CH-721 to a connected third-party siren and light system (e.g., Federal Signal SS2000 SmartSiren). Data rate = 1200 bps. Connects to SS2000’s DB-9 pin 3. For a remote-mount radio installation, see footnote <sup>10</sup> .

<sup>10</sup> In a remote-mount M5300/M7300 mobile radio installation, this pin on the radio’s DB-44 connector is typically not used. For the CH-721 control head, use the respective pin on the CH-721 Option Cable’s female DB-25 pin connector. For the HHC-731 hand-held controller, use the respective pin on the HHC-731 Interface Cable’s female DB-25 connector.

Table 12-2: 44-Pin Option/Accessory Connector Pin-Out

44-PIN I/O CABLE CONNECTOR P1 PIN	SIGNAL NAME	OPTION CABLE 14002-0174-01 (or CA-012349-001)	DESCRIPTION
5	FDISC	P4 pin 9	Buffered Filtered Discriminator Audio Output (typically not used). A fixed-level audio output with DC bias. Approximately 200 mV rms into a 600-ohm load at rated deviation. Does <u>not</u> contain signaling (e.g., CTCSS). Mutes when speaker mutes. Use a 33 $\mu$ F / 50 V (or greater) AC-coupling capacitor to couple to a 600-ohm load. Use P4 pin 12 for ground.
13	ALO	P4 pin 10	In a front-mount M5300/M7300 radio installation, this 600-ohm AC-coupled differential audio output from the mounted (local) CH-721 is typically not used. In a remote-mount M5300/M7300 radio installation, these two pins of the radio's DB-44 connector are not functional.
12	MICHI	P4 pin 11	
1	EXTALO	P4 pin 12	In a front-mount M5300/M7300 radio installation, VOLHI (a single-ended AC-coupled audio signal) and EXTALO (signal ground) provide public address (PA) mic audio from the mounted (local) CH-721 to a siren and light system, such as the Federal Signal SS2000 SmartSiren. Pin 13 connects to SS2000's DB-9 pin 5. Pin 12 connects to SS2000's DB-9 pin 6. For a remote-mount radio installation, these two pins can provide an unmuted volume-level-controlled single-ended audio signal to external devices. P1 pin 1 is over-current protected by a fuse on radio's PK Board.
14	VOLHI	P4 pin 13	
15	CTLON	P4 pin 14	Control-On Digital Input for data-only radio on/off power control.
16	XTONEENC	P4 pin 15	External Tone Encode Audio Input (default) or Auxiliary Mic Audio Input. For use as an aux mic audio input with OpenSky (see footnote <sup>9</sup> ), send the following AT command to the radio: AT@MIC_REAR_INPUT2. Also see P4 pin 24.
17	XTONEDEC	P4 pin 16	External Tone Decode Audio Output.
6	EXTALO	P4 pin 17	Reference/Ground for external audio. Over-current protected by a fuse on radio's PK Board.

Table 12-2: 44-Pin Option/Accessory Connector Pin-Out

44-PIN I/O CABLE CONNECTOR P1 PIN	SIGNAL NAME	OPTION CABLE 14002-0174-01 (or CA-012349-001)	DESCRIPTION
24	HORNRING	P4 pin 18	In a front-mount M5300/M7300 radio installation, this pin for the siren/PA interface is the horn/ring logic input to the radio's mounted (local) CH-721. When a connected third-party siren and light system (e.g., Federal Signal SmartSiren SS2000) has its horn/ring function active, this input is used to signal the head/radio as such. Connects to SS2000's DB-9 pin 8. For a remote-mount radio installation, see footnote <sup>10</sup> .
23	SONOFF	P4 pin 19	In a front-mount M5300/M7300 radio installation, this pin for the siren/PA interface is the siren on/off logic output (open-collector) from the radio's mounted (local) CH-721. It is the signal that powers the connected third-party siren and light system (e.g., Federal Signal SmartSiren SS2000) on and off. Connects to SS2000's DB-9 pin 4. For a remote-mount radio installation, see footnote <sup>10</sup> .
18	INP1	P4 pin 21	Digital Input 1. Active = Ground. Inactive = Open. Use P4 pin 1 for ground (software definable with OTP R18D).  For ECP, configure via the "Auxiliary Input 1" in Radio Personality Manager's (RPM's) External I/O dialog Box.  For OpenSky running OTP software R18C or earlier, send AT@PTT_INPUT1 to the radio to select only this input for auxiliary PTT control.  For OpenSky running OTP software R18D or later, send AT@AUXIO0,1,0,1,4 to the radio to set this input for non-emergency auxiliary PTT control. Using a "4" as the last digit of this command pairs this input as PTT control for the external mic input at P4 pin 27. Send AT@AUXIO0,0 to disable this input. Additional addressable functions are available such as defining this input as an emergency function. Refer to the OpenSky MES Command Manual MM-016649-001 or contact the Harris Technical Assistance Center.
2	OUT1	P4 pin 22	Digital Output 1 (open-collector, 100 mA / 17 V maximum). External pull-up resistor needed if required by the external device's input during the high/off state. Use P4 pin 1 for ground.  For ECP, configure via the "External Output Control Line 1" in Radio Personality Manager's (RPM's) External I/O dialog Box.

Table 12-2: 44-Pin Option/Accessory Connector Pin-Out

44-PIN I/O CABLE CONNECTOR P1 PIN	SIGNAL NAME	OPTION CABLE 14002-0174-01 (or CA-012349-001)	DESCRIPTION
29	TXENB+	P4 pin 23	Transmit Enable B+ Output (open-collector, 100 mA / 17 V maximum). Radio transmitting = low/on. Radio not transmitting = high/off. External pull-up resistor needed if required by the external device's input during the high/off state. Use P4 pin 1 for ground. Typically, this output is not used.
27	EXTMIC	P4 pin 24	External/Auxiliary Mic Audio Input. Fixed-level audio input (i.e., input gain is not adjustable). Approximately 120 mV rms gives full-rated deviation. Use P4 pin 17 for ground.  For OpenSky running OTP software R15C through R18C, to use as an aux mic audio input, send the following AT command to the radio: AT@MIC_REAR_INPUT1.  For OpenSky running OTP software R18D or later, refer to the notes for P4 pins 25 or 18. Refer to the OpenSky MES Command Manual MM-016649-001 or contact the Harris Technical Assistance Center.
28	SWA+	P4 pin 25	Switched A+ DC Power Output. Typically, this output is not used.
32	GPS_NMEA_RX	P5 pin 2	NMEA-Formatted GPS Receiver Position Data Serial Data Output.
31	GPS_NMEA_TX	P5 pin 3	NMEA-Formatted GPS Receiver Module Initialization Data Serial Data Input.
7	GND	P5 pin 5	Ground for GPS Serial Data Signals. Over-current-protected by a fuse on radio's PK Board.
11	IGNITION	Yellow Wire	Unused/Spare ignition sense input.
33 — 44	—	(no connections)	These twelve pins are typically not used. See page 175 for pin-out information.

## 13. GPS RECEIVER FIELD UPGRADE KIT

M5300/M7300 GPS Receiver Field Upgrade Kit KT-015605-001 is available which includes a GPS receiver module, software, and the kit's installation manual. This optional kit allows an M5300 or M7300 mobile radio that was not originally equipped with the GPS receiver option to be upgraded in the field with an internal GPS receiver. Refer to the kit's installation manual, publication number MM-015617-001 for installation instructions.

The kit can also be ordered via part number KT-012350-001. This kit does not include the installation manual. Otherwise, it is the same as kit KT-015605-001.

To order a kit, contact the Customer Care center using the contact information included in Section 16 of this manual.

## 14. DISASSEMBLY AND REASSEMBLY

This section includes disassembly and reassembly procedures for the radio. Also refer to the assembly diagrams shown in Section 15 as necessary.



Observe precautions for damage due to **Electro-Static Discharge (ESD)**. Use proper grounding techniques (wrist or waist straps with grounding cords, grounded table-top mats, etc.) and other approved methods in order to minimize the chance of damage from ESD.

### 14.1 TOOLS REQUIRED

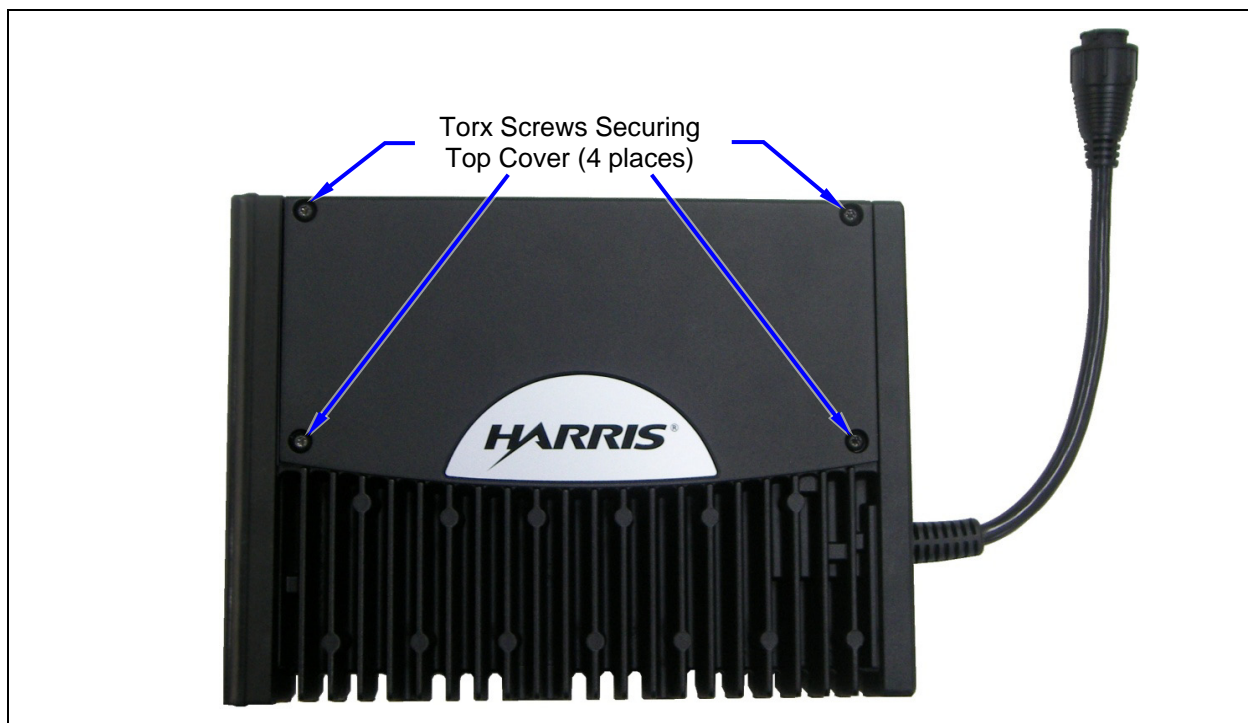
- T7 Torx® Screwdriver
- T10 Torx Screwdriver
- T15 Torx Screwdriver
- Torque Screwdriver with Torx T7, T10 and T15 Torx bits
- 5.5-Millimeter Wrench or Nutdriver (required only if the radio has the optional GPS receiver)

The following items are only needed for RF Processor Board and RF Power Amplifier (PA) Module removal and installation:

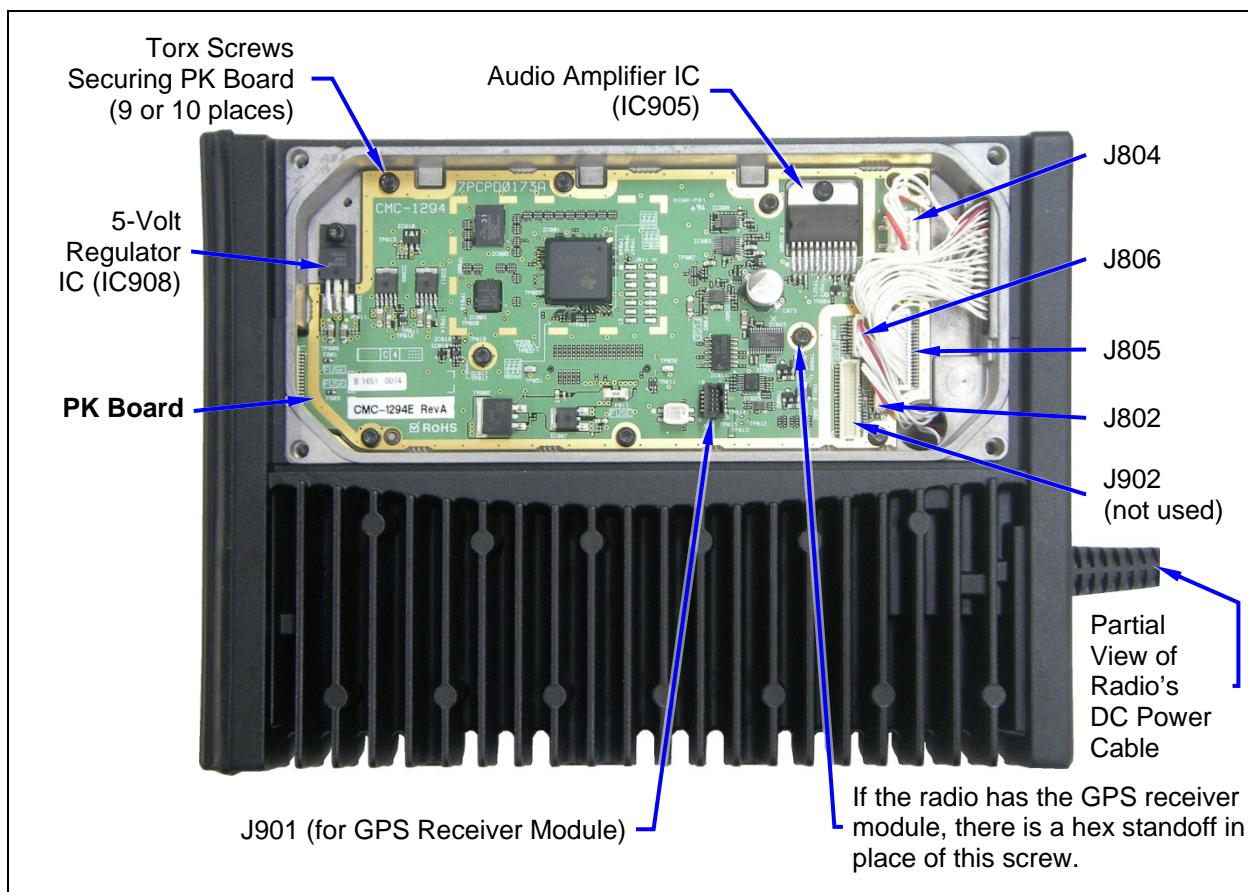
- Thermal Heat-Transfer Compound: Dow Chemical 340 or equivalent
- ESD-Safe Temperature Controlled Soldering Iron/Station
- Solder and ¼-Inch Solder Wick

### 14.2 REMOVING THE PK BOARD

1. Lay the radio on a flat ESD-safe surface, in a top-up position. See Figure 14-1.
2. Using a T15 Torx screwdriver, loosen the four (4) screws securing the top cover to the radio. These are captive-type screws, so complete removal from the cover is not required.
3. Lift and remove the cover (with screws and gasket) off of the radio chassis.
4. Unplug the cables mated to J802, J804, J805, and J806 of the PK Board. See Figure 14-2.
5. Using a T10 Torx screwdriver, loosen and remove the two (2) screws securing the audio amplifier IC (IC905) and the 5-volt regulator IC (IC908) to the radio chassis.
6. If the radio is equipped with the optional GPS receiver module, loosen and remove the screw that secures the module, then lift it up to unplug the module from connector J901 of the PK Board. The module is not shown in Figure 14-2.
7. Using a T10 Torx screwdriver, loosen and remove the ten (10) screws securing the PK Board to the radio chassis. If the radio is equipped with the optional GPS receiver module, there are nine (9) screws and one (1) hex standoff which must be loosened and removed.
8. Carefully lift and remove the PK Board from the chassis. The 40-pin board-to-board connector on the bottom of the board must be carefully disengaged from the connector of the RF Processor Board.



**Figure 14-1: Removing the Top Cover**



**Figure 14-2: Removing the PK Board (Shown without Top Cover)**

## 14.3 INSTALLING THE PK BOARD

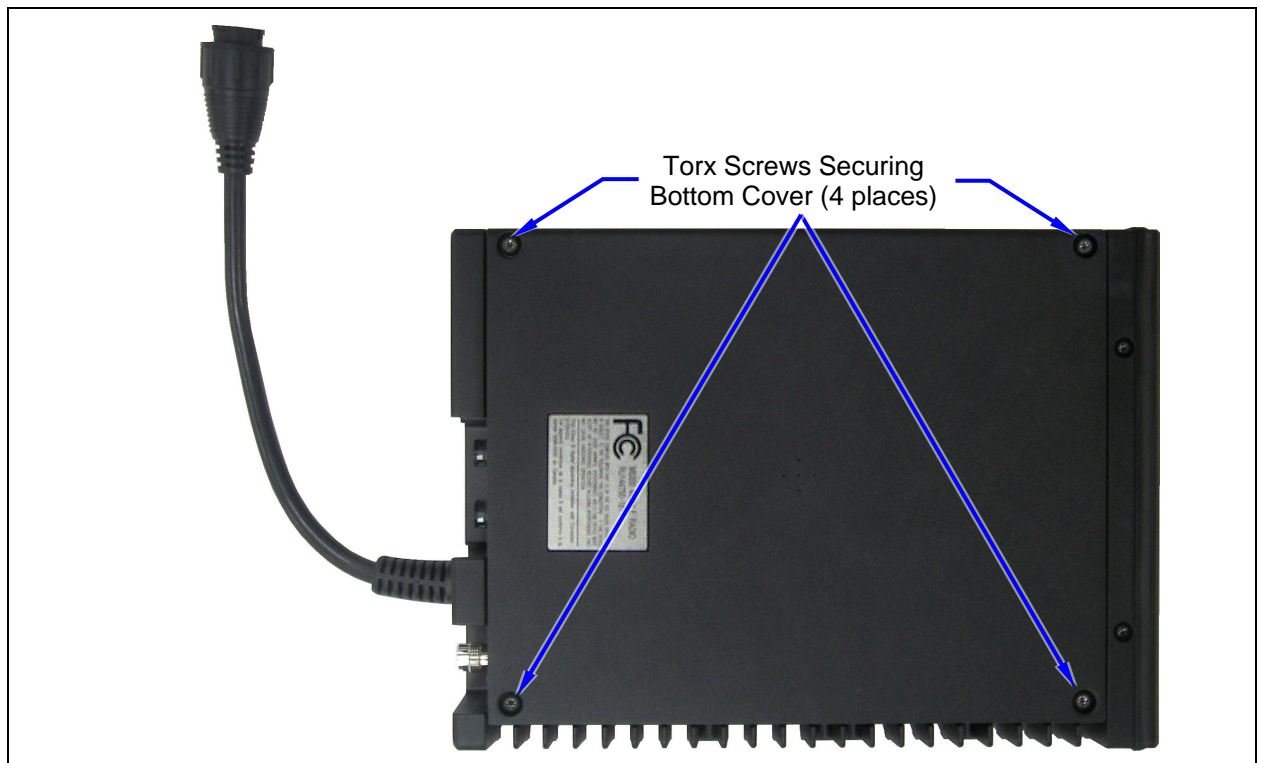
Follow this procedure to install a PK Board into the radio chassis:

1. Obtain a replacement PK Board. Refer to Table 16-1 which begins on page 124 as necessary.
2. Lay the radio on a flat ESD-safe surface, in a top-up position.
3. Verify the upper cavity of the chassis is completely clear of any foreign material such as loose screws, dirt, dust, etc. Clean and/or vacuum it as necessary.
4. Carefully lay the PK Board into the chassis so the 40-pin board-to-board connector on the bottom of the board smoothly mates to the connector of the RF Processor Board. Connector mating should be sensed and the board should lay completely flat on the floor of the casting. Thermal compound/grease on the two ICs that mount to the chassis (IC905 and IC908) is not required.
5. Start but do not tighten all ten T10 Torx-head screws into the threaded holes of the chassis. Be sure to use the correct screws, as screws that are too long will damage the RF Processor Board in the opposite cavity of the chassis. **The correct screws are between 9 and 10 millimeters long.**
6. Start but do not tighten a T10 Torx-head screw in each of the two ICs that mount to the chassis (IC905 and IC908). **The correct screws are between 9 and 10 millimeters long.**
7. Using a T10 Torx bit and a torque driver, torque the two (2) screws nearest to the center of the board first, and then torque the remaining eight (8) screws around the perimeter of the board. Torque all ten (10) screws to 7.4 inch-pounds (8.5 kg/cm).
8. Torque the two (2) screws securing the ICs to the chassis to 7.4 inch-pounds (8.5 kg/cm).
9. At the rear of the radio, mate the four cables to the corresponding header connectors on the PK Board. Refer to Figure 14-2 as necessary.
10. Verify the top cover's perimeter gasket is in good condition and embedded into the groove in the interior side of the cover.
11. Place the top cover (with screws and gasket) on to the top of the radio.
12. Using a T15 bit and torque driver, tighten the cover's four (4) screws to 10.4 inch-pounds (12 kg/cm). Use an "X" pattern torque pattern sequence.

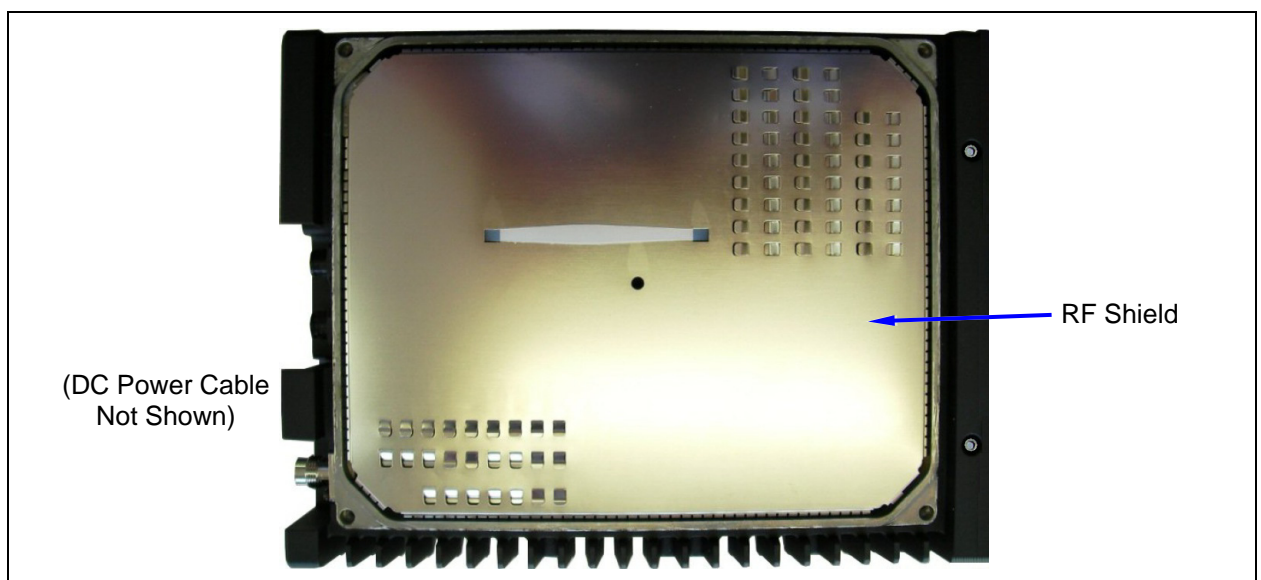
## 14.4 REMOVING THE RF PROCESSOR BOARD AND RF PA MODULE

Follow this procedure to remove the radio's RF Processor Board and RF PA module:

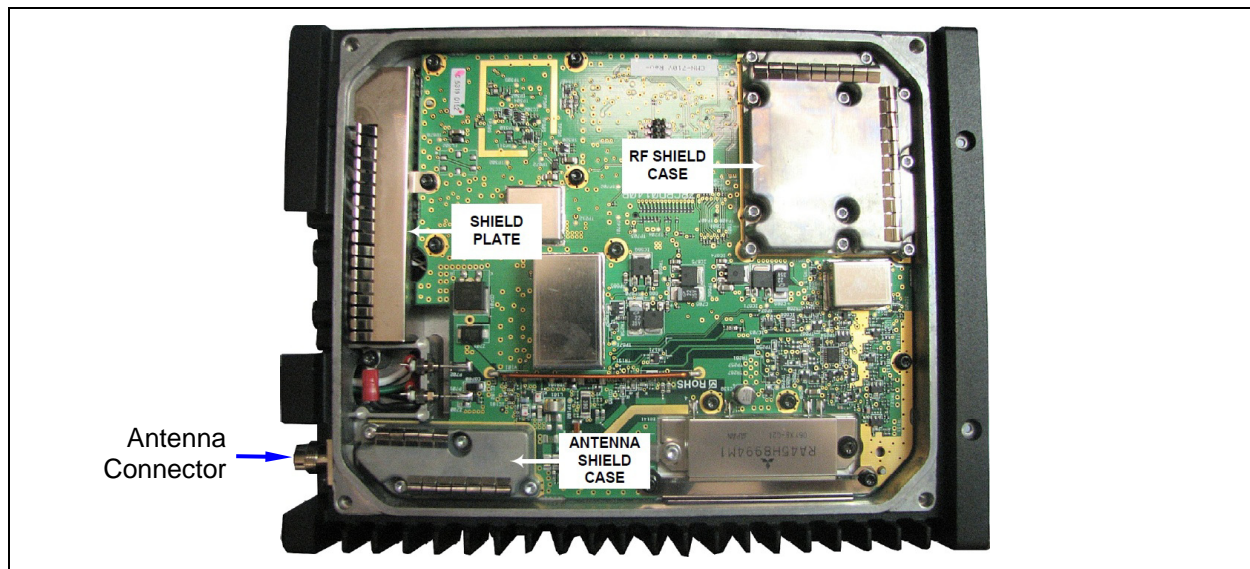
1. Lay the radio on a flat ESD-safe surface, in a bottom-up position. See Figure 14-3.
2. Using a T15 Torx screwdriver, loosen the four (4) screws securing the bottom cover to the radio. These are captive-type screws, so complete removal from the cover is not required.
3. Lift and remove the cover (with screws and gasket) off of the radio chassis. This exposes the large RF shield which slides into the chassis to cover the RF Processor Board. See Figure 14-4.
4. Carefully lift and remove this RF shield from the radio chassis. List the shield by the strap located in its approximate center.
5. Using a T10 Torx screwdriver, remove the four (4) screws securing the antenna shield case located near the rear of the radio. See Figure 14-5. Carefully lift and remove the case from the radio chassis.
6. Using a T10 Torx screwdriver, remove the eleven (11) screws securing the RF shield case located near the front of the radio. Carefully lift and remove the case from the radio chassis.
7. Using a T10 Torx screwdriver, remove the screw securing the shield plate near the rear of the radio. Carefully lift and remove the plate from the radio chassis.



**Figure 14-3: Removing the Bottom Cover**

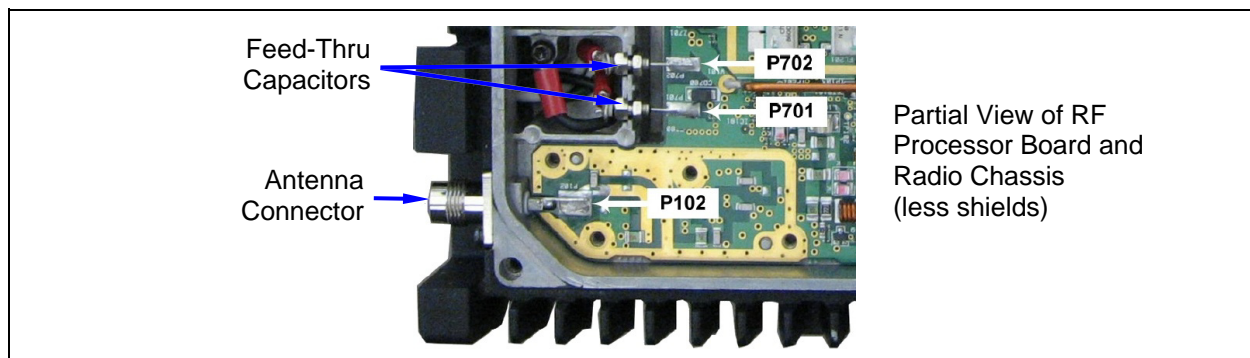


**Figure 14-4: RF Shield over RF Processor Board**



**Figure 14-5: RF Processor Board (with Large RF Shield Removed)**

8. Using a small wrench, slightly loosen each feed-through capacitor's hex nut. See Figure 14-6.
9. Near the rear of the board, carefully unsolder the center conductor of the antenna connector (P102) and the leads of the two (2) DC power feed-through capacitors (P701 and P702) from the printed circuit board. **Use great care to avoid damaging board pads, traces, and all board components!** See Figure 14-6.
10. Slide each feed-through capacitor up in its slot. Re-heating of each solder joint may be necessary in order to avoid pad/trace damage. Do **not** bend the lead of a feed-through cap.



**Figure 14-6: RF Processor Board's Antenna Connector and Feed-Through Capacitors**

11. Using a T7 Torx screwdriver, remove the two (2) screws securing the antenna connector to the chassis, and then carefully slide the connector out of the chassis.
12. Carefully unsolder the four (4) leads of the RF PA module. Use caution as to not damage the board's pads or components.
13. Loosen and remove the two (2) screws that secure the module to the chassis, then lift and remove the module from the chassis.
14. Loosen and remove the ten (10) remaining screws securing the board to the chassis.
15. Carefully lift and remove the RF Processor Board from the chassis. The 40-pin board-to-board connector on the bottom of the board must be carefully disengaged from the connector of the PK Board.

## **14.5 INSTALLING THE RF PROCESSOR BOARD AND RF PA MODULE**

Follow this procedure to install the radio's RF Processor Board and RF PA module:

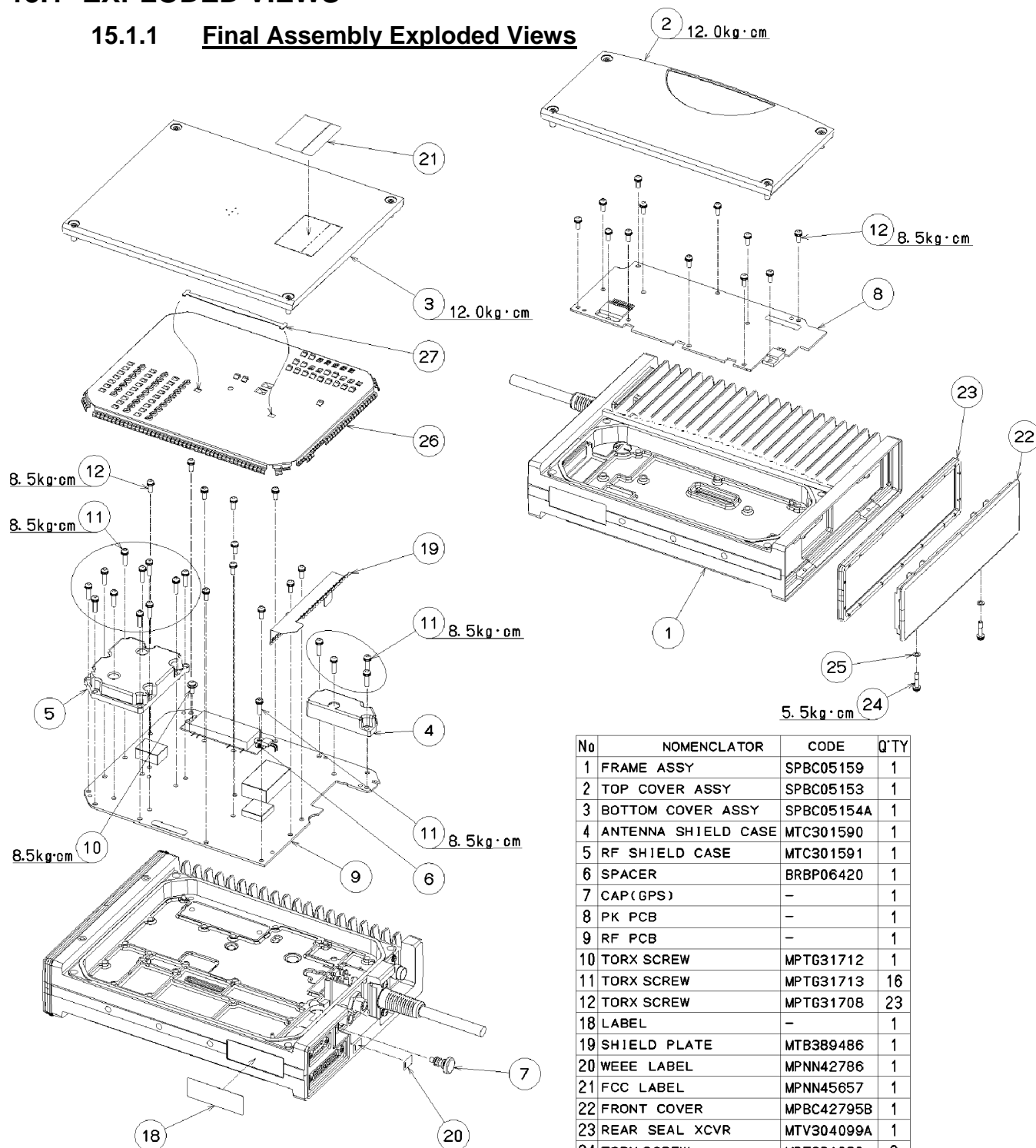
1. Obtain a replacement RF Processor Board and PF PA module. Refer to Table 16-1 which begins on page 124 as necessary.
2. Lay the radio on a flat ESD-safe surface, in a bottom-up position.
3. Verify the lower cavity of the chassis is completely clear of any foreign material such as loose screws, dirt, dust, etc. Clean and/or vacuum it as necessary.
4. Carefully lay the RF Processor Board into the chassis so the 40-pin board-to-board connector on the bottom of the board smoothly mates to the connector of the PK Board. Connector mating should be sensed and the board should lay completely flat on the floor of the casting.
5. Start but do not tighten ten **10-millimeter-long** T10 Torx-head screws into the threaded holes of the chassis. See Figure 14-5. Be sure to use the correct screws, as screws that are too long will damage the PK Board in the opposite cavity of the chassis.
6. Torque these ten (10) screws to 7.4 inch-pounds (8.5 kg/cm).
7. Apply a thin layer of thermal compound/grease to the bottom surface of the RF PA module, and onto the corresponding position on the surface of the radio chassis. Avoid bending the leads of the module.
8. Carefully lay the RF PA module into position. Again, avoid bending the leads of the module.
9. Install a **9-millimeter-long** T10 Torx-head screw into the hole in the metal tab of the RF PA module closest to the front corner of the board/radio.
10. Install a **13-millimeter-long** screw and spacer at the hole in the metal tab of the RF PA module closest to the rear of the board/radio. This screw also secures the temperature-sensing thermistor (RT101). The spacer must be located between the metal tabs of the module and thermistor.
11. Torque these two (2) screws to 7.4 inch-pounds (8.5 kg/cm).
12. Carefully solder all four (4) leads of the RF PA module to the corresponding printed circuit board pads. **Use great care to avoid damaging board pads, traces, and all board components!**
13. Install the antenna connector into its hole in the rear panel and secure it to the rear panel using two (2) screws. Torque these two screws to 4.3 inch-pounds (5.0 kg/cm).
14. Solder the center terminal of the antenna connector to the respective pad of the RF Processor Board. **Use great care to avoid damaging board pads, traces, and all board components!**
15. Carefully lay the antenna shield case into its position on the board, and install four (4) **13-millimeter-long** screws to secure it to the board and radio chassis.
16. Carefully lay the RF shield case into its position on the board, and install eleven (11) **13-millimeter-long** screws to secure it to the board and radio chassis.
17. Install the shield plate and its screw. The correct screw is **10 millimeters long**.
18. Torque all sixteen (16) of these screws to 7.4 inch-pounds (8.5 kg/cm).
19. Slide each of the two (2) feed-through capacitors down into its slots until the lead of the capacitor touches the pad on the printed circuit board, then using a small wrench, gently tighten the capacitor's nut.
20. Carefully solder the lead of each the feed-through capacitor to the pad of the printed circuit board.
21. Install the large RF shield into the radio chassis so it covers the RF Processor Board and the smaller shields. Refer to Figure 14-4 for correct orientation.

22. Verify the bottom cover's perimeter gasket is in good condition and embedded into the groove in the interior side of the cover.
23. Place the bottom cover (with screws and gasket) onto the bottom of the radio.
24. Using a T15 bit and torque driver, tighten the cover's four (4) screws to 10.4 inch-pounds (12 kg/cm). Use an "X" pattern torque pattern sequence.

## 15. ASSEMBLY DIAGRAMS

### 15.1 EXPLODED VIEWS

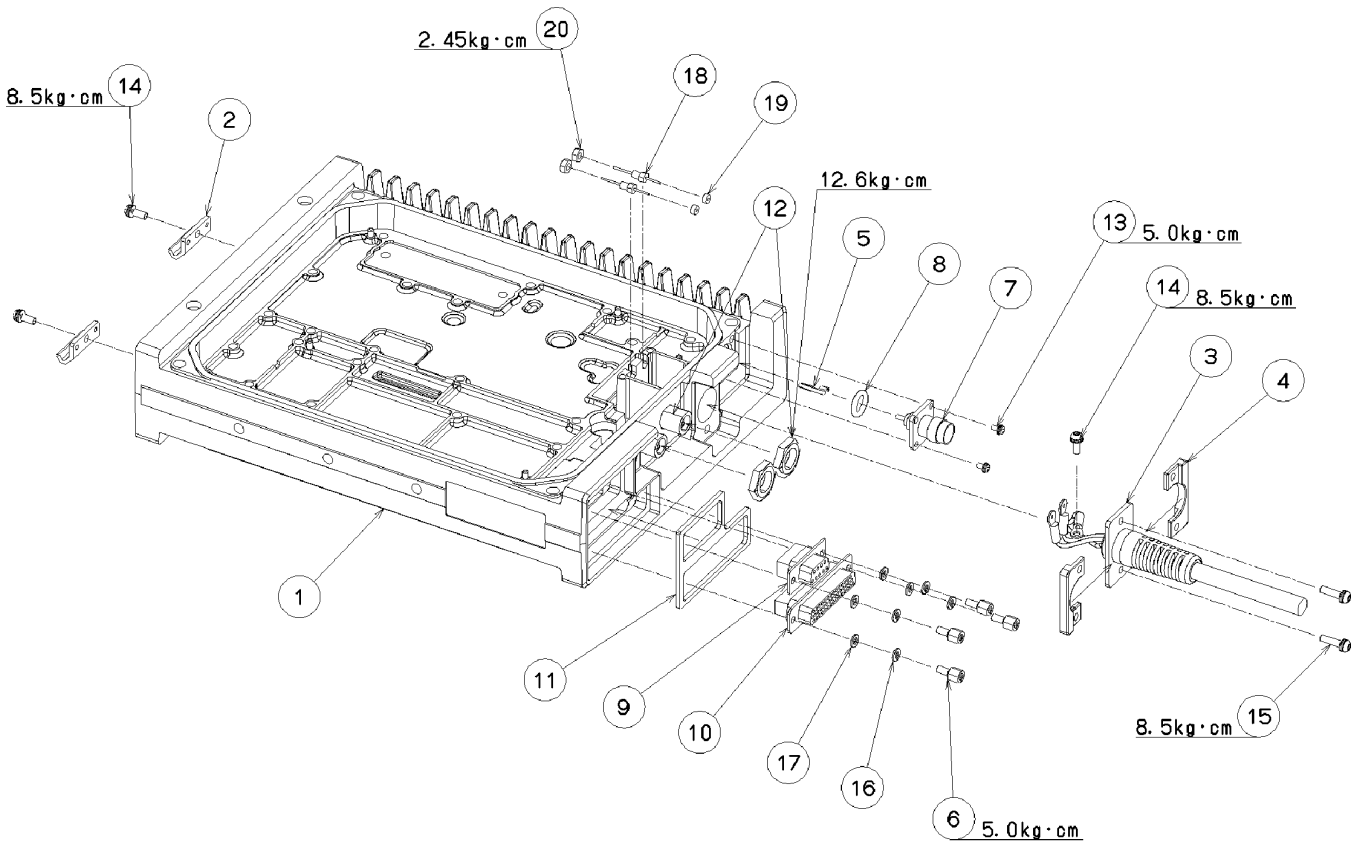
#### 15.1.1 Final Assembly Exploded Views



No	NOMENCLATOR	CODE	Q'TY
1	FRAME ASSY	SPBC05159	1
2	TOP COVER ASSY	SPBC05153	1
3	BOTTOM COVER ASSY	SPBC05154A	1
4	ANTENNA SHIELD CASE	MTC301590	1
5	RF SHIELD CASE	MTC301591	1
6	SPACER	BRBP06420	1
7	CAP(GPS)	-	1
8	PK PCB	-	1
9	RF PCB	-	1
10	TORX SCREW	MPTG31712	1
11	TORX SCREW	MPTG31713	16
12	TORX SCREW	MPTG31708	23
18	LABEL	-	1
19	SHIELD PLATE	MTB389486	1
20	WEEE LABEL	MPNN42786	1
21	FCC LABEL	MPNN45657	1
22	FRONT COVER	MPBC42795B	1
23	REAR SEAL XCVR	MTV304099A	1
24	TORX SCREW	MPTG31989	2
25	PLAIN WASHER	BRTG00339	2
26	SHIELD COVER	MTD301804	1
27	STRAP	MTV300335A	1

(SDJHM5025B-0101, Rev. 20080812)

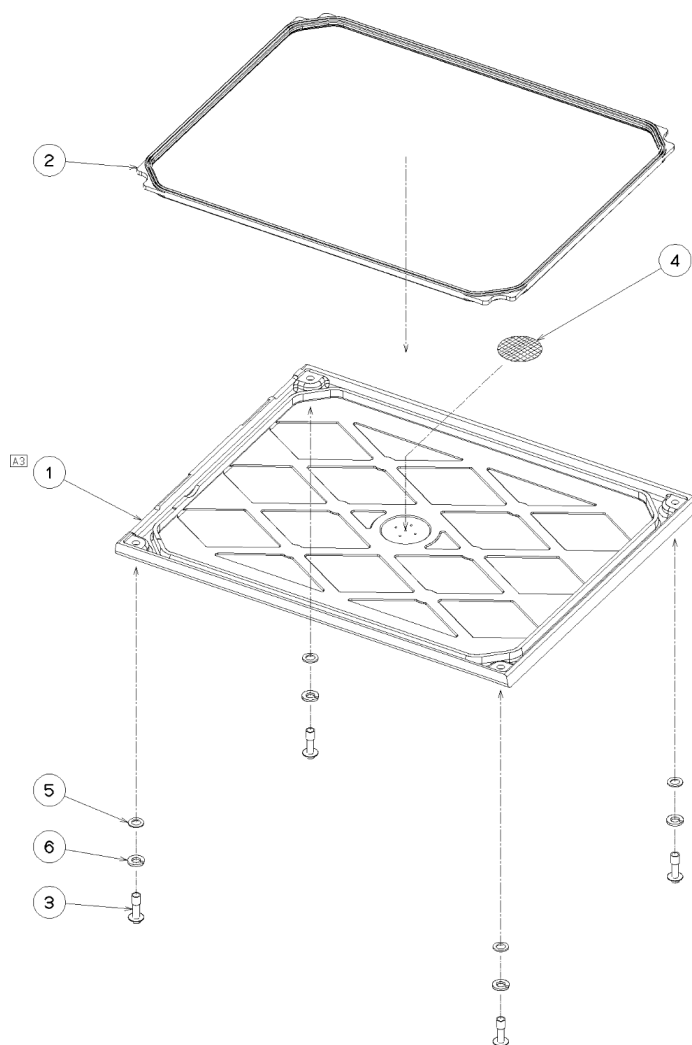
### 15.1.2 Frame Sub-Assembly Exploded View



No	NOMENCLATOR	CODE	Q'TY
1	CHASSIS	MTC301587B	1
2	BRACKET	MTV300093	2
3	PIGTAIL CABLE	-	1
4	CLAMP	MTC301592	2
5	ANTENNA BRACKET	-	1
6	SCREW LOCK	MTL322391	4
7	ANTENNA CONNECTOR	-	1
8	O-RING	MPPK01858	1
9	DB9 CONNECTOR	-	1
10	DB44 CONNECTOR	-	1
11	GASKET	MTZ303709	1
12	CAN CONNECTOR	-	2
13	TORX SCREW	MPTG31709	2
14	TORX SCREW	MPTG31708	3
15	TORX SCREW	MPTG31984	2
16	SPRING LOCK WASHER	BSSW03000S	4
17	PLAIN WASHER	BSLW03000R	4
18	FEEDTHROUGH TYPE CERAMIC CAPACITOR	-	2
19	SPACER	BRBP07003	2
20	HEX NUT	BSHN03000W	2

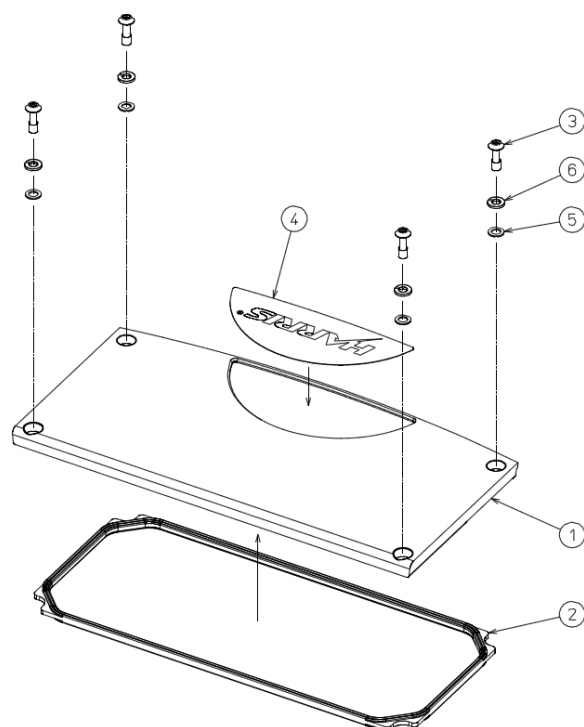
(SDJHM5159-0101, Rev 20080403)

## 15.1.3 Bottom and Top Cover Assemblies Exploded Views



No	NOMENCLATOR	CODE	Q'TY
1	BOTTOM COVER	MTC301589A <sup>A3</sup>	1
2	GASKET	-	1
3	TORX SCREW	MPTG31710	4
4	VENT FILTER	BRPK05034	1
5	PLAIN WASHER	MPTG31711	4
6	SPRING LOCK WASHER	BRTG09206	4

DATE  
28 SEP '07



No	NOMENCLATOR	CODE	Q'TY
1	TOP COVER	MTC301588	1
2	GASKET	-	1
3	TORX SCREW	MPTG31710	4
4	LOGO LABEL	MPNM35816	1
5	PLAIN WASHER	MPTG31711	4
6	SPRING LOCK WASHER	BRTG09206	4

DATE  
30 SEP '09

## 16. REPLACEMENT PARTS

Parts listed in Section 16.1 can be ordered via our Customer Care center. To order replacement parts, contact the Customer Care center at <http://www.pspc.harris.com/CustomerService> or:

### United States:

- Phone Number: 1-800-368-3277
- Fax Number: 1-321-409-4393 (U.S. Only)
- E-mail: [PSPC\\_CustomerFocus@harris.com](mailto:PSPC_CustomerFocus@harris.com)

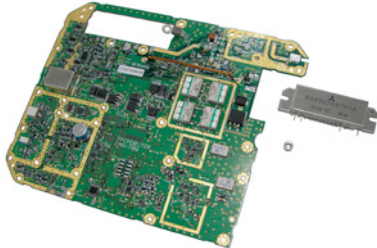



### International:

- Phone Number: 434-455-6403
- Fax Number: 321-409-4394
- E-mail: [PSPC-InternationalCustomerFocus@harris.com](mailto:PSPC-InternationalCustomerFocus@harris.com)

Component parts listed in Section 16.2 are for reference only or are considered common parts which can be obtained from an electronic parts distributor.

### 16.1 SERVICE PARTS


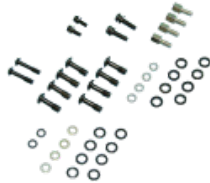





**Table 16-1: Service Parts for 800 MHz M5300 and 700/800 MHz M7300**

SERVICE PARTS PART NUMBER	DESCRIPTION	ILLUSTRATION
CB-015584	Board Assembly, 700/800 MHz RF Processor (MDHW10689) Includes RF PA module and spacer for thermistor.	
CB-015585	Board Assembly, PK (CMC-1294E/MDCW11220)	
CA-013869	Kit, Pigtail DC Power	
CA-013891	Kit, CAN Connectors	

**Table 16-1: Service Parts for 800 MHz M5300 and 700/800 MHz M7300**

SERVICE PARTS PART NUMBER	DESCRIPTION	ILLUSTRATION
CA-013870	Kit, DB-9 Cable Assembly	
CA-015586	Kit, DB-44 Cable Assembly	
14002-0177-01	Kit, Rear Connector Jackscrews (includes 4 jackscrews, 4 lockwashers, and 4 flat washers)	
CN-013898	Kit, TNC Antenna Connector	
XD-015595	Kit, Feed-Through Capacitors, Ceramic (C1 and C2 of Frame Unit) Includes spacers and nuts.	
EA-015593	Module, RF PA, RA45H7687M1A-121 (IC141 of RF Processor Board)	
AM-015589	Integrated Circuit, TDA7391 Audio Amp (IC905 of PK Board)	
IC-015593	Integrated Circuit, NJM7805FA Fixed 5-Volt Regulator (IC908 of PK Board)	
14018-0178-06	Kit, Fuses for PK Board. Includes: <ul style="list-style-type: none"> <li>Mastuo KAB3202 102NA 29 010 1.0-Amp / 1.6 x 0.8 mm (8 pcs)</li> <li>Mastuo KAB2402 322 NA31010 3.15-Amp / 2.0 x 1.25 mm (1 pcs)</li> <li>Littelfuse® 0453005.MR 5.0-Amp / 6.10 x 2.69 mm (1 pcs)</li> </ul>	

Table 16-1: Service Parts for 800 MHz M5300 and 700/800 MHz M7300

SERVICE PARTS PART NUMBER	DESCRIPTION	ILLUSTRATION
SC-013865	Kit, Internal Screws	
SC-013867	Kit, External Screws	
FM-015596	Cover, Bottom (includes metal cover and shield gasket)	
MA-013861	Cover, Top	
NP-013868	Label, Harris (for Top Cover)	
FM-013890	Cap, GPS	
MA-013357	Kit, Front Panel (for Remote-Mount Radios)	



For CH-721 control head parts, refer to the CH-721 maintenance manual included with this manual set, publication number MM-008918-001.

For HHC-731 hand-held controller parts, refer to the HHC-731 maintenance manual included with this manual set, publication number MM-018323-001.

## 16.2 PARTS LIST

### 16.2.1 PK Board

(CMC-1294E Rev. B/MDCW11220)

SYMBOL	DESCRIPTION
----- CAPACITORS -----	
C801	0.01 uF; similar to Murata GRM155B11E103KA01D.
C802	0.01 uF; similar to Murata GRM155B11E103KA01D.
C803	0.01 uF; similar to Murata GRM155B11E103KA01D.
C804	0.01 uF; similar to Murata GRM155B11E103KA01D.
C805	0.01 uF; similar to Murata GRM155B11E103KA01D.
C806	0.01 uF; similar to Murata GRM155B11E103KA01D.
C809	0.01 uF; similar to Murata GRM155B11E103KA01D.
C810	0.01 uF; similar to Murata GRM155B11E103KA01D.
C811	0.01 uF; similar to Murata GRM155B11E103KA01D.
C812	0.01 uF; similar to Murata GRM155B11E103KA01D.
C813	0.01 uF; similar to Murata GRM155B11E103KA01D.
C814	0.01 uF; similar to Murata GRM155B11E103KA01D.
C815	0.01 uF; similar to Murata GRM155B11E103KA01D.
C816	0.01 uF; similar to Murata GRM155B11E103KA01D.
C817	0.01 uF; similar to Murata GRM155B11E103KA01D.
C818	10 pF; similar to Taiyo Yuden UMK105CH100DV-F.
C819	9 pF; similar to Taiyo Yuden UMK105CH090DV-F.
C820	0.01 uF; similar to Murata GRM155B11E103KA01D.
C821	10 uF; similar to Murata GRM31CR61C106KA88L.
C822	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C823	0.01 uF; similar to Murata GRM155B11E103KA01D.
C824	0.01 uF; similar to Murata GRM155B11E103KA01D.
C825	0.01 uF; similar to Murata GRM155B11E103KA01D.
C826	0.01 uF; similar to Murata GRM155B11E103KA01D.
C830	0.1 uF; similar to Murata GRM155B11A104KA01D.
C831	0.22 uF; similar to Murata GRM188B11A224KA01D.
C832	0.01 uF; similar to Murata GRM155B11E103KA01D.
C833	22 pF; similar to Taiyo Yuden UMK105CH220JV-F.
C834	18 pF; similar to Taiyo Yuden UMK105CH180JV-F.
C835	15 pF; similar to Taiyo Yuden UMK105CH150JV-F.
C836	18 pF; similar to Taiyo Yuden UMK105CH180JV-F.
C837	0.01 uF; similar to Murata GRM155B11E103KA01D.
C838	0.01 uF; similar to Murata GRM155B11E103KA01D.
C839	0.01 uF; similar to Murata GRM155B11E103KA01D.
C840	0.01 uF; similar to Murata GRM155B11E103KA01D.
C841	0.01 uF; similar to Murata GRM155B11E103KA01D.

SYMBOL	DESCRIPTION
C842	0.01 uF; similar to Murata GRM155B11E103KA01D.
C843	0.01 uF; similar to Murata GRM155B11E103KA01D.
C844	0.01 uF; similar to Murata GRM155B11E103KA01D.
C845	10 uF; similar to Murata GRM31CR61C106KA88L.
C846	0.1 uF; similar to Murata GRM155B11A104KA01D.
C847	10 uF; similar to Murata GRM31CR61C106KA88L.
C848	0.1 uF; similar to Murata GRM155B11A104KA01D.
C849	0.01 uF; similar to Murata GRM155B11E103KA01D.
C851	10 uF; similar to Murata GRM31CR61C106KA88L.
C852	0.1 uF; similar to Murata GRM155B11A104KA01D.
C853	470 pF; similar to Taiyo Yuden UMK105BJ471KV-F.
C854	0.1 uF; similar to Murata GRM155B11A104KA01D.
C855	4.7 uF; similar to Murata GRM21BB31E475KA75L.
C856	0.1 uF; similar to Murata GRM155B11A104KA01D.
C857	4.7 uF; similar to Murata GRM21BB31E475KA75L.
C858	1 uF; similar to Taiyo Yuden LMK105BJ105KV-F.
C859	47 pF; similar to Murata GRM155C1H470JZ01D.
C860	1 uF; similar to Taiyo Yuden LMK105BJ105KV-F.
C861	0.1 uF; similar to Murata GRM155B11A104KA01D.
C862	0.01 uF; similar to Murata GRM155B11E103KA01D.
C863	0.1 uF; similar to Murata GRM155B11A104KA01D.
C864	4.7 uF; similar to Murata GRM21BB31E475KA75L.
C865	0.1 uF; similar to Murata GRM155B11A104KA01D.
C866	0.1 uF; similar to Murata GRM155B11A104KA01D.
C867	47 pF; similar to Murata GRM155C1H470JZ01D.
C868	0.01 uF; similar to Murata GRM155B11E103KA01D.
C869	0.47 uF; similar to Murata GRM155B30J474KE18D.
C870	0.22 uF; similar to Murata GRM188B11A224KA01D.
C871	0.22 uF; similar to Murata GRM188B11A224KA01D.
C872	0.1 uF; similar to Murata GRM188B11E104KA01D.
C873	220 uF; similar to NIPON CHEMI-CON EMVH350ADA221MJA0G.
C874	22 uF; similar to Murata GRM32EB31E226KE15L.
C875	0.01 uF; similar to Murata GRM155B11E103KA01D.
C876	0.1 uF; similar to Murata GRM155B11A104KA01D.
C878	2.2 uF; similar to Murata GRM21BB31E225KA75L.
C879	0.01 uF; similar to Murata GRM155B11E103KA01D.
C882	1800 pF; similar to Murata GRM188B11H182KA01D.
C883	0.01 uF; similar to Murata GRM155B11E103KA01D.
C884	0.01 uF; similar to Murata GRM155B11E103KA01D.
C885	2200 pF; similar to Murata GRM155B11H222KA01D.

SYMBOL	DESCRIPTION
C886	0.01 uF; similar to Murata GRM155B11E103KA01D.
C887	0.1 uF; similar to Murata GRM188B11E104KA01D.
C888	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C889	4.7 uF; similar to Murata GRM21BB31E475KA75L.
C890	22 uF; similar to Taiyo Yuden EMK325BJ226MM-T.
C892	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C893	0.1 uF; similar to Murata GRM155B11A104KA01D.
C894	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C895	0.01 uF; similar to Murata GRM155B11E103KA01D.
C896	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C897	0.33 uF; similar to Murata GRM319B11E334KA01D.
C898	0.1 uF; similar to Murata GRM155B11A104KA01D.
C899	10 uF; similar to Murata GRM31CR61C106KA88L.
C900	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C901	0.01 uF; similar to Murata GRM155B11E103KA01D.
C902	0.33 uF; similar to Murata GRM319B11E334KA01D.
C903	4.7 uF; similar to Murata GRM21BB31E475KA75L.
C905	0.1 uF; similar to Murata GRM155B11A104KA01D.
C906	0.1 uF; similar to Murata GRM155B11A104KA01D.
C907	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F.
C908	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C909	0.33 uF; similar to Murata GRM319B11E334KA01D.
C910	4.7 uF; similar to Murata GRM21BB31E475KA75L.
C911	0.1 uF; similar to Murata GRM188B11E104KA01D.
C912	0.1 uF; similar to Murata GRM188B11E104KA01D.
C913	1 uF; similar to Taiyo Yuden LMK105BJ105KV-F.
C914	0.01 uF; similar to Murata GRM155B11E103KA01D.
C920	0.1 uF; similar to Murata GRM188B11E104KA01D.
C921	0.1 uF; similar to Murata GRM188B11E104KA01D.
C922	10 uF; similar to Murata GRM31CR61C106KA88L.
C923	0.1 uF; similar to Murata GRM188B11E104KA01D.
C924	0.1 uF; similar to Murata GRM188B11E104KA01D.
C925	0.1 uF; similar to Murata GRM188B11E104KA01D.
C926	0.01 uF; similar to Murata GRM155B11E103KA01D.
C927	0.01 uF; similar to Murata GRM155B11E103KA01D.
C928	0.01 uF; similar to Murata GRM155B11E103KA01D.
C929	0.01 uF; similar to Murata GRM155B11E103KA01D.
C930	0.01 uF; similar to Murata GRM155B11E103KA01D.
C931	0.01 uF; similar to Murata GRM155B11E103KA01D.
C932	0.01 uF; similar to Murata GRM155B11E103KA01D.
C933	0.01 uF; similar to Murata GRM155B11E103KA01D.

SYMBOL	DESCRIPTION
C934	0.01 uF; similar to Murata GRM155B11E103KA01D.
C935	0.01 uF; similar to Murata GRM155B11E103KA01D.
C936	0.01 uF; similar to Murata GRM155B11E103KA01D.
C937	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C938	0.01 uF; similar to Murata GRM155B11E103KA01D.
C939	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C941	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C943	0.1 uF; similar to Murata GRM155B11A104KA01D.
C944	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C945	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C946	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C947	10 pF; similar to Taiyo Yuden UMK105CH100DV-F.
C948	10 pF; similar to Taiyo Yuden UMK105CH100DV-F.
C951	0.01 uF; similar to Murata GRM155B11E103KA01D.
C952	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C953	0.01 uF; similar to Murata GRM155B11E103KA01D.
C954	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C955	0.01 uF; similar to Murata GRM155B11E103KA01D.
C956	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C957	0.1 uF; similar to Murata GRM155B11A104KA01D.
C959	0.01 uF; similar to Murata GRM155B11E103KA01D.
C960	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C961	0.01 uF; similar to Murata GRM155B11E103KA01D.
C962	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C966	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C967	0.01 uF; similar to Murata GRM155B11E103KA01D.
C968	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C969	0.01 uF; similar to Murata GRM155B11E103KA01D.
C970	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C971	0.01 uF; similar to Murata GRM155B11E103KA01D.
C972	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C973	0.01 uF; similar to Murata GRM155B11E103KA01D.
C974	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C975	0.01 uF; similar to Murata GRM155B11E103KA01D.
C976	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C977	0.01 uF; similar to Murata GRM155B11E103KA01D.
C978	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C979	0.01 uF; similar to Murata GRM155B11E103KA01D.
C980	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C981	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C982	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.

SYMBOL	DESCRIPTION
C983	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C984	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C985	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C986	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C987	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C988	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C989	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C990	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C991	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C992	0.01 uF; similar to Murata GRM155B11E103KA01D.
C993	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C994	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C995	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C998	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1121	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1122	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1123	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1124	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1125	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1126	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1127	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1128	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1129	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1130	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1131	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1132	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1133	0.1 uF; similar to Murata GRM188B11E104KA01D.
C1134	0.1 uF; similar to Murata GRM188B11E104KA01D.
C1135	0.1 uF; similar to Murata GRM188B11E104KA01D.
C1136	0.1 uF; similar to Murata GRM188B11E104KA01D.
C1137	0.1 uF; similar to Murata GRM188B11E104KA01D.
C1138	10 uF; similar to Murata GRM31CR61C106KA88L.
C1148	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1149	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1150	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1151	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1152	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1153	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1154	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1155	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1156	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.

SYMBOL	DESCRIPTION
C1158	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1159	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1160	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1161	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1162	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1163	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1164	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1165	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1166	100 pF; similar to Taiyo Yuden UMK105CH101JV-F.
C1170	0.01 uF; similar to Murata GRM155B11E103KA01D.
C1171	0.01 uF; similar to Murata GRM155B11E103KA01D.
C1172	0.01 uF; similar to Murata GRM155B11E103KA01D.
C1173	0.1 uF; similar to Murata GRM188B11E104KA01D.
----- DIODES -----	
CD805	Similar to Toshiba DF2S24FS(TPL3).
CD806	Similar to Toshiba DF7A6.8CFU(TE85L_F).
CD807	Similar to Toshiba DF7A6.8CFU(TE85L_F).
CD808	Similar to Toshiba DF2S24FS(TPL3).
CD809	Similar to Toshiba DF2S24FS(TPL3).
CD810	Similar to Toshiba DF2S24FS(TPL3).
CD811	Similar to Toshiba DF7A6.8CFU(TE85L_F).
CD812	Similar to Toshiba DF7A6.8CFU(TE85L_F).
CD813	Similar to Toshiba DF7A6.8CFU(TE85L_F).
CD814	Similar to Toshiba DF7A6.8CFU(TE85L_F).
CD815	Similar to Toshiba DF7A6.8CFU(TE85L_F).
CD816	Similar to Toshiba DF2S24FS(TPL3).
CD817	Similar to Toshiba DF2S24FS(TPL3).
----- FUSES -----	
F801	1.0 Amp; similar to MASTUO KAB3202 102NA 29 010.
F803	1.0 Amp; similar to MASTUO KAB3202 102NA 29 010.
F804	1.0 Amp; similar to MASTUO KAB3202 102NA 29 010.
F805	1.0 Amp; similar to MASTUO KAB3202 102NA 29 010.
F806	1.0 Amp; similar to MASTUO KAB3202 102NA 29 010.
F808	1.0 Amp; similar to MASTUO KAB3202 102NA 29 010.
F810	3.15 Amp; similar to MASTUO KAB2402 322 NA31010.
F811	5 Amp; similar to Littlefuse 0453005.MR.
----- INTEGRATED CIRCUITS -----	
IC801	Similar to Texas Instruments OMAP5910JZDY2.
IC802	Similar to SPANSION S29WS128J0PBFW000A.
IC803	Similar to CYPRESS CY62167EV18LL-55BVXIT.

SYMBOL	DESCRIPTION
IC804	Similar to Texas Instruments SN74LVCH16652ADGGR.
IC805	Similar to Toshiba TC74VCX164245(EL_F).
IC806	Similar to Renesas HD74LV1G126ACME-E.
IC807	Similar to Renesas HD74LV2G32AUSE-E.
IC808	Similar to MICROCHIP MCP2515T-I/ST.
IC809	Similar to Texas Instruments SN65HVD251DR.
IC810	Similar to Toshiba TC74HCT32AF(EL_F).
IC811	Similar to Renesas RD74LVC32BFPEL-E.
IC812	Similar to Renesas HD74LV2G125AUSE-E.
IC813	Similar to Renesas HD74LV1G125ACME-E.
IC814	Similar to FAIRCHILD NC7SZ373P6X.
IC815	Similar to Renesas HD74LV1G125ACME-E.
IC817	Similar to Renesas HD74LV1G02ACME-E.
IC818	Similar to Renesas HD74LV1G08ACME-E.
IC819	Similar to RICOH R3112Q441C-TR-F.
IC820	Similar to Toshiba TC74HC244AF(EL_F).
IC821	Similar to SIPEX SP3238EEY-L/TR.
IC822	Similar to ETRON EM636165TS-7IG.
IC823	Similar to SIPEX SP3243EBEY-L.
IC824	Similar to Toshiba TC74VHC04FT-EL.
IC825	Similar to Renesas HD74LV2GT04AUSE-E.
IC901	Similar to Texas Instruments TLV320AIC26IRHBG4.
IC902	Similar to NJRC NJM3404AV(TE1).
IC903	Similar to NJRC NJM3403AV(TE1).
IC904	Similar to Toshiba TC7S66FU(TE85L_F).
IC905	Similar to STMICROELECTRONICS TDA7391. See Table 16-1 which begins on page 124 for Harris part number.
IC906	Similar to NJRC NJM3404AV(TE1).
IC907	Similar to Toshiba TA58M05F(TE16L1,NQ).
IC908	Similar to NJRC NJM7805FA. See Table 16-1 which begins on page 124 for Harris part number.
IC909	Similar to NJRC NJM2887DL3(TE1).
IC910	Similar to RICOH R1130H181B-T1-F.
IC911	Similar to NJRC NJM2887DL3(TE1).
-----CONNECTOR-----	
J801	16-pin; similar to HIROSE FH12-16S-1SH(55).
J802	3-pin; similar to JST BM03B-SRSS-TB(LF)(SN).
J804	4-pin; similar to JST BM04B-XASS-TF(LF)(SN).
J805	40-pin; similar to JST BM40B-SRDS-G-TFC(LF)(SN).
J806	9-pin; similar to JST BM09B-SRSS-TB(LF)(SN).

SYMBOL	DESCRIPTION
J807	40-pin; similar to SUYIN 127150FA040G209ZR.
J901	14-pin; similar to SUYIN 127174MA010G200ZR.
J902	40-pin; similar to JST BM40B-SRDS-G-TFC(LF)(SN).
----- INDUCTORS -----	
L801	2.2 mH; similar to EPCOS B82790C0225N265.
L901	60 ohm at 100 MHz; similar to Murata BLM18PG600SN1D.
L902	60 ohm at 100 MHz; similar to Murata BLM18PG600SN1D.
----- RESISTORS -----	
R801	100 ohm; similar to Panasonic EXB28V101JX.
R802	100 ohm; similar to Panasonic EXB28V101JX.
R803	100 ohm; similar to Panasonic EXB28V101JX.
R804	100 ohm; similar to Panasonic EXB28V101JX.
R805	100 ohm; similar to Panasonic EXB28V101JX.
R806	100 ohm; similar to Panasonic EXB28V101JX.
R807	100 ohm; similar to Panasonic EXB28V101JX.
R808	51 ohm; similar to Panasonic EXB28V510JX.
R809	100 ohm; similar to Panasonic EXB28V101JX.
R810	33 ohm; similar to Panasonic EXB28V330JX.
R811	33 ohm; similar to Panasonic EXB28V330JX.
R812	33 ohm; similar to Panasonic EXB28V330JX.
R813	33 ohm; similar to Panasonic EXB28V330JX.
R814	33 ohm; similar to Panasonic EXB28V330JX.
R815	33 ohm; similar to Panasonic EXB28V330JX.
R816	33 ohm; similar to Panasonic EXB28V330JX.
R817	33 ohm; similar to Panasonic EXB28V330JX.
R818	33 ohm; similar to Panasonic EXB28V330JX.
R819	33 ohm; similar to Panasonic EXB28V330JX.
R820	33 ohm; similar to Panasonic EXB28V330JX.
R821	33 ohm; similar to Panasonic EXB28V330JX.
R822	33 ohm; similar to Panasonic EXB28V330JX.
R823	82 ohm; similar to Panasonic EXB28V820JX.
R824	82 ohm; similar to Panasonic EXB28V820JX.
R825	82 ohm; similar to Panasonic EXB28V820JX.
R826	82 ohm; similar to Panasonic EXB28V820JX.
R827	82 ohm; similar to Panasonic EXB28V820JX.
R828	82 ohm; similar to Panasonic EXB28V820JX.
R829	82 ohm; similar to Panasonic EXB28V820JX.
R830	82 ohm; similar to Panasonic EXB28V820JX.
R831	10k ohm; similar to Panasonic ERJ2GEJ103X.

SYMBOL	DESCRIPTION
R832	470 ohm; similar to Panasonic ERJ6GEYJ471V.
R833	10k ohm; similar to Panasonic ERJ2GEJ103X.
R834	470 ohm; similar to Panasonic ERJ6GEYJ471V.
R835	100 ohm; similar to Panasonic ERJ2GEJ101X.
R840	0 ohm; similar to Panasonic ERJ2GE0R00X.
R841	0 ohm; similar to Panasonic ERJ2GE0R00X.
R842	0 ohm; similar to Panasonic ERJ2GE0R00X.
R843	0 ohm; similar to Panasonic ERJ2GE0R00X.
R844	0 ohm; similar to Panasonic ERJ2GE0R00X.
R845	0 ohm; similar to Panasonic ERJ2GE0R00X.
R846	0 ohm; similar to Panasonic ERJ2GE0R00X.
R847	0 ohm; similar to Panasonic ERJ2GE0R00X.
R848	0 ohm; similar to Panasonic ERJ2GE0R00X.
R849	0 ohm; similar to Panasonic ERJ2GE0R00X.
R850	0 ohm; similar to Panasonic ERJ2GE0R00X.
R851	0 ohm; similar to Panasonic ERJ2GE0R00X.
R852	0 ohm; similar to Panasonic ERJ2GE0R00X.
R853	0 ohm; similar to Panasonic ERJ2GE0R00X.
R854	0 ohm; similar to Panasonic ERJ2GE0R00X.
R855	0 ohm; similar to Panasonic ERJ2GE0R00X.
R857	22k ohm; similar to Panasonic ERJ2GEJ223X.
R860	22k ohm; similar to Panasonic ERJ2GEJ223X.
R861	22k ohm; similar to Panasonic ERJ2GEJ223X.
R862	22k ohm; similar to Panasonic ERJ2GEJ223X.
R868	22k ohm; similar to Panasonic ERJ2GEJ223X.
R869	22k ohm; similar to Panasonic ERJ2GEJ223X.
R870	22k ohm; similar to Panasonic ERJ2GEJ223X.
R887	10k ohm; similar to Panasonic ERJ2GEJ103X.
R888	10k ohm; similar to Panasonic ERJ2GEJ103X.
R890	22k ohm; similar to Panasonic ERJ2GEJ223X.
R891	22k ohm; similar to Panasonic ERJ2GEJ223X.
R892	22k ohm; similar to Panasonic ERJ2GEJ223X.
R893	22k ohm; similar to Panasonic ERJ2GEJ223X.
R894	22k ohm; similar to Panasonic ERJ2GEJ223X.
R895	22k ohm; similar to Panasonic ERJ2GEJ223X.
R896	22k ohm; similar to Panasonic ERJ2GEJ223X.
R897	22k ohm; similar to Panasonic ERJ2GEJ223X.
R898	150 ohm; similar to Panasonic ERJ2GEJ151X.
R899	150 ohm; similar to Panasonic ERJ2GEJ151X.
R900	150 ohm; similar to Panasonic ERJ2GEJ151X.
R901	22k ohm; similar to Panasonic ERJ2GEJ223X.

SYMBOL	DESCRIPTION
R902	22k ohm; similar to Panasonic ERJ2GEJ223X.
R903	22k ohm; similar to Panasonic ERJ2GEJ223X.
R904	10k ohm; similar to Panasonic ERJ2GEJ103X.
R905	51 ohm; similar to Panasonic ERJ2GEJ510X.
R906	51 ohm; similar to Panasonic ERJ2GEJ510X.
R907	51 ohm; similar to Panasonic ERJ2GEJ510X.
R908	82 ohm; similar to Panasonic ERJ2GEJ820X.
R909	82 ohm; similar to Panasonic ERJ2GEJ820X.
R910	33 ohm; similar to Panasonic ERJ2GEJ330X.
R911	22k ohm; similar to Panasonic ERJ2GEJ223X.
R912	22k ohm; similar to Panasonic ERJ2GEJ223X.
R913	22k ohm; similar to Panasonic ERJ2GEJ223X.
R915	22k ohm; similar to Panasonic ERJ2GEJ223X.
R916	22k ohm; similar to Panasonic ERJ2GEJ223X.
R917	22k ohm; similar to Panasonic ERJ2GEJ223X.
R918	22k ohm; similar to Panasonic ERJ2GEJ223X.
R919	22k ohm; similar to Panasonic ERJ2GEJ223X.
R920	22k ohm; similar to Panasonic ERJ2GEJ223X.
R921	75 ohm; similar to HOKURIKUDENNKI CR10-750FV.
R922	6.8k ohm; similar to Panasonic ERJ2GEJ682X.
R923	22k ohm; similar to Panasonic ERJ2GEJ223X.
R924	22k ohm; similar to Panasonic ERJ2GEJ223X.
R925	22k ohm; similar to Panasonic ERJ2GEJ223X.
R926	22k ohm; similar to Panasonic ERJ2GEJ223X.
R927	22k ohm; similar to Panasonic ERJ2GEJ223X.
R928	22k ohm; similar to Panasonic ERJ2GEJ223X.
R929	10k ohm; similar to Panasonic ERJ2GEJ103X.
R932	4.7k ohm; similar to Panasonic ERJ2GEJ472X.
R933	4.7k ohm; similar to Panasonic ERJ2GEJ472X.
R934	4.7k ohm; similar to Panasonic ERJ2GEJ472X.
R935	4.7k ohm; similar to Panasonic ERJ2GEJ472X.
R936	4.7k ohm; similar to Panasonic ERJ2GEJ472X.
R939	22k ohm; similar to Panasonic ERJ2GEJ223X.
R940	22k ohm; similar to Panasonic ERJ2GEJ223X.
R942	22k ohm; similar to Panasonic ERJ2GEJ223X.
R944	47k ohm; similar to Panasonic ERJ2GEJ473X.
R945	1.5k ohm; similar to Panasonic ERJ2GEJ152X.
R946	10 ohm; similar to Panasonic ERJ2GEJ100X.
R947	10 ohm; similar to Panasonic ERJ2GEJ100X.
R949	22k ohm; similar to Panasonic ERJ2GEJ223X.
R951	82k ohm; similar to Panasonic ERJ2GEJ823X.

SYMBOL	DESCRIPTION
R952	2.2k ohm; similar to Panasonic ERJ2GEJ222X.
R953	22k ohm; similar to Panasonic ERJ2GEJ223X.
R954	47k ohm; similar to Panasonic ERJ2GEJ473X.
R955	100k ohm; similar to Panasonic ERJ2GEJ104X.
R957	4.7k ohm; similar to Panasonic ERJ2GEJ472X.
R958	100k ohm; similar to Panasonic ERJ2GEJ104X.
R959	22k ohm; similar to Panasonic EXB28V223JX.
R960	120 ohm; similar to Panasonic EXB28V121JX.
R961	120 ohm; similar to Panasonic EXB28V121JX.
R962	100k ohm; similar to Panasonic ERJ2GEJ104X.
R963	150k ohm; similar to Panasonic ERJ2GEJ154X.
R964	22k ohm; similar to Panasonic ERJ2GEJ223X.
R965	22k ohm; similar to Panasonic ERJ2GEJ223X.
R966	22k ohm; similar to Panasonic ERJ2GEJ223X.
R967	22k ohm; similar to Panasonic ERJ2GEJ223X.
R968	22k ohm; similar to Panasonic ERJ2GEJ223X.
R970	22k ohm; similar to Panasonic ERJ2GEJ223X.
R971	120 ohm; similar to Panasonic ERJ2GEJ121X.
R972	120 ohm; similar to Panasonic ERJ2GEJ121X.
R973	22k ohm; similar to Panasonic ERJ2GEJ223X.
R974	22k ohm; similar to Panasonic ERJ2GEJ223X.
R975	10k ohm; similar to Panasonic ERJ2GEJ103X.
R976	56k ohm; similar to Panasonic ERJ2GEJ563X.
R977	270k ohm; similar to Panasonic ERJ2GEJ274X.
R978	150k ohm; similar to Panasonic ERJ2GEJ154X.
R979	56k ohm; similar to Panasonic ERJ2GEJ563X.
R980	0 ohm; similar to Panasonic ERJ2GE0R00X.
R982	56k ohm; similar to Panasonic ERJ2GEJ563X.
R983	56k ohm; similar to Panasonic ERJ2GEJ563X.
R984	33k ohm; similar to Panasonic ERJ2GEJ333X.
R985	68k ohm; similar to Panasonic ERJ2GEJ683X.
R986	680 ohm; similar to Panasonic ERJ2GEJ681X.
R987	0 ohm; similar to Panasonic ERJ2GE0R00X.
R988	3.3k ohm; similar to Panasonic ERJ2GEJ332X.
R990	100 ohm; similar to Panasonic ERJ2GEJ101X.
R991	3.3K ohm; similar to Panasonic ERJ2GEJ332X.
R994	100 ohm; similar to Panasonic ERJ2GEJ101X.
R995	10k ohm; similar to Panasonic ERJ2GEJ103X.
R996	10 ohm; similar to Panasonic ERJ2GEJ100X.
R997	56k ohm; similar to Panasonic ERJ2GEJ563X.
R998	470k ohm; similar to Panasonic ERJ2GEJ474X.

SYMBOL	DESCRIPTION
R1100	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1101	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1102	100k ohm; similar to Panasonic ERJ2GEJ104X.
R1103	24k ohm; similar to HOKURIKUDENNKI CR10-243FV.
R1104	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1105	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1106	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1107	33 ohm; similar to Panasonic EXB28V330JX.
R1108	33 ohm; similar to Panasonic EXB28V330JX.
R1109	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1110	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1112	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1113	4.7k ohm; similar to Panasonic ERJ2GEJ472X.
R1114	4.7k ohm; similar to Panasonic ERJ2GEJ472X.
R1115	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1116	22k ohm; similar to Panasonic EXB28V223JX.
R1120	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1121	33 ohm; similar to Panasonic ERJ2GEJ330X.
R1124	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1130	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1131	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1132	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1133	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1136	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1137	22k ohm; similar to Panasonic EXB28V223JX.
R1138	22k ohm; similar to Panasonic EXB28V223JX.
R1139	10k ohm; similar to Panasonic ERJ2GEJ103X.
R1140	10k ohm; similar to Panasonic ERJ2GEJ103X.
R1142	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1143	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1144	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1145	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1146	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1147	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1148	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1149	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1150	0 ohm; similar to Panasonic ERJ2GE0R00X.
R1151	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1152	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1153	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1154	22k ohm; similar to Panasonic ERJ2GEJ223X.

SYMBOL	DESCRIPTION
R1155	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1156	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1157	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1158	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1159	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1160	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1161	22k ohm; similar to Panasonic ERJ2GEJ223X.
R1163 thru R1166	33 ohm; similar to Panasonic ERJ2GEJ330X.
R1168	22k ohm; similar to Panasonic ERJ2GEJ223X.
----- TEST POINTS -----	
TP851 and TP852	HK-2; similar to MAC8 HK-2-S.
----- TRANSISTORS -----	
TR801	Similar to Toshiba 2SK1829(TE85L_F.
TR802	Similar to ROHM UMD2NTR.
TR803	Similar to ROHM QS6M3TR.
TR804	Similar to ROHM UMD2NTR.
TR805	Similar to Toshiba RN1304(TE85L_F.
TR806	Similar to ROHM UMG2NTR.
TR807	Similar to Toshiba 2SC2859-Y(TE85L_F.
TR808	Similar to NEC 2SC3736T1-AZ OK.
TR809	Similar to Toshiba 2SC2859-Y(TE85L_F.
TR810	Similar to NEC 2SC3736T1-AZ OK.
TR811 thru TR815	Similar to ROHM UMG2NTR.
TR816	Similar to Toshiba RN1304(TE85L_F.
TR901	Similar to ROHM UMG2NTR.
TR902	Similar to Renesas 2SJ553STR-E.
TR904	Similar to Toshiba 2SC2859-Y(TE85L_F.
TR905 thru TR911	Similar to ROHM UMD2NTR.
----- OSCILLATOR MODULES/CRYSTALS -----	
X801	12.0 MHz; similar to CITIZEN CS20_12.000.000MABJT, or NDK NX1255GB-12MHZ-30PPM.
X802	32.768 kHz; similar to Epson Toyocom MC-306- 32.768KHZ-12.5/2.
X803	40.0 MHz; similar to CITIZEN CS10_40.000.000MABJT or Epson Toyocom FA-365-40MHZ-18PF/50PPM-F.

## 16.2.2 RF Processor Board

(CMN-709, Rev. B)

SYMBOL	DESCRIPTION
-----CAPACITORS-----	
C101	5 pF; similar to Taiyo Yuden UMK105CH050CW-F
C103	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C104	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C106	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C107	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C108	4 pF; similar to Taiyo Yuden UMK105CH040CW-F
C110	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C111	4 pF; similar to Taiyo Yuden UMK105CH040CW-F
C113	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C114	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C115	4 pF; similar to Taiyo Yuden UMK105CH040CW-F
C116	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C117	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C118	4 pF; similar to Taiyo Yuden UMK105CH040CW-F
C120	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C121	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C122	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C123	6 pF; similar to Taiyo Yuden UMK105CH060DW-F
C124	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C125	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C126	6 pF; similar to Taiyo Yuden UMK105CH060DW-F
C127	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C128	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C129	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C130	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C131	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C132	0.01 uF; similar to Murata GRM155B11E103KA01D
C133	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C134	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C135	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C136	1 uF; similar to Murata GRM31MB11C105KA01L
C137	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C138	0.01 uF; similar to Murata GRM155B11E103KA01D
C139	33 uF; similar to Rubycon 25SGV33M6.3X6.1
C140	0.01 uF; similar to Murata GRM155B11E103KA01D
C141	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C142	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C145	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F

SYMBOL	DESCRIPTION
C146	1.5 pF; similar to Murata GRM1554C1H1R5CZ01D
C147	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C148	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C150	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C152	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C153	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C154	0.01 uF; similar to Murata GRM155B11E103KA01D
C155	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C156	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C157	100 pF; similar to Soshin UC342H1000J-T
C158	90 pF; similar to Soshin UC232H0900J-T
C160	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C161	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C162	1.5 pF; similar to Soshin UC232H01R5C-T
C164	3 pF; similar to Murata GRM31M3C2H3R0CY21L
C165	4 pF; similar to Murata GRM31M2C2H4R0CY21L
C166	3 pF; similar to Murata GRM31M3C2H3R0CY21L
C168	6 pF; similar to Soshin UC232H0060D-T
C169	6 pF; similar to Soshin UC232H0060D-T
C171	1 pF; similar to Murata GRM31M4C2H1R0CY21L
C172	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C173	0.01 uF; similar to Murata GRM155B11E103KA01D
C174	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C175	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C176	1.5 pF; similar to Soshin UC232H01R5C-T
C178	3 pF; similar to Murata GRM31M3C2H3R0CY21L
C181	1 pF; similar to Taiyo Yuden UMK105CK010CW-F
C182	6 pF; similar to Taiyo Yuden UMK105CH060DW-F
C184	15 pF; similar to Murata GRM1552C1H150JZ01D
C186	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C188	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C190	12 pF; similar to Murata GRM1552C1H120JZ01D
C194	0.01 uF; similar to Murata GRM155B11E103KA01D
C195	0.01 uF; similar to Murata GRM155B11E103KA01D
C196	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C199	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C201	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C202	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C203	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C204	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C205	100 pF; similar to Taiyo Yuden UMK105CH101JV-F

SYMBOL	DESCRIPTION
C206	2 pF; similar to Taiyo Yuden UMK105CK020CW-F
C207	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C208	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C209	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C210	2 pF; similar to Taiyo Yuden UMK105CK020CW-F
C211	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C212	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C213	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C214	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C215	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C216	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C217	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C218	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C219	8 pF; similar to Taiyo Yuden UMK105CH080DV-F
C220	0.01 uF; similar to Murata GRM155B11E103KA01D
C221	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C222	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C223	12 pF; similar to Taiyo Yuden UMK105CH120JV-F
C224	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C225	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C226	15 pF; similar to Murata GRM1552C1H150JZ01D
C227	12 pF; similar to Taiyo Yuden UMK105CH120JV-F
C228	39 pF; similar to Murata GRM1552C1H390JZ01D
C229	15 pF; similar to Murata GRM1552C1H150JZ01D
C232	15 pF; similar to Murata GRM1552C1H150JZ01D
C234	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C235	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C236	4 pF; similar to Murata GRM1552C1H4R0BZ01D
C237	1.5 pF; similar to Murata GRM1554C1H1R5BZ01D
C238	4 pF; similar to Murata GRM1552C1H4R0BZ01D
C239	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C240	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C243	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C244	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C257	0.01 uF; similar to Murata GRM155B11E103KA01D
C258	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C259	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C260	0.01 uF; similar to Murata GRM155B11E103KA01D
C261	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C262	0.01 uF; similar to Murata GRM155B11E103KA01D
C263	100 pF; similar to Taiyo Yuden UMK105CH101JV-F

SYMBOL	DESCRIPTION
C264	0.01 uF; similar to Murata GRM155B11E103KA01D
C265	0.01 uF; similar to Murata GRM155B11E103KA01D
C266	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C267	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C270	0.01 uF; similar to Murata GRM155B11E103KA01D
C272	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C273	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C274	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C275	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C276	1 uF; similar to Murata GRM31CR61C106KA88L
C279	0.01 uF; similar to Murata GRM155B11E103KA01D
C280	0.01 uF; similar to Murata GRM188R11H103KA01D
C281	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C299	0.01 uF; similar to Murata GRM155B11E103KA01D
C301	0.01 uF; similar to Murata GRM155B11E103KA01D
C303	0.01 uF; similar to Murata GRM155B11E103KA01D
C304	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C305	12 pF; similar to Murata GRM1552C1H120JZ01D
C306	18 pF; similar to Murata GRM1552C1H180JZ01D
C307	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C311	15 pF; similar to Murata GRM1552C1H150JZ01D
C312	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C313	18 pF; similar to Murata GRM1552C1H180JZ01D
C314	180 pF; similar to Taiyo Yuden UMK105CH181JV-F
C315	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C316	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C317	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C318	0.1 uF; similar to Murata GRM155B11A104KA01D
C319	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C320	0.1 uF; similar to Murata GRM155B11A104KA01D
C321	2200 pF; similar to Murata GRM155B11H222KA01D
C322	0.01 uF; similar to Murata GRM155B11E103KA01D
C323	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C324	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C325	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C326	0.22 uF; similar to Murata GRM188B11C224KA01D
C327	1 uF; similar to Murata GRM188B31C105KA92D
C328	0.01 uF; similar to Murata GRM155B11E103KA01D
C329	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C330	0.1 uF; similar to Murata GRM155B11A104KA01D
C331	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F

SYMBOL	DESCRIPTION
C332	1 uF; similar to Murata GRM188B31C105KA92D
C333	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C334	0.1 uF; similar to Murata GRM155B11A104KA01D
C335	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C336	0.1 uF; similar to Murata GRM155B11A104KA01D
C337	0.01 uF; similar to Murata GRM155B11E103KA01D
C338	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C339	0.1 uF; similar to Murata GRM155B11A104KA01D
C340	0.1 uF; similar to Murata GRM155B11A104KA01D
C341	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C343	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C344	0.01 uF; similar to Murata GRM155B11E103KA01D
C345	0.01 uF; similar to Murata GRM155B11E103KA01D
C346	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C347	0.01 uF; similar to Murata GRM155B11E103KA01D
C348	0.01 uF; similar to Murata GRM155B11E103KA01D
C349	0.01 uF; similar to Murata GRM155B11E103KA01D
C350	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C351	0.01 uF; similar to Murata GRM155B11E103KA01D
C352	47 pF; similar to Murata GRM1552C1H470JZ01D
C353	47 pF; similar to Murata GRM1552C1H470JZ01D
C354	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C355	9 pF; similar to Taiyo Yuden UMK105CH090DV-F
C356	0.01 uF; similar to Murata GRM155B11E103KA01D
C357	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C358	82 pF; similar to Taiyo Yuden UMK105CH820JV-F
C359	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C360	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C361	4700 pF; similar to Panasonic ECHU1C472JX5
C362	0.1 uF; similar to Panasonic ECPU1C104MA5
C363	1000 pF; similar to Murata GRM1552C1H102JA01D
C364	1000 pF; similar to Murata GRM1552C1H102JA01D
C365	22 pF; similar to Murata GRM1552C1H220FZ01D
C366	2 pF; similar to Murata GRM1552C1H2R0BZ01D
C367	2 pF; similar to Murata GRM1552C1H2R0BZ01D
C368	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C369	22 pF; similar to Murata GRM1552C1H220FZ01D
C370	39 pF; similar to Murata GRM1552C1H390FZ01D
C371	47 pF; similar to Murata GRM1552C1H470FZ01D
C372	0.01 uF; similar to Murata GRM155B11E103KA01D
C373	0.01 uF; similar to Murata GRM155B11E103KA01D

SYMBOL	DESCRIPTION
C375	1 pF; similar to Taiyo Yuden UMK105CK010CW-F
C376	8 pF; similar to Murata GRM1552C1H8R0GZ01D
C377	0.01 uF; similar to Murata GRM155B11E103KA01D
C378	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C379	0.01 uF; similar to Murata GRM155B11E103KA01D
C380	0.01 uF; similar to Murata GRM155B11E103KA01D
C381	9 pF; similar to Murata GRM1552C1H9R0GZ01D
C383	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C385	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C386	0.01 uF; similar to Murata GRM155B11E103KA01D
C387	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C388	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C389	10 uF; similar to Murata GRM31CR61C106KA88L
C390	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C391	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C392	0.1 uF; similar to Murata GRM155B11A104KA01D
C393	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C394	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C396	0.01 uF; similar to Murata GRM155B11E103KA01D
C398	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C399	0.1 uF; similar to Murata GRM155B11A104KA01D
C401	100 pF; similar to Murata GRM1552C1H100FZ01D
C403	100 pF; similar to Murata GRM1552C1H100FZ01D
C404	39 pF; similar to Murata GRM1552C1H390FZ01D
C405	33 pF; similar to Murata GRM1552C1H330FZ01D
C406	2 pF; similar to Murata GRM1552C1H2R0BZ01D
C407	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C408	3 pF; similar to Murata GRM1552C1H3R0BZ01D
C409	3 pF; similar to Murata GRM1552C1H3R0BZ01D
C410	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C411	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C412	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C416	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C417	6 pF; similar to Taiyo Yuden UMK105CH060DW-F
C418	1 uF; similar to Murata GRM31MB11C105KA01L
C419	1000 pF; similar to Murata GRM1552C1H102JA01D
C420	12 pF; similar to Murata GRM1552C1H120FZ01D
C421	12 pF; similar to Murata GRM1552C1H120FZ01D
C422	2 pF; similar to Murata GRM1552C1H2R0BZ01D
C423	6 pF; similar to Murata GRM1552C1H6R0BZ01D
C424	6 pF; similar to Murata GRM1552C1H6R0BZ01D

SYMBOL	DESCRIPTION
C425	6 pF; similar to Murata GRM1552C1H6R0BZ01D
C426	4 pF; similar to Murata GRM1552C1H4R0BZ01D
C431	5 pF; similar to Murata GRM1552C1H5R0BZ01D
C432	6 pF; similar to Murata GRM1552C1H6R0BZ01D
C433	47 pF; similar to Murata GRM1552C1H470JZ01D
C434	47 pF; similar to Murata GRM1552C1H470JZ01D
C436	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C438	1 pF; similar to Taiyo Yuden UMK105CK010CW-F
C439	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C440	9 pF; similar to Murata GRM1552C1H9R0GZ01D
C441	10 pF; similar to Murata GRM1552C1H100FZ01D
C442	2200 pF; similar to Murata GRM155R11H222KA01D
C443	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C444	220 pF; similar to Murata GRM1552C1H221GA01D
C445	560 pF; similar to Murata GRM1552C1H561GA01D
C446	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C447	0.1 uF; similar to Murata GRM155R11C104KA88D
C448	2200 pF; similar to Murata GRM155R11H222KA01D
C449	220 pF; similar to Murata GRM1552C1H221GA01D
C451	2.7 pF; similar to Murata GRM1553C1H2R7BZ01D
C452	1.5 pF; similar to Murata GRM1554C1H1R5BZ01D
C456	4 pF; similar to Murata GRM1552C1H4R0BZ01D
C461	2 pF; similar to Murata GRM1552C1H2R0BZ01D
C462	4 pF; similar to Murata GRM1552C1H4R0BZ01D
C463	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C464	0.5 pF; similar to Murata GRM1554C1HR50CZ01D
C465	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C466	27 pF; similar to Murata GRM1552C1H270JZ01D
C467	560 pF; similar to Murata GRM1552C1H561GA01D
C469	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C471	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C472	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C473	6 pF; similar to Taiyo Yuden UMK105CH060DW-F
C477	2200 pF; similar to Murata GRM155R11H222KA01D
C478	220 pF; similar to Murata GRM1552C1H221GA01D
C479	560 pF; similar to Murata GRM1552C1H561GA01D
C480	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C481	15p; similar to Taiyo Yuden UMK105CH150JV-F
C482	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C483	15 pF; similar to Taiyo Yuden UMK105CH150JV-F
C484	0.1 uF; similar to Murata GRM155R11C104KA88D

SYMBOL	DESCRIPTION
C485	2200 pF; similar to Murata GRM155R11H222KA01D
C486	220 pF; similar to Murata GRM1552C1H221GA01D
C487	560 pF; similar to Murata GRM1552C1H561GA01D
C488	0.1 uF; similar to Murata GRM155R11C104KA88D
C489	0.1 uF; similar to Murata GRM155R11C104KA88D
C490	0.1 uF; similar to Murata GRM155R11C104KA88D
C492	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C493	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C494	1 pF; similar to Taiyo Yuden UMK105CK010CW-F
C495	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C497	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C498	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C501	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C502	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C503	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C504	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C505	5 pF; similar to Taiyo Yuden UMK105CH050CW-F
C506	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C507	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C510	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C511	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C512	7 pF; similar to Taiyo Yuden UMK105CH070DW-F
C513	0.01 uF; similar to Panasonic ECHU1C103JX5
C514	3.3 uF; similar to Nichicon F931A335MAA
C515	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C516	10 uF; similar to Murata GRM31CR61C106KA88L
C517	10 uF; similar to Murata GRM31CR61C106KA88L
C518	1 uF; similar to Panasonic ECPU1C105MA5
C519	0.022 uF; similar to Panasonic ECHU1C223JX5
C520	0.1 uF; similar to Panasonic ECPU1C104MA5
C522	0.1 uF; similar to Murata GRM155B11A104KA01D
C523	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C524	0.047 uF; similar to Murata GRM188R11E473KA01D
C525	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C526	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C532	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C533	0.01 uF; similar to Murata GRM155B11E103KA01D
C535	0.01 uF; similar to Murata GRM155B11E103KA01D
C542	0.01 uF; similar to Murata GRM155B11E103KA01D
C551	0.01 uF; similar to Murata GRM155B11E103KA01D
C555	6 pF; similar to Taiyo Yuden UMK105CH060DW-F

SYMBOL	DESCRIPTION
C556	0.01 uF; similar to Murata GRM155B11E103KA01D
C557	82 pF; similar to Taiyo Yuden UMK105CH820JV-F
C558	0.01 uF; similar to Murata GRM155B11E103KA01D
C561	0.01 uF; similar to Murata GRM155B11E103KA01D
C563	0.01 uF; similar to Murata GRM155B11E103KA01D
C564	1000 pF; similar to Murata GRM1552C1H102JA01D
C565	0.47 uF; similar to Panasonic ECPU1C474MA5
C566	4.7 uF; similar to Nichicon F931A475MAA
C567	4.7 uF; similar to Murata GRM21BB31E475KA75L
C568	4.7 uF; similar to Murata GRM21BB31E475KA75L
C582	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C583	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C584	0.1 uF; similar to Murata GRM155B11A104KA01D
C585	0.1 uF; similar to Murata GRM155B11A104KA01D
C586	0.1 uF; similar to Murata GRM155B11A104KA01D
C589	0.01 uF; similar to Murata GRM155B11E103KA01D
C590	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C591	1 uF; similar to Murata GRM31MR11E105KA01L
C592	0.01 uF; similar to Murata GRM155B11E103KA01D
C593	10 uF; similar to Murata GRM31CR61C106KA88L
C594	10 uF; similar to Murata GRM31CR61C106KA88L
C595	1 uF; similar to Murata GRM21BR11C105KA01L
C596	10 uF; similar to Murata GRM31CR61C106KA88L
C597	10 uF; similar to Murata GRM31CR61C106KA88L
C598	0.01 uF; similar to Murata GRM155B11E103KA01D
C599	0.01 uF; similar to Murata GRM155B11E103KA01D
C601	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C602	39 pF; similar to Murata GRM1552C1H390JZ01D
C603	39 pF; similar to Murata GRM1552C1H390JZ01D
C604	7 pF; similar to Taiyo Yuden UMK105CH070DW-F
C605	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C606	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C607	22 pF; similar to Murata GRM1552C1H220JZ01D
C608	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C609	0.5 pF; similar to Murata GRM1554C1HR50CZ01D
C610	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C611	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C612	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C613	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C614	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C621	100 pF; similar to Taiyo Yuden UMK105CH101JV-F

SYMBOL	DESCRIPTION
C623	3.3 pF; similar to Murata GRM1553C1H3R3BZ01D
C624	2 pF; similar to Murata GRM1552C1H2R0BZ01D
C625	1 pF; similar to Murata GRM1554C1H1R0CZ01D
C626	3 pF; similar to Murata GRM1552C1H3R0BZ01D
C631	3 pF; similar to Murata GRM1552C1H3R0BZ01D
C632	6 pF; similar to Murata GRM1552C1H6R0GZ01D
C633	5 pF; similar to Murata GRM1552C1H5R0BZ01D
C634	1.5 pF; similar to Murata GRM1554C1H1R5BZ01D
C635	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C636	5 pF; similar to Murata GRM1552C1H5R0BZ01D
C637	5 pF; similar to Murata GRM1552C1H5R0BZ01D
C641	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C642	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C643	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C644	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C645	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C646	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C647	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C648	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C651	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C652	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C653	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C654	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C655	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C656	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C657	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C658	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C660	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C661	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C662	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C663	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C664	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C665	0.33 uF; similar to Murata GRM21BB11E334KA01L
C666	22 uF; similar to Nichicon F931V226MNC
C667	0.01 uF; similar to Murata GRM155B11E103KA01D
C668	0.01 uF; similar to Murata GRM155B11E103KA01D
C669	1 uF; similar to Murata GRM188B31C105KA92D
C670	0.22 uF; similar to Murata GRM188R11C224KA01D
C671	0.33 uF; similar to Murata GRM21BB11E334KA01L
C672	10 uF; similar to Murata GRM31CR61C106KA88L
C673	0.01 uF; similar to Murata GRM155B11E103KA01D

SYMBOL	DESCRIPTION
C676	10 uF; similar to Murata GRM31CR61C106KA88L
C677	0.01 uF; similar to Murata GRM155B11E103KA01D
C678	0.33 uF; similar to Murata GRM21BB11E334KA01L
C679	10 uF; similar to Murata GRM31CR61C106KA88L
C680	0.01 uF; similar to Murata GRM155B11E103KA01D
C681	0.01 uF; similar to Murata GRM155B11E103KA01D
C682	0.22 uF; similar to Murata GRM188B11A224KA01D
C683	1 uF; similar to Murata GRM188B31C105KA92D
C684	10 uF; similar to Murata GRM31CR61C106KA88L
C685	0.33 uF; similar to Murata GRM21BB11E334KA01L
C686	22 uF; similar to Nichicon F931V226MNC
C687	0.01 uF; similar to Murata GRM155B11E103KA01D
C688	0.01 uF; similar to Murata GRM155B11E103KA01D
C689	22 uF; similar to Rubycon 35SEV220M 10X10.5
C690	0.01 uF; similar to Murata GRM155B11E103KA01D
C691	0.01 uF; similar to Murata GRM155B11E103KA01D
C692	0.047 uF; similar to Murata GRM188B11E473KA01D
C693	0.047 uF; similar to Murata GRM188B11E473KA01D
C694	0.1 uF; similar to Murata GRM188R11E104KA01D
C695	10 uF; similar to Murata GRM31CR61C106KA88L
C696	0.01 uF; similar to Murata GRM155B11E103KA01D
C697	0.01 uF; similar to Murata GRM155B11E103KA01D
C698	1 uF; similar to Murata GRM188B31C105KA92D
C699	1 uF; similar to Murata GRM188B31C105KA92D
C701	1 uF; similar to Murata GRM188B31C105KA92D
C702	0.1 uF; similar to Murata GRM155B11A104KA01D
C703	0.1 uF; similar to Murata GRM155B11A104KA01D
C704	0.1 uF; similar to Murata GRM155B11A104KA01D
C705	0.1 uF; similar to Murata GRM155B11A104KA01D
C706	0.1 uF; similar to Murata GRM155B11A104KA01D
C707	0.01 uF; similar to Murata GRM155B11E103KA01D
C708	10 uF; similar to Murata GRM31CR61C106KA88L
C709	0.1 uF; similar to Murata GRM155B11A104KA01D
C710	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C711	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C713	0.01 uF; similar to Murata GRM155B11E103KA01D
C714	0.1 uF; similar to Murata GRM155B11A104KA01D
C715	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C716	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C717	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C718	100 pF; similar to Taiyo Yuden UMK105CH101JV-F

SYMBOL	DESCRIPTION
C719	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C720	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C721	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C722	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C723	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C724	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C725	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C726	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C728	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C729	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C730	0.01 uF; similar to Murata GRM155B11E103KA01D
C731	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C732	1 uF; similar to Murata GRM188B11A105KA61D
C733	0.1 uF; similar to Murata GRM155B11A104KA01D
C734	0.1 uF; similar to Murata GRM155B11A104KA01D
C735	0.1 uF; similar to Murata GRM155B11A104KA01D
C736	0.1 uF; similar to Murata GRM155B11A104KA01D
C737	0.1 uF; similar to Murata GRM155B11A104KA01D
C738	0.1 uF; similar to Taiyo Yuden TMK105BJ104KV-F
C739	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C740	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C741	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C765	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C766	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C767	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C768	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C769	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C770	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C771	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C775	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C780	0.01 uF; similar to Murata GRM155B11E103KA01D
C781	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C782	0.33 uF; similar to Murata GRM21BB11E334KA01L
C783	10 uF; similar to Murata GRM31CR61C106KA88L
C784	0.01 uF; similar to Murata GRM155B11E103KA01D
C785	0.33 uF; similar to Murata GRM21BB11E334KA01L
C786	22 uF; similar to Nichicon F931V226MNC
C787	0.01 uF; similar to Murata GRM155B11E103KA01D
C788	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C790	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C795	100 pF; similar to Taiyo Yuden UMK105CH101JV-F

SYMBOL	DESCRIPTION
C796	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C797	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C798	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C799	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1101	0.01 uF; similar to Murata GRM155B11E103KA01D
C1102	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1103	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1104	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1201	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1301	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1302	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1303	0.1 uF; similar to Murata GRM155B11A104KA01D
C1305	15 pF; similar to Taiyo Yuden UMK105CH150JV-F
C1306	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1307	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1309	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1310	22 pF; similar to Murata GRM1552C1H220JZ01D
C1311	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1312	22 pF; similar to Murata GRM1552C1H220JZ01D
C1401	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1402	12 pF; similar to Murata GRM1552C1H120JZ01D
C1403	8 pF; similar to Taiyo Yuden UMK105CH080DV-F
C1404	10 pF; similar to Taiyo Yuden UMK105CH100DV-F
C1405	27 pF; similar to Murata GRM1552C1H270JZ01D
C1406	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C1407	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C1408	22 pF; similar to Murata GRM1552C1H220JZ01D
C1409	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C1410	3 pF; similar to Taiyo Yuden UMK105CJ030CW-F
C1411	15 pF; similar to Murata GRM1552C1H150JZ01D
C1418	100 pF; similar to Murata GRM155R11C104KA88D
C1419	100 pF; similar to Murata GRM155R11C104KA88D
C1420	0.1 uF; similar to Taiyo Yuden TMK105BJ104KV-F
C1421	0.1 uF; similar to Taiyo Yuden TMK105BJ104KV-F
C1422	0.1 uF; similar to Taiyo Yuden TMK105BJ104KV-F
C1423	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1424	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1425	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1431	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1434	1000 pF; similar to Taiyo Yuden UMK105BJ102KV-F
C1437	100 pF; similar to Taiyo Yuden UMK105CH101JV-F

SYMBOL	DESCRIPTION
C1440	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1441	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1444	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1448	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1450	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1451	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1454	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1455	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1458	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1459	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1460	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1463	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1464	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1467	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1469	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1472	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1501	0.01 uF; similar to Murata GRM155B11E103KA01D
C1502	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1503	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1621	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1622	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1624	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1627	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1630	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1632	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1635	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1636	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1701	100 pF; similar to Taiyo Yuden UMK105CH101JV-F
C1703	0.01 uF; similar to Murata GRM155B11E103KA01D
CV402	VARIABLE 3 pF; similar to Murata TZY2Z030A001R00
CV403	VARIABLE 3 pF; similar to Murata TZY2Z030A001R00
----- DIODES -----	
CD101	Similar to Agilent HSMP-3864-TR1G
CD102	Similar to Agilent HSMP-3864-TR1G
CD141	Similar to Panasonic MA2J72800L
CD142	Similar to Panasonic MA2J72800L
CD144	Similar to Panasonic MA2J72800L
CD146	Similar to Panasonic MA2J72800L
CD147	Similar to Litec L709CER

SYMBOL	DESCRIPTION
CD148	Similar to Litec L709CER
CD149	Similar to Panasonic MA3X71600L
CD161	Similar to Litec L709CER
CD162	Similar to Litec L709CER
CD165	Similar to Toshiba 1SS300(TE85L_F)
CD251	Similar to Panasonic MA2J72800L
CD252	Similar to NEC RD6.2M-T1B-A B2
CD261	Similar to Panasonic MA2J72800L
CD301	Similar to Toko KV1870STL-G
CD302	Similar to Toshiba 1SV276(TPH3_F)
CD303	Similar to ROHM 1SS356TW11
CD304	Similar to ROHM 1SS356TW11
CD305	Similar to Agilent HSMP-3864-TR1G
CD306	Similar to Agilent HSMP-3864-TR1G
CD401	Similar to Toshiba 1SV276(TPH3_F)
CD402	Similar to Renesas HVC383BTRF-E
CD403	Similar to ROHM 1SS356TW11
CD404	Similar to ROHM 1SS356TW11
CD410	Similar to Renesas HVC383BTRF-E
CD411	Similar to Renesas HVC383BTRF-E
CD412	Similar to Renesas HVC383BTRF-E
CD413	Similar to Renesas HVC383BTRF-E
CD420	Similar to Renesas HVC383BTRF-E
CD421	Similar to Renesas HVC383BTRF-E
CD422	Similar to Renesas HVC383BTRF-E
CD423	Similar to Renesas HVC383BTRF-E
CD501	Similar to Renesas HSU88TRF-E
CD502	Similar to Toshiba 02CZ2.4-X(TE85R_F)
CD701	Similar to Shindengen DF25V60-5072
CD780	Similar to Shindengen D1F60-5063
----- FILTERS -----	
FL201	Similar to Toko H-7NBPD0002
FL202	Similar to Toko H-7NBPD0003
FL203	Similar to Toko H-7NBPD0002
FL204	Similar to Toko H-7NBPD0003
FL301	Similar to NDK H-7XMPD0017
FL302	Similar to NDK H-7XMPD0018
FL601	Similar to EPCOS B4161
----- CONNECTORS -----	
J701	40-pin; similar to SUYIN Connector 127180MA040G200ZR

SYMBOL	DESCRIPTION
	-----INDUCTORS-----
L101	6.8 nH; similar to Toko LL1005-FHL6N8J
L102	10 nH; similar to Toko LL1005-FHL10NJ
L111	10 nH; similar to Toko LL1608-FSL10NJ
L112	10 nH; similar to Toko LL1005-FHL10NJ
L121	10 nH; similar to Toko LL1608-FSL10NJ
L122	10 nH; similar to Toko LL1005-FHL10NJ
L131	2.7 nH; similar to Taiyo Yuden HK1005 2N7S-T
L132	0.47 uH; similar to Toko LLQ2012-FR47J
L133	4.7 nH; similar to Taiyo Yuden HK1608 4N7S-T
L141	0.27 uH; similar to Toko LLQ1608-FR27G
L142	0.27 uH; similar to Toko LLQ1608-FR27G
L143	0.27 uH; similar to Toko LLQ1608-FR27G
L144	12 nH; similar to Toko LLQ1608-F12NG
L145	12 nH; similar to Toko LLQ1608-F12NG
L146	33 nH; similar to Korin AS080447-33NK-T
L147	60 nH; similar to Korin AS030921-60NJ-T
L161	Similar to Midori Musen H-7LAPD0042
L162	5.6 nH; similar to Toko LLQ2012-F5N6J
L163	0.27 uH; similar to Toko LLQ1608-FR27G
L201	6.8 nH; similar to Toko LL1005-FHL6N8J
L202	56 nH; similar to Toko LL1005-FHL56NJ
L203	6.8 nH; similar to Toko LL1005-FHL6N8J
L204	56 nH; similar to Toko LL1005-FHL56NJ
L205	10 nH; similar to Toko LL1608-FSL10NJ
L206	5.6 nH; similar to Toko LL1608-FSL5N6S
L207	5.6 nH; similar to Toko LL1608-FSL5N6S
L208	47 nH; similar to Toko LL1608-FSL47NJ
L209	0.18 uH; similar to Toko LL1608-FSLR18J
L210	47 nH; similar to Toko LL1608-FSL47NJ
L211	0.18 uH; similar to Toko LL1608-FSLR18J
L212	0.18 uH; similar to Toko LL1608-FSLR18J
L221	10 nH; similar to Toko LL1005-FHL10NJ
L222	8.2 nH; similar to Toko LL1005-FHL8N2J
L223	5.6 nH; similar to Toko LL1005-FHL5N6S
L301	0.82 uH; similar to Toko LLQ2012-FR82J
L302	0.33 uH; similar to Toko LLQ2012-FR33J
L304	0.15 uH; similar to Toko LLQ2012-FR15J
L306	10 uH; similar to Murata LQH32CN100K23L
L307	10 uH; similar to Murata LQH32CN100K23L
L308	1.2 uH; similar to Murata LQH31MN1R2K03L

SYMBOL	DESCRIPTION
L311	0.27 uH; similar to Toko LL1608-FSLR27J
L315	0.15 uH; similar to Toko LLQ2012-FR15J
L316	0.18 uH; similar to Toko LLQ1608-FR18J
L317	0.18 uH; similar to Toko LLQ1608-FR18J
L321	82 nH; similar to Toko LL1005-FHL82NJ
L322	0.33 uH; similar to Taiyo Yuden LK1608 R33K-T
L323	56 nH; similar to Toko LL1005-FHL56NJ
L324	0.82 uH; similar to Toko LLQ2012-FR82J
L325	0.82 uH; similar to Toko LLQ2012-FR82J
L326	0.82 uH; similar to Toko LLQ2012-FR82J
L331	0.15 uH; similar to Toko LLQ2012-FR15G
L333	0.82 uH; similar to Toko LLQ2012-FR82J
L334	0.82 uH; similar to Toko LLQ2012-FR82J
L335	0.33 uH; similar to Taiyo Yuden LK1608 R33K-T
L336	4.7 uH; similar to Murata LQH31MN4R7J03L
L337	4.7 uH; similar to Murata LQH31MN4R7J03L
L401	22 nH; similar to Toko LLQ2012-F22NG
L403	0.56 uH; similar to Toko LLQ2012-FR56J
L404	0.22 uH; similar to Toko LLQ1608-FR22J
L405	68 nH; similar to Toko LL1608-FSL68NJ
L406	22 nH; similar to Toko LL1608-FSL22NJ
L407	0.56 uH; similar to Toko LLQ2012-FR56J
L408	0.56 uH; similar to Toko LLQ2012-FR56J
L409	33 nH; similar to Toko LL1608-FSL33NJ
L411	Similar to Maruwa H-7LZPD0008
L412	68 nH; similar to Toko LLQ1608-F68NJ
L413	68 nH; similar to Toko LLQ1608-F68NJ
L416	68 nH; similar to Toko LLQ1608-F68NJ
L417	68 nH; similar to Toko LLQ1608-F68NJ
L421	Similar to Maruwa H-7LZPD0011
L422	47 nH; similar to Toko LLQ1608-F47NJ
L423	0.12 uH; similar to Toko LLQ1608-FR12J
L426	0.18 uH; similar to Toko LLQ1608-FR18J
L427	47 nH; similar to Toko LLQ1608-F47NJ
L430	6.8 nH; similar to Toko LL1005-FHL6N8J
L432	47 nH; similar to Toko LLQ1608-F47NJ
L433	47 nH; similar to Toko LLQ1608-F47NJ
L434	47 nH; similar to Toko LLQ1608-F47NJ
L503	6.8 nH; similar to Toko LL1005-FHL6N8J
L505	56 nH; similar to Toko LL1608-FSL56NJ
L506	68 nH; similar to Toko LL1005-FHL68NJ

SYMBOL	DESCRIPTION
L507	1 uH; similar to Murata LQH31MN1R0K03L
L508	6.8 nH; similar to Toko LL1005-FHL6N8J
L601	47 nH; similar to Toko LL1608-FSL47NJ
L602	47 nH; similar to Toko LL1608-FSL47NJ
L603	18 nH; similar to Toko LL1005-FHL18NJ
L604	18 nH; similar to Toko LL1005-FHL18NJ
L605	5.4 nH; similar to Korin AS050321-5R4NJ
L606	9 nH; similar to Korin AS050325-9R0NJ
L607	18 nH; similar to Toko LLQ2012-F18NG
L608	12 nH; similar to Toko LLQ2012-F12NG
L609	12 nH; similar to Toko LL1005-FHL12NJ
L665	1 uH; similar to Murata LQH31MN1R0K03L
L666	4.7 uH; similar to Murata LQH31MN4R7J03L
L667	1 uH; similar to Murata LQH31MN1R0K03L
L701	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L703	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L704	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L706	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L707	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L708	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L709	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L711	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L712	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L713	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L714	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L715	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L716	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L717	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L718	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L719	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L720	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D

SYMBOL	DESCRIPTION
L721	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L722	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L723	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L724	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L725	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L726	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L727	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L728	60 ohm at 100MHz; similar to Murata BLM18PG600SN1D
L1301	0.27 uH; similar to Toko LLQ2012-FR27NJ
----- TRANSISTORS -----	
TR101	Similar to NEC 2SC3356-T1B-A R
TR111	Similar to NEC 2SC3357-T1-A RF
TR121	Similar to NEC 2SC3357-T1-A RF
TR131	Similar to Mitsubishi RD01MUS1-T113
TR161	Similar to ROHM 2SD1781KT146R
TR171	Similar to ROHM 2SD1781KT146R
TR201	Similar to Agilent MGA-62563-TR1G
TR202	Similar to Agilent MGA-62563-TR1G
TR203	Similar to ROHM 2SA1037AKT146R
TR204	Similar to Toshiba RN1301(TE85L_F)
TR205	Similar to ROHM 2SA1037AKT146R
TR206	Similar to Toshiba RN1301(TE85L_F)
TR210	Similar to NEC 2SC3356-T1B-A R
TR251	Similar to Toshiba RN1301(TE85L_F)
TR252	Similar to ROHM 2SA1037AKT146R
TR253	Similar to Toshiba RN1301(TE85L_F)
TR254	Similar to NEC 2SB798-T2-AZ DK
TR255	Similar to Toshiba RN1301(TE85L_F)
TR256	Similar to ROHM 2SA1037AKT146R
TR257	Similar to NEC 2SB798-T2-AZ DK
TR258	Similar to Toshiba RN1301(TE85L_F)
TR261	Similar to Toshiba 2SA1618GR(TE85L_F)
TR262	Similar to ROHM 2SD1781KT146R
TR263	Similar to ROHM 2SA1037AKT146R
TR266	Similar to Toshiba RN1501(TE85L_F)
TR267	Similar to ROHM 2SD1781KT146R

SYMBOL	DESCRIPTION
TR268	Similar to Toshiba RN1501(TE85L_F)
TR301	Similar to ON Semiconductor MMBFJ310LT1G
TR302	Similar to Toshiba 2SC3356-T1B-A R
TR303	Similar to Toshiba 2SC2714-Y(TE85L_F)
TR311	Similar to ON Semiconductor MMBFJ310LT1G
TR312	Similar to Toshiba 2SC3356-T1B-A R
TR320	Similar to ROHM 2SD1781KT146R
TR321	Similar to NEC 2SC3356-T1B-A R
TR322	Similar to Toshiba 2SC2714-Y(TE85L_F)
TR323	Similar to Panasonic XP0121600L
TR401	Similar to NEC 2SC3356-T1B-A R
TR403	Similar to Toshiba 2SC2714-Y(TE85L_F)
TR404	Similar to Renesas 2SC5773JR-TL-E
TR405	Similar to Toshiba RN1305(TE85L_F)
TR407	Similar to Panasonic XP0121600L
TR408	Similar to Renesas 2SC5773JR-TL-E
TR409	Similar to Toshiba RN1305(TE85L_F)
TR410	Similar to NEC 2SC3356-T1B-A R
TR412	Similar to ROHM QS6M3TR
TR501	Similar to Sanyo 2SK536-TB-E
TR502	Similar to ROHM 2SA1037AKT146R
TR503	Similar to Toshiba RN1301(TE85L_F)
TR504	Similar to Toshiba RN1301(TE85L_F)
TR505	Similar to Sanyo 2SK536-TB-E
TR506	Similar to Sanyo 2SK536-TB-E
TR507	Similar to Toshiba 2SC2714-Y(TE85L_F)
TR512	Similar to Toshiba RN1301(TE85L_F)
TR513	Similar to Toshiba RN1301(TE85L_F)
TR514	Similar to NEC 2SC3356-T1B-A R
TR668	Similar to ROHM 2SD1781KT146R
----- RESISTORS -----	
R101	220 ohm; similar to Panasonic ERJ2GEJ221X
R102	22 ohm; similar to Panasonic ERJ2GEJ120X
R103	220 ohm; similar to Panasonic ERJ2GEJ221X
R104	1k ohm; similar to Panasonic ERJ2GEJ102X
R106	2.7k ohm; similar to Panasonic ERJ2GEJ272X
R107	150 ohm; similar to Panasonic ERJ2GEJ151X
R108	18 ohm; similar to Panasonic ERJ2GEJ180X
R111	820 ohm; similar to Panasonic ERJ2GEJ821X
R112	5.6 ohm; similar to Panasonic ERJ2GEJ5R6X
R113	820 ohm; similar to Panasonic ERJ2GEJ821X

SYMBOL	DESCRIPTION
R114	1k ohm; similar to Panasonic ERJ2GEJ102X
R116	1.8k ohm; similar to Panasonic ERJ2GEJ182X
R117	100 ohm; similar to Panasonic ERJ2GEJ101X
R118	18 ohm; similar to Panasonic ERJ2GEJ180X
R119	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R121	820 ohm; similar to Panasonic ERJ2GEJ821X
R122	5.6 ohm; similar to Panasonic ERJ2GEJ5R6X
R123	820 ohm; similar to Panasonic ERJ2GEJ821X
R124	560 ohm; similar to Panasonic ERJ2GEJ561X
R125	1k ohm; similar to Panasonic ERJ2GEJ102X
R126	1.8k ohm; similar to Panasonic ERJ2GEJ182X
R127	27 ohm; similar to Panasonic ERJ2GEJ270X
R128	18 ohm; similar to Panasonic ERJ2GEJ180X
R131	220 ohm; similar to Panasonic ERJ2GEJ221X
R132	22 ohm; similar to Panasonic ERJ2GEJ220X
R133	220 ohm; similar to Panasonic ERJ2GEJ221X
R134	5.6 ohm; similar to Panasonic ERJ2GEJ5R6X
R135	1.2k ohm; similar to Panasonic ERJ2GEJ122X
R136	1k ohm; similar to Panasonic ERJ2GEJ102X
R137	5.6 ohm; similar to Panasonic ERJ2GEJ5R6X
R138	56 ohm; similar to Panasonic ERJ3GEYJ560V
R139	56 ohm; similar to Panasonic ERJ3GEYJ560V
R140	470 ohm; similar to Panasonic ERJ2GEJ471X
R142	150 ohm; similar to Panasonic ERJ2GEJ151X
R143	560 ohm; similar to Panasonic ERJ2GEJ561X
R144	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R145	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R146	560 ohm; similar to Panasonic ERJ2GEJ561X
R147	6.8k ohm; similar to Panasonic ERJ2GEJ682X
R148	1.5k ohm; similar to Panasonic ERJ2GEJ152X
R149	82 ohm; similar to Panasonic ERJ6GEYJ820V
R150	100 ohm; similar to Panasonic ERJ6GEYJ101V
R151	100 ohm; similar to Panasonic ERJ6GEYJ101V
R152	82 ohm; similar to Panasonic ERJ6GEYJ820V
R153	1k ohm; similar to Panasonic ERJ2GEJ102X
R154	100 ohm; similar to Panasonic ERJ2GEJ101X
R155	100k ohm; similar to Panasonic ERJ2GEJ104X
R156	33k ohm; similar to Panasonic ERJ2GEJ333X
R157	150k ohm; similar to Panasonic ERJ2GEJ154X
R158	18k ohm; similar to Panasonic ERJ2GEJ183X
R159	1k ohm; similar to Panasonic ERJ2GEJ102X

SYMBOL	DESCRIPTION
R160	56k ohm; similar to Panasonic ERJ2GEJ563X
R161	56k ohm; similar to Panasonic ERJ2GEJ563X
R162	39 ohm; similar to Panasonic ERJ1TYJ390U
R163	22k ohm; similar to Panasonic ERJ14YJ223U
R164	15k ohm; similar to Panasonic ERJ6GEYJ153V
R165	1k ohm; similar to Panasonic ERJ2GEJ102X
R166	1k ohm; similar to Panasonic ERJ2GEJ102X
R167	47k ohm; similar to Panasonic ERJ2GEJ473X
R168	39 ohm; similar to Panasonic ERJ1TYJ390U
R169	1k ohm; similar to Panasonic ERJ6GEYJ102V
R170	1k ohm; similar to Panasonic ERJ2GEJ102X
R171	1.2k ohm; similar to Panasonic ERJ2GEJ122X
R172	10k ohm; similar to Panasonic ERJ2GEJ103X
R173	1k ohm; similar to Panasonic ERJ2GEJ102X
R174	560 ohm; similar to Panasonic ERJ2GEJ561X
R175	0 ohm; similar to Panasonic ERJ2GE0R00X
R176	330 ohm; similar to Panasonic ERJ3GEYJ331V
R181	27k ohm; similar to Panasonic ERJ2GEJ273X
R182	0 ohm; similar to Panasonic ERJ2GE0R00X
R183	0 ohm; similar to Panasonic ERJ2GE0R00X
R201	10 ohm; similar to Panasonic ERJ2GEJ100X
R202	680 ohm; similar to Panasonic ERJ2GEJ681X
R203	10 ohm; similar to Panasonic ERJ2GEJ100X
R204	680 ohm; similar to Panasonic ERJ2GEJ681X
R205	0 ohm; similar to Panasonic ERJ2GE0R00X
R208	0 ohm; similar to Panasonic ERJ2GE0R00X
R211	39k ohm; similar to Panasonic ERJ2GEJ393X
R212	1.2k ohm; similar to Panasonic ERJ2GEJ122X
R213	39k ohm; similar to Panasonic ERJ2GEJ393X
R214	1.2k ohm; similar to Panasonic ERJ2GEJ122X
R215	0 ohm; similar to Panasonic ERJ3GEY0R00V
R216	0 ohm; similar to Panasonic ERJ3GEY0R00V
R217	0 ohm; similar to Panasonic ERJ3GEY0R00V
R218	0 ohm; similar to Panasonic ERJ3GEY0R00V
R221	68k ohm; similar to Panasonic ERJ2GEJ683X
R223	820 ohm; similar to Panasonic ERJ2GEJ821X
R224	0 ohm; similar to Panasonic ERJ2GE0R00X
R225	390 ohm; similar to Panasonic ERJ2GEJ391X
R226	12 ohm; similar to Panasonic ERJ2GEJ120X
R227	390 ohm; similar to Panasonic ERJ2GEJ391X
R251	10k ohm; similar to Panasonic ERJ2GEJ103X

SYMBOL	DESCRIPTION
R252	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R253	6.8k ohm; similar to Panasonic ERJ2GEJ682X
R254	1k ohm; similar to Panasonic ERJ6GEYJ102V
R255	10k ohm; similar to Panasonic ERJ2GEJ103X
R256	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R258	0 ohm; similar to Panasonic ERJ2GE0R00X
R259	10k ohm; similar to Panasonic ERJ2GEJ103X
R260	1k ohm; similar to Panasonic ERJ2GEJ102X
R263	12k ohm; similar to Panasonic ERJ2GEJ123X
R264	10k ohm; similar to Panasonic ERJ2GEJ103X
R265	1k ohm; similar to Panasonic ERJ2GEJ102X
R268	1k ohm; similar to Panasonic ERJ2GEJ102X
R269	0 ohm; similar to Panasonic ERJ2GE0R00X
R271	1.5k ohm; similar to Panasonic ERJ2GEJ152X
R272	560 ohm; similar to Panasonic ERJ2GEJ561X
R273	10k ohm; similar to Panasonic ERJ2GEJ103X
R274	560 ohm; similar to Panasonic ERJ2GEJ561X
R275	1k ohm; similar to Panasonic ERJ2GEJ102X
R276	10k ohm; similar to Panasonic ERJ2GEJ103X
R277	10k ohm; similar to Panasonic ERJ2GEJ103X
R278	10k ohm; similar to Panasonic ERJ2GEJ103X
R279	1k ohm; similar to Panasonic ERJ2GEJ102X
R281	6.8k ohm; similar to Panasonic ERJ2GEJ682X
R282	1k ohm; similar to Panasonic ERJ6GEYJ102V
R283	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R304	56 ohm; similar to Panasonic ERJ3GEYJ560V
R305	10 ohm; similar to Panasonic ERJ2GEJ100X
R306	4.7k ohm; similar to Panasonic ERJ2GEJ472X
R307	680 ohm; similar to Panasonic ERJ2GEJ681X
R309	100 ohm; similar to Panasonic ERJ2GEJ101X
R313	47 ohm; similar to Panasonic ERJ2GEJ470X
R316	0 ohm; similar to Panasonic ERJ2GE0R00X
R317	47 ohm; similar to Panasonic ERJ2GEJ470X
R318	100k ohm; similar to Panasonic ERJ2GEJ104X
R320	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R321	1k ohm; similar to Panasonic ERJ2GEJ102X
R322	820 ohm; similar to Panasonic ERJ2GEJ821X
R323	22k ohm; similar to Panasonic ERJ2GEJ223X
R326	33 ohm; similar to Panasonic ERJ2GEJ330X
R327	33 ohm; similar to Panasonic ERJ2GEJ330X
R328	33 ohm; similar to Panasonic ERJ2GEJ330X

SYMBOL	DESCRIPTION
R329	33 ohm; similar to Panasonic ERJ2GEJ330X
R330	47 ohm; similar to Panasonic ERJ2GEJ470X
R334	560 ohm; similar to Panasonic ERJ2GEJ561X
R335	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R336	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R337	680 ohm; similar to Panasonic ERJ2GEJ681X
R338	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R339	560 ohm; similar to Panasonic ERJ2GEJ561X
R340	390 ohm; similar to Panasonic ERJ2GEJ391X
R341	100 ohm; similar to Panasonic ERJ2GEJ101X
R342	68 ohm; similar to Panasonic ERJ2GEJ680X
R343	100 ohm; similar to Panasonic ERJ2GEJ101X
R344	470 ohm; similar to Panasonic ERJ2GEJ471X
R345	18 ohm; similar to Panasonic ERJ2GEJ180X
R346	3.3k ohm; similar to Panasonic ERJ2GEJ332X
R347	5.6k ohm; similar to Panasonic ERJ2GEJ562X
R348	22k ohm; similar to Panasonic ERJ2GEJ223X
R349	1k ohm; similar to Panasonic ERJ2GEJ102X
R351	1k ohm; similar to Panasonic ERJ2GEJ102X
R352	100k ohm; similar to Panasonic ERJ2GEJ104X
R353	12k ohm; similar to Panasonic ERJ2GEJ123X
R354	0 ohm; similar to Panasonic ERJ2GE0R00X
R355	680 ohm; similar to Panasonic ERJ2GEJ681X
R356	1.8k ohm; similar to Panasonic ERJ2GEJ182X
R357	1.2k ohm; similar to Panasonic ERJ2GEJ122X
R358	0 ohm; similar to Panasonic ERJ2GE0R00X
R361	68 ohm; similar to Panasonic ERJ2GEJ680X
R362	1.8k ohm; similar to Panasonic ERJ2GEJ182X
R363	1k ohm; similar to Panasonic ERJ2GEJ102X
R364	4.7 ohm; similar to Panasonic ERJ2GEJ4R7X
R365	(Not Used)
R366	2.7 ohm; similar to Panasonic ERJ2GEJ2R7X
R367	1.8k ohm; similar to Panasonic ERJ2GEJ182X
R368	(Not Used)
R369	18 ohm; similar to Panasonic ERJ2GEJ180X
R370	18 ohm; similar to Panasonic ERJ2GEJ180X
R371	18 ohm; similar to Panasonic ERJ2GEJ180X
R372	4.7 ohm; similar to Panasonic ERJ2GEJ4R7X
R373	330 ohm; similar to Panasonic ERJ14YJ331U
R374	3.3k ohm; similar to Panasonic ERJ2GEJ332X
R375	12k ohm; similar to Panasonic ERJ2GEJ123X

SYMBOL	DESCRIPTION
R376	8.2k ohm; similar to Panasonic ERJ2GEJ822X
R377	2.7k ohm; similar to Panasonic ERJ2GEJ272X
R378	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R379	560 ohm; similar to Panasonic ERJ2GEJ561X
R380	330k ohm; similar to Panasonic ERJ2GEJ334X
R382	2.7 ohm; similar to Panasonic ERJ2GEJ2R7X
R384	10k ohm; similar to Panasonic ERJ2GEJ103X
R385	0 ohm; similar to Panasonic ERJ2GE0R00X
R386	2.7k ohm; similar to Panasonic ERJ2GEJ272X
R387	4.7k ohm; similar to Panasonic ERJ2GEJ472X
R388	0 ohm; similar to Panasonic ERJ2GE0R00X
R389	1k ohm; similar to Panasonic ERJ6GEYJ102V
R390	1k ohm; similar to Panasonic ERJ6GEYJ102V
R391	10k ohm; similar to Panasonic ERJ6GEYJ103V
R401	2.7k ohm; similar to Panasonic ERJ2GEJ272X
R402	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R403	270 ohm; similar to Panasonic ERJ2GEJ271X
R404	68k ohm; similar to Panasonic ERJ2GEJ683X
R405	68k ohm; similar to Panasonic ERJ2GEJ683X
R406	820k ohm; similar to Panasonic ERJ2GEJ824X
R407	82k ohm; similar to Panasonic ERJ2GEJ823X
R410	680 ohm; similar to Panasonic ERJ2GEJ681X
R411	18 ohm; similar to Panasonic ERJ2GEJ180X
R412	18 ohm; similar to Panasonic ERJ2GEJ180X
R413	18 ohm; similar to Panasonic ERJ2GEJ180X
R416	0 ohm; similar to Panasonic ERJ2GE0R00X
R418	2.7k ohm; similar to Panasonic ERJ2GEJ272X
R419	10k ohm; similar to Panasonic ERJ2RKF103X
R420	10k ohm; similar to Panasonic ERJ2RKF103X
R421	1.8k ohm; similar to Panasonic ERJ2GEJ182X
R422	1.5k ohm; similar to Panasonic ERJ2GEJ152X
R423	330 ohm; similar to Panasonic ERJ2GEJ331X
R424	2.2k ohm; similar to Panasonic ERJ2RKF222X
R425	2.7k ohm; similar to Panasonic ERJ2RKF272X
R426	18k ohm; similar to Panasonic ERJ2RKF183X
R427	3.3k ohm; similar to Panasonic ERJ2RKF332X
R428	56k ohm; similar to Panasonic ERJ2RKF563X
R429	10k ohm; similar to Panasonic ERJ2RKF103X
R430	10k ohm; similar to Panasonic ERJ2RKF103X
R431	1.8k ohm; similar to Panasonic ERJ2GEJ182X
R432	3.3k ohm; similar to Panasonic ERJ2GEJ332X

SYMBOL	DESCRIPTION
R433	270 ohm; similar to Panasonic ERJ3GEYJ271V
R434	10k ohm; similar to Panasonic ERJ2GEJ103X
R435	2.2k ohm; similar to Panasonic ERJ2RKF222X
R436	2.7k ohm; similar to Panasonic ERJ2RKF272X
R437	18k ohm; similar to Panasonic ERJ2RKF183X
R438	10k ohm; similar to Panasonic ERJ2RKF103X
R439	10k ohm; similar to Panasonic ERJ2RKF103X
R440	2.7k ohm; similar to Panasonic ERJ2GEJ272X
R441	3.3k ohm; similar to Panasonic ERJ2GEJ332X
R442	180 ohm; similar to Panasonic ERJ6GEYJ181V
R443	18 ohm; similar to Panasonic ERJ2GEJ180X
R444	18 ohm; similar to Panasonic ERJ2GEJ180X
R445	18 ohm; similar to Panasonic ERJ2GEJ180X
R447	18 ohm; similar to Panasonic ERJ2GEJ180X
R448	3.3k ohm; similar to Panasonic ERJ2RKF332X
R456	39k ohm; similar to Panasonic ERJ2GEJ393X
R457	1k ohm; similar to Panasonic ERJ6GEYJ102V
R458	1k ohm; similar to Panasonic ERJ6GEYJ102V
R459	10k ohm; similar to Panasonic ERJ6GEYJ103V
R461	10k ohm; similar to Panasonic ERJ2RKF103X
R462	10k ohm; similar to Panasonic ERJ2RKF103X
R463	2.2k ohm; similar to Panasonic ERJ2RKF222X
R464	2.7k ohm; similar to Panasonic ERJ2RKF272X
R465	18k ohm; similar to Panasonic ERJ2RKF183X
R466	3.3k ohm; similar to Panasonic ERJ2RKF332X
R467	56k ohm; similar to Panasonic ERJ2RKF563X
R468	10k ohm; similar to Panasonic ERJ2RKF103X
R469	10k ohm; similar to Panasonic ERJ2RKF103X
R470	10k ohm; similar to Panasonic ERJ2GEJ103X
R471	2.2k ohm; similar to Panasonic ERJ2RKF222X
R472	2.7k ohm; similar to Panasonic ERJ2RKF272X
R473	18k ohm; similar to Panasonic ERJ2RKF183X
R474	10k ohm; similar to Panasonic ERJ2RKF103X
R475	10k ohm; similar to Panasonic ERJ2RKF103X
R476	3.3k ohm; similar to Panasonic ERJ2RKF332X
R477	10k ohm; similar to Panasonic ERJ2GEJ103X
R479	1.2k ohm; similar to Panasonic ERJ2RKF122X
R480	1.2k ohm; similar to Panasonic ERJ2RKF122X
R481	1.2k ohm; similar to Panasonic ERJ2RKF122X
R482	1.2k ohm; similar to Panasonic ERJ2RKF122X
R483	330 ohm; similar to Panasonic ERJ2GEJ331X

SYMBOL	DESCRIPTION
R484	270 ohm; similar to Panasonic ERJ3GEYJ271V
R501	18 ohm; similar to Panasonic ERJ2GEJ180X
R502	18 ohm; similar to Panasonic ERJ2GEJ180X
R504	270 ohm; similar to Panasonic ERJ2GEJ271X
R505	18 ohm; similar to Panasonic ERJ2GEJ180X
R506	270 ohm; similar to Panasonic ERJ2GEJ271X
R507	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R508	120 ohm; similar to Panasonic ERJ2GEJ121X
R509	1k ohm; similar to Panasonic ERJ2GEJ102X
R510	820 ohm; similar to Panasonic ERJ2GEJ821X
R512	33k ohm; similar to Panasonic ERJ2GEJ333X
R513	330 ohm; similar to Panasonic ERJ12YJ331U
R514	47 ohm; similar to Panasonic ERJ2GEJ470X
R515	150k ohm; similar to Panasonic ERJ2GEJ154X
R516	8.2k ohm; similar to Panasonic ERJ2GEJ822X
R517	1k ohm; similar to Panasonic ERJ2GEJ102X
R518	0 ohm; similar to Panasonic ERJ2GE0R00X
R519	470 ohm; similar to Panasonic ERJ2GEJ471X
R520	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R521	1M ohm; similar to Panasonic ERJ2GEJ105X
R522	2.2k ohm; similar to Panasonic ERJ2GEJ222X
R523	0 ohm; similar to Panasonic ERJ2GE0R00X
R524	180 ohm; similar to Panasonic ERJ2GEJ181X
R525	18k ohm; similar to Panasonic ERJ2GEJ183X
R530	47 ohm; similar to Panasonic ERJ2GEJ470X
R531	0 ohm; similar to Panasonic ERJ2GE0R00X
R533	33k ohm; similar to Panasonic ERJ2GEJ333X
R534	0 ohm; similar to Panasonic ERJ2GE0R00X
R535	270 ohm; similar to Panasonic ERJ6GEYJ271V
R536	33k ohm; similar to Panasonic ERJ2GEJ333X
R538	0 ohm; similar to Panasonic ERJ2GE0R00X
R540	220 ohm; similar to Panasonic ERJ2GEJ221X
R541	47 ohm; similar to Panasonic ERJ2GEJ470X
R542	22 ohm; similar to Panasonic ERJ2GEJ220X
R543	220 ohm; similar to Panasonic ERJ2GEJ221X
R544	1.2k ohm; similar to Panasonic ERJ2GEJ122X
R545	120k ohm; similar to Panasonic ERJ2GEJ124X
R546	150 ohm; similar to Panasonic ERJ2GEJ151X
R547	39 ohm; similar to Panasonic ERJ2GEJ390X
R548	150 ohm; similar to Panasonic ERJ2GEJ151X
R549	0 ohm; similar to Panasonic ERJ2GE0R00X

SYMBOL	DESCRIPTION
R552	47k ohm; similar to Panasonic ERJ2GEJ473X
R553	100k ohm; similar to Panasonic ERJ2GEJ104X
R561	2.7k ohm; similar to Panasonic ERJ2GEJ272X
R562	180k ohm; similar to Panasonic ERJ2GEJ184X
R563	1M ohm; similar to Panasonic ERJ2GEJ105X
R564	10k ohm; similar to Panasonic ERJ2GEJ103X
R567	12k ohm; similar to Panasonic ERJ2GEJ123X
R572	1.8k ohm; similar to Panasonic ERJ2GEJ182X
R573	4.7k ohm; similar to Panasonic ERJ2GEJ472X
R580	10k ohm; similar to Panasonic ERJ2GEJ103X
R583	10k ohm; similar to Panasonic ERJ2GEJ103X
R584	10k ohm; similar to Panasonic ERJ2GEJ103X
R585	10k ohm; similar to Panasonic ERJ2GEJ103X
R591	10k ohm; similar to Panasonic ERJ2GEJ103X
R592	10k ohm; similar to Panasonic ERJ2GEJ103X
R593	10k ohm; similar to Panasonic ERJ2GEJ103X
R594	10k ohm; similar to Panasonic ERJ2RKF103X
R595	12k ohm; similar to Panasonic ERJ2RKF123X
R596	10k ohm; similar to Panasonic ERJ2RKF103X
R597	3.9k ohm; similar to Panasonic ERJ2RKF392X
R601	220 ohm; similar to Panasonic ERJ2GEJ221X
R602	220 ohm; similar to Panasonic ERJ2GEJ221X
R603	220 ohm; similar to Panasonic ERJ2GEJ221X
R604	220 ohm; similar to Panasonic ERJ2GEJ221X
R668	330 ohm; similar to Panasonic ERJ14YJ331U
R669	27 ohm; similar to Panasonic ERJ1TYJ270U
R670	27 ohm; similar to Panasonic ERJ1TYJ270U
R701	10k ohm; similar to Panasonic ERJ2GEJ103X
R702	22k ohm; similar to Panasonic ERJ2GEJ223X
R703	22k ohm; similar to Panasonic ERJ2GEJ223X
R704	22k ohm; similar to Panasonic ERJ2GEJ223X
R705	22k ohm; similar to Panasonic ERJ2GEJ223X
R706	22k ohm; similar to Panasonic ERJ2GEJ223X
R708	10k ohm; similar to Panasonic ERJ2GEJ103X
R709	10k ohm; similar to Panasonic ERJ2GEJ103X
R710	10k ohm; similar to Panasonic ERJ2GEJ103X
R712	10k ohm; similar to Panasonic ERJ2GEJ103X
R713	10k ohm; similar to Panasonic ERJ2GEJ103X
R714	27k ohm; similar to Panasonic ERJ2GEJ273X
R718	22k ohm; similar to Panasonic ERJ2GEJ223X
R719	22k ohm; similar to Panasonic ERJ2GEJ223X

SYMBOL	DESCRIPTION
R720	22k ohm; similar to Panasonic ERJ2GEJ223X
R721	22k ohm; similar to Panasonic ERJ2GEJ223X
R722	22k ohm; similar to Panasonic ERJ2GEJ223X
R723	22k ohm; similar to Panasonic ERJ2GEJ223X
R724	22k ohm; similar to Panasonic ERJ2GEJ223X
R725	33 ohm; similar to Panasonic ERJ2GEJ330X
R726	33 ohm; similar to Panasonic ERJ2GEJ330X
R727	10k ohm; similar to Panasonic ERJ2GEJ103X
R728	10k ohm; similar to Panasonic ERJ2GEJ103X
R729	10k ohm; similar to Panasonic ERJ2GEJ103X
R730	0 ohm; similar to Panasonic ERJ2GE0R00X
R731	0 ohm; similar to Panasonic ERJ2GE0R00X
R732	0 ohm; similar to Panasonic ERJ2GE0R00X
R733	0 ohm; similar to Panasonic ERJ2GE0R00X
R734	27k ohm; similar to Panasonic ERJ2GEJ273X
R735	47k ohm; similar to Panasonic ERJ2GEJ473X
R736	0 ohm; similar to Panasonic ERJ2GE0R00X
R737	22k ohm; similar to Panasonic ERJ2GEJ223X
R739	22k ohm; similar to Panasonic ERJ2GEJ223X
R745	10k ohm; similar to Panasonic ERJ2GEJ103X
R746	10k ohm; similar to Panasonic ERJ2GEJ103X
R747	10k ohm; similar to Panasonic ERJ2GEJ103X
R748	10k ohm; similar to Panasonic ERJ2GEJ103X
R749	10k ohm; similar to Panasonic ERJ2GEJ103X
R751	2.2 ohm; similar to Panasonic ERJ8GEYJ2R2V
R752	51k ohm; similar to Panasonic ERJ2RKF513X
R753	47k ohm; similar to Panasonic ERJ2RKF473X
R754	51k ohm; similar to Panasonic ERJ2RKF513X
R755	27k ohm; similar to Susumu RR0510R-273-D
R756	51k ohm; similar to Panasonic ERJ2RKF513X
R757	10k ohm; similar to Panasonic ERJ2RKF103X
R758	51k ohm; similar to Panasonic ERJ2RKF513X
R759	10k ohm; similar to Panasonic ERJ2RKF103X
R760	200k ohm; similar to Panasonic ERJ2RKF204X
R761	27k ohm; similar to Susumu RR0510R-273-D
R762	22k ohm; similar to Panasonic ERJ2GEJ223X
R764	39 ohm; similar to Panasonic ERJ1TYJ390U
R765	39 ohm; similar to Panasonic ERJ1TYJ390U
R766	47k ohm; similar to Panasonic ERJ2GEJ473X
R767	12k ohm; similar to Panasonic ERJ2GEJ123X
R1117	100 ohm; similar to Panasonic ERJ2GEJ101X

SYMBOL	DESCRIPTION
R1127	27 ohm; similar to Panasonic ERJ2GEJ270X
R1176	330 ohm; similar to Panasonic ERJ3GEJ331V
R1301	100 ohm; similar to Panasonic ERJ2GEJ101X
R1302	68 ohm; similar to Panasonic ERJ2GEJ680X
R1303	390 ohm; similar to Panasonic ERJ2GEJ391X
R1304	680 ohm; similar to Panasonic ERJ2GEJ681X
R1311	390 ohm; similar to Panasonic ERJ2GEJ391X
R1312	680 ohm; similar to Panasonic ERJ2GEJ681X
R1409	18k ohm; similar to Panasonic ERJ2GEJ183X
R1410	18k ohm; similar to Panasonic ERJ2GEJ183X
R1608	150 ohm; similar to Panasonic ERJ2GEJ151X
R1609	39 ohm; similar to Panasonic ERJ2GEJ390X
R1610	150 ohm; similar to Panasonic ERJ2GEJ151X
R1611	18k ohm; similar to Panasonic ERJ2GEJ183X
RT101	Thermistor, 2.2k ohm; similar to Murata PTFM04BD222Q2N34B0
----- TRANSFORMER -----	
T601	Similar to Toko 617DB-1675=P3
-----INTEGRATED CIRCUITS-----	
IC141	RF PA Module; Similar to Mitsubishi RA45H7687M1A-121
IC181	Similar to NJRC NJG1533KB2(TE1)
IC201	Similar to NJRC NJG1533KB2(TE1)
IC202	Similar to NJRC NJG1533KB2(TE1)
IC261	Similar to Toshiba TC74HC4053AFT-EL
IC301	Similar to Analog Devices AD9864BCPZRL
IC303	Similar to NJRC NJM2125F-TE1
IC304	Similar to NEC UPC3224TB-E3-A
IC401	Similar to Analog Devices ADL5385ACPZ-WP
IC402	Similar to NJRC NJM2746RB1(TE1)
IC403	Similar to NJRC NJM2746RB1(TE1)
IC404	Similar to NJRC NJM2746RB1(TE1)
IC408	Similar to Analog Devices AD5304ARMZ
IC501	Similar to National Semiconductor LMX2364SLEX/NOPB
IC503	Similar to NJRC NJM2125F-TE1
IC504	Similar to NJRC NJM3404AM(TE1)
IC505	Similar to NJRC NJM2125F-TE1
IC506	Similar to AKM Semiconductor AK4386VT-E2
IC507	Similar to Toshiba TC74HC4040AF(EL_F)
IC508	Similar to Toshiba TC7W74FU(TE12L_F)
IC509	Similar to Toshiba TC7W74FU(TE12L_F)

SYMBOL	DESCRIPTION
IC510	Similar to Cypress H-7DLPD0023B
IC511	Similar to NJRC NJM2125F-TE1
IC512	Similar to Texas Instruments TS3A5018PW
IC602	Similar to NJRC NJG1533KB2(TE1)
IC603	Similar to NJRC NJG1533KB2(TE1)
IC604	Similar to NJRC NJG1533KB2(TE1)
IC605	Similar to NJRC NJG1533KB2(TE1)
IC606	Similar to NJRC NJG1533KB2(TE1)
IC607	Similar to NJRC NJG1533KB2(TE1)
IC665	Similar to ROHM BA09FP-E2
IC666	Similar to Toko TK11250CMCL-G
IC669	Similar to NJRC NJM7805DL1A-TE1
IC670	Similar to Toko TK11233CUCB-G
IC671	Similar to ROHM BA09FP-E2
IC672	Similar to NJRC NJM78L05UA(TE1)
IC673	Similar to RICOH R1114D301B-TR-F
IC674	Similar to NJRC NJM7805DL1A-TE1
IC675	Similar to ROHM BA09FP-E2
IC676	Similar to NJRC NJM7805DL1A-TE1
IC701	Similar to Silicon Lab H-7DLPD0029
IC703	Similar to NJRC NJM2125F-TE1
IC704	Similar to Toshiba TC7W34FU(TE12L_F)
IC705	Similar to Toshiba TC7S04FU(TE85L_F)
IC706	Similar to NJRC NJM2741F3(TE1)
IC1501	Similar to Toshiba TC7WH157FU(TE12L_F)
----- OSCILLATOR -----	
X501	Oscillator; Similar to NDK H-7XNPD0004
-----SURGE ABSORBERS-----	
Z701	Surge Absorber; similar to Panasonic ERZCF2MK220
Z780	Surge Absorber; similar to KOA NV73A2ATTE22
----- MISCELLANEOUS -----	
W101	Jumper; similar to Y.C.E H-7ZCPD0269

**16.2.3 Frame Unit**

DD00-CWB-1403NY

SYMBOL	DESCRIPTION
C1 and C2	Capacitor, Feed-Thru: 1000 pF, with nut and spacer. (For ordering information, see Section 16.1 on page 124.)
J2	Connector, RF TNC Female. (For ordering information, see Section 16.1 on page 124.)
W1	Cable Assembly, DC Power. (For ordering information, see Section 16.1 on page 124.)

SYMBOL	DESCRIPTION
W2	Cable Assembly, 44-Pin Accessory. (For ordering information, see Section 16.1 on page 124.)
W3	Cable Assembly, 9-Pin Serial. (For ordering information, see Section 16.1 on page 124.)
W4	Cable Assembly, 3-Pin CAN. (For ordering information, see Section 16.1 on page 124.)

## 17. PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a “Revision Letter” which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for the descriptions of parts affected by these revisions.

Rev. - **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

Rev. - **PK Board (CMC-1294E)**

Rev. - **RF Processor Board (CMN-709)**

Initial release

Rev. A **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

Changed CAN connectors W4-1 and W4-2 from Conxall 17282-3SG-300 to Conxall M9037R.

Rev. B **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

Rev. A **RF Processor Board (CMN-709)**

Changed the following components on the radio’s RF Processor Board: C442 from 3300 pF to 2200 pF, C444 from 390 pF to 220 pF, C445 from 20 pF to 560 pF, C448 from 3300 pF to 2200 pF, C449 from 390 pF to 220 pF, C467 from 820 pF to 560 pF, C477 from 3300 pF to 2200 pF, C478 from 390 pF to 220 pF, C479 from 820 pF to 560 pF, C485 from 3300 pF to 2200 pF, C486 from 390 pF to 220 pF, C487 from 820 pF to 560 pF, R424 from 4.7 kΩ to 2.2 kΩ, R425 from 4.7 kΩ to 2.7 kΩ, R426 from 18 kΩ to 18 kΩ, R435 from 4.7 kΩ to 2.2 kΩ, R436 from 4.7 kΩ to 2.7 kΩ, R437 from 18 kΩ to 18 kΩ, R463 from 4.7 kΩ to 2.2 kΩ, R464 from 4.7 kΩ to 2.7 kΩ, R465 from 18 kΩ to 18 kΩ, R471 from 4.7 kΩ to 2.2 kΩ, R472 from 4.7 kΩ to 2.7 kΩ, and R473 from 18 kΩ to 18 kΩ.

Rev. C **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

Rev. A **PK Board (CMC-1294E)**

Changed the following components on the radio’s PK Board: R954 from 2.2 kΩ to 47 kΩ, R955 from 82 kΩ to 100 kΩ, R958 from 3.3 kΩ to 470 kΩ, C858 and C860 from 0.1 μF to 1 μF, C859 from 4700 pF to 10 pF, and R991 from 0 Ω (jumper) to 3.3 kΩ. Also, added C885 at 2200 pF. PK Board schematic diagram changed to DD01-CMC-1294E.

Rev. D **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

No radio hardware changes.

Rev. E **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

Rev. B **PK Board (CMC-1294E)**

To improve reliability during vehicle engine starting, changed the following components on the PK Board: Changed 5-volt regulator IC907 from NJU7223DL1-50 to TA58M05, and changed C890 at the regulator’s output from 0.47 μF to 22 μF. See sheet 3 of the PK Board’s schematic diagram. PK Board schematic diagram changed to DD02-CMC-1294E.

Rev. F **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

To improve reliability of CAN connections W4-1 and W4-2, changed connectors from Conxall part number M9037R to Conxall part number M9037R-BR.

Rev. G **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

Rev. C **PK Board (CMC-1294E)**

To address component obsolescence issues, changed X801 from Citizen part number CS20\_12.000.000MABJT to NDK part number NX1255GB-12MHZ-30PPM and changed X803 from Citizen part number CS10\_40.000.000MABJT to Epson/Toyocom part number FA-365-40MHZ-18PF/50PPM-F.

**Rev. H**      **M7300 700/800 MHz and M5300 800 MHz Mobile Radios (RU-144750-061)**

**Rev. D**      **PK Board (CMC-1294E)**

**Rev. B**      **RF Processor Board (CMN-709)**

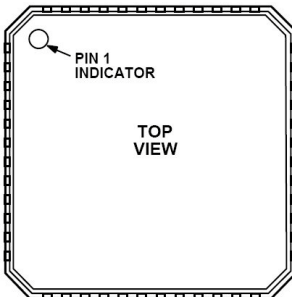
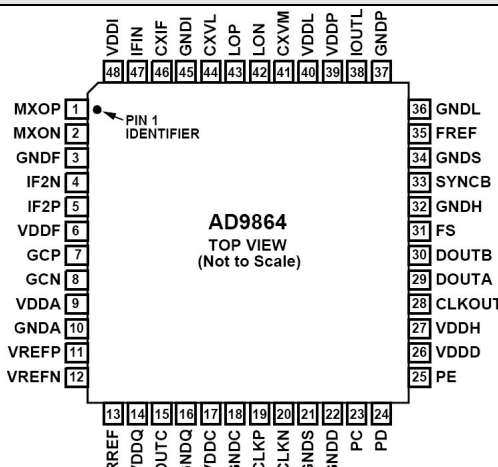
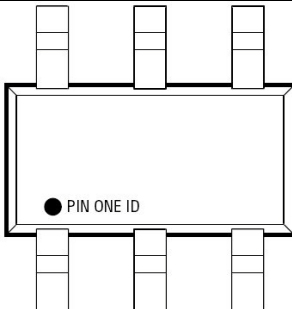
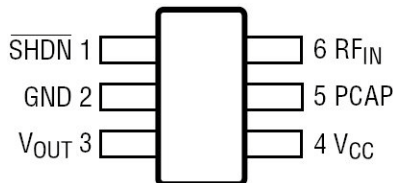

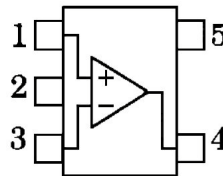
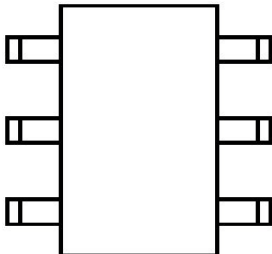
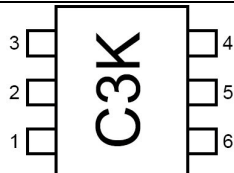
To decrease gain of the PK Board's XTONEENC audio input line (from pin 16 of 44-pin rear connector), on the board at op-amp IC902-2, changed C859 from 10 pF to 47 pF and changed R958 from 470 k $\Omega$  to 100 k $\Omega$ . See sheet 3 of the PK Board's schematic diagram. PK Board schematic diagram changed to DD03-CMC-1294E.

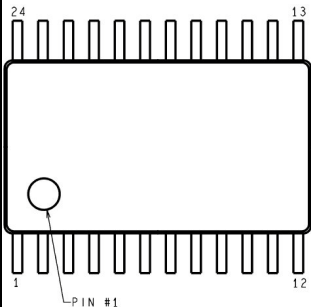
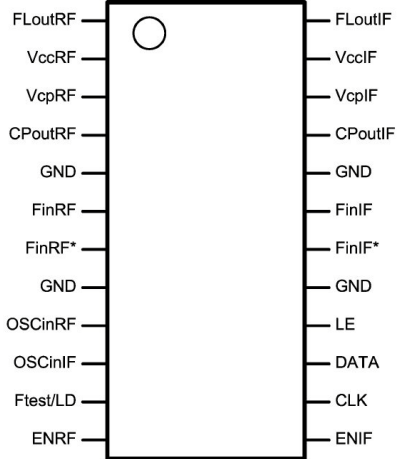
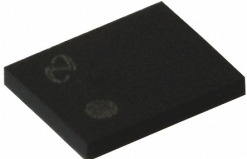
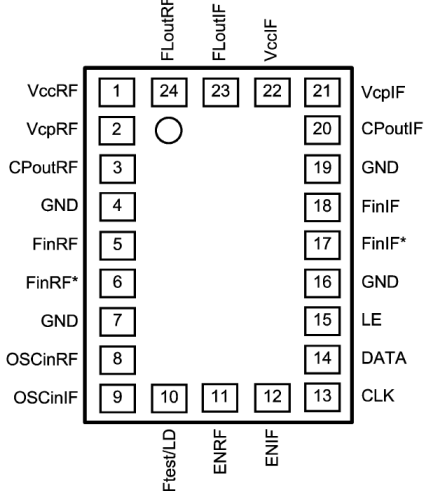

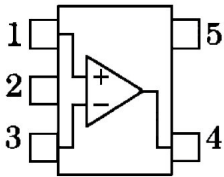

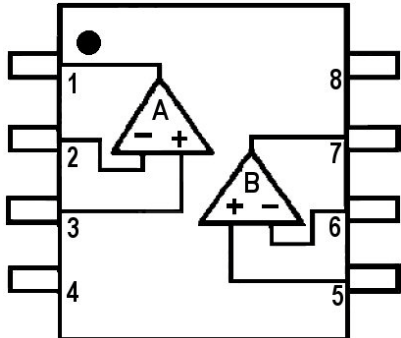
On the RF Processor Board, to address component obsolescence issues and to improve performance on simulcast systems, added, deleted, and changed the following components between 1<sup>st</sup> IF amp filter FL301 and 1<sup>st</sup> IF amp transistor TR312. See sheet 2 of the RF Processor Board's schematic diagram. RF Processor Board schematic diagram changed to DD06-CMN-709Y.

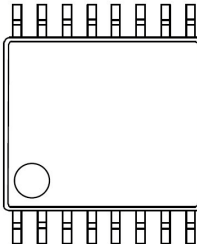
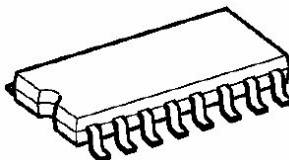
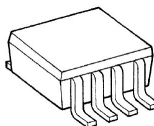
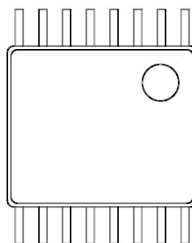
- Added C1301 at 1000 pF, C1302 at 1000 pF, C1309 at 1000 pF, C1310 at 22 pF, C1311 at 1000 pF, C1312 at 22 pF, L1301 at 0.27  $\mu$ H, R362 at 1.8 k $\Omega$ , R367 at 1.8 k $\Omega$ , R1303 at 390  $\Omega$ , R1304 at 680  $\Omega$ , R1311 at 390  $\Omega$ , R1312 at 680  $\Omega$ .
- Deleted R365 and R368.
- Changed C306 from 0.01  $\mu$ F to 18 pF, C307 from 10 pF to 3 pF, C311 from 0.01  $\mu$ F to 15 pF, C313 from 0.01  $\mu$ F to 18 pF, C373 from 22 pF to 0.01  $\mu$ F, L304 from 0.68  $\mu$ H to 0.15  $\mu$ H, L315 from 0.22  $\mu$ H to 0.15  $\mu$ H, L316 from 0.27  $\mu$ H to 0.18  $\mu$ H, L317 from 0.22  $\mu$ H to 0.18  $\mu$ H, R306 from 330 k $\Omega$  to 4.7 k $\Omega$ , R307 from 330  $\Omega$  to 680  $\Omega$ , R309 from 68  $\Omega$  to 100  $\Omega$ , R355 from 330  $\Omega$  to 680  $\Omega$ , R364 from 10  $\Omega$  to 4.7  $\Omega$ , R366 from 0  $\Omega$  to 2.7  $\Omega$ , R372 from 10  $\Omega$  to 4.7  $\Omega$ , R382 from 0  $\Omega$  to 2.7  $\Omega$ , R387 from 330 k $\Omega$  to 4.7 k $\Omega$ , R1301 from 68  $\Omega$  to 100  $\Omega$ , R1302 from 150  $\Omega$  to 68  $\Omega$ , TR302 from 2SC2714 to 2SC3356, TR312 from 2SC2714 to 2SC3356 and IC501 from LMX2364TMX (a 24-Pin TSSOP package) to LMX2364SLEX (an Ultra-Thin 24-Pin CSP package). IC501 is located on the secondary side of the board, near 40-pin board-to-board connector J701 and Micro Controller Unit (MCU) IC701.
- Changed RF Processor Board's print circuit board from 7PCPD0172B to 7PCPD0250A.

## 18. IC DATA

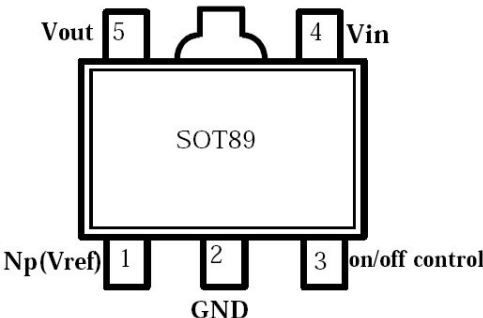
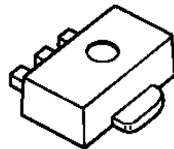
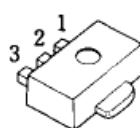
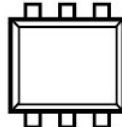
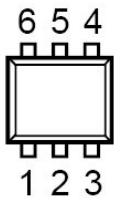

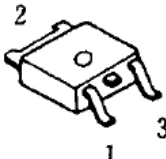
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
	45W 12.8V, 2 Stage Amplifier Similar to MITSUBISHI RA45H8994M1-121	IC141	① RF Input added Gate Voltage 1( $P_{in}$ & $V_{GG1}$ ) ② Gate Voltage 2( $V_{GG2}$ ), Power Control ③ Drain Voltage ( $V_{DD}$ ), Battery ④ RF Output ( $P_{out}$ ) ⑤ RF Ground (Case)
	SPDT Switch GaAs MMIC Similar to JRC NJG1533KB2	IC181, IC201, IC202	Pin connection 1.P1 2.GND 3.P2 4.VCTL2 5.PC 6.VCTL1
	High Linearity GaAs FET Mixer Similar to Avago Tech. IAM-92516-TR1	IC203	
	Analog Mux/Demux Similar to Toshiba TC74HC4053AFT-EL	IC261	1Y 1 0Y 2 1Z 3 Z-COM 4 0Z 5 INH 6 $V_{EE}$ 7 GND 8 16 $V_{CC}$ 15 Y-COM 14 X-COM 13 1X 12 0X 11 A 10 B 9 C

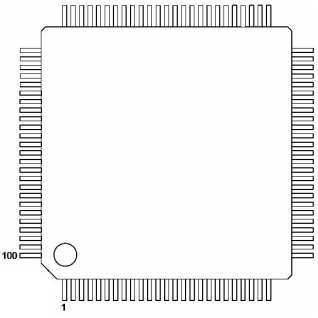

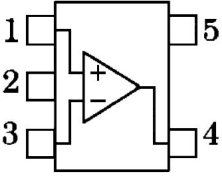
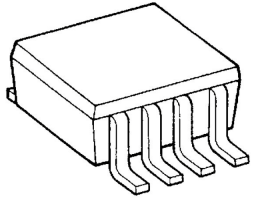
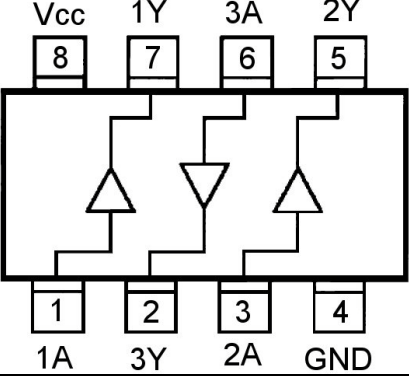
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT														
	IF Digitizing Subsystem Similar to Analog Devices AD9864BCPZRL	IC301															
	100kHz to 1GHz RF Power Detector Similar to Linear Technology LTC5507ES6	IC302															
	Single-Supply Operational Amplifier Similar to JRC NJM2125F-TE1	IC303	 <p><b>PIN FUNCTION</b></p> <p>1.+INPUT 2.GND 3.-INPUT 4.OUTPUT 5.V<sup>+</sup></p>														
	5V,MMIC WIDEBAND AMPLIFIER Similar to NEC UPC3224TB-E3-A	IC304	 <table><thead><tr><th>Pin No.</th><th>Pin Name</th></tr></thead><tbody><tr><td>1</td><td>INPUT</td></tr><tr><td>2</td><td>GND</td></tr><tr><td>3</td><td>GND</td></tr><tr><td>4</td><td>OUTPUT</td></tr><tr><td>5</td><td>GND</td></tr><tr><td>6</td><td>V<sub>CC</sub></td></tr></tbody></table>	Pin No.	Pin Name	1	INPUT	2	GND	3	GND	4	OUTPUT	5	GND	6	V <sub>CC</sub>
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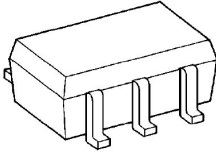
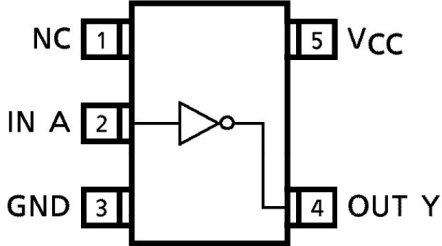
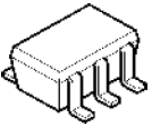
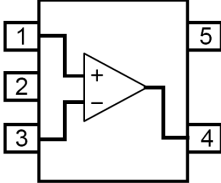
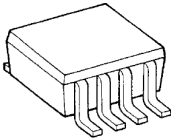
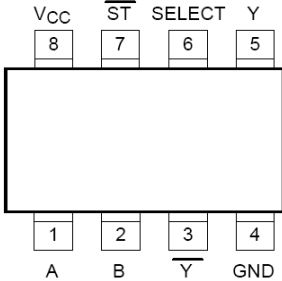
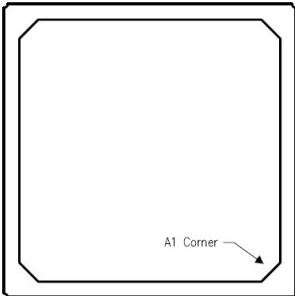
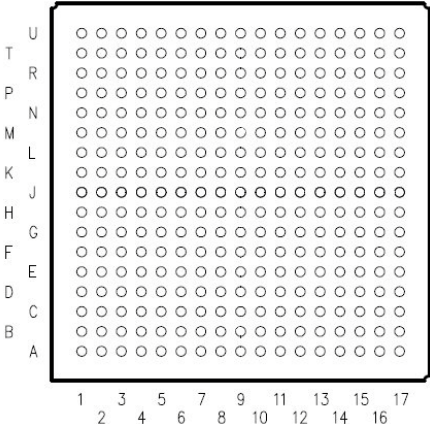
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
	2.6 GHz Fractional RF Frequency Synthesizer Similar to National Semiconductor LMX2364TMX	IC501 (RF Processor Board CMN-709Y Rev. A and earlier)	
 (Top View)	2.6 GHz Fractional RF Frequency Synthesizer Similar to National Semiconductor LMX2364SLEX	IC501 (RF Processor Board CMN-709Y Rev. B and later)	
	Single-Supply Operational Amplifier Similar to JRC NJM2125F-TE1	IC503, IC505, & IC511	 <b>PIN FUNCTION</b> 1.+INPUT 2.GND 3.-INPUT 4.OUTPUT 5.V <sup>+</sup>
	Single-Supply Dual Operational Amplifier Similar to JRC NJM3404AM	IC504	

BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT																																																																				
	DAC Similar to AKM AK4386VT-E2	IC506	<div><div><div>MCLK</div><div>BICK</div><div>SDTI</div><div>LRCK</div><div>PDN</div><div>DFS0</div><div>DFS1</div><div>DEM</div></div><div><div>1</div><div>2</div><div>3</div><div>4</div><div>5</div><div>6</div><div>7</div><div>8</div></div><div>Top View</div><div><div>16</div><div>15</div><div>14</div><div>13</div><div>12</div><div>11</div><div>10</div><div>9</div></div><div><div>TEST</div><div>DIF1</div><div>VDD</div><div>VSS</div><div>VCOM</div><div>LOUT</div><div>ROUT</div><div>DIF0</div></div></div>																																																																				
		<table><tr><th>No.</th><th>Pin Name</th><th>I/O</th><th>Function</th></tr><tr><td>1</td><td>MCLK</td><td>I</td><td>Master Clock Input Pin</td></tr><tr><td>2</td><td>BICK</td><td>I</td><td>Audio Serial Data Clock Pin</td></tr><tr><td>3</td><td>SDTI</td><td>I</td><td>Audio Serial Data Input Pin</td></tr><tr><td>4</td><td>LRCK</td><td>I</td><td>Input Channel Clock Pin</td></tr><tr><td>5</td><td>PDN</td><td>I</td><td>Full Power Down Mode Pin “L” : Power down, “H” : Power up</td></tr><tr><td>6</td><td>DFS0</td><td>I</td><td>Sampling Speed Select 0 Pin</td></tr><tr><td>7</td><td>DFS1</td><td>I</td><td>Sampling Speed Select 1 Pin</td></tr><tr><td>8</td><td>DEM</td><td>I</td><td>De-emphasis Filter Enable Pin “L” : OFF, “H” : ON (De-emphasis of fs=44.1kHz is enable.)</td></tr><tr><td>9</td><td>DIF0</td><td>I</td><td>Audio Interface Format 0 Pin</td></tr><tr><td>10</td><td>ROUT</td><td>O</td><td>Rch Analog Output Pin</td></tr><tr><td>11</td><td>LOUT</td><td>O</td><td>Lch Analog Output Pin</td></tr><tr><td>12</td><td>VCOM</td><td>O</td><td>Common Voltage Output Pin, 0.55 × VDD Normally connected to VSS with a 4.7μF (min. 1μF, max. 10μF) electrolytic capacitor.</td></tr><tr><td>13</td><td>VSS</td><td>-</td><td>Ground Pin</td></tr><tr><td>14</td><td>VDD</td><td>-</td><td>Power Supply Pin, 2.2 ~ 3.6V</td></tr><tr><td>15</td><td>DIF1</td><td>I</td><td>Audio Interface Format 1 Pin</td></tr><tr><td>16</td><td>TEST</td><td>I</td><td>TEST Pin This pin should be connected to VDD.</td></tr></table>	No.	Pin Name	I/O	Function	1	MCLK	I	Master Clock Input Pin	2	BICK	I	Audio Serial Data Clock Pin	3	SDTI	I	Audio Serial Data Input Pin	4	LRCK	I	Input Channel Clock Pin	5	PDN	I	Full Power Down Mode Pin “L” : Power down, “H” : Power up	6	DFS0	I	Sampling Speed Select 0 Pin	7	DFS1	I	Sampling Speed Select 1 Pin	8	DEM	I	De-emphasis Filter Enable Pin “L” : OFF, “H” : ON (De-emphasis of fs=44.1kHz is enable.)	9	DIF0	I	Audio Interface Format 0 Pin	10	ROUT	O	Rch Analog Output Pin	11	LOUT	O	Lch Analog Output Pin	12	VCOM	O	Common Voltage Output Pin, 0.55 × VDD Normally connected to VSS with a 4.7μF (min. 1μF, max. 10μF) electrolytic capacitor.	13	VSS	-	Ground Pin	14	VDD	-	Power Supply Pin, 2.2 ~ 3.6V	15	DIF1	I	Audio Interface Format 1 Pin	16	TEST	I	TEST Pin This pin should be connected to VDD.	
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	12-Stage Binary Counter Similar to Toshiba TC74HC4040AF	IC507	<div><div><div>Q12</div><div>Q6</div><div>Q5</div><div>Q7</div><div>Q4</div><div>Q3</div><div>Q2</div><div>GND</div></div><div><div>1</div><div>2</div><div>3</div><div>4</div><div>5</div><div>6</div><div>7</div><div>8</div></div><div><div>16</div><div>15</div><div>14</div><div>13</div><div>12</div><div>11</div><div>10</div><div>9</div></div><div><div>V<sub>CC</sub></div><div>Q11</div><div>Q10</div><div>Q8</div><div>Q9</div><div>CLR</div><div>CK</div><div>Q1</div></div></div>																																																																				
	D-Type Flip-Flop Similar to Toshiba TC7W74FU	IC508 & IC509	<div><div><div>CK</div><div>D</div><div>Q</div><div>GND</div></div><div><div>1</div><div>2</div><div>3</div><div>4</div></div><div><div>8</div><div>7</div><div>6</div><div>5</div></div><div><div>V<sub>CC</sub></div><div>PR</div><div>CLR</div><div>Q</div></div></div>																																																																				
	One-PLL Flash Programmable Clock Generator Similar to Cypress CY22050FZXI	IC510	<div><div><div>XIN</div><div>VDD</div><div>AVDD</div><div>PWRDWN</div><div>AVSS</div><div>VSSL</div><div>LCLK1</div><div>LCLK2</div></div><div><div>1</div><div>2</div><div>3</div><div>4</div><div>5</div><div>6</div><div>7</div><div>8</div></div><div><div>16</div><div>15</div><div>14</div><div>13</div><div>12</div><div>11</div><div>10</div><div>9</div></div><div><div>XOUT</div><div>CLK6</div><div>CLK5</div><div>VSS</div><div>LCLK4</div><div>VDDL</div><div>OE</div><div>LCLK3</div></div></div>																																																																				

BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
	Single-Supply Operational Amplifier Similar to JRC NJM2125F-TE1	IC511	<p><b>PIN FUNCTION</b></p> <p>1.+INPUT</p> <p>2.GND</p> <p>3.-INPUT</p> <p>4.OUTPUT</p> <p>5.V<sup>+</sup></p>
Base diagram not available.	Very High Linearity Active Mixer Similar to Linear Technology LT5521EUF	IC601	
	SPDT Switch GaAs MMIC Similar to JRC NJG1533KB2	IC603 - IC607	<p>Pin connection</p> <p>1.P1</p> <p>2.GND</p> <p>3.P2</p> <p>4.VCTL2</p> <p>5.PC</p> <p>6.VCTL1</p>
	3-pin Voltage Regulator Similar to ROHM BA09FP-E2	IC665, IC671, & IC675	<p>1. Vcc</p> <p>2. GND</p> <p>3. OUT</p>
	Voltage Regulator with On/Off Switch Similar to Toko TK11250CMCL-G	IC666	
	Voltage Regulator Similar to JRC NJM7805DL1A-TE1	IC669	<p>1. IN</p> <p>2. GND</p> <p>3. OUT</p>

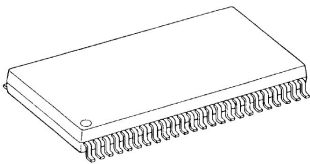
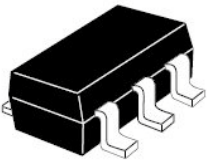
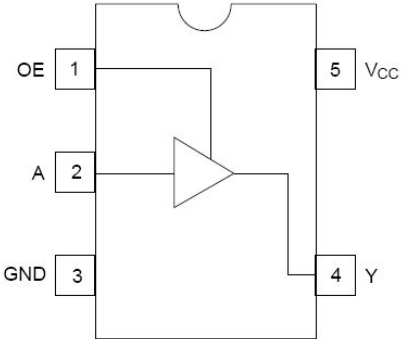
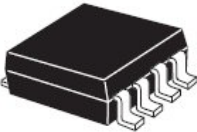
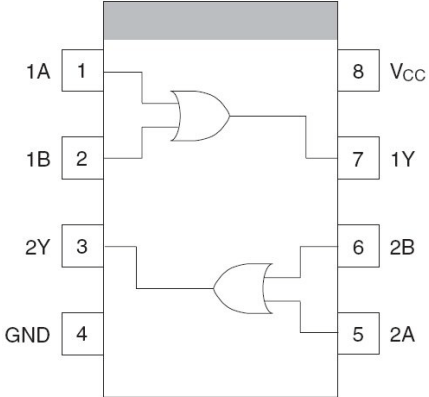
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT																					
Base diagram not available	LDO Regulator with On/Off switch Similar to Toko TK11233CUCB-G	IC670	<div></div>																					
	3-Terminal Positive Voltage Regulator Similar to JRC NJM78L05UA-TE1	IC672	<div><div>1.OUT 2.GND 3.IN</div></div>																					
	Low Noise 150 mA LDO Regulator Similar to Ricoh R1114D301B-TR-F	IC673	<div><table><tr><th>Pin No.</th><th>Symbol</th><th>Description</th></tr><tr><td>1</td><td>V<sub>DD</sub></td><td>Input Pin</td></tr><tr><td>2</td><td>GND</td><td>Ground Pin</td></tr><tr><td>3</td><td>V<sub>OUT</sub></td><td>Output pin</td></tr><tr><td>4</td><td>NC</td><td>No Connection</td></tr><tr><td>5</td><td>GND</td><td>Ground Pin</td></tr><tr><td>6</td><td><math>\overline{\text{CE}}</math> or CE</td><td>Chip Enable Pin</td></tr></table></div>	Pin No.	Symbol	Description	1	V <sub>DD</sub>	Input Pin	2	GND	Ground Pin	3	V <sub>OUT</sub>	Output pin	4	NC	No Connection	5	GND	Ground Pin	6	$\overline{\text{CE}}$ or CE	Chip Enable Pin
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	Voltage Regulator Similar to JRC NJM7805DL1A-TE1	IC674	<div><div>1. IN 2. GND 3. OUT</div></div>																					

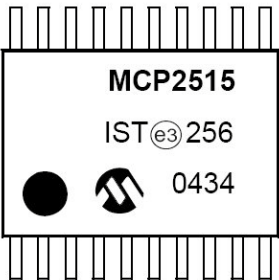

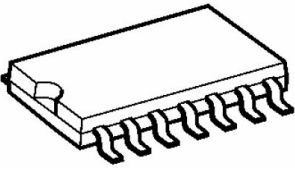
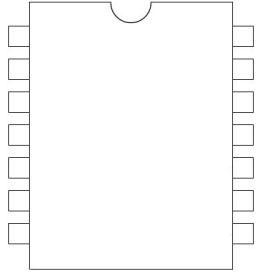
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
	8K ISP FLASH MCU Similar to Silicon Laboratories C8051F022-GQ	IC701	<div><div><div>100 DAC0</div><div>99 DAC1</div><div>98 P4.0</div><div>97 P4.1</div><div>96 P4.2</div><div>95 P4.3</div><div>94 P4.4</div><div>93 ALE/P4.5</div><div>92 /RD/P4.6</div><div>91 /WR/P4.7</div><div>90 VDD</div><div>89 DGND</div><div>88 A8/P5.0</div><div>87 A9/P5.1</div><div>86 A10/P5.2</div><div>85 A11/P5.3</div><div>84 A12/P5.4</div><div>83 A13/P5.5</div><div>82 A14/P5.6</div><div>81 A15/P5.7</div><div>80 A8mA0/P5.0</div><div>79 A9mA1/P5.1</div><div>78 A10mA2/P5.2</div><div>77 A11mA3/P5.3</div><div>76 A12mA4/P5.4</div></div><div><div>TMS 1</div><div>TCK 2</div><div>TDI 3</div><div>TDO 4</div><div>/RST 5</div><div>CP1+ 6</div><div>CP1+ 7</div><div>CP0+ 8</div><div>CP0+ 9</div><div>AGND 10</div><div>AV+ 11</div><div>VREF 12</div><div>AGND 13</div><div>AV+ 14</div><div>VREFD 15</div><div>VREF0 16</div><div>VREF1 17</div><div>AIN0.0 18</div><div>AIN0.1 19</div><div>AIN0.2 20</div><div>AIN0.3 21</div><div>AIN0.4 22</div><div>AIN0.5 23</div><div>AIN0.6 24</div><div>AIN0.7 25</div></div><div><div>75 A13mA5/P5.5</div><div>74 A14mA6/P5.6</div><div>73 A15mA7/P5.7</div><div>72 AD0/D0/P7.0</div><div>71 AD1/D1/P7.1</div><div>70 AD2/D2/P7.2</div><div>69 AD3/D3/P7.3</div><div>68 AD4/D4/P7.4</div><div>67 AD5/D5/P7.5</div><div>66 AD6/D6/P7.6</div><div>65 AD7/D7/P7.7</div><div>64 VDD</div><div>63 DGND</div><div>62 P0.0</div><div>61 P0.1</div><div>60 P0.2</div><div>59 P0.3</div><div>58 P0.4</div><div>57 ALE/P0.5</div><div>56 /RD/P0.6</div><div>55 /WR/P0.7</div><div>54 AD0/D0/P3.0</div><div>53 AD1/D1/P3.1</div><div>52 AD2/D2/P3.2</div><div>51 AD3/D3/P3.3</div></div><div><div>26 XTAL1</div><div>27 XTAL2</div><div>28 MONEN</div><div>29 AIN1.7/A15P1.7</div><div>30 AIN1.6/A14P1.6</div><div>31 AIN1.5/A13P1.5</div><div>32 AIN1.4/A12P1.4</div><div>33 AIN1.3/A11P1.3</div><div>34 AIN1.2/A10P1.2</div><div>35 AIN1.1/A9P1.1</div><div>36 AIN1.0/A8P1.0</div><div>37 VDD</div><div>38 DGND</div><div>39 A15mA7/P2.7</div><div>40 A14mA6/P2.6</div><div>41 A13mA5/P2.5</div><div>42 A12mA4/P2.4</div><div>43 A11mA3/P2.3</div><div>44 A10mA2/P2.2</div><div>45 A9mA1/P2.1</div><div>46 A8mA0/P2.0</div><div>47 AD7/D7/P3.7/IE7</div><div>48 AD6/D6/P3.6/IE6</div><div>49 AD5/D5/P3.5</div><div>50 AD4/D4/P3.4</div></div></div>
	Single-Supply Operational Amplifier Similar to JRC NJM2125F-TE1	IC703	<div><div><div>1</div><div>2</div><div>3</div><div>4</div><div>5</div></div></div> <div><b>PIN FUNCTION</b> <b>1.+INPUT</b> <b>2.GND</b> <b>3.-INPUT</b> <b>4.OUTPUT</b> <b>5.V<sup>+</sup></b></div>
	CMOS Buffer Similar to Toshiba TC7W34FU	IC704	<div><div><div>Vcc 8</div><div>1Y 7</div><div>3A 6</div><div>2Y 5</div></div></div> <div><div>1A 1</div><div>3Y 2</div><div>2A 3</div><div>GND 4</div></div>

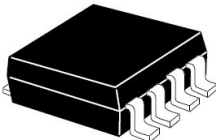
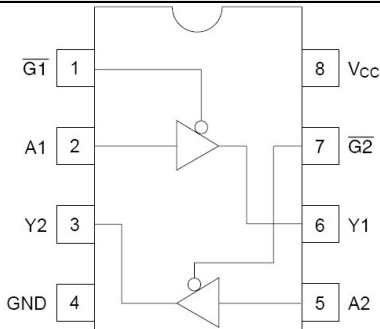
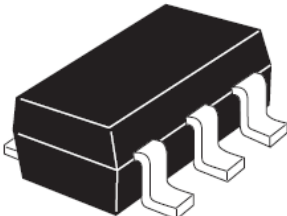
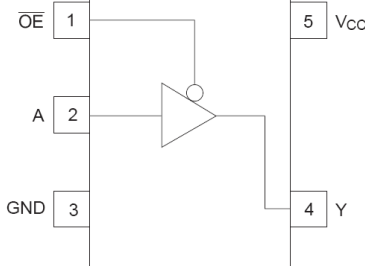
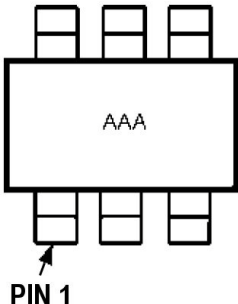
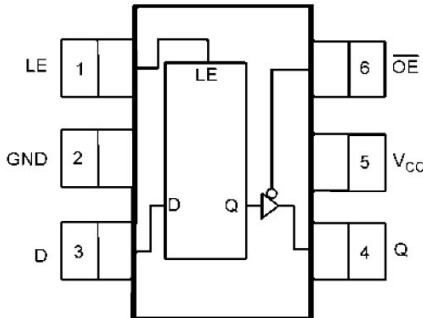
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
	CMOS Inverter Similar to Toshiba TC7S04FU	IC705	
	Low Supply Voltage Operational Amplifier Similar to JRC NJM2741F3(TE1)	IC706	 <p><b>PIN FUNCTION</b></p> <ol style="list-style-type: none"> <li>1. +INPUT</li> <li>2. GND</li> <li>3. -INPUT</li> <li>4. OUTPUT</li> <li>5. <math>V^+</math></li> </ol>
	Similar to Toshiba TC7WH157FU	IC1501	
	Dual-Core Processor Similar to Texas Instruments OMAP5910JZDY2	U801	

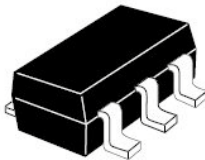
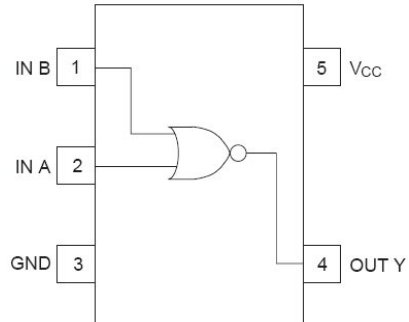
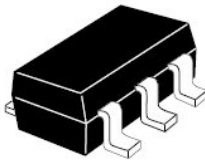
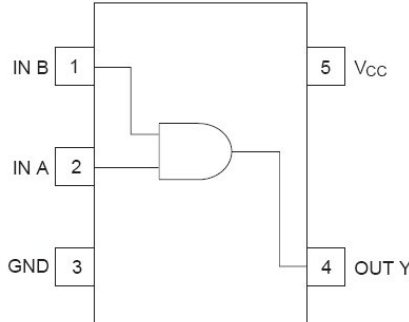
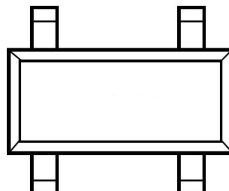
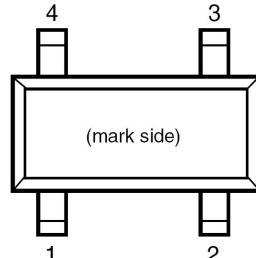
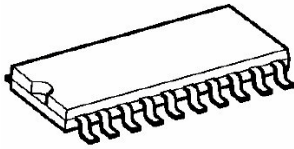
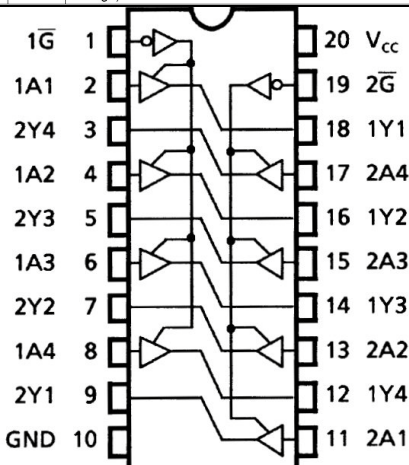
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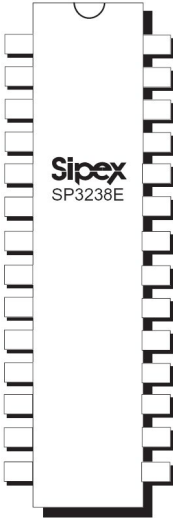
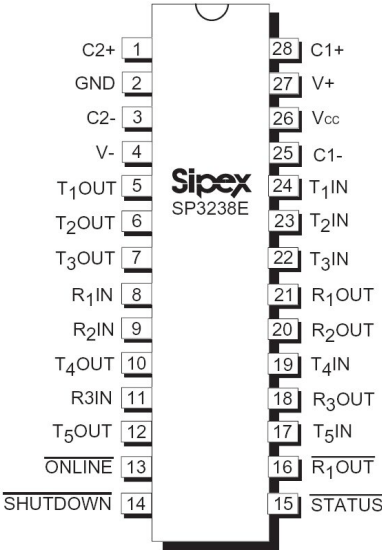
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
Base diagram not available.	16M Static RAM Similar to Cypress CY62167DV18LL- 55BVXIT	IC803	<p>Top View</p> <p>Note: DNU pins are to be connected to V<sub>SS</sub> or left open.</p>
	16-BIT Bus transceiver Similar to Texas Instruments SN74LVCH16652ADGGR	IC804	

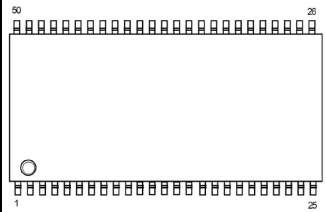
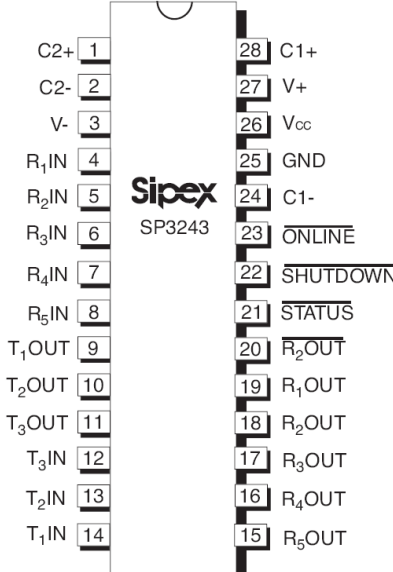
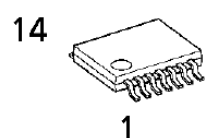
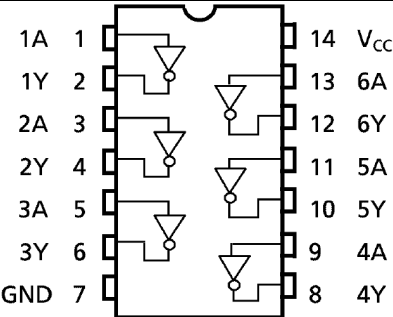
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT																																																																																																
	16-Bit Dual Supply Bus Transceiver Similar to Toshiba TC74VCX164245	IC805	<table><tr><td>1DIR</td><td>1</td><td>48</td><td><math>\overline{\text{IOE}}</math></td></tr><tr><td>1B1</td><td>2</td><td>47</td><td>1A1</td></tr><tr><td>1B2</td><td>3</td><td>46</td><td>1A2</td></tr><tr><td>GND</td><td>4</td><td>45</td><td>GND</td></tr><tr><td>1B3</td><td>5</td><td>44</td><td>1A3</td></tr><tr><td>1B4</td><td>6</td><td>43</td><td>1A4</td></tr><tr><td><math>V_{CCB}</math></td><td>7</td><td>42</td><td><math>V_{CCA}</math></td></tr><tr><td>1B5</td><td>8</td><td>41</td><td>1A5</td></tr><tr><td>1B6</td><td>9</td><td>40</td><td>1A6</td></tr><tr><td>GND</td><td>10</td><td>39</td><td>GND</td></tr><tr><td>1B7</td><td>11</td><td>38</td><td>1A7</td></tr><tr><td>1B8</td><td>12</td><td>37</td><td>1A8</td></tr><tr><td>2B1</td><td>13</td><td>36</td><td>2A1</td></tr><tr><td>2B2</td><td>14</td><td>35</td><td>2A2</td></tr><tr><td>GND</td><td>15</td><td>34</td><td>GND</td></tr><tr><td>2B3</td><td>16</td><td>33</td><td>2A3</td></tr><tr><td>2B4</td><td>17</td><td>32</td><td>2A4</td></tr><tr><td><math>V_{CCB}</math></td><td>18</td><td>31</td><td><math>V_{CCA}</math></td></tr><tr><td>2B5</td><td>19</td><td>30</td><td>2A5</td></tr><tr><td>2B6</td><td>20</td><td>29</td><td>2A6</td></tr><tr><td>GND</td><td>21</td><td>28</td><td>GND</td></tr><tr><td>2B7</td><td>22</td><td>27</td><td>2A7</td></tr><tr><td>2B8</td><td>23</td><td>26</td><td>2A8</td></tr><tr><td>2DIR</td><td>24</td><td>25</td><td><math>2\overline{\text{OE}}</math></td></tr></table>	1DIR	1	48	$\overline{\text{IOE}}$	1B1	2	47	1A1	1B2	3	46	1A2	GND	4	45	GND	1B3	5	44	1A3	1B4	6	43	1A4	$V_{CCB}$	7	42	$V_{CCA}$	1B5	8	41	1A5	1B6	9	40	1A6	GND	10	39	GND	1B7	11	38	1A7	1B8	12	37	1A8	2B1	13	36	2A1	2B2	14	35	2A2	GND	15	34	GND	2B3	16	33	2A3	2B4	17	32	2A4	$V_{CCB}$	18	31	$V_{CCA}$	2B5	19	30	2A5	2B6	20	29	2A6	GND	21	28	GND	2B7	22	27	2A7	2B8	23	26	2A8	2DIR	24	25	$2\overline{\text{OE}}$
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	Bus Buffer Gate with 3-state Output Similar to Renesas HD74LV1G126ACME-E	IC806																																																																																																	
	Dual 2-input OR Gates Similar to Renesas HD74LV2G32AUSE-E	IC807																																																																																																	

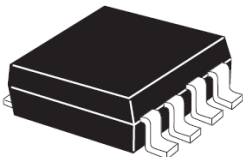
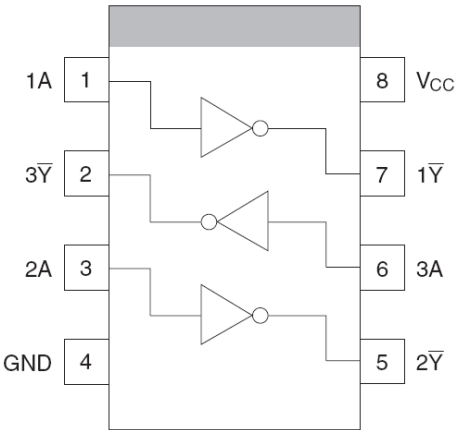
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
	Stand-Alone CAN Controller Similar to Microchip MCP2515T-I/ST	IC808	<div> <div> TXCAN 1  RXCAN 2  CLKOUT/SOF 3  TX0RTS 4  TX1RTS 5  NC 6  TX2RTS 7  OSC2 8  OSC1 9  Vss 10 </div> <div> MCP2515 </div> <div> 20 VDD  19 RESET  18 CS  17 SO  16 SI  15 NC  14 SCK  13 INT  12 RX0BF  11 RX1BF </div> </div>
	CAN Transceiver Similar to Texas Instruments SN65HVD251DR	IC809	<div> D 1  GND 2  Vcc 3  R 4 </div> <div> 8 Rs  7 CANH  6 CANL  5 Vref </div>
	Quad 2-Input OR Gate Similar to Toshiba TC74HCT32AF	IC810	<div> 1A 1  1B 2  1Y 3  2A 4  2B 5  2Y 6  GND 7 </div> <div> 14 Vcc  13 4B  12 4A  11 4Y  10 3B  9 3A  8 3Y </div>
	Quad 2-input OR Gate Similar to Renesas HD74LVC32FPEL	IC811	<div> 1A 1  1B 2  1Y 3  2A 4  2B 5  2Y 6  GND 7 </div> <div> 14 Vcc  13 4B  12 4A  11 4Y  10 3B  9 3A  8 3Y </div>


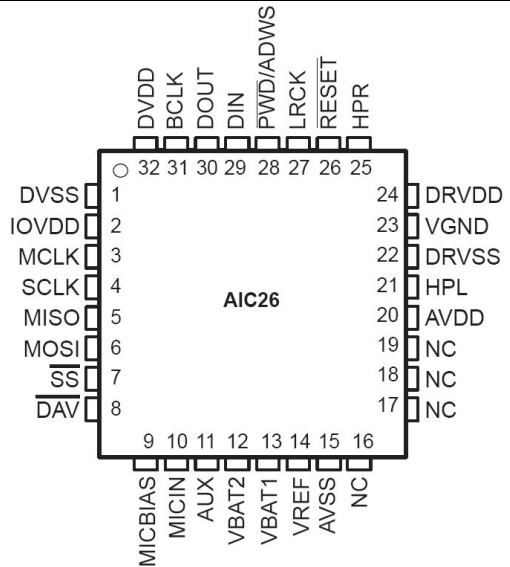
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT															
	Dual Bus Buffer with 3-state Output Similar to Renesas HD74LV2G125AUSE-E	IC812																
	Bus Buffer Gate with 3-state Output Similar to Renesas HD74LV1G125ACME	IC813, IC815	 <table><tr><th colspan="2">Inputs</th><th>Output Y</th></tr><tr><th>OE</th><th>A</th><th></th></tr><tr><td>L</td><td>H</td><td>H</td></tr><tr><td>L</td><td>L</td><td>L</td></tr><tr><td>H</td><td>X</td><td>Z</td></tr></table> <p>H : High level L : Low level X : Immaterial Z : High impedance</p>	Inputs		Output Y	OE	A		L	H	H	L	L	L	H	X	Z
Inputs		Output Y																
OE	A																	
L	H	H																
L	L	L																
H	X	Z																
	UHS D-Type Latch with 3-STATE Output Similar to Fairchild NC7SZ373P6X	IC814																

BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT															
	2-input NOR Gate Similar to Renesas HD74LV1G02ACME	IC817																
	2-input AND Gate Similar to Renesas HD74LV1G08ACME	IC818																
	Low voltage detector with output delay Similar to Richoh R3112Q441C-TR-F	IC819	<div><table><tr><th>Pin No.</th><th>Symbol</th><th>Description</th></tr><tr><td>1</td><td>V<sub>DD</sub></td><td>Voltage Supply Pin</td></tr><tr><td>2</td><td>GND</td><td>Ground Pin</td></tr><tr><td>3</td><td>C<sub>o</sub></td><td>Pin for External Capacitor (for setting output delay)</td></tr><tr><td>4</td><td>OUT</td><td>Output Pin(Output "L" at detector threshold, Output "H" at released voltage)</td></tr></table></div>	Pin No.	Symbol	Description	1	V <sub>DD</sub>	Voltage Supply Pin	2	GND	Ground Pin	3	C <sub>o</sub>	Pin for External Capacitor (for setting output delay)	4	OUT	Output Pin(Output "L" at detector threshold, Output "H" at released voltage)
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4	OUT	Output Pin(Output "L" at detector threshold, Output "H" at released voltage)																
	Non-Inverted, 3-State Output Octal Bus Buffer Similar to Toshiba TC74HC244AF	IC820																

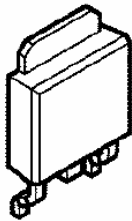
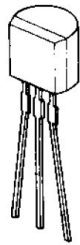

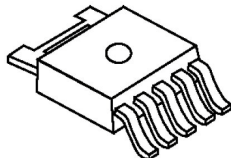
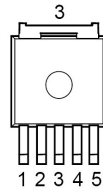
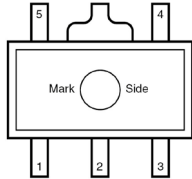
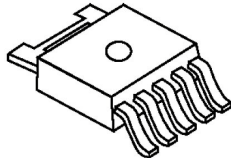
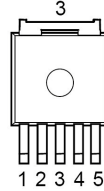
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT																																																																																							
	RS-232 Transceiver Similar to Sipex SP3238EEY	IC821	 <table><thead><tr><th>NAME</th><th>FUNCTION</th><th>PIN NO.</th></tr></thead><tbody><tr><td>C2+</td><td>Positive terminal of the symmetrical charge-pump capacitor C2.</td><td>1</td></tr><tr><td>GND</td><td>Ground.</td><td>2</td></tr><tr><td>C2-</td><td>Negative terminal of the symmetrical charge-pump capacitor C2.</td><td>3</td></tr><tr><td>V-</td><td>Regulated -5.5V output generated by the charge pump.</td><td>4</td></tr><tr><td>T<sub>1</sub>OUT</td><td>RS-232 driver output.</td><td>5</td></tr><tr><td>T<sub>2</sub>OUT</td><td>RS-232 driver output.</td><td>6</td></tr><tr><td>T<sub>3</sub>OUT</td><td>RS-232 driver output.</td><td>7</td></tr><tr><td>R<sub>1</sub>IN</td><td>RS-232 receiver input.</td><td>8</td></tr><tr><td>R<sub>2</sub>IN</td><td>RS-232 receiver input.</td><td>9</td></tr><tr><td>T<sub>4</sub>OUT</td><td>RS-232 driver output.</td><td>10</td></tr><tr><td>R<sub>3</sub>IN</td><td>RS-232 receiver input.</td><td>11</td></tr><tr><td>T<sub>5</sub>OUT</td><td>RS-232 driver output.</td><td>12</td></tr><tr><td>ONLINE</td><td>Apply logic HIGH to override <b>AUTO ON-LINE</b>® circuitry keeping drivers active (SHUTDOWN must also be logic HIGH, refer to Table 2).</td><td>13</td></tr><tr><td>SHUTDOWN</td><td>Apply logic LOW to shut down drivers and charge pump. This overrides all <b>AUTO ON-LINE</b>® circuitry and ONLINE (refer to Table 2).</td><td>14</td></tr><tr><td>STATUS</td><td>TTL/CMOS Output indicating if a RS-232 signal is present on any receiver input.</td><td>15</td></tr><tr><td>R<sub>1</sub>OUT</td><td>Non-inverting receiver-1 output, active in shutdown.</td><td>16</td></tr><tr><td>T<sub>5</sub>IN</td><td>TTL/CMOS driver input.</td><td>17</td></tr><tr><td>R<sub>3</sub>OUT</td><td>TTL/CMOS receiver output.</td><td>18</td></tr><tr><td>T<sub>4</sub>IN</td><td>TTL/CMOS driver input.</td><td>19</td></tr><tr><td>R<sub>2</sub>OUT</td><td>TTL/CMOS receiver output.</td><td>20</td></tr><tr><td>R<sub>1</sub>OUT</td><td>TTL/CMOS receiver output.</td><td>21</td></tr><tr><td>T<sub>3</sub>IN</td><td>TTL/CMOS driver input.</td><td>22</td></tr><tr><td>T<sub>2</sub>IN</td><td>TTL/CMOS driver input.</td><td>23</td></tr><tr><td>T<sub>1</sub>IN</td><td>TTL/CMOS driver input.</td><td>24</td></tr><tr><td>C1-</td><td>Negative terminal of the symmetrical charge-pump capacitor C1.</td><td>25</td></tr><tr><td>V<sub>cc</sub></td><td>+3.0V to +5.5V supply voltage.</td><td>26</td></tr><tr><td>V+</td><td>Regulated +5.5V output generated by the charge pump.</td><td>27</td></tr><tr><td>C1+</td><td>Positive terminal of the symmetrical charge-pump capacitor C1</td><td>28</td></tr></tbody></table>	NAME	FUNCTION	PIN NO.	C2+	Positive terminal of the symmetrical charge-pump capacitor C2.	1	GND	Ground.	2	C2-	Negative terminal of the symmetrical charge-pump capacitor C2.	3	V-	Regulated -5.5V output generated by the charge pump.	4	T <sub>1</sub> OUT	RS-232 driver output.	5	T <sub>2</sub> OUT	RS-232 driver output.	6	T <sub>3</sub> OUT	RS-232 driver output.	7	R <sub>1</sub> IN	RS-232 receiver input.	8	R <sub>2</sub> IN	RS-232 receiver input.	9	T <sub>4</sub> OUT	RS-232 driver output.	10	R <sub>3</sub> IN	RS-232 receiver input.	11	T <sub>5</sub> OUT	RS-232 driver output.	12	ONLINE	Apply logic HIGH to override <b>AUTO ON-LINE</b> ® circuitry keeping drivers active (SHUTDOWN must also be logic HIGH, refer to Table 2).	13	SHUTDOWN	Apply logic LOW to shut down drivers and charge pump. This overrides all <b>AUTO ON-LINE</b> ® circuitry and ONLINE (refer to Table 2).	14	STATUS	TTL/CMOS Output indicating if a RS-232 signal is present on any receiver input.	15	R <sub>1</sub> OUT	Non-inverting receiver-1 output, active in shutdown.	16	T <sub>5</sub> IN	TTL/CMOS driver input.	17	R <sub>3</sub> OUT	TTL/CMOS receiver output.	18	T <sub>4</sub> IN	TTL/CMOS driver input.	19	R <sub>2</sub> OUT	TTL/CMOS receiver output.	20	R <sub>1</sub> OUT	TTL/CMOS receiver output.	21	T <sub>3</sub> IN	TTL/CMOS driver input.	22	T <sub>2</sub> IN	TTL/CMOS driver input.	23	T <sub>1</sub> IN	TTL/CMOS driver input.	24	C1-	Negative terminal of the symmetrical charge-pump capacitor C1.	25	V <sub>cc</sub>	+3.0V to +5.5V supply voltage.	26	V+	Regulated +5.5V output generated by the charge pump.	27	C1+	Positive terminal of the symmetrical charge-pump capacitor C1	28
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T <sub>3</sub> OUT	RS-232 driver output.	7																																																																																								
R <sub>1</sub> IN	RS-232 receiver input.	8																																																																																								
R <sub>2</sub> IN	RS-232 receiver input.	9																																																																																								
T <sub>4</sub> OUT	RS-232 driver output.	10																																																																																								
R <sub>3</sub> IN	RS-232 receiver input.	11																																																																																								
T <sub>5</sub> OUT	RS-232 driver output.	12																																																																																								
ONLINE	Apply logic HIGH to override <b>AUTO ON-LINE</b> ® circuitry keeping drivers active (SHUTDOWN must also be logic HIGH, refer to Table 2).	13																																																																																								
SHUTDOWN	Apply logic LOW to shut down drivers and charge pump. This overrides all <b>AUTO ON-LINE</b> ® circuitry and ONLINE (refer to Table 2).	14																																																																																								
STATUS	TTL/CMOS Output indicating if a RS-232 signal is present on any receiver input.	15																																																																																								
R <sub>1</sub> OUT	Non-inverting receiver-1 output, active in shutdown.	16																																																																																								
T <sub>5</sub> IN	TTL/CMOS driver input.	17																																																																																								
R <sub>3</sub> OUT	TTL/CMOS receiver output.	18																																																																																								
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T <sub>1</sub> IN	TTL/CMOS driver input.	24																																																																																								
C1-	Negative terminal of the symmetrical charge-pump capacitor C1.	25																																																																																								
V <sub>cc</sub>	+3.0V to +5.5V supply voltage.	26																																																																																								
V+	Regulated +5.5V output generated by the charge pump.	27																																																																																								
C1+	Positive terminal of the symmetrical charge-pump capacitor C1	28																																																																																								

BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
	1M x 16 SDRAM Similar to EtronTech EM636165TS-7IG	IC822	<div> <div> V<sub>DD</sub> 1  DQ0 2  DQ1 3  V<sub>SSQ</sub> 4  DQ2 5  DQ3 6  V<sub>DDQ</sub> 7  DQ4 8  DQ5 9  V<sub>SSQ</sub> 10  DQ6 11  DQ7 12  V<sub>DDQ</sub> 13  LDQM 14  WE# 15  CAS# 16  RAS# 17  CS# 18  A11 19  A10 20  A0 21  A1 22  A2 23  A3 24  V<sub>DD</sub> 25 </div> <div> 50  49  48  47  46  45  44  43  42  41  40  39  38  37  36  35  34  33  32  31  30  29  28  27  26 </div> <div> V<sub>SS</sub>  DQ15  DQ14  V<sub>SSQ</sub>  DQ13  DQ12  V<sub>DDQ</sub>  DQ11  DQ10  V<sub>SSQ</sub>  DQ9  DQ8  V<sub>DDQ</sub>  NC  UDQM  CLK  CKE  NC  A9  A8  A7  A6  A5  A4  V<sub>SS</sub> </div> </div>
Base diagram not available.	RS-232 Transceiver Similar to Sipex SP3243EBEY	IC823	 <div> <div> C2+ 1  C2- 2  V- 3  R<sub>1</sub>IN 4  R<sub>2</sub>IN 5  R<sub>3</sub>IN 6  R<sub>4</sub>IN 7  R<sub>5</sub>IN 8  T<sub>1</sub>OUT 9  T<sub>2</sub>OUT 10  T<sub>3</sub>OUT 11  T<sub>3</sub>IN 12  T<sub>2</sub>IN 13  T<sub>1</sub>IN 14 </div> <div> 28  27  26  25  24  23  22  21  20  19  18  17  16  15 </div> <div> C1+  V+  V<sub>CC</sub>  GND  C1-  ONLINE  SHUTDOWN  STATUS  R<sub>2</sub>OUT  R<sub>1</sub>OUT  R<sub>2</sub>OUT  R<sub>3</sub>OUT  R<sub>4</sub>OUT  R<sub>5</sub>OUT </div> </div>
	CMOS Inverter Similar to Toshiba TC74VHC04FT	IC824	 <div> <div> 1A 1  1Y 2  2A 3  2Y 4  3A 5  3Y 6  GND 7 </div> <div> 14  13  12  11  10  9  8 </div> <div> V<sub>CC</sub>  6A  6Y  5A  5Y  4A  4Y </div> </div>

BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT						
	Triple Inverters Similar to Renesas HD74LV2GT04AUSE	IC825	<div></div> <table><tr><th>Input A</th><th>Output <math>\bar{Y}</math></th></tr><tr><td>H</td><td>L</td></tr><tr><td>L</td><td>H</td></tr></table> <div>H : High level L : Low level</div>	Input A	Output $\bar{Y}$	H	L	L	H
Input A	Output $\bar{Y}$								
H	L								
L	H								

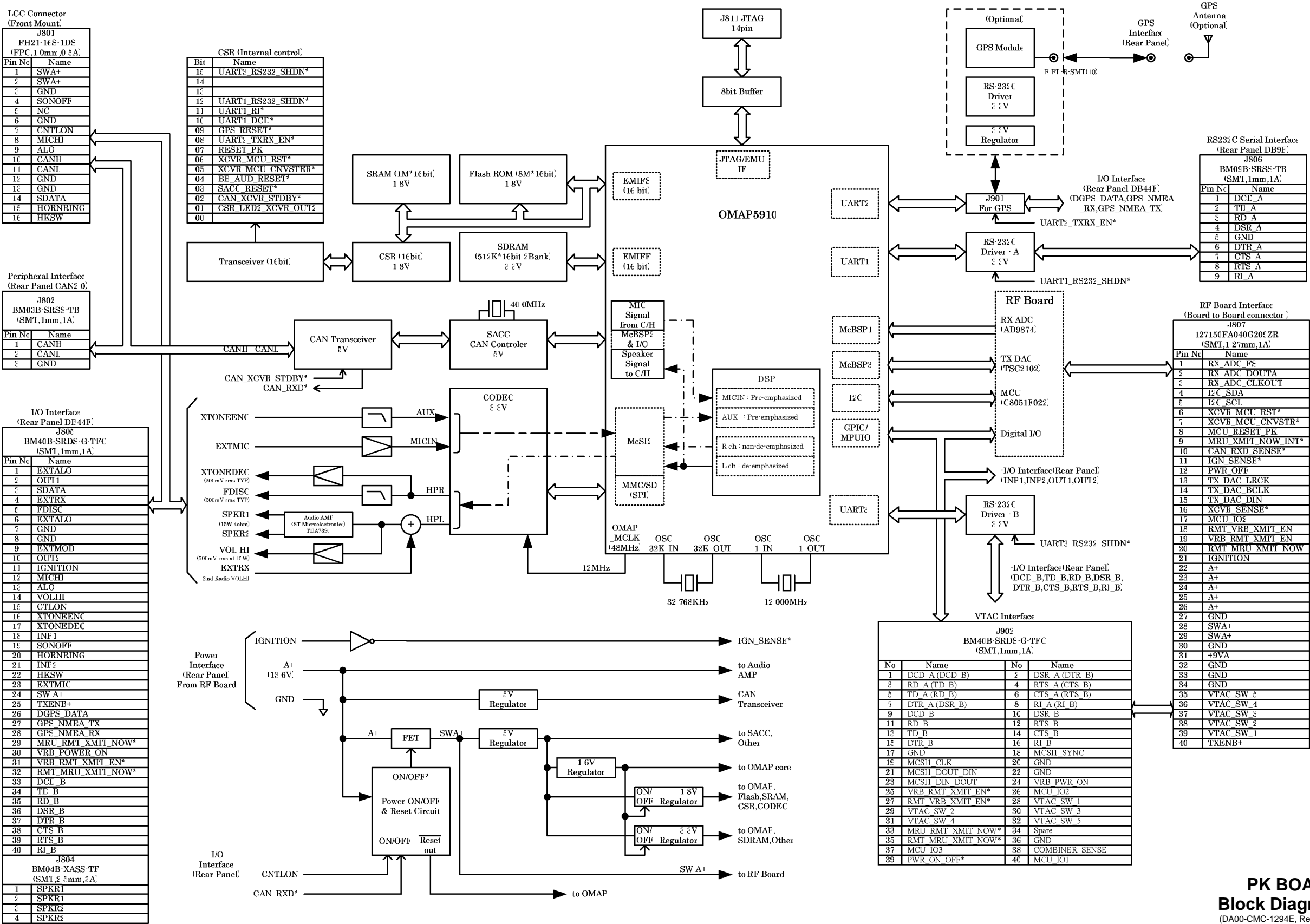
BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT																																																																																																			
	Low power audio CODEC Similar to Texas Instruments TLV320AIC26IRHB	IC901	<div></div> <table><thead><tr><th>QFN PIN</th><th>NAME</th><th>DESCRIPTION</th></tr></thead><tbody><tr><td>29</td><td>DIN</td><td>Audio data input</td></tr><tr><td>30</td><td>DOUT</td><td>Audio data output</td></tr><tr><td>31</td><td>BCLK</td><td>Audio bit-clock</td></tr><tr><td>32</td><td>DVDD</td><td>Digital core supply</td></tr><tr><td>1</td><td>DVSS</td><td>Digital core and IO ground</td></tr><tr><td>2</td><td>IOVDD</td><td>IO supply</td></tr><tr><td>3</td><td>MCLK</td><td>Master clock</td></tr><tr><td>4</td><td>SCLK</td><td>SPI serial clock input</td></tr><tr><td>5</td><td>MISO</td><td>SPI serial data output</td></tr><tr><td>6</td><td>MOSI</td><td>SPI serial data input</td></tr><tr><td>7</td><td>SS</td><td>SPI slave select input</td></tr><tr><td>8</td><td>DAV</td><td>Auxiliary data available output</td></tr><tr><td>9</td><td>MICBIAS</td><td>Microphone bias voltage</td></tr><tr><td>10</td><td>MICIN</td><td>Microphone input</td></tr><tr><td>11</td><td>AUX</td><td>Auxiliary input</td></tr><tr><td>12</td><td>VBAT2</td><td>Battery monitor input</td></tr><tr><td>13</td><td>VBAT1</td><td>Battery monitor input</td></tr><tr><td>14</td><td>VREF</td><td>Reference voltage I/O</td></tr><tr><td>15</td><td>AVSS</td><td>Analog ground</td></tr><tr><td>16</td><td>NC</td><td>No connect</td></tr><tr><td>17</td><td>NC</td><td>No connect</td></tr><tr><td>18</td><td>NC</td><td>No connect</td></tr><tr><td>19</td><td>NC</td><td>No connect</td></tr><tr><td>20</td><td>AVDD</td><td>Analog power supply</td></tr><tr><td>21</td><td>HPL</td><td>Left channel audio output</td></tr><tr><td>22</td><td>DRVSS</td><td>Speaker ground</td></tr><tr><td>23</td><td>VGND</td><td>Virtual ground for audio output</td></tr><tr><td>24</td><td>DRVDD</td><td>Speaker /PLL supply</td></tr><tr><td>25</td><td>HPR</td><td>Right channel audio output</td></tr><tr><td>26</td><td>RESET</td><td>Device reset</td></tr><tr><td>27</td><td>LRCK</td><td>Audio DAC word-clock</td></tr><tr><td>28</td><td>PWD/ADWS</td><td>Hardware powerdown/ADC word clock</td></tr></tbody></table>	QFN PIN	NAME	DESCRIPTION	29	DIN	Audio data input	30	DOUT	Audio data output	31	BCLK	Audio bit-clock	32	DVDD	Digital core supply	1	DVSS	Digital core and IO ground	2	IOVDD	IO supply	3	MCLK	Master clock	4	SCLK	SPI serial clock input	5	MISO	SPI serial data output	6	MOSI	SPI serial data input	7	SS	SPI slave select input	8	DAV	Auxiliary data available output	9	MICBIAS	Microphone bias voltage	10	MICIN	Microphone input	11	AUX	Auxiliary input	12	VBAT2	Battery monitor input	13	VBAT1	Battery monitor input	14	VREF	Reference voltage I/O	15	AVSS	Analog ground	16	NC	No connect	17	NC	No connect	18	NC	No connect	19	NC	No connect	20	AVDD	Analog power supply	21	HPL	Left channel audio output	22	DRVSS	Speaker ground	23	VGND	Virtual ground for audio output	24	DRVDD	Speaker /PLL supply	25	HPR	Right channel audio output	26	RESET	Device reset	27	LRCK	Audio DAC word-clock	28	PWD/ADWS	Hardware powerdown/ADC word clock
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BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT
	Single-Supply Dual Op Amplifier Similar to JRC NJM3404AV	IC902	<p><b>PIN FUNCTION</b>  1.A OUTPUT  2.A -INPUT  3.A +INPUT  4.V<sup>-</sup>  5.B +INPUT  6.B -INPUT  7.B OUTPUT  8.V<sup>+</sup></p>
	Single-Supply Quad Op Amp Similar to JRC NJM3403AV(TE1)	IC903	<p><b>PIN FUNCTION</b>  1.A OUTPUT  2.A -INPUT  3.A +INPUT  4.V<sup>-</sup>  5.B +INPUT  6.B -INPUT  7.B OUTPUT  8.V<sup>+</sup>  9.C -INPUT  10.C +INPUT  11.V<sup>-</sup>  12.D +INPUT  13.D -INPUT  14.D OUTPUT</p>
	Bilateral Switch Similar to Toshiba TC7S66FU(TE85L)	IC904	<p>IN / OUT 1  OUT / IN 2  GND 3  VCC 5  CONT 4</p>
	35W BRIDGE class AB audio power amplifier Similar to STMicroelectronics TDA7391	IC905	<p>11 MUTE  10 SYNC  9 +V<sub>S</sub>  8 STAND-BY  7 OUT+  6 GND  5 OUT-  4 CD  3 +V<sub>S</sub>  2 IN+  1 IN-  TAB CONNECTED TO PIN 6</p>
	Single-Supply Dual Op Amp Similar to JRC NJM3404AV(TE1)	IC906	<p><b>PIN FUNCTION</b>  1.A OUTPUT  2.A -INPUT  3.A +INPUT  4.V<sup>-</sup>  5.B +INPUT  6.B -INPUT  7.B OUTPUT  8.V<sup>+</sup></p>

BASE DIAGRAM	DESCRIPTION	REFERENCE DESIGNATOR	PIN-OUT												
<div><p>HSOP3-P-2.30D</p></div>	500mA Low Dropout Voltage Regulator Similar to JRC TA58M05F(TE16L1,NQ	IC907	<div><div><div>Mark</div><div><div>1</div><div>3</div><div>2</div></div><div><div>IN</div><div>GND</div><div>OUT</div></div></div><table><tr><th>Pin No.</th><th>Symbol</th><th>Description</th></tr><tr><td>1</td><td>IN</td><td>Input terminal. Connected by capacitor (C<sub>IN</sub>) to GND.</td></tr><tr><td>3</td><td>GND</td><td>Ground terminal</td></tr><tr><td>2</td><td>OUT</td><td>Output terminal. Connected by capacitor (C<sub>OUT</sub>) to GND.</td></tr></table></div>	Pin No.	Symbol	Description	1	IN	Input terminal. Connected by capacitor (C <sub>IN</sub> ) to GND.	3	GND	Ground terminal	2	OUT	Output terminal. Connected by capacitor (C <sub>OUT</sub> ) to GND.
Pin No.	Symbol	Description													
1	IN	Input terminal. Connected by capacitor (C <sub>IN</sub> ) to GND.													
3	GND	Ground terminal													
2	OUT	Output terminal. Connected by capacitor (C <sub>OUT</sub> ) to GND.													
<div></div>	Positive Voltage Regulator Similar to JRC NJM7805FA	IC908	<div><div><div><div>1. OUT</div><div>2. GND</div><div>3. IN</div></div></div></div>												
<div></div>	Adjustable Low Dropout Voltage Regulator Similar to JRC NJM2887DL3	IC909	<div><div><div><div>3</div><div>1 2 3 4 5</div></div><div><div>PIN FUNCTION</div><div>1.CONTROL</div><div>2. V<sub>IN</sub></div><div>3.GND</div><div>4.V<sub>OUT</sub></div><div>5.V<sub>ADJ</sub></div></div></div></div>												
<div><i>Base diagram not available.</i></div>	300mA LDO Regulator Similar to Ricoh R1130H181B-T1	IC910	<div><div><div><div>5 4</div><div>Mark Side</div><div>1 2 3</div></div></div></div>												
<div></div>	Adjustable Low Dropout Voltage Regulator Similar to JRC NJM2887DL3	IC911	<div><div><div><div>3</div><div>1 2 3 4 5</div></div><div><div>PIN FUNCTION</div><div>1.CONTROL</div><div>2. V<sub>IN</sub></div><div>3.GND</div><div>4.V<sub>OUT</sub></div><div>5.V<sub>ADJ</sub></div></div></div></div>												

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## 19.1 PK BOARD



# PK BOARD

## Block Diagram

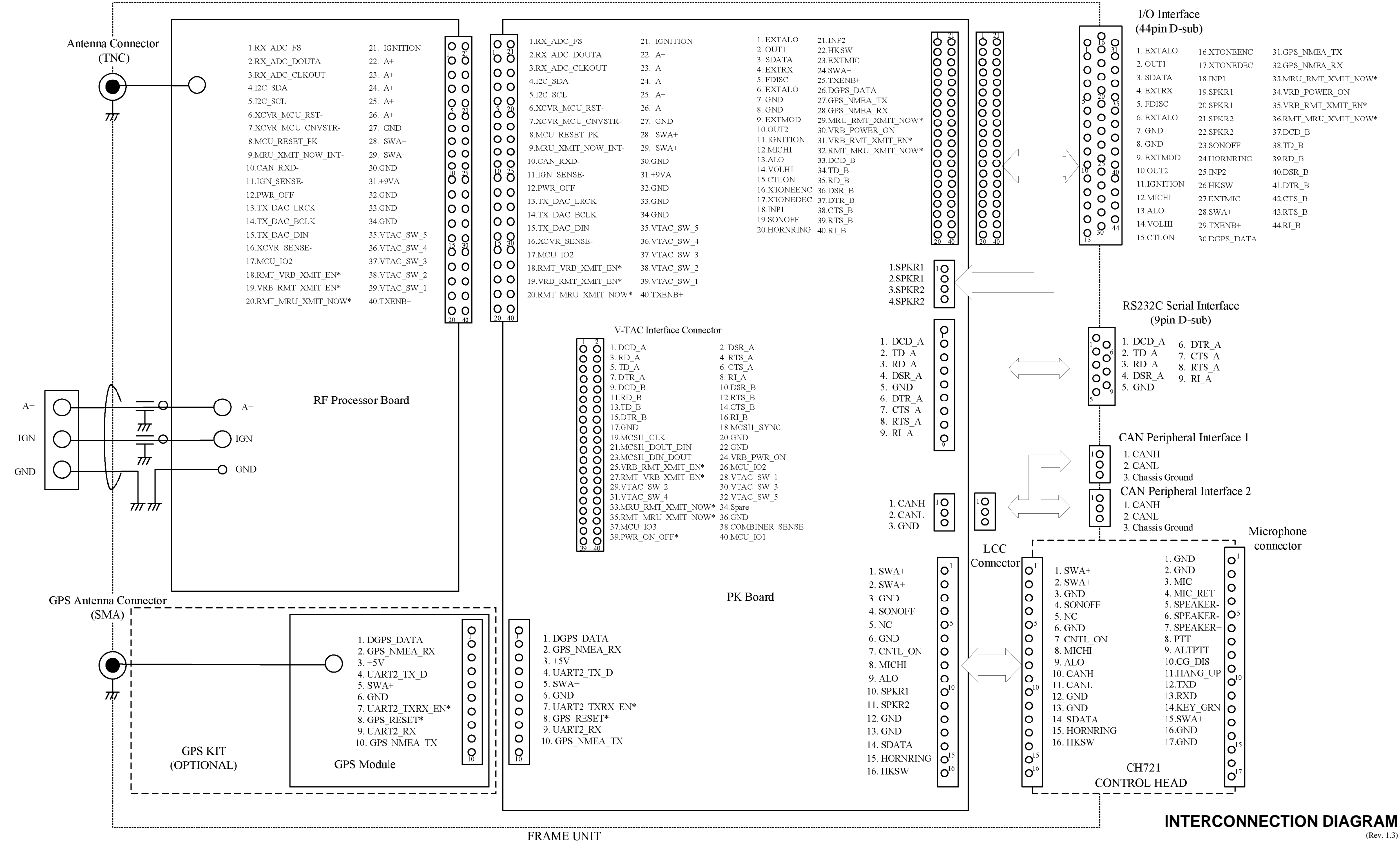
(DA00-CMC-1294E, Rev. 2.11)

# 700/800 MHz RF PROCESSOR BOARD Block Diagram

(CMN-709Y, Rev. 2.51)



# 20. INTERCONNECTION DIAGRAM



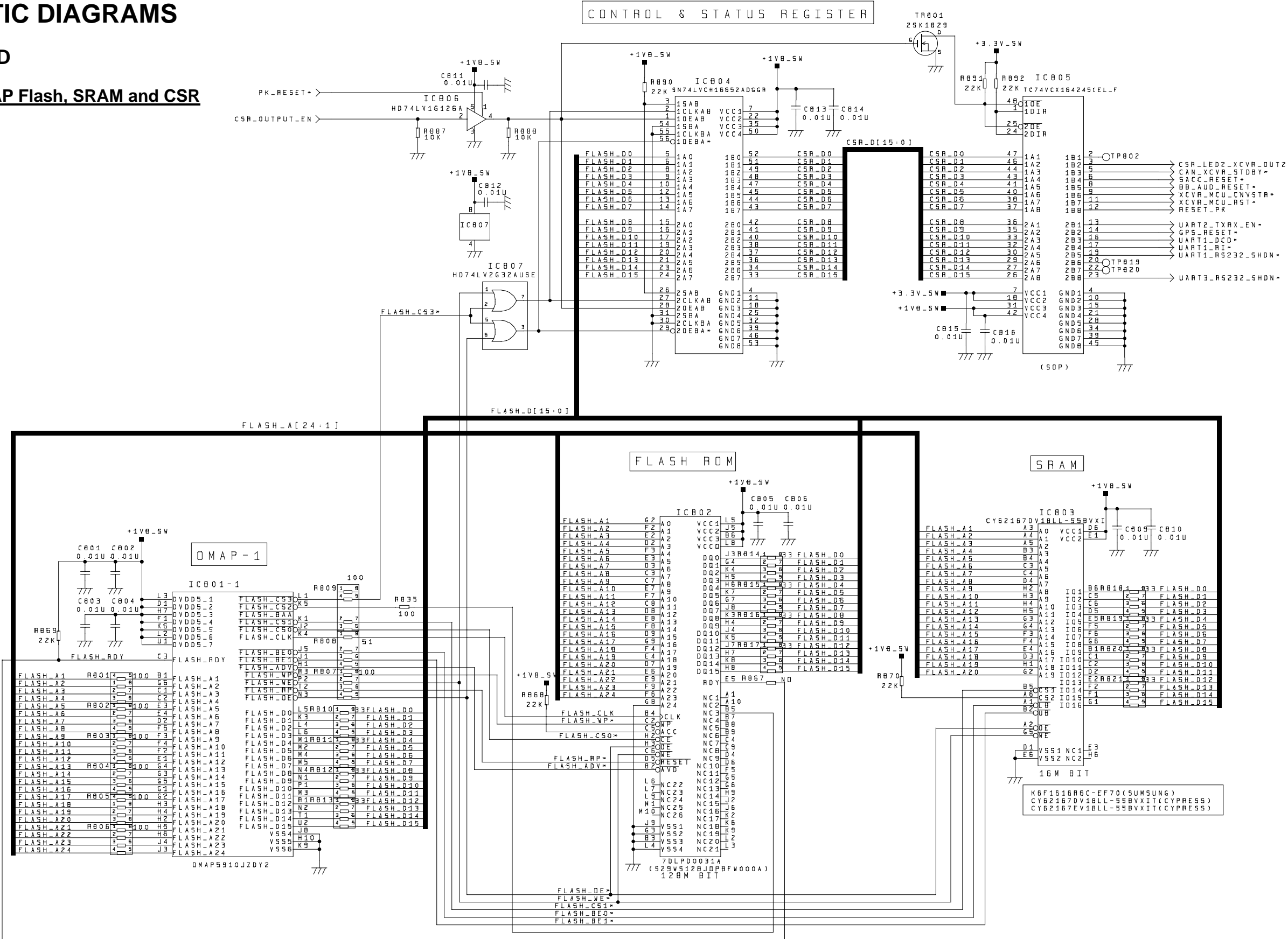
**INTERCONNECTION DIAGRAM**

(Rev. 1.3)

# 21. SCHEMATIC DIAGRAMS

## 21.1 PK BOARD

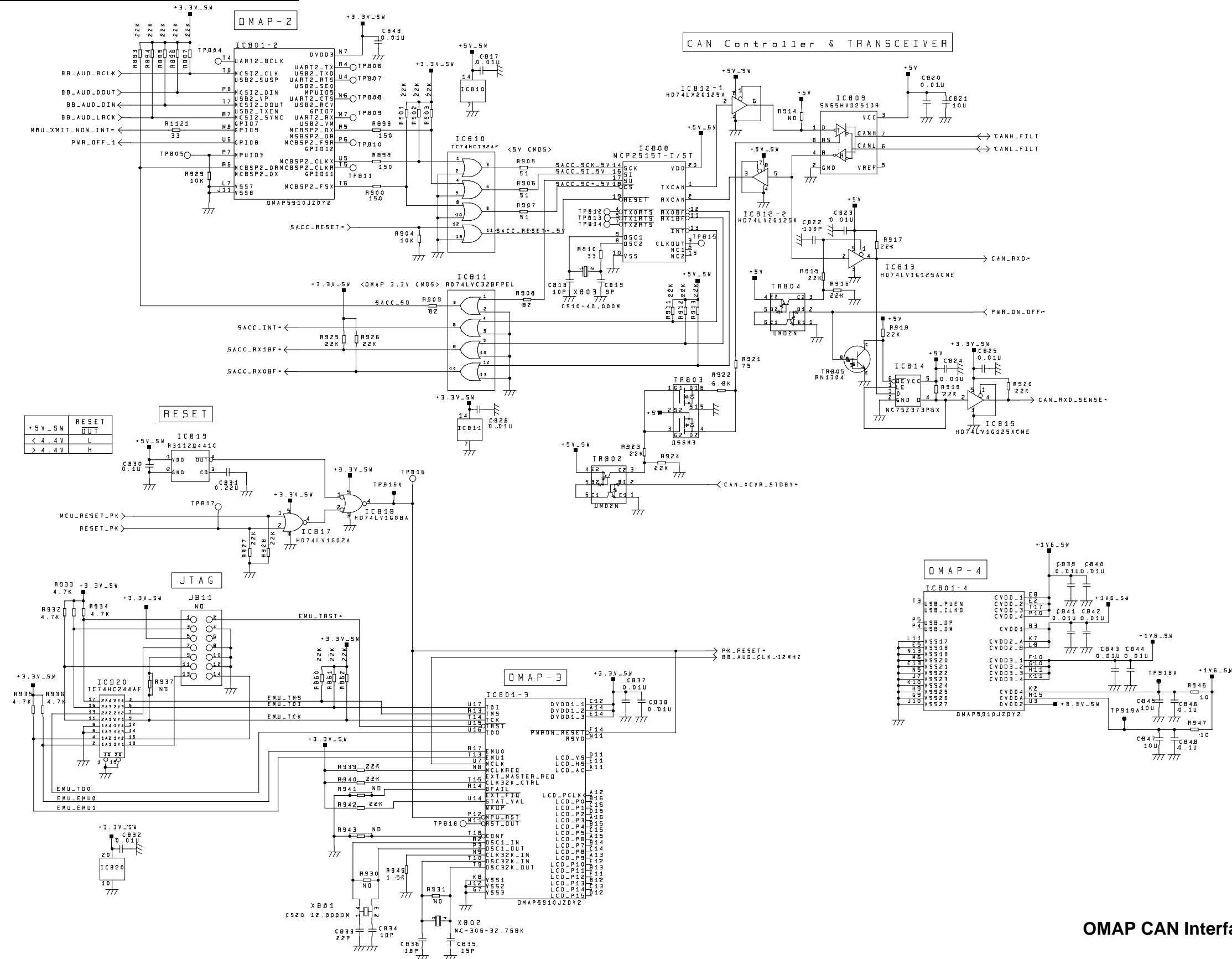
### 21.1.1 OMAP Flash, SRAM and CSR



PK BOARD  
Schematic Diagram  
Sheet 1 of 6

OMAP Flash, SRAM  
and CSR  
(DD03-CMC-1294E)

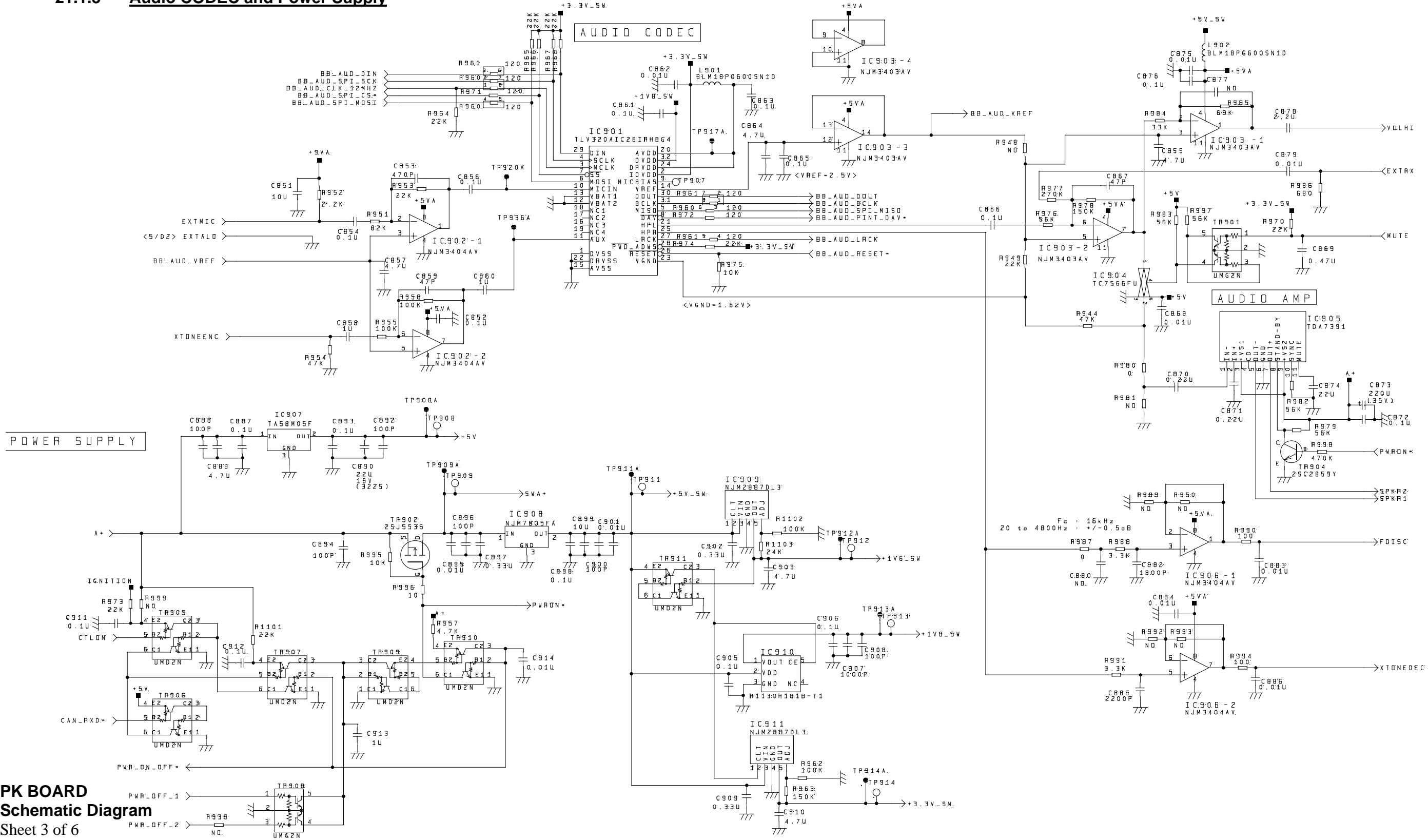
## 21.1.2 OMAP CAN Interface, JTAG and Reset



PK BOARD  
Schematic Diagram  
Sheet 2 of 6

OMAP CAN Interface, JTAG and Reset  
(DD03-CMC-1294E)

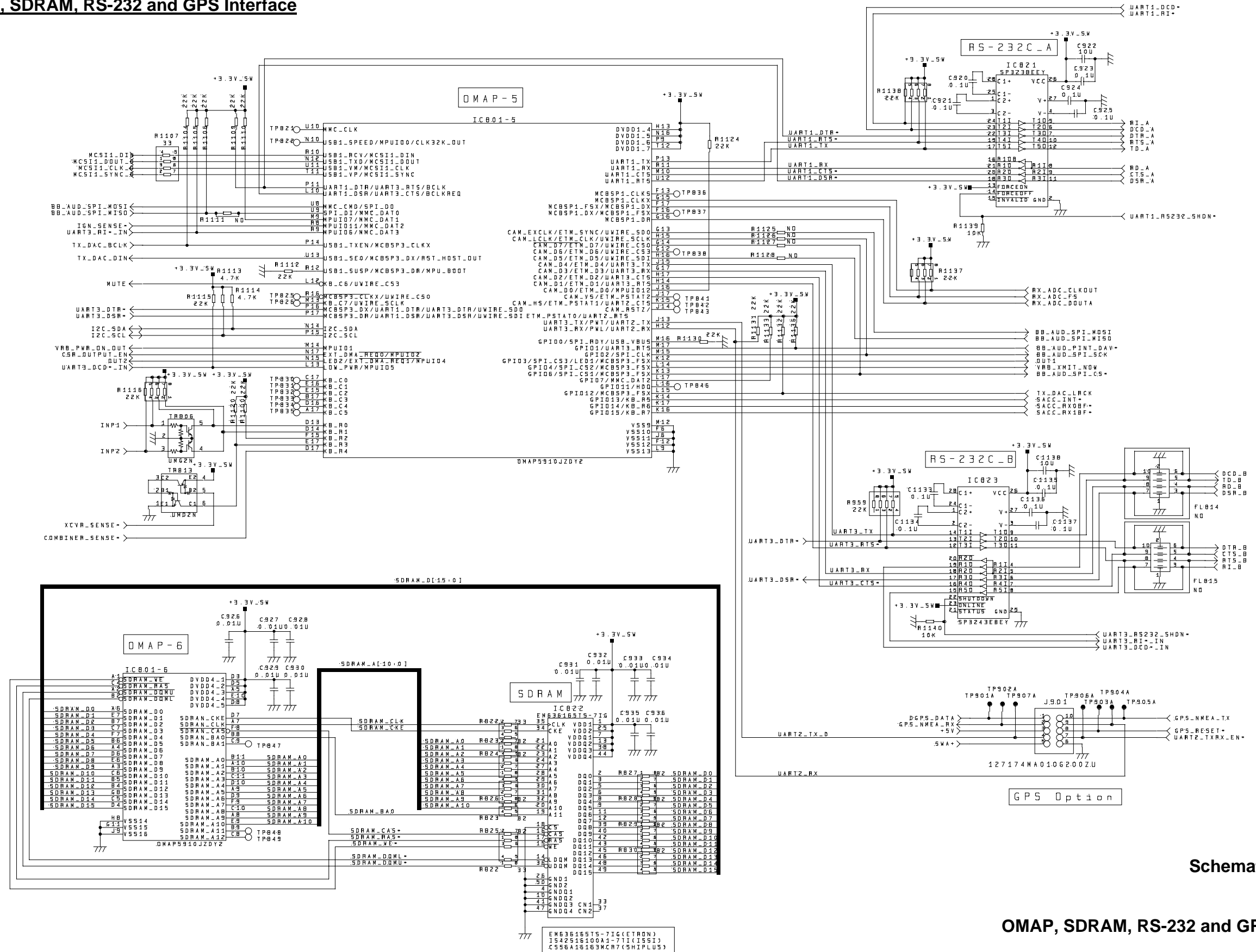
21.1.3 Audio CODEC and Power Supply



PK BOARD  
Schematic Diagram  
Sheet 3 of 6

Audio CODEC and Power Supply  
(DD03-CMC-1294E)

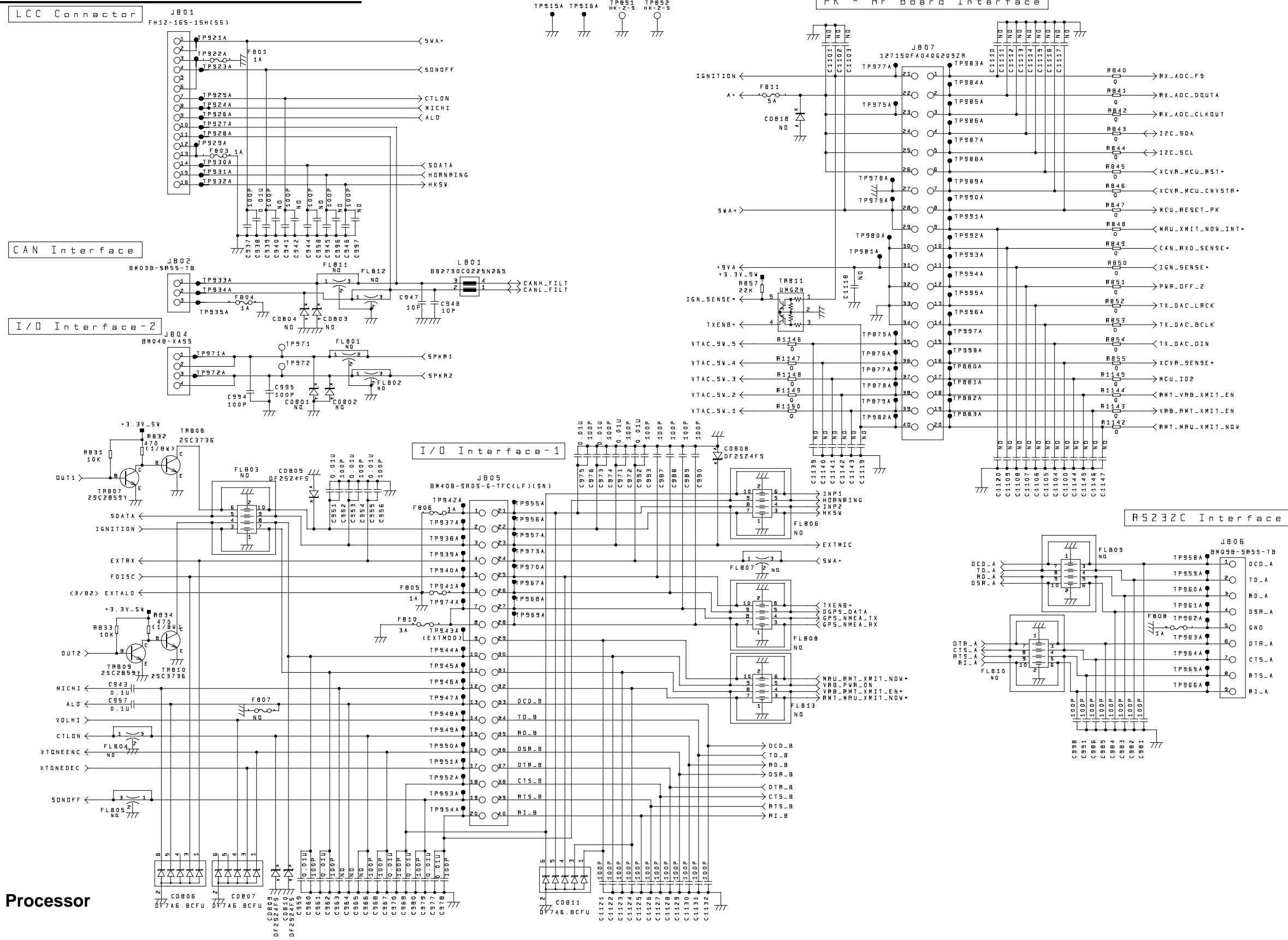
## 21.1.4 OMAP, SDRAM, RS-232 and GPS Interface



PK BOARD  
Schematic Diagram  
Sheet 4 of 6

OMAP, SDRAM, RS-232 and GPS Interface  
(DD03-CMC-1294E)

### 21.1.5 PK Board I/O and RF Processor Board Interface

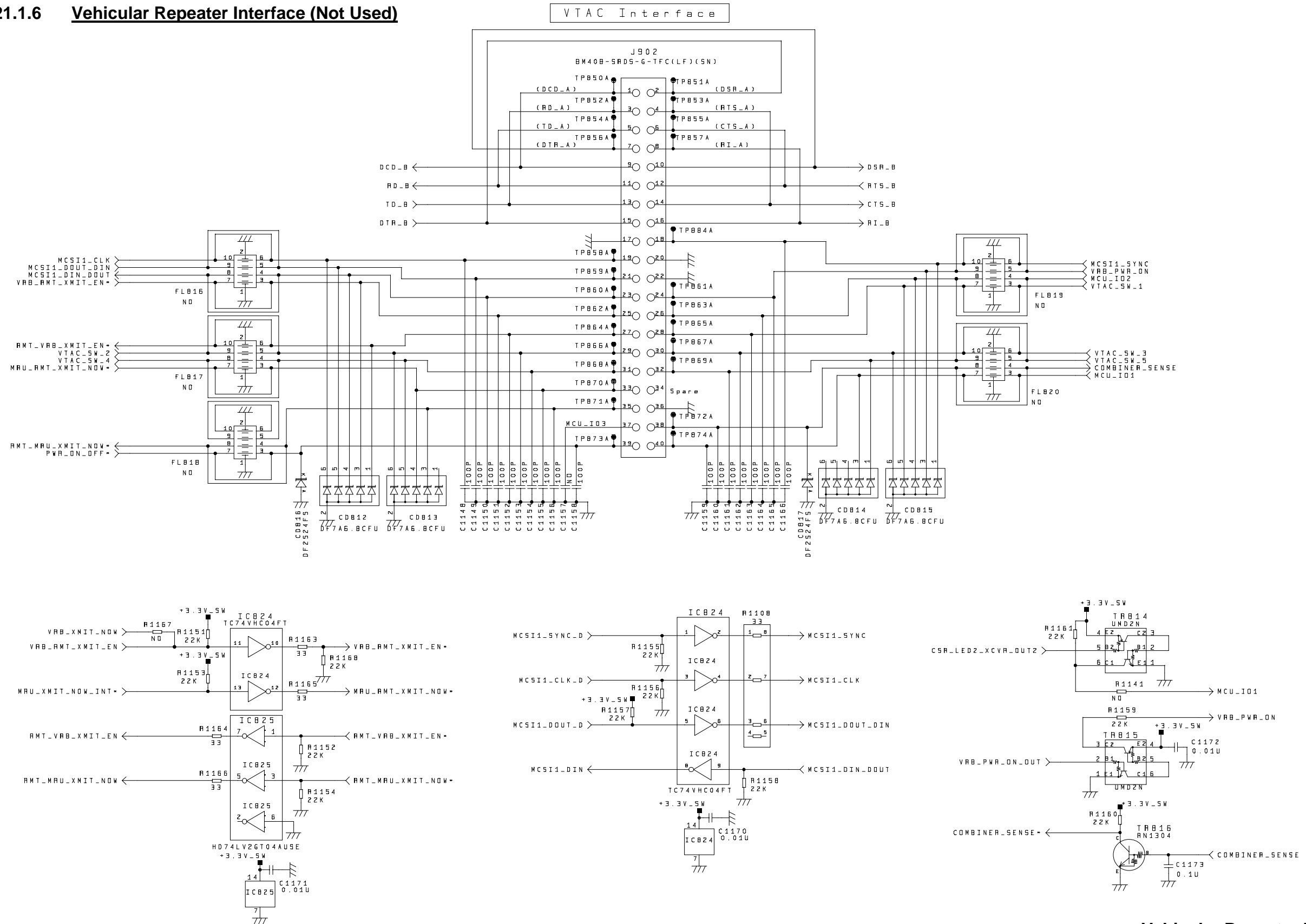


**PK BOARD**  
**Schematic Diagram**  
Sheet 5 of 6

## PK Board I/O and RF Processor Board Interface

(DD03-CMC-1294E)

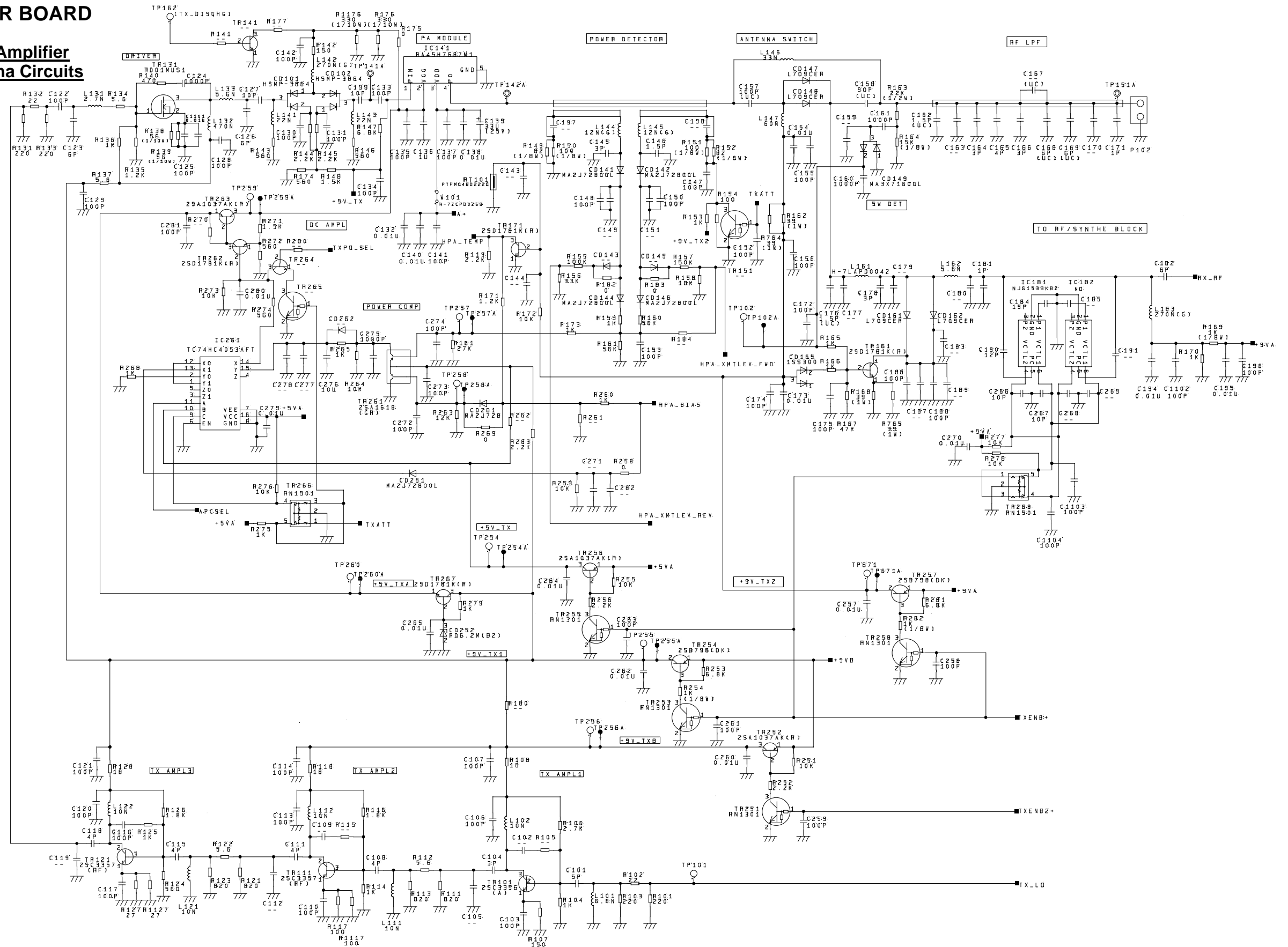
## 21.1.6 Vehicular Repeater Interface (Not Used)



**PK BOARD**  
**Schematic Diagram**  
 Sheet 6 of 6

**Vehicular Repeater Interface (Not Used)**  
 (DD03-CMC-1294E)

### 21.2.1 RF Power Amplifier and Antenna Circuits

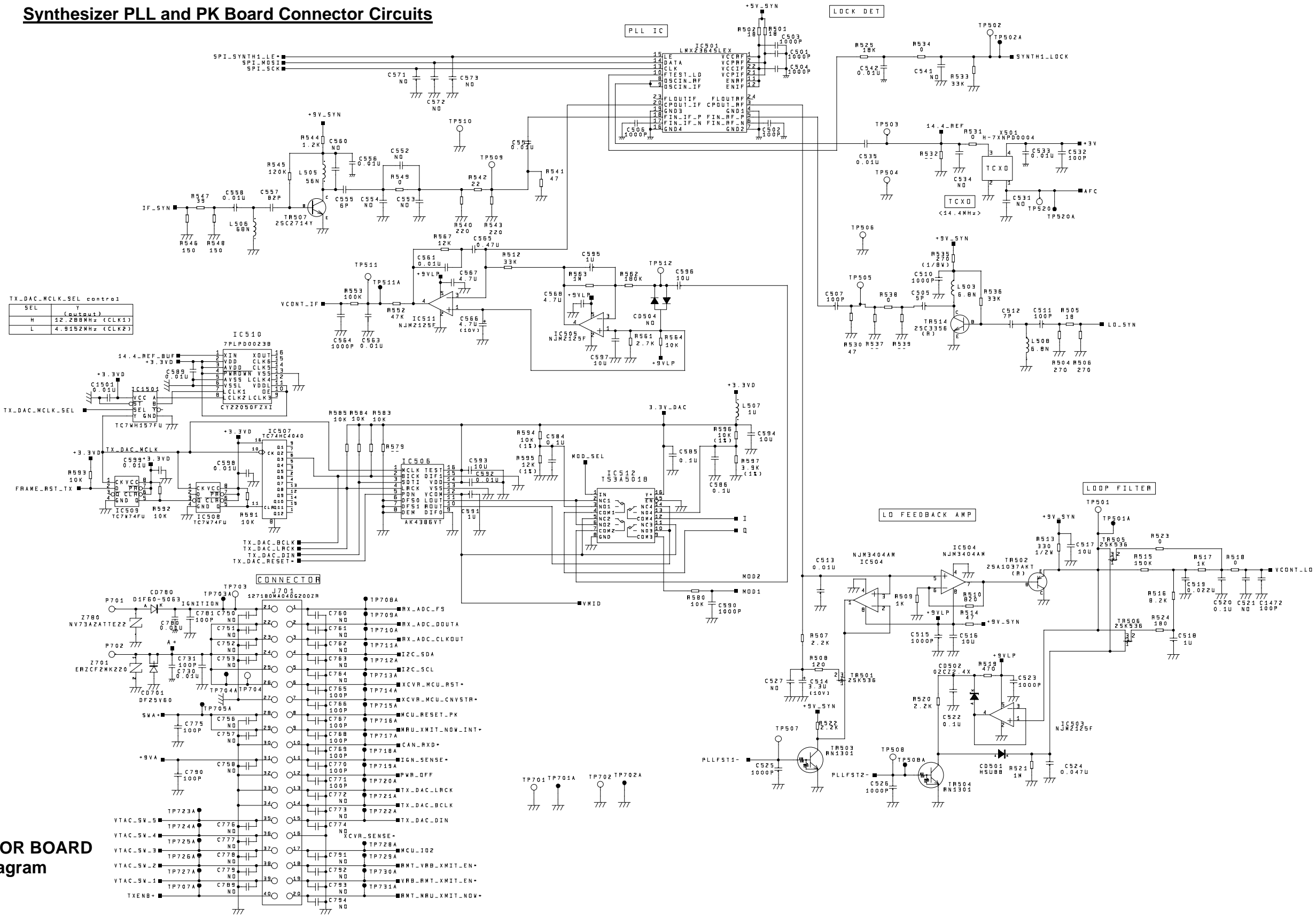


## RF Power Amplifier and Antenna Circuits

700/800 MHz  
RF PROCESSOR BOARD  
Schematic Diagram  
Sheet 2 of 7



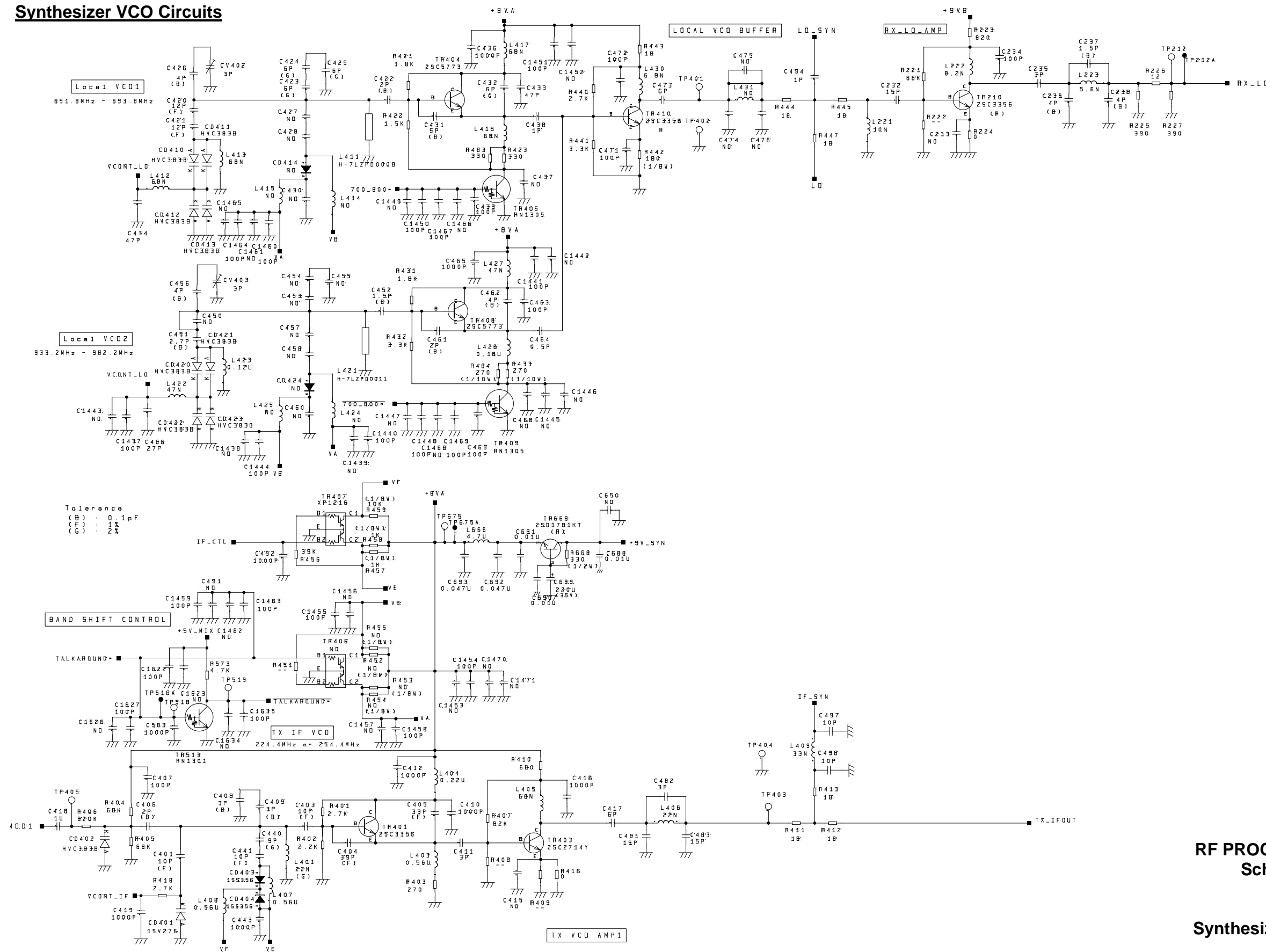
21.2.3 Synthesizer PLL and PK Board Connector Circuits



700/800 MHz  
RF PROCESSOR BOARD  
Schematic Diagram  
Sheet 3 of 7

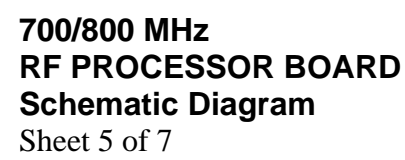
Synthesizer PLL and PK Board Connector Circuits  
(DD06-CMN-709Y)

### 21.2.4 Synthesizer VCO Circuits



## Synthesizer VCO Circuits

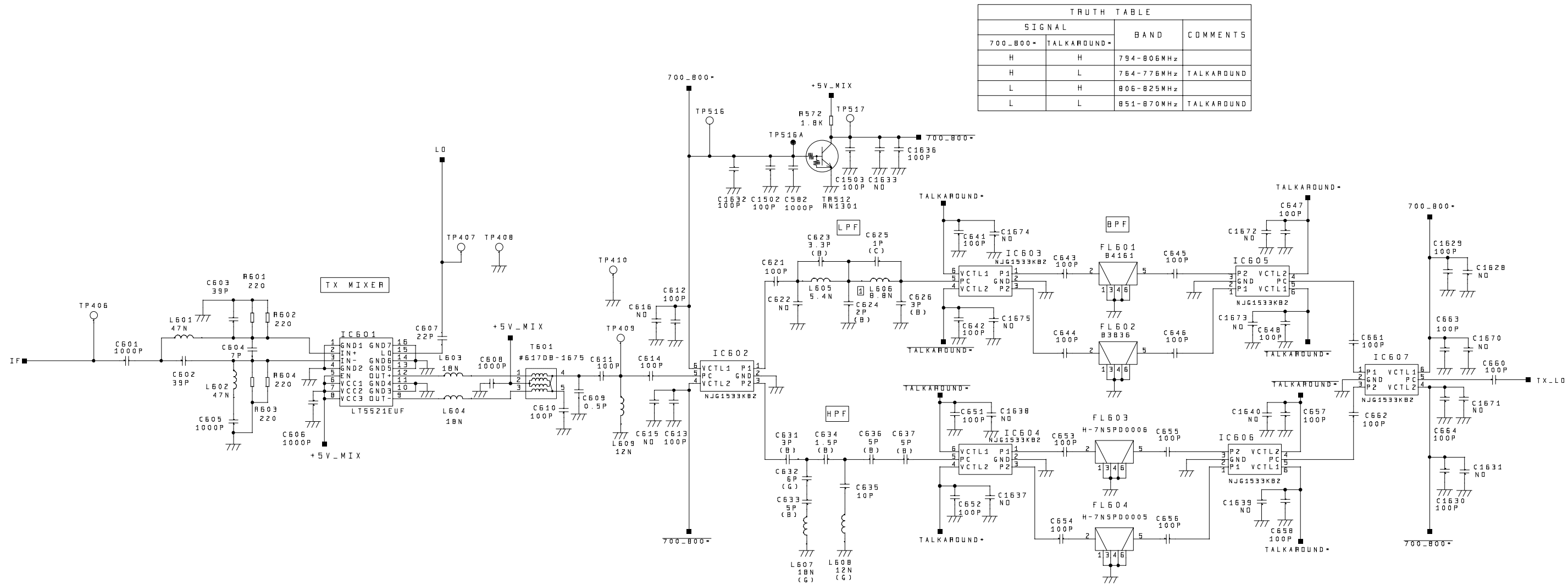
### 21.2.5 I/Q Modulator Circuits



## I/Q Modulator Circuits

(DD06-CMN-709Y)

21.2.6 Transmit Mixer and Bandpass Filter Circuits

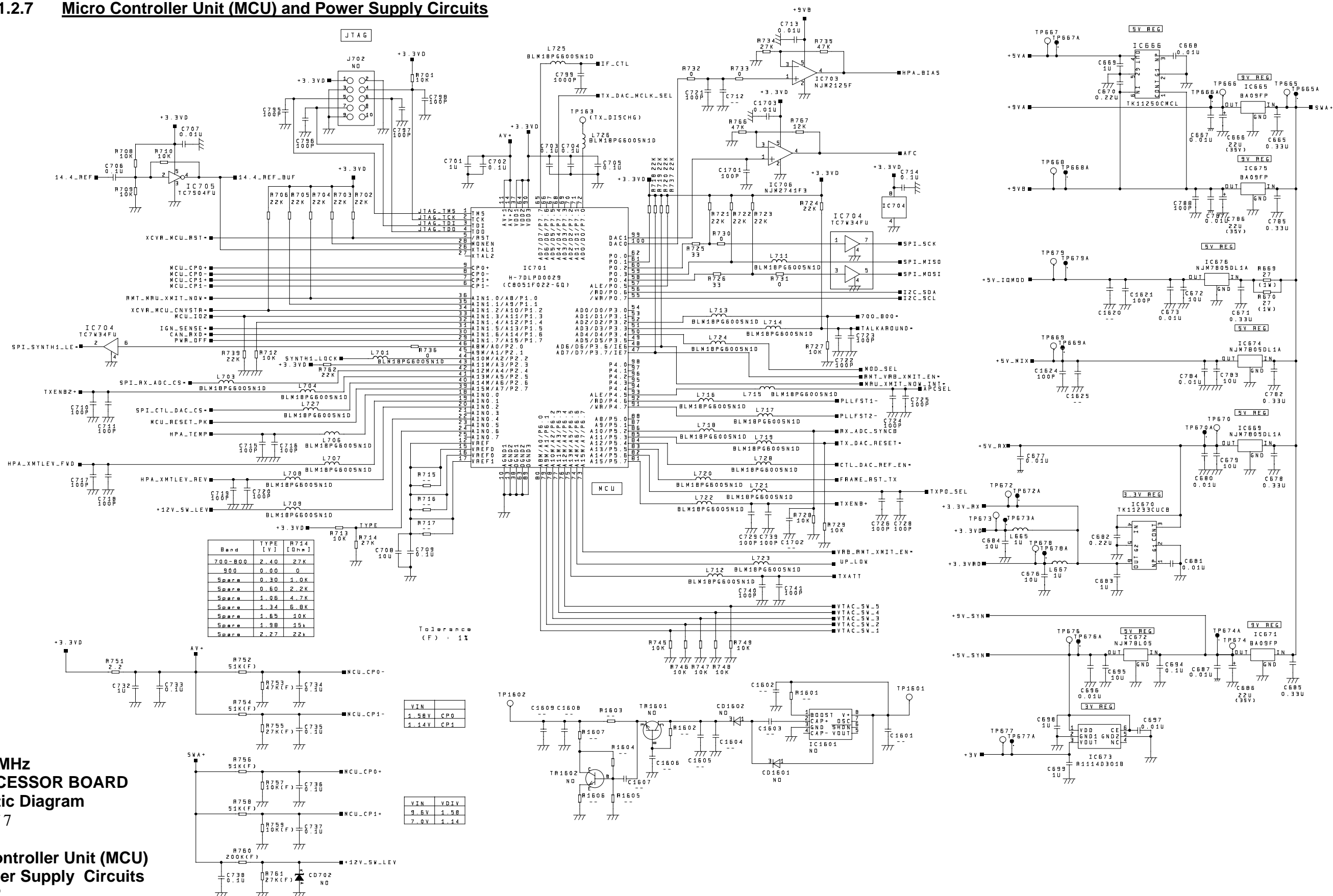


**700/800 MHz  
RF PROCESSOR BOARD  
Schematic Diagram**  
Sheet 6 of 7

## 700/800 MHz RF PROCESSOR BOARD Schematic Diagram

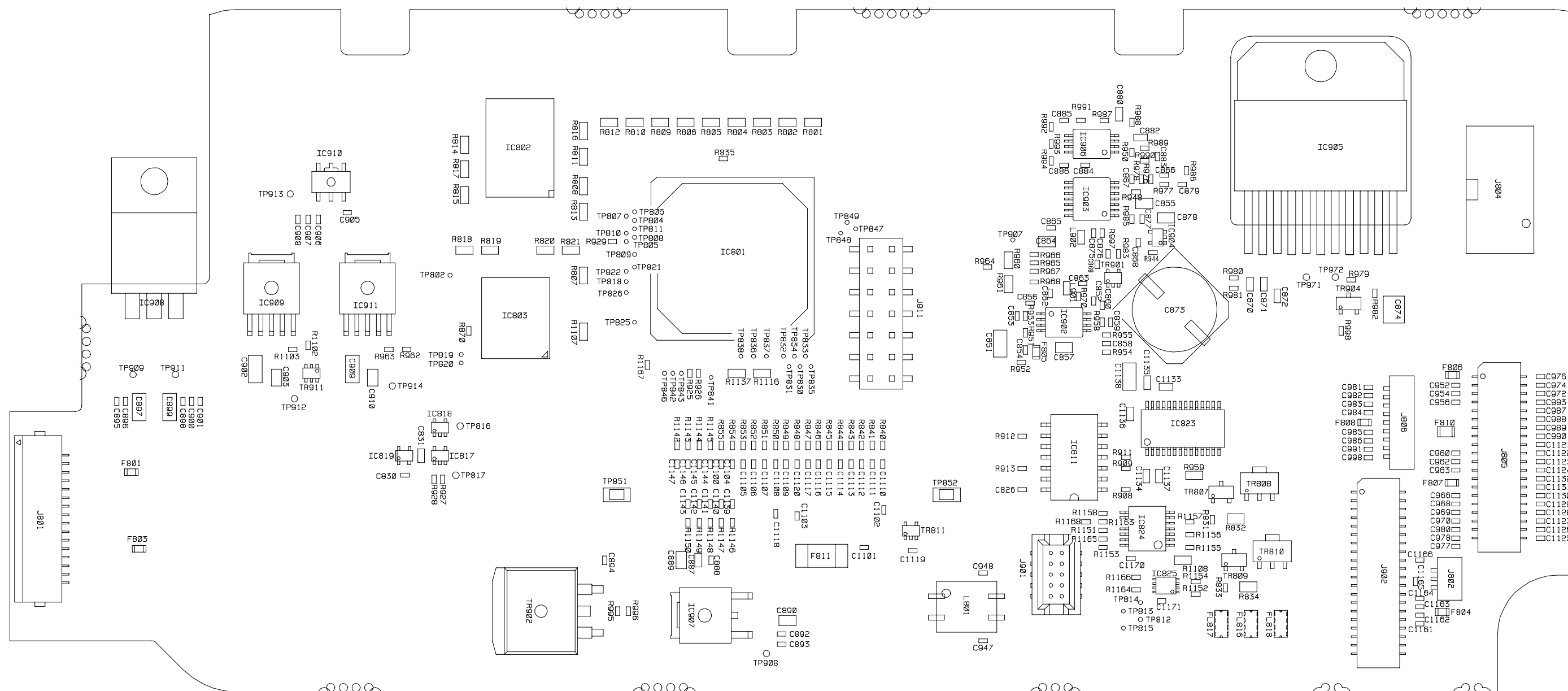
## Micro Controller Unit (MCU) and Power Supply Circuits

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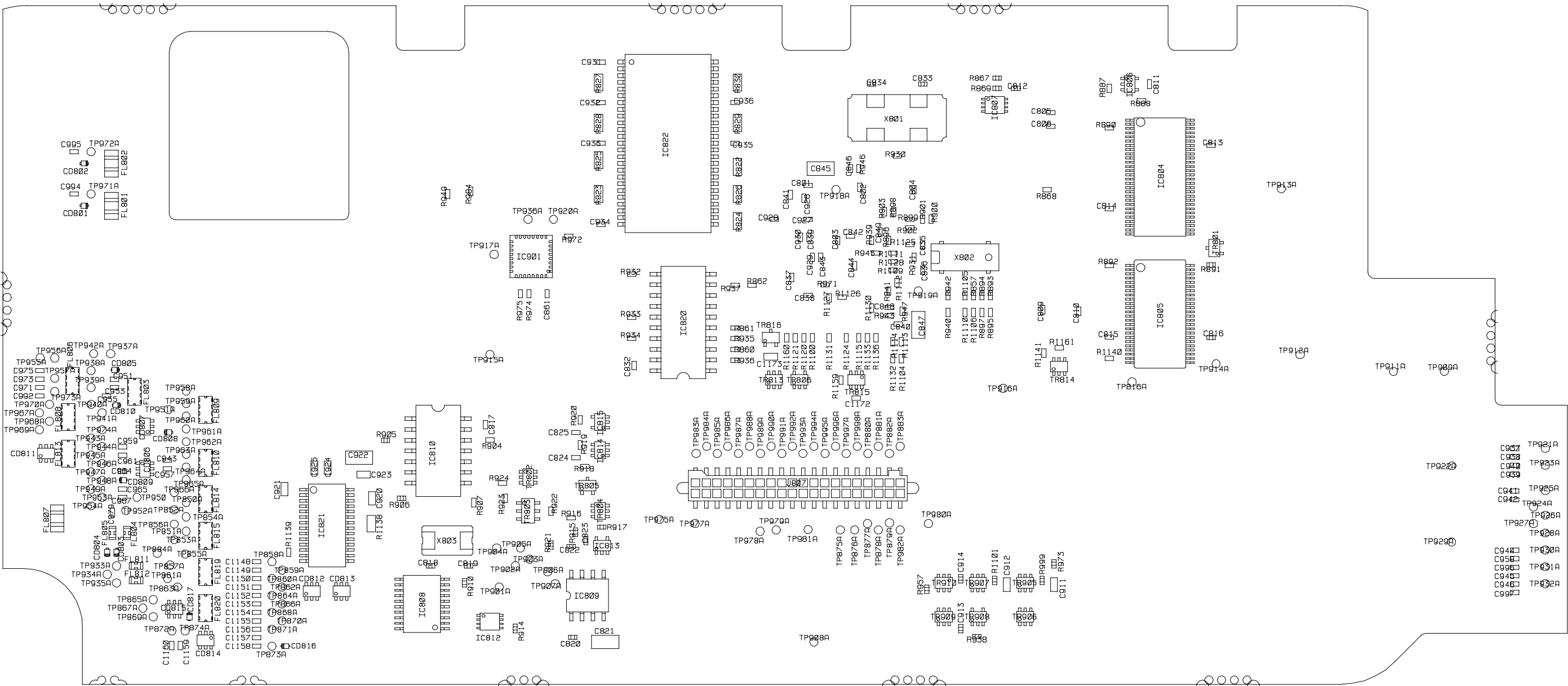
## 22. BOARD OUTLINE DIAGRAMS

### 22.1 PK BOARD — PRIMARY SIDE



Observe precautions to prevent damage due to **Electro-Static Discharge (ESD)!**

22.2 PK BOARD — SECONDARY SIDE



Observe precautions to prevent damage due to Electro-Static Discharge (ESD)!

**PK BOARD**  
**Secondary Side**  
(Rev. 8/6/2010)



Observe precautions to prevent  
damage due to **Electro-Static  
Discharge (ESD)**!

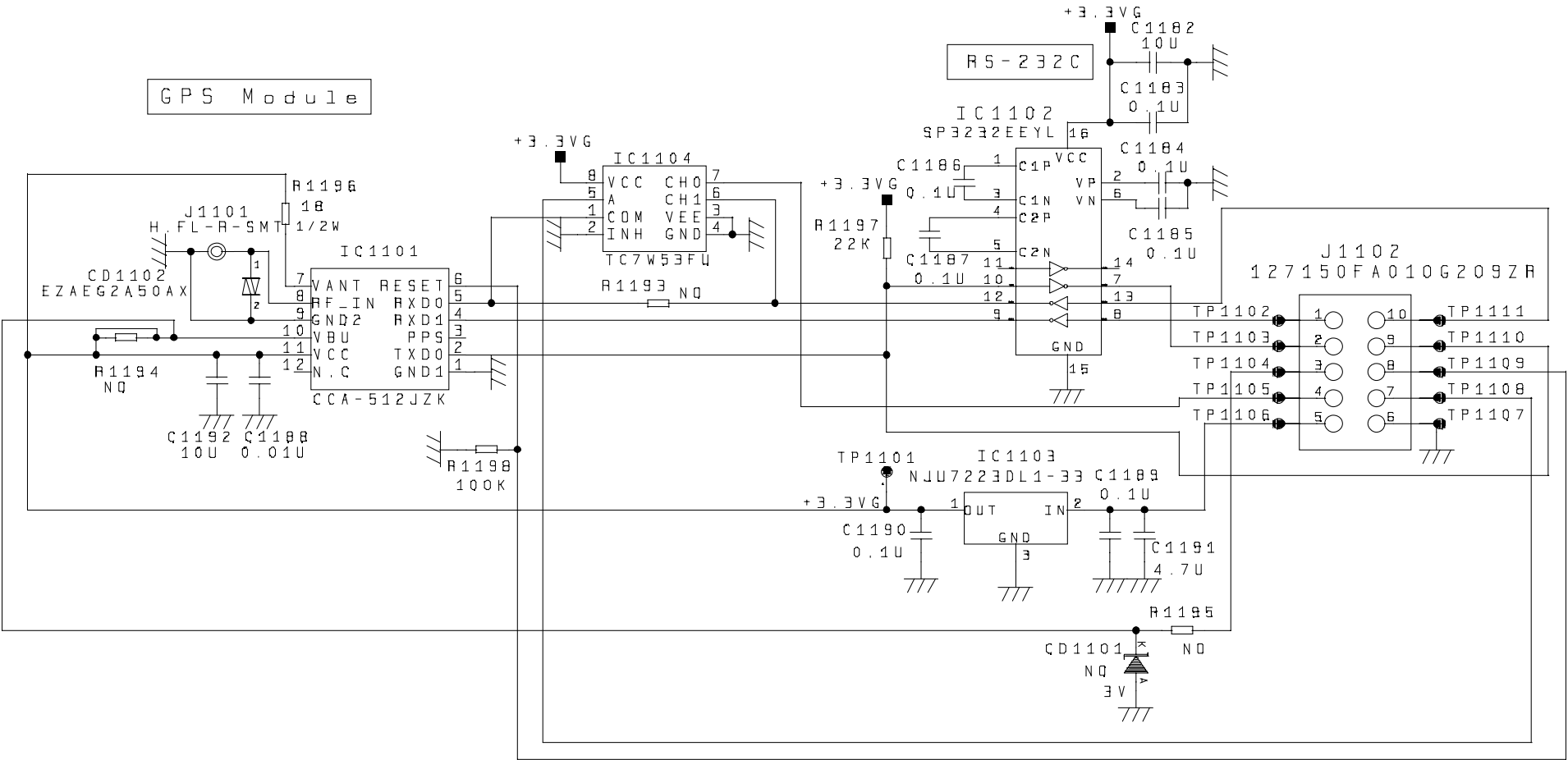
**700/800 MHz  
RF PROCESSOR  
BOARD  
Secondary Side  
(7PCPD0250A)**

23. SERVICE SHEET

23.1 GPS RECEIVER MODULE (OPTIONAL)

J1102 Pin-Out

PIN	PK BOARD SIGNAL NAME	SOURCE	DESCRIPTION
1	DGPS_DATA	External	DGPS Correction Data Input (RXD1); RS-232C
2	GPS_NMEA_RX	GPS	Position Data Output (TXD0); RS-232C
3	+5V	Radio	Backup Power (Not used.)
4	UART2_TX_D	Radio	Initial Setting Data Input (RXD0); +3.3V
5	SWA+	Radio	Switched A+ (+13.6V)
6	GND	Radio	GND
7	UART2_TXRX_EN*	Radio	Select signal of RXD0 H: External GPS_NMEA_TX L: Radio UART2_TX_D
8	GPS_RESET*	Radio	Reset for GPS
9	UART2_RX	GPS	Position Data Output (TXD0); +3.3V
10	GPS_NMEA_TX	External	Initial Setting Data Input (RXD0) RS-232C



**BLOCK, SCHEMATIC AND BOARD OUTLINE  
DIAGRAMS INSIDE  
for  
PK Board and RF Processing Board**

**and**

**SERVICE SHEET INSIDE  
for  
GPS Receiver Module (Optional)**