



MOTOROLA

Cleartone CM5000

**TETRA Mobile Repeater/Gateway
380 - 430 MHz (MT912CR)**

Basic Service Manual

Part Number: 6866539D44-A



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DOCUMENT HISTORY

The following major changes have been implemented in this manual since the previous edition:

Edition	Description	Date
6866539D44-A	Initial edition	Nov. 2007

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Product Safety and RF Energy Exposure for TETRA Mobile Terminals installed in Vehicles or as Fixed Site Control Stations



Caution

THIS CHAPTER IS AN EXTRACT OF THE MULTI LINGUAL MOBILE SAFETY BOOKLET PUBLICATION No. 6866537D37_.

FOR THE LATEST SAFETY INFORMATION REFER TO THE SEPARATE SAFETY BOOKLET DELIVERED WITH YOUR TERMINAL.

BEFORE USING THIS TERMINAL READ THIS INFORMATION WHICH CONTAINS IMPORTANT OPERATING INSTRUCTIONS FOR SAFE USAGE AND RF ENERGY AWARENESS AND CONTROL INFORMATION FOR COMPLIANCE WITH RF ENERGY EXPOSURE LIMITS IN APPLICABLE NATIONAL AND INTERNATIONAL STANDARDS.

RF Energy Exposure Awareness and Control Information, and Operational Instructions for FCC Occupational Use Requirements.

Note: This terminal is intended for use in occupational / controlled conditions, where users have full knowledge of their exposure and can exercise control over their exposure to meet FCC/ICNIRP limits. This terminal device is NOT authorized for general population, consumer or any other use.

This 2-way terminal uses electromagnetic energy in the radio frequency (RF) spectrum to provide communications between two or more users over a distance. It uses radio frequency (RF) energy or radio waves to send and receive calls. RF energy is one form of electromagnetic energy. Other forms include, but are not limited to, sunlight and x-rays. RF energy, however, should not be confused with these other forms of electromagnetic energy, which when used improperly, can cause biological damage. Very high levels of x-rays, for example, can damage tissues and genetic material.

Experts in science, engineering, medicine, health and industry work with organisations to develop standards for safe exposure to RF energy. These standards provide recommended levels of RF exposure for both workers and the general public. These recommended RF exposure levels include substantial margins of protection.

All Motorola 2-way terminals are designed, manufactured and tested to ensure they meet government-established RF exposure levels. In addition, manufacturers also recommend specific operating instructions to users of 2-way terminals. These instructions are important because they inform users about RF energy exposure and provide simple procedures on how to control it.

Please refer to the following Web sites for more information on what RF energy exposure is and how to control your exposure to assure compliance with established RF exposure limits.

<http://www.fcc.gov/oet/rfsafety/rf-faqs.html>

<http://www.osha.gov/SLTC/radiofrequencyradiation/index.html>

Federal Communications Commission Regulations (US markets only)

The FCC rules require manufacturers to comply with the FCC RF energy exposure limits for mobile 2-way terminals before they can be marketed in the U.S. When 2-way terminals are used as a consequence of employment, the FCC requires users to be fully aware of and able to control their exposure to meet occupational requirements. Exposure awareness can be facilitated by the use of a label directing users to specific user awareness information. Your Motorola 2-way terminal has an RF exposure product label. Do not remove this RF exposure label from the device. Also, your Motorola user manual, or separate safety booklet, includes information and operating instructions required to control your RF exposure and to satisfy compliance requirements.

Compliance with RF Exposure Standard

Your Motorola terminal is designed and tested to comply with a number of national and international standards and guidelines (listed below) regarding human exposure to radio frequency electromagnetic energy. **This terminal complies with IEEE and ICNIRP exposure limits for occupational/controlled RF** exposure environments at duty factors of up to 50% talk–50% listen and is authorised by the IEEE/ICNIRP for occupational use. In terms of measuring RF energy for compliance with these exposure guidelines, your terminal antenna radiates measurable RF energy only while it is transmitting (during talking), not when it is receiving (listening) or in standby mode.

Your Motorola two-way terminal complies with the following RF energy exposure standards and guidelines:

- United States Federal Communications Commission, Code of Federal Regulations; 47 CFR part 2 sub-part J
- American National Standards Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999 Edition
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6. Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz, 1999
- Australian Communications Authority Radiocommunications (Electromagnetic Radiation - Human Exposure) Standard 2003
- ANATEL, Brasil Regulatory Authority, Resolution 256 (April 11, 2001) “additional requirements for SMR, cellular and PCS product certification.”

RF Exposure Compliance and Control Guidelines and Operating Instructions

To control exposure to yourself and others and to ensure compliance with the RF exposure limits, always adhere to the following procedures.

Guidelines:

- User awareness instructions should accompany device when transferred to other users.
- Do not use this device if the operational requirements described herein are not met.

Instructions:

- **Transmit no more than the rated duty factor of 50% of the time.** To transmit (talk), push the Push-To-Talk (PTT) button. To receive calls, release the PTT button. Transmitting 50% of the time, or less, is important because this terminal generates measurable RF energy exposure only when transmitting (in terms of measuring for standards compliance).
- **Transmit only when people outside the vehicle are at least the recommended minimum lateral distance away, as shown in Table 1, from the body of a vehicle with a properly installed antenna.** This separation distance will ensure that there is sufficient distance from a properly installed (according to installation instructions) externally-mounted antenna to satisfy the RF exposure requirements in the standards listed above.

Note: Table 1 lists the recommended lateral distance for bystanders in an uncontrolled environment from the body of a vehicle with an approved, properly installed transmitting antenna (i.e. monopoles over a ground plane, or dipoles) at several different ranges of rated radio power for mobile terminals installed in a vehicle.

Table 1. Recommended lateral distance for bystander

Mobile terminal Rated Power (see Note below)	Minimum Lateral Distance From Vehicle Body
Less than 7 Watts	20 cm (8 Inches)
7 to 15 Watts	30 cm (1 Ft)
16 to 39 Watts	60 cm (2 Ft)
40 to 110 Watts	90 cm (3 Ft)

Note: If you are not sure of the rated power of your terminal, contact your Motorola representative or dealer and supply the terminal model number found on the terminal model label. If you cannot determine the rated power out, then assure 90cms (3 feet) separation from the body of the vehicle.

Mobile Antenna Installation Guidelines

- These mobile antenna installation guidelines are limited to metal body motor vehicles or vehicles with appropriate ground planes.
- Antennas should be installed in the centre area of the roof or the trunk lid taking into account the bystander exposure conditions of backseat passengers and according to the specific instructions and restrictions in the Radio (Terminal) Installation Manual along with the requirements of the antenna supplier.
- Trunk lid installations are limited to vehicles with clearly defined flat trunk lids, and in some cases, to specific terminal models and antennas. See the Radio (Terminal) Installation Manual for specific information on how and where to install specific types of approved antennas to facilitate recommended operating distances to all potentially exposed persons.
- **Use only Motorola-approved supplied antenna or a Motorola approved replacement antenna.** Unauthorised antennas, modifications, or attachments could damage the terminal and may result in non-compliance with RF Safety Standards.

Approved Accessories

- This terminal has been tested and meets the RF Safety Standards when used with the Motorola accessories supplied or designated for this product. Use of other accessories may result in non-compliance with RF Safety Standards.
- For a list of Motorola approved antennas, please see your dealer or local Motorola contact. Your nearest dealer can be found at the following web site:

<http://www.motorola.com/businessandgovernment/wemea/en-gb/public/functions/dealerlocator/dealerlocator.aspx>

Additional Information

- For additional information on exposure requirements or other training information, visit

<http://www.motorola.com/rfhealth>

Compliance and Control Guidelines and Operating Instructions for Mobile Two-Way Terminals Installed as Fixed Site Control Stations

If mobile terminal equipment is installed at a fixed location and operated as a control station or as a fixed unit, the antenna installation must comply with the following requirements in order to ensure optimal performance and compliance with the RF energy exposure limits in the standards and guidelines listed on previous page:

- The antenna should be mounted outside the building on the roof or a tower if at all possible.

- As with all fixed site antenna installations, it is the responsibility of the licensee to manage the site in accordance with applicable regulatory requirements and may require additional compliance actions such as site survey measurements, signage, and site access restrictions in order to insure that exposure limits are not exceeded.

Electromagnetic Interference/Compatibility

Note: Nearly every electronic device is susceptible to electromagnetic interference (EMI) if inadequately shielded, designed or otherwise configured for electromagnetic compatibility. It may be necessary to conduct compatibility testing to determine if any electronic equipment used in or around vehicles or near fixed site antenna is sensitive to external RF energy or if any procedures need to be followed to eliminate or mitigate the potential for interaction between the terminal transmitter and the equipment or device.

Facilities

To avoid electromagnetic interference and/or compatibility conflicts, turn off your terminal in any facility where posted notices instruct you to do so. Hospitals or health care facilities may be using equipment that is sensitive to external RF energy.

Vehicles

To avoid possible interaction between the terminal transmitter and any vehicle electronic control modules, such as, ABS, engine, or transmission controls, the terminal should be installed only by an experienced installer and that the following precautions be used when installing the terminal:

1. Refer to the manufacturer's instructions or other technical bulletins for recommendations on terminal installation.
2. Before installing the terminal, determine the location of the electronic control modules and their harnesses in the vehicle.
3. Route all terminal wiring, including the antenna transmission line, as far away as possible from the electronic control units and associated wiring.

Driver Safety

Check the laws and regulations on the use of terminals in the area where you drive. Always obey them. **When using your terminal while driving, please:**

- Give full attention to driving and to the road.
- Pull off the road and park before making or answering a call if driving conditions so require.



OPERATIONAL WARNINGS

WARNING

For Vehicles With Air Bags

Do not mount or place a mobile terminal in the area over an air bag or in the air bag deployment area. Air bags inflate with great force. If a terminal is placed in the air bag deployment area and the air bag inflates, the terminal may be propelled with great force and cause serious injury to occupants of the vehicle.

Potentially Explosive Atmospheres

Turn off your terminal prior to entering any area with a potentially explosive atmosphere. Sparks in a potentially explosive atmosphere can cause an explosion or fire resulting in bodily injury or even death.

The areas with potentially explosive atmospheres referred to above include fuelling areas such as below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles, such as grain, dust or metal powders. Areas with potentially explosive atmospheres are often but not always posted.

Blasting Caps And Blasting Areas

To avoid possible interference with blasting operations, turn off your terminal when you are near electrical blasting caps, in a blasting area, or in areas posted:

"Turn off two-way radio (terminal)". Obey all signs and instructions.

For terminals installed in vehicles fueled by liquefied petroleum gas, refer to the (U.S.) National Fire Protection Association standard, NFPA 58, for storage, handling, and/or container information. For a copy of the LP-gas standard, NFPA 58, contact the National Fire Protection Association, One Battery Park, Quincy, MA.

**Caution****ADDITIONAL IMPORTANT INFORMATION
FOR SERVICING AND INSTALLING THE TERMINAL**

Only specialized workshops should be contacted for installation, maintenance and repair work.

This unit is equipped with protection fuses in the Power and Ignition Sense Cable.
Replace these fuses only with the original ratings!

Caution: **Failure to use correct manufactures approved parts
may result in physical damage to this unit.**

Fuse for Power Cable GKN6270/GKN6274: 10A (Motorola Part Number: 65C80283E05)
Fuse for Ignition Sense Cable HKN9327: 4A (Motorola Part Number: 65C80283E02)

**Achtung****ZUSÄTZLICHE SICHERHEITSINFORMATIONEN FÜR
SERVICE UND INSTALLATION DES FUNKGERÄTES**

Installations, Wartungs- und Reparaturarbeiten dürfen ausschließlich von autorisiertem und geschultem Personal ausgeführt werden.

Dieses Gerät ist mit einer Schutzsicherung im Stromversorgungskabel ausgestattet.
Bei Austausch ausschließlich den Originalwert verwenden

WARNUNG: **Bei Einsetzen von nicht vom Hersteller freigegebenen Ersatzteilen
kann das Gerät zerstört werden.**

Sicherung für Stromversorgungskabel GKN6270/GKN6274: 10A (Motorola Best.-Nr.:65C80283E05)
Sicherung für Zündungserkennungskabel HKN9327: 4A (Motorola Best.-Nr.:6580283E02)

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CHAPTER 1

SCOPE & WARRANTY INFORMATION

Scope of this manual

This manual is intended for use by trained service technicians familiar with similar types of equipment only. It contains information required for the installation of the equipment described and is current as of the printing date. Changes which occur after the printing date may be incorporated by a complete Manual revision or alternatively as additions.

NOTE Before planning or starting the installation, please read the Safety Information Section in the front of this manual.

This manual is divided into the following sections:

- Copyright
- Document History
- User Safety, Training and General Information
- CHAPTER 1 Scope and Warranty Information
- CHAPTER 2 Model Information
- CHAPTER 3 Overview
- CHAPTER 4 Test Setup & Adjustment
- CHAPTER 5 Connector Pin Function
- CHAPTER 6 Parts List and Drawings
- APPENDIX A Replacement Parts and Kits, Service Information

Manuals & User Guides

Service Manual

6866539D44 CM5000 Basic Service Manual (English)

User Guides

6866539D60 CM5000 Basic User Guide (English, German, French, Spanish, Lithuanian)

6866539D64 CM5000 Basic User Guide (English, Swedish, Polish, Dutch, Norwegian)

6866539D54 CM5000 Feature User Guide (English)

Installation Manual

6866539D45 CM5000 Installation Manual (English)

Programmer's Guide

6866539D46 CM5000 Programmer's Guide (English)

Product Safety & RF Exposure Booklet

6866537D37 TETRA Mobile Safety and RF Exposure Booklet (Multilanguage)

6866534D68 TETRA Mobile RTTE Leaflet (English)

Warranty

Motorola offers long term support for its products. This support includes full exchange and/or repair of the product during the warranty period, and service/ repair or spare parts support out of warranty. Warranty Period and Return Instructions

The terms and conditions of warranty are defined fully in the Motorola Dealer or Distributor or Reseller contract. These conditions may change from time to time and the following notes are for guidance purposes only. In instances where the product is covered under a "return for replacement" or "return for repair" warranty, a check of the product should be performed prior to shipping the unit back to Motorola. This is to ensure that the product has been correctly programmed or has not been subjected to damage outside the terms of the warranty.

Prior to shipping any terminal back to the appropriate Motorola warranty depot, please contact Customer Resources or your Motorola dealer, distributor or reseller. All returns must be accompanied by a Warranty Claim Form, available from your Customer Service representative or Motorola Online Extranet (MOL) or your Motorola dealer, distributor or reseller (refer to list in Appendix A). Products should be shipped back in the original packaging, or correctly packaged to ensure no damage occurs in transit.

After Warranty Period

After the Warranty period, Motorola continues to support its products in two ways.

- Motorola's Regional Radio Support Centres offer a repair service to both end users and dealers at competitive prices.
- AAD supplies parts support for the Control Head only. The parts can be purchased by dealers who are technically capable of performing fault analysis and repair. The repairs that require spare parts not listed must be shipped to Motorola for repair.

NOTE

Only Motorola Service Centers or Approved Motorola Service Dealers can perform these functions. Any tampering by non-authorized Motorola Service Centers voids the warranty of your radio.

**To find out more about Motorola and its approved Centers, please visit:
<http://www.motorola.com/governmentandenterprise>**

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CHAPTER 2

MODEL INFORMATION

CM5000 Model Information

The CM5000 is an advanced TETRA mobile radio terminal which has been designed using the latest digital radio communication and micro-computer technology.

The operating protocol and facilities are based on ETS TETRA standards.

Features

- Sophisticated high performance micro-computer controlled.
- High reliability design and production by adoption of surface mount technology and LSI devices.
- User friendly controls with audio and visual confidence indicators.
- Large screen full dot matrix color display.
- Multiple facilities and options:
 - Status Messages
 - Emergency Call
 - Multi-Site Roaming
 - Serial Communication Port for PC Connection
 - Data Communication Air Interface
 - Serial Data Port
 - GPS Receiver Connection

Technical Specifications

GENERAL		RECEIVER		TRANSMITTER	
ETSi:	ETS 300 394-1	Receiver Type:	Superheterodyne	Modulation Type:	$\pi/4$ DQPSK
Type Number:		Frequency Range:		RF Power:	
380-430 MHz	MT912CR	380-430 MHz		TMO	3,16 W / 35 dBm
				DMO	3,16 W / 35 dBm
Temperature Range for Transceiver:		Channel Spacing:	25 kHz	Frequency Range TMO:	
Operating	-20°C to +60°C			380-430 MHz	
Storage:	-40°C to +80°C	Sensitivity (3.5%) BER:	-112 dBm	Frequency Range DMO:	
Power Supply:		Intermodulation Response Rejection:	-47 dBm	380-430 MHz	
Minimum:	10.8 Vdc	Spurious Response Rejection:	-45 dBm	Frequency Stability:	
Nominal:	13.2 Vdc	Adjacent Channel Interference Ratio:	-45 dB	Locked to Base	+/-100 Hz
Maximum:	15.6 Vdc	Frequency Stability:		Not Locked to Base	+/- 1 kHz
max. Current	approx. 3.5 A	Locked to Base	+/-100 Hz	Spurious Emissions:	
Dimensions (HxWxD) in mm:		Unlocked to Base	+/- 1 kHz	Conducted/ Radiated – 36 dBm <=1GHz	
Radio Unit:	63 x 188 x 201	Audio Rated		– 30 dBm > 1GHz	
Control Head:	72 x 185 x 53	(@4 Ohms):	10 W	Adjacent Channel Power (@ ± 25 kHz):	
Weight in grams:		For External Speaker:	5% Max.	380-430 MHz	– 60 dBc
Radio Unit only	1450	Distortion at Rated Audio:			
Control Head only	250				
Radio Unit plus CH	1700				

Note: Technical information may be subject to change without further notice.

Feature Specification

Title	Specifications
Talk Groups - TMO	2048
Talk Groups - DMO	1024
Phone Book Entries	1000
Text Message List	20
Status List	100
Country Code/Network Code List	100
Scan Lists	20 Lists of 20 Groups
Operating Temperature	-20 to +60 °C
Storage Temperature	-40 to +80 °C
Humidity	ETS 300 019-1-5 Class 5.1 and 5.2, up to 95% R.H. @35 °C; EIA/TIA 603 (95%)
Dust & Water	IP54
Shock, Drop & Vibration	ETS 300 019-1-5 class 5M2 and class 5M3
Thermal Shock	-40 °C to +80 °C

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CHAPTER 3

OVERVIEW

General

CM5000 TETRA Radio Terminal consists of two PC boards. One is the Main Unit and the other is the Key & Display Unit.

The Main Unit consists of Digital Control Circuit unit and the Radio Circuit.

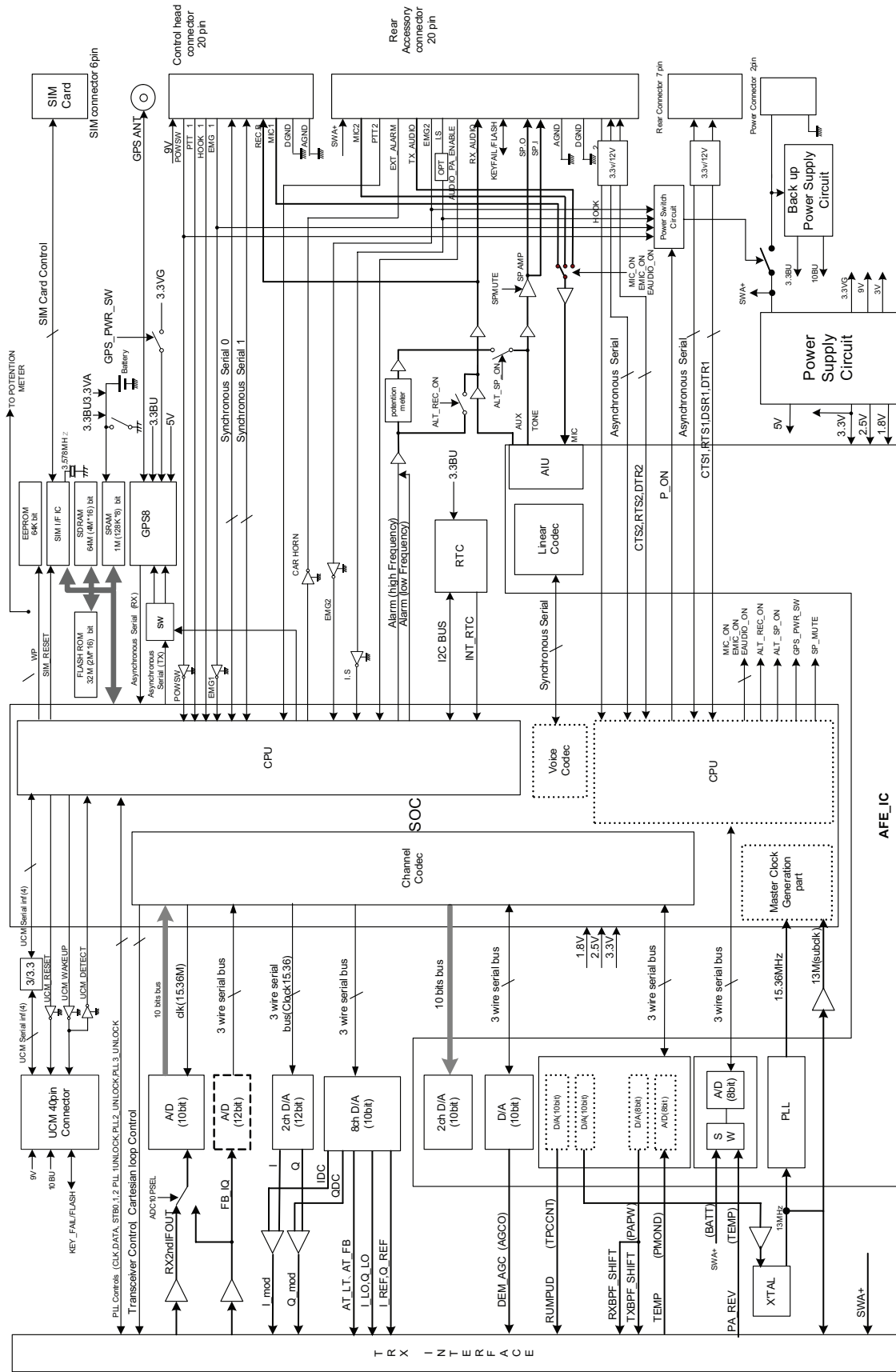
Digital Control Circuit

The Digital Control Circuit controls the whole radio equipment accordance with key operation of the Key/Display Unit or received signal from TRBS (TETRA Network Radio Base Station) which are fed from the radio circuit or external data from PEI (Peripheral Equipment Interface Circuit).

The Digital Control Circuit consists of:

- System Controller
- Digital Signal Processing
- External Interface Circuit

Figure 1. Digital Control Circuit



System Controller

System Controller consists of System On Chip (SOC), ROM / RAMs, and supply voltage regulator.

The SOC (IC 601) contains Microprocessor (CPU), DSP (Digital Signal Processor) and peripheral circuit. It is constantly working when the radio unit is turned on. It is sampling the signal cause from switch operation of the radio and the received control signal from a TRBS which is processed by digital signal processor circuit.

Once any of these signal lines have been changed the microprocessor knows what to do and then sends out the control signal to the necessary circuit.

The system program for the Main unit is installed in the Flash-ROM (IC602).

The microprocessor in the SOC copies the program from Flash-ROM to the SDRAM (IC603) when the radio is powered up. The microprocessor reads the program from SDRAM, and executes the instructions accordingly.

The radio parameter of the equipment is installed in the free area of the Flash-ROM (IC602). The temporary data of the equipment is stored in the SDRAM (IC603) and SRAM (IC604). The radio parameters (e.g. output power adjustment, receiver adjustment) are stored in the EEPROM (IC605).

Digital Signal Processing

Digital signal processing circuit is consist of the following devices.

- Channel CODEC DSP, Voice CODEC DSP and signal processing hardware in the SOC (System On Chip)
- ADC, DAC and Linear CODEC in the AFE (Analog Front End).
- Peripheral 10 bit ADC and 12 bit DAC

Receive Process and Decoding

Received analog signal that is converted to the IF frequency was converted to the digital signal by the 10 bit ADC and fed to the SOC.

The digital signal is quadrature detected and filtered, then converted to the I/Q signal.

The channel CODEC recover the I/Q signal to the original signal stream by delay detection, and perform Channel Decoding.

Then the decoded signal is fed to Voice CODEC in case of voice signal or fed to CPU in case of control signal or message data.

Transmit Process and Coding

The voice CODEC DSP sends the coded voice data to the Channel CODEC. The CPU sends the control and message data to the Channel CODEC.

The channel CODEC DSP perform channel encoding and framing the provided signal, then convert to the I/Q signal.

The I/Q signal is filtered (roll off alpha = 0.35) by the signal processing hardware in the SOC. Then converted to the analog signal as I/Q signal by the 12 bit DAC.

Voice CODEC (ACELP)

Transmit analog voice data is converted to the digital signal by the linear CODEC and fed to the Voice CODEC DSP.

The Voice CODEC DSP compresses the input digital signal by ACELP algorithm to the coded voice data. And the data is fed to the Channel CODEC DSP.

Received digital voice data is fed to the voice CODEC DSP from Channel CODEC DSP as coded voice data.

The Voice CODEC DSP expands the coded voice data and fed to the linear CODEC. The digital signal is converted to the analog signal by the linear CODEC and output as analog signal.

Frequency Compensation

The Channel CODEC DSP calculates frequency error between the radio and base station (Master station in DMO). It controls the VC-TCXO by DAC so as to minimize the frequency error. The VC-TCXO works as time base reference of the radio.

Transmit Power Control and Linearization

The Channel CODEC DSP controls the output power by the DAC based on the receive signal strength and broadcast information from the base station.

Also the DSP calculates so as to minimize the distortion of the transmitter and carrier leak and controls the Cartesian Loop by DAC.

VC-TCXO

The reference signal for the PLL synthesizer is generated by VC-TCXO. The oscillation frequency of the 13 MHz reference signal is fine controlled by Channel CODEC DSP. The frequency error between the Radio Terminal and TRBS is detected and error correction signal is generated by DPS. And the error correction signal is fed to Voltage Control circuit of the TCXO to make fine frequency tuning.

Interface Unit

The Main unit has analog interface circuit and digital interface circuit for external interface.

Digital Interface

Digital interface is connected to the connector J902 and J904 at the rear of the Main unit. Those connectors are combined in the one connector, but electrically independent. One is RS232 level interface, and the other is 0 V / 3 V interface level.

The RS232 level serial communication is connected to the 7 pins connector (J904) at the rear of the Main unit. This connector is used for the programming of the radio parameter, AT command control, data output for the log etc.

0 V / 3 V level serial communication is connected to the 20 pins connector (J902). This connector is used for same purpose. Features of those connectors are configured by programming. When connecting the external equipment with the 20 pins connector (J902), appropriate level converter is required.

Analog Interface

For the external interface other than serial communication, J902 has analog interface as follows:

- | | | |
|-----|-----------|---|
| 1. | Ext. SP | External speaker output |
| 2. | Ext. Mic | Microphone input terminal other than Key/Display unit |
| 3. | Ext. PTT | PTT input terminal other than Key/Display unit |
| 4. | Ext. Alm | Alarm output terminal for external alarm device |
| 5. | TX Audio | Transmit audio signal input other than Key/Display unit |
| 6. | EMG SW | EMG input terminal other than Key/Display unit |
| 7. | RX Audio | RX signal output terminal for external device |
| 8. | SP enable | Speaker output control |
| 9. | SW B+ | Switched 13 V output |
| 10. | Hook | Hook signal input |

Panel Interface

Communication with the Key & Display unit such as Key operation signal, LCD control interface, LCD/Key backlight control, and 2 color indicator LED control interface is performed via connector J901 by serial communication. The signaling level is 0 V / 3.3 V and baud rate is 115.2 kbps. Other than control signal, audio output signal for the handset, audio signal from microphone and Hook signal are connect with Key/Display unit via J901.

Audio Circuit

Audio circuit includes receive audio, transmit audio circuit.

Receive audio circuit has speaker amplifier and handset audio circuit.

Receive Speaker

Received signal that is converted to the analog signal at Linear CODEC in the AFE is volume controlled by the linear CODEC and amplified by the OP amplifier (IC802)

Speaker amplifier (IC805) is BTL type amplifier. It amplifies audio signal. Speaker output signal is connected to the external speaker via interface connector J902.

Operational tone signal is generated by the SOC and amplified by the OP amplifier (IC802). Then the tone volume is adjusted by the potentiometer (IC803) and OP amplifier (IC802) and mixed with receive signal by the OP amplifier (IC802).

Handset Circuit

Fixed level received audio signal is outputted by the AFE and amplified by the OP amplifier (IC801). Variable volume control received audio signal is mixed at OP amplifier (IC801) via audio switch (IC806). Operation tone is mixed in IC801 via audio switch IC804. SOC controls selection of these signals.

These signals are connected to the Microphone connector on the Key/Display unit and the interface connector (J902) at the rear of the main units.

Transmit Audio Signal

TX audio, Ext. Mic of the external analog interface and Microphone signal of the Key/Display unit is selected by the audio switch (IC806). SOC selects those signals. The selected signal is adjusted the level by IC802 and fed to the Linear CODEC in the AFE.

Power Supply Circuit

DC power for the radio is connected to the DC connector (J851) at the rear of the main unit. DC power is divided to the un-switched pass and switched pass.

Not switched pass is connected to the voltage regulators (IC851 and IC852). The voltage regulators supply DC power for the backup memory.

Switched pass is connected to the FET switch (TR851). This FET is controlled ON/OFF by the control signal that activated by the encoder on the Key/display unit or external device. ON/OFF control signal is fed to the Gate of the FET via transistor (TR852 to TR855). The switched power is named as SWA+. This power is connected to the followed voltage regulators.

IC853 and peripheral circuit consists of DC/DC converter and generate 3.3 V. This power is used for the digital circuit such as SOC. And this power is connected to the followed voltage regulators to generate lower voltage.

IC854 generates 1.8 V (1.8 VC), IC855 generates 2.5 V (2.5 VID) and IC856 generates 2.5 V (2.5 VIA). Those regulators are designed to turn on in the order of 2.5 VIA, 2.5 VID and 1.8 VC. IC857 generates 1.8 V (1.8 VI).

The reset IC (IC861) generates reset signal for SOC.

SIM Interface

The GSM type SIM card is used. SIM card is inserted to the SIM card connector (J801).

SIM interface IC (IC809) is used for the interface to the SOC.

GPS

GPS receiver (IC611) is used for receiving the GPS signal. External GPS antenna is connected to the GPS antenna connector at the rear of the main unit. The GPS signal from the GPS antenna is connected to the GPS receiver via the RF connector (J605).

The GPS receiver is connected via the serial interface IC (IC612) to the SOC. Received GPS signal from the receiver or control signal from SOC is communicated by the serial communication.

DC power supply for the GPS antenna is feed through the J605.

RTC

The RTC (Real Time Clock) is controlled by the SOC via IIC bus. Also the RTC signal is outputted to the SOC via IIC bus.

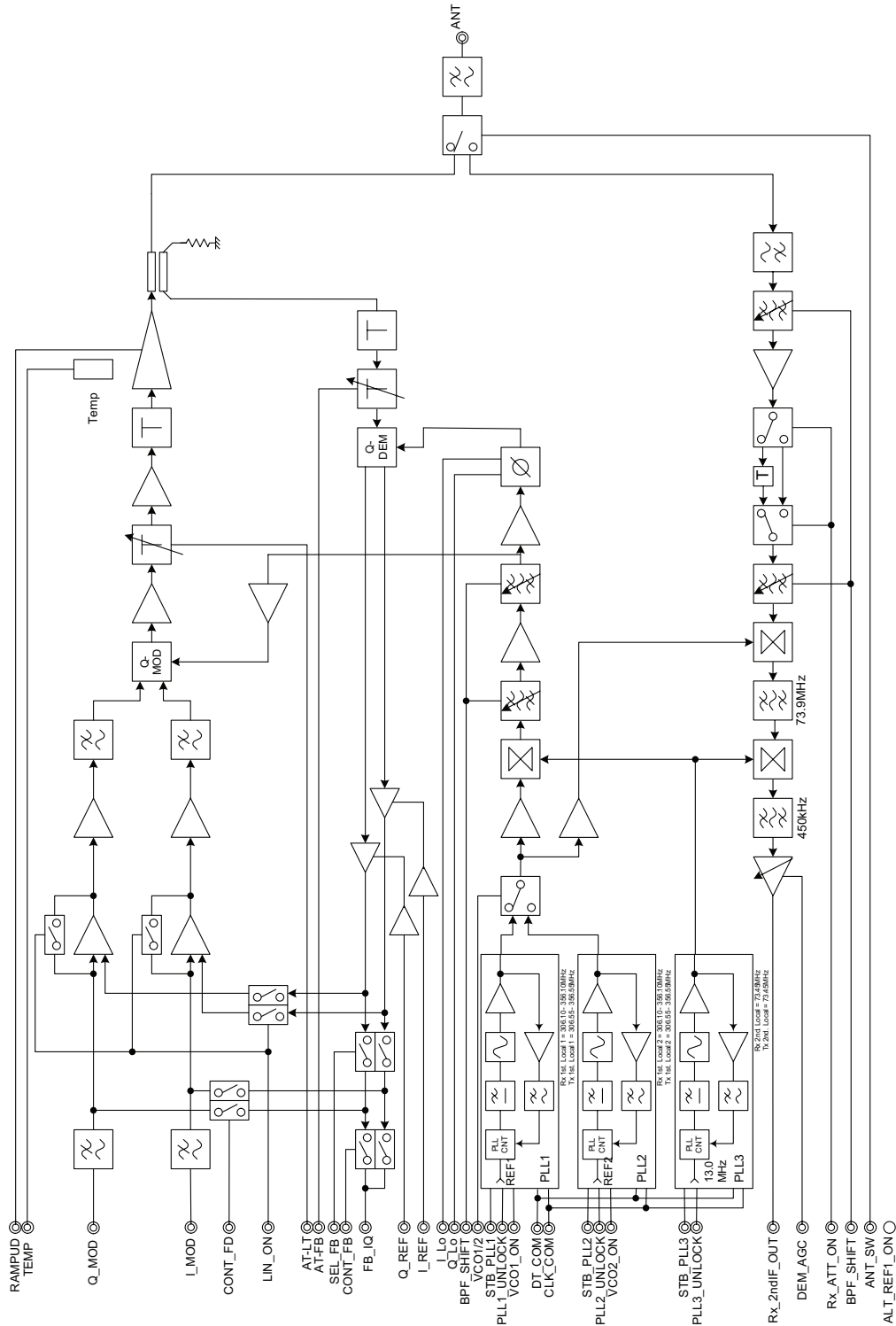
UCM

The main unit has UCM connector (J903). This is serial interface to the SOC.

Radio Circuit

Radio circuit contains Receiver RF amplifier and mixer, first IF stage, 2nd if stage, Phase lock loop (PLL) frequency synthesizer, Transmitter I/Q modulator and buffer, Power Amplifier, linearizer and Output power control circuit and power supply circuit.

Figure 2. Radio Circuit Block Diagram



Receiver RF Amplifier and Mixer

Received signal that is connected to the antenna connector (J201) is fed to the receiver circuit via the Low Pass Filter (FL201) and antenna switch (CD204 and IC204).

The antenna switch is controlled by the transistor (TR201 and TR203).

Received signal from antenna switch is fed to the double tuned band pass filter and unwanted signal is rejected at the filter. This filter is voltage controlled tunable filter.

The control voltage is fed to the filter via the buffer amplifier (IC471).

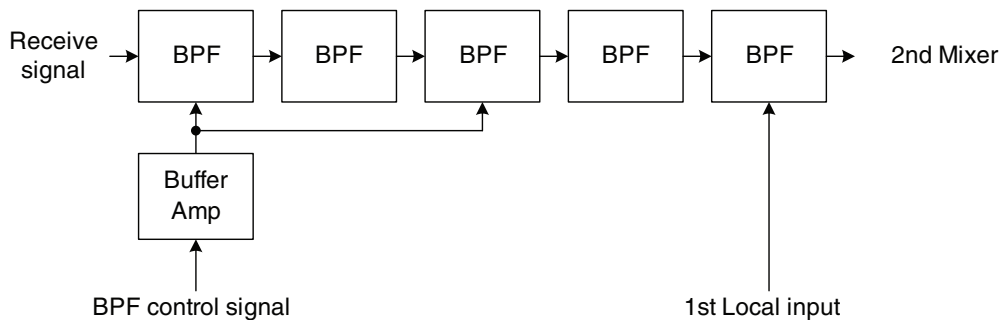
Output signal from the filter is amplified by the RF amplifier (TR401) and fed to the attenuator circuit (IC402 ad IC403). This attenuator is used to expand the dynamic range of the receiver and it is switched according to received signal strength. Attenuator control signal is fed to the attenuator via the transistor (TR470) and IC (IC472).

Output signal from the attenuator is filtered by the 2nd double tune band pass filter and fed to the 1st mixer (TR402). This band pass filter is also tuned by the control voltage.

The 1st mixer is N-channel dual gate MOS FET. The received signal is fed to the Gate 1 and the local signal is fed to the Gate 2 of the FET.

The received signal is converted to the 1st IF signal. The converted 1st IF signal is 73.9 MHz and it is fed to the 1st IF circuit.

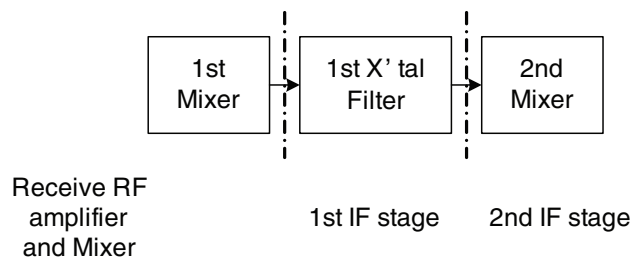
Figure 3. Receiver RF amplifier and Mixer Block Diagram



First IF stage

The 1st IF stage consists of the crystal filter (FL470). The output signal from the 1st mixer is fed to the input of the crystal filter (FL470), and unwanted signal is filtered. The output signal of the filter is fed to the 2nd IF stage.

Figure 4. 1st IF Stage Block Diagram



Second IF stage

The second IF stage consists of IF IC (IC470) and Ceramic filter (FL471). The IF IC consists of 2nd Mixer and AGC amplifier.

The IF IC consists of the 2nd Mixer and AGC amplifier.

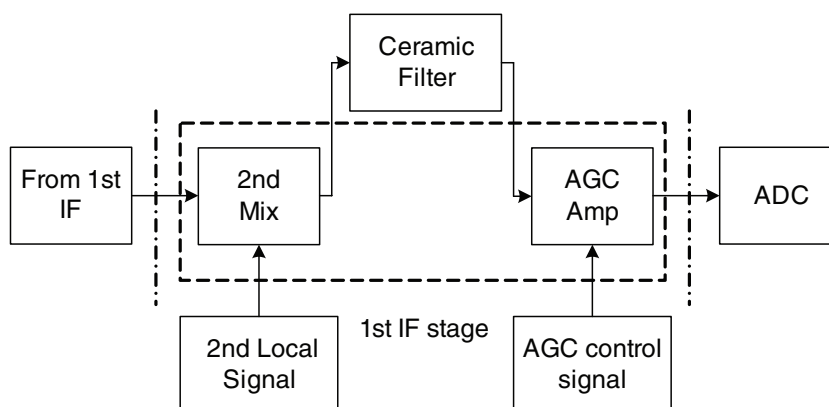
Received signal from the 1st IF filter and 2nd local signal from the PLL are fed to the input terminal of the 2nd mixer in the IF IC. Then 1st IF signal is converted to the 450 kHz 2nd IF signal. The signal from the 2nd Mixer is connected to the AGC amplifier in the IF IC through 450 kHz ceramic filter.

Amplified signal at the AGC amplifier is fed to the ADC in the control circuit.

The AGC amplifier is controlled by the AGC voltage to maintain constant output voltage so as to maintain appropriate ADC input voltage.

Control circuit determines the gain of AGC amplifier, and it generates the DC voltage by DAC and fed to the AGC amplifier via the buffer amplifier (IC471).

Figure 5. 2nd IF stage and AGC amplifier Block Diagram



PLL (Phase lock loop) frequency synthesizer

PLL (Phase lock loop) frequency synthesizer consists of two main blocks. One is RX 1st Local PLL frequency synthesizer block and the other one is 2nd Local PLL frequency synthesizer.

1st Local PLL

The 1st Local PLL consists of the PLL IC (IC501), Loop filter, VCO (HC501) and peripheral circuit. To realise the TETRA TDMA burst signaling at high speed, fractional N counter type synthesizer is used.

The 1st local signal is fed to the 1st mixer (TR402) in the receiver circuit and transmit mixer (CD1002).

2nd Local PLL

The 2nd local PLL consists of the PLL IC (IC1001), Loop filter, VCO (TR1001), buffer transistor (TR1003 and TR1004) and peripheral circuit.

Output signal of the VCO (TR1001) is amplified by the amplifier (TR1003 and TR1004). This signal is divided into 2, one is feed back to the PLL IC. The other signal is fed to the receive mixer and the transmit mixer through the buffer amplifier (TR1004).

This PLL generates constant frequency in RX and TX.

Output signal of the 2nd PLL is fed to the 2nd mixer in the IF IC (IC470) and transmit mixer (CD1002).

Transmit Mixer and Peripheral Circuit

The 1st local signal is amplified by the buffer amplifier (IC507 and TR1005) and fed to the transmit mixer (CD1002).

The transmit mixer (CD1002) mixes the 1st local signal and 2nd local signal to generate the transmit signal. High linearity double balanced mixer is used.

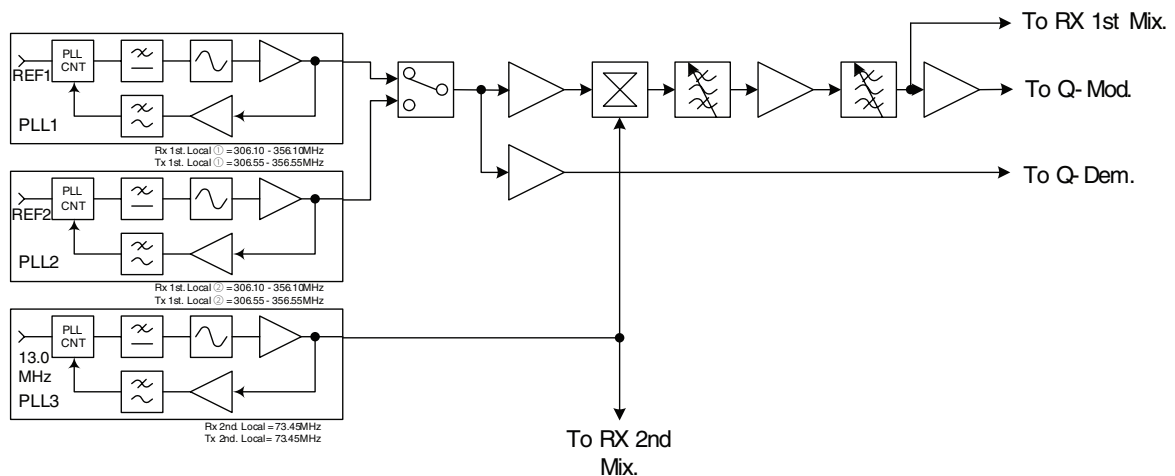
Mixed signal is fed to the 2 stages of the band pass filter and buffer amplifier.

The output of the mixer is filtered by the 1st band pass filter. Center frequency of the filter is controlled by the tuning voltage from the control circuit. The control voltage is generated by the DAC (IC701) and fed to the filter via buffer amplifier (IC1002).

The output of the band pass filter is amplified by the buffer amplifier (IC2001) and fed to the 2nd band pass filter. The 2nd band pass filter is also tunable filter same as 1st filter.

The output signal of the 2nd band pass filter is divided into 2, and fed to the quadrature modulator and quadrature demodulator in the Cartesian Loop through the buffer amplifier (IC510 and IC511).

Figure 6. PLL (Phase lock loop) frequency synthesizer



Transmitter I/Q modulator and buffer circuit

The base band signal of the digital signal processing circuit is fed to the quadrature modulator (IC306) via OP amplifier (IC301), comparator (IC302) and buffer amplifier (IC305). The carrier signal from PLL synthesizer is fed to the quadrature modulator.

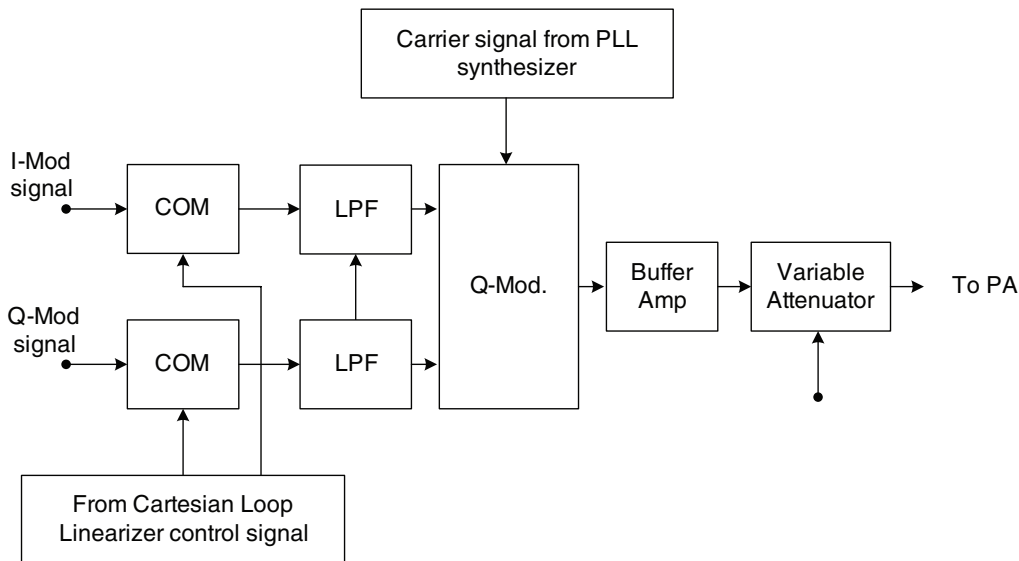
The comparator in the modulation circuit operates as linearizer. Error correct signal of I and Q signals are generated at the linearizer circuit and fed to the comparator.

Carrier signal is modulated as pi/4 shift DQPSK signal by I and Q signal. Modulated signal is amplified by the buffer amplifier (TR301) to the appropriate level to drive the power amplifier.

Output of the buffer amplifier is fed to variable attenuator (CD301). Variable attenuator is controlled by the digital signal processing circuit to output suitable level.

The output of the attenuator is fed to the Power amplifier module (HC201).

Figure 7. Transmitter I/Q modulator and buffer Block Diagram



Transmitter Power Amplifier

Modulated signal is fed to the PA hybrid IC (HC201). This hybrid IC consists of 3 stage amplifier. Using high level FET at the final stage to realize high linearity.

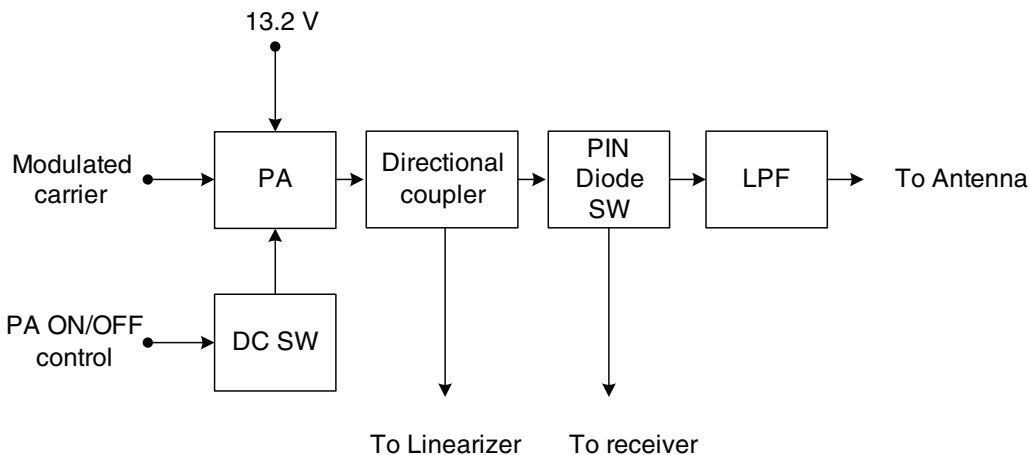
The gate bias voltage for the PA module is controlled by the control circuit and fed to the PA stage via buffer amplifier (IC202).

The output of the PA is picked up by the directional coupler (CD202) and fed to the linearizer.

PIN diode antenna switch (CD203 and CD 204) are used to realize TDMA fast transmit receive switching. The control circuit controls the bias current of the antenna switch with transistor (TR201).

The transmit signal that passed the antenna switch is fed to the Low pass filter (FL201) to reject the spurious signal. Output signal of the LPF is fed to the BNC connector (J201).

Figure 8. Transmitter Power Amplifier Block Diagram



Linearizer and Power Control Circuit

This circuit consists of coupler, carrier phase shifter, quadrature demodulator, DC offset buffer and comparator. To meet TETRA ACP specification requirements, Cartesian loop type linearizer is used.

The transmit signal that is picked up by the coupler is attenuated by the variable attenuator (CD303) and fed to the quadrature demodulator (IC308). The output of the quadrature demodulator is fed to the ADC of the control circuit and comparator. The control circuit calculates the phase and amplitude difference between the modulate signal and demodulate signal. Amplitude balance is adjusted at the factory.

Phase difference is adjusted dynamically by phase shifter (IC319) to adjust the phase of quadrature demodulator.

The DAC (IC702) output voltage is controlled and this voltage controls phase of the carried via buffer amplifier (IC318).

The DC offset of the demodulated I and Q signal is corrected by adding the DC voltage from DAC (IC702) at adder IC (IC318). Each I and Q signal is fed to the comparator and compared with reference modulation signal.

Transmit signal level is controlled by operating the forward attenuator (CD301) and reverse attenuator (CD303) complementary.

Those attenuator should be controlled depend on the transmit power level. Output voltage of the DAC (IC702) is changed and this voltage is fed to the buffer amplifier (IC307) and attenuator (CD301). Then the output level of attenuator (CD301) is changed and input level of the Power amplifier is changed.

Due to transmit level change, the picked up signal by the coupler for quadrature demodulator is changed. To maintain the input level of the demodulator, attenuation of the reverse attenuator (CD303) should be change. DAC (IC702) generates the control voltage for the reverse attenuator to maintain the input level of the quadrature demodulator.

Power Supply

The voltage regulator of the RF circuit is series drop type. DC power via the power switch is fed to the 9 V regulator IC (IC206). This voltage is used for transmit circuit.

9 V power is fed to the 5 V and 3.3 V regulator.

5 V voltage regulator (IC207) provides 5 V power for PLL circuit. Also this voltage is switched by transistor (TR204) and fed to PLL circuit.

3.3 V voltage regulator (IC210) provides 3.3 V power for PLL circuit.

5 V regulator (IC208) provides 5 V power for the transmitter and receiver circuit. Also this voltage is switched by transistor (TR206) and fed to receiver circuit.

5 V regulator (IC209) provides 5 V power for the transmitter circuit. Also this voltage is switched by transistor (TR208) and fed to transmitter circuit.

Key and display Unit

Panel CPU and Peripheral Circuit

Panel CPU (IC001) is communicating with Main CPU in the main unit. It transfer key operation to the Main CPU and control the LCD based on the command from Main CPU.

CPU contains FLSH ROM, SD RAM interface, ADC, DAC, LCD controller and serial communication.

The Flash ROM (IC003) stores the source code, font data and portrayal bit map data. SDRAM (IC002) is working area.

The panel CPU communicates with the main unit CPU via buffer IC (IC008). The serial communication is baud rate 115.2kbps, 8 bits, non parity and 0 V / 3.3 V level.

Temperature sensor IC (IC004) is used for the temperature compensation of the LCD contrast. The CPU reads the temperature data of temperature sensor by ADC.

White color LED driver IC (IC106) controls the intensity of the LCD back light LED.

The intensity is controlled by the output voltage of the DAC in the CPU.

CPU oscillates clock frequency with crystal (X001) and multiplies 8 times internally.

The core of the CPU operates at 115.2 MHz, Bus clock operates at 57.6 MHz and peripheral block operate at 28.8 MHz.

Interface

The Connector (J006) connects the Key/Display unit and main unit.

Microphone signal, received signal for handset, hook signal, control signal and power source of key/display unit are connected to the J006.

Key

Key is switched ON and OFF by metal dome contacts (SW101 to SW124).

SW101 to SW114 and SW116 to SW124 are scanned by key matrix. The emergency key SW115 is independent input contact.

Keys are back lighted by the blue LEDs. The back light intensity is controlled as 3 levels (OFF - Low - High) by controlling the transistor (TR107 and TR108) by the control signal of the CPU.

Switch

The power switch and volume control are adjusted by the rotary knob (SW001).

Pushing the rotary knob turns the radio on. Turning the encoder controls the audio volume and selects the screen menu.

Other than pushing the rotary knob, pressing the emergency button will turn the radio on. In this case an emergency call will be originated as soon as power on the radio.

Display

The display is 2.8 inch STN type 240RGB x 160 dots matrix color LCD module (DD001).

The control signal from the Panel CPU is connected to the LCD unit via the LCD interface connector (J102).

The LCD is back lighted by the internal back light white LED in the LCD module. Intensity of the LCD back light is controlled by the output voltage of the back light power supply (IC106) by the output voltage of the DAC of the CPU.

Back light signal is connected to the LCD unit via the back light connector (J101).

Indicator LED

2 colors LED indicator (CD102) indicates the status of the radio. The panel CPU controls the LED as red, green or amber via the transistor (TR101 and TR102)

Connector

Microphone is connected to the Key/Display unit via the RJ-45 type connector (J005).

Microphone signal, hook signal, receive signal and function key signal for handset are connected to the microphone connector.

Audio Circuit

The microphone signal fed to the connector (J005) is amplified by the microphone amplifier (IC107) and fed to the main unit via interface connector (J006).

Receive signal for the handset is amplified by the audio amplifier (IC107) and fed to the microphone connector.

Power Supply Circuit

The power supply for the Key/Display unit converts the DC 9 V from the main unit to generates each voltage power for the Key/Display unit.

The 9 V voltage is fed to the audio circuit, indicator LED and back light LED.

The 5 V voltage is generated by the voltage regulator IC (IC102) and fed to the back light of the LCD.

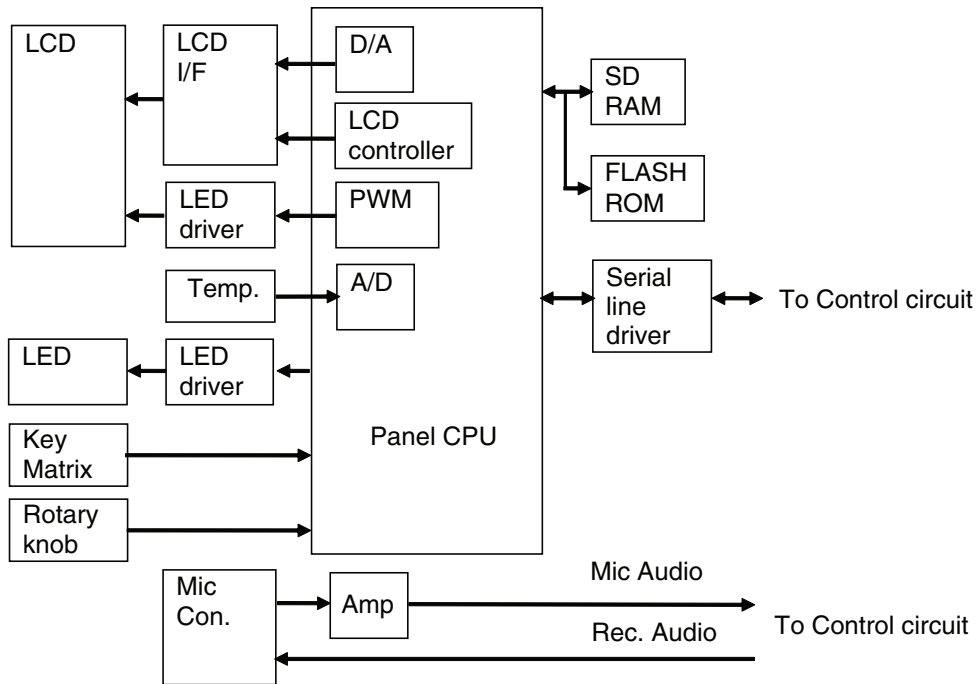
The 3.3 V voltage is generated by the voltage regulator IC (IC103) and fed to the CPU, LCD module and other digital circuit.

The 1.5 V voltage is generated by the voltage regulator IC (IC105) and fed to the CPU core.

1.5 V power will be turn on after turn ON the 3.3 V regulator.

The reset IC (IC108) generates the reset signal at power on the radio and reset the CPU.

Figure 10. Key/display Sub-Unit block Diagram



CHAPTER 4

TEST SETUP & ADJUSTMENT

Typical Test Setup

STEP 1

Set the DC power supply to 13.2 V. (More than 5 A current capacity DC power supply is required.)

STEP 2

Connect under adjustment radio terminal to DC power supply. (The radio terminal should be turned off in this period.)

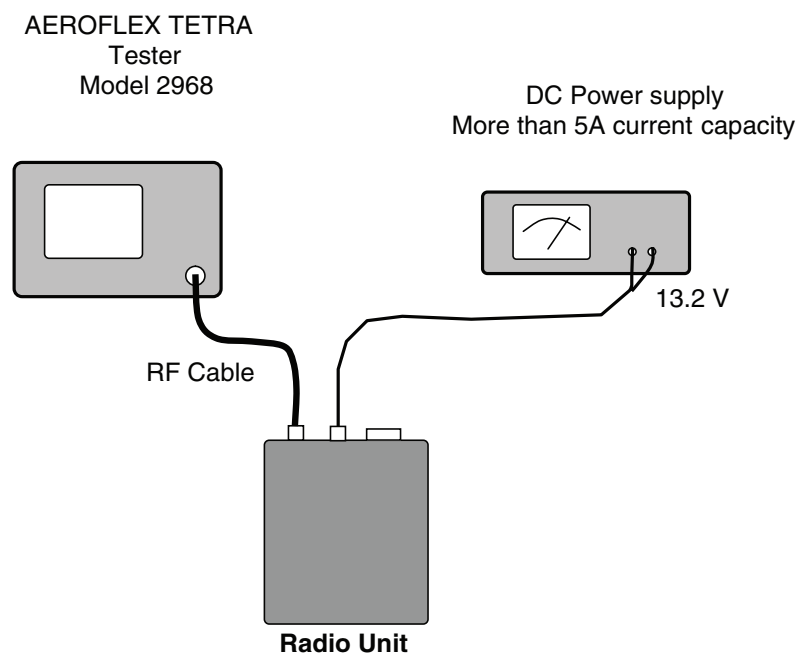
STEP 3

Connect the Antenna connector of radio terminal and RF connector of TETRA Tester of AEROFLEX Type 2968.

STEP 4

Press Menu key and numeric key [2] and the Rotary knob simultaneously. The radio terminal switches to JRC TEST mode.

Figure 11. Test Connection Diagram



Self Check

When a radio unit is turned on, a self check program is started automatically.

If no failures occur then all segments of the display on the front panel are turned on. A short beep indicates that the self check test has been completed without a failure.

Self check takes approximately 1 second.

After the test radio unit displays its own ID for approximately 1 second and switches to normal operation.

Error Codes

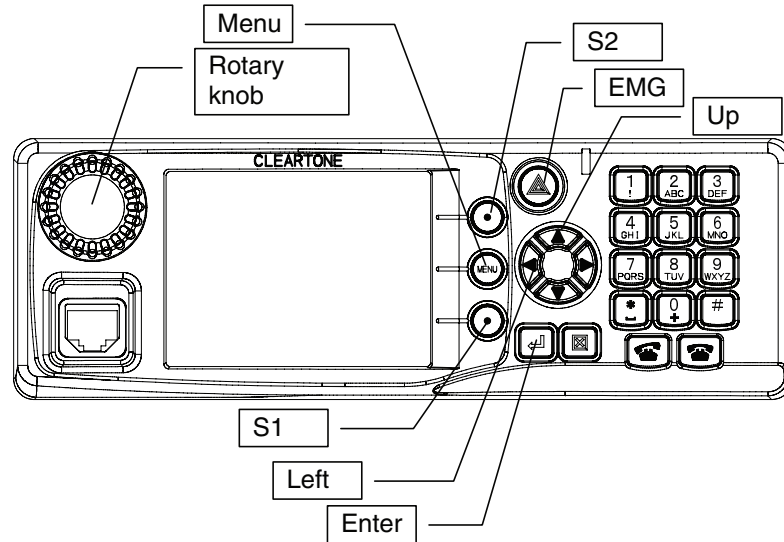
If the radio unit fails in the self check routine, an error code is shown on the display and a alert beep is played.

Table 2. Error codes

Error Code	Description
Native data prog. error	Programming data error
Radio config. prog. error	Radio configuration programming error
Security prog. error	Security data programming error

IFR 2968 - Channel and Mode Setting

Figure 12. Panel Layouts



IFR 2968 should be set as follows:

Table 3. Channel and mode

Radio Channel	IFR2968 Channel	Frequency		IFR2968 Setting	(see item 2 and 3)	Power adjustment
		TX	RX	Band	Normal/Reverse	
3200	3200		380.0125 MHz	A	Reverse	
3600	3600	380.0125 MHz		A	Normal	x
4000	4000	390.0125 MHz				x
4400		400.0125 MHz		B	Normal	x
4208	0208h		405.2125 MHz	B	Normal	
4608	0608h	405.2125 MHz		B	Normal	
4800	800	410.0125 MHz		B	Normal	x
5200	1200	420.0125 MHz		B	Normal	x
5600	1600	430.0125 MHz				x
5200	1200h		430.0125 MHz		Normal	
4800	0800h	430.0125 MHz			Reverse	

Note: On the radio the channels have a displacement of 4000 (B Band only). For example IFR Channel 0800 is equal to CM5000 Channel 4800.

STEP 1

Set the IFR to the following parameter in system parameters.
(MAX TX LEVEL) to 40 dBm

STEP 2

RF Gen Level
-112 dBm

STEP 3

Channel Plan
Set to "USER DEFINED"

STEP 4

Channel Block setting in "User Defined" menu

- i) Select "CHANNEL BLOCK 1" and enter the following parameters:
- | | |
|-----------------------------|--------------|
| CHANNEL BLOCK | EXCLUDED |
| LOWEST CHANNEL | 0000 |
| HIGHEST CHANNEL | 4095 |
| LOWEST CHANNEL TX FREQUENCY | 290.0125 MHz |
| DUPLEXT OFFSET | 10 MHz |
| CHANNEL SPACING | 25 kHz |
- ii) Select "CHANNEL BLOCK 2" and enter the following parameters:
- | | |
|-----------------------------|--------------|
| CHANNEL BLOCK | EXCLUDED |
| LOWEST CHANNEL | 0000 |
| HIGHEST CHANNEL | 4095 |
| LOWEST CHANNEL TX FREQUENCY | 310.0125 MHz |
| DUPLEXT OFFSET | -10 MHz |
| CHANNEL SPACING | 25 kHz |
- iii) Select "CHANNEL BLOCK 2" and enter the following parameters:
- | | |
|-----------------------------|--------------|
| CHANNEL BLOCK | EXCLUDED |
| LOWEST CHANNEL | 0000 |
| HIGHEST CHANNEL | 4095 |
| LOWEST CHANNEL TX FREQUENCY | 390.0125 MHz |
| DUPLEXT OFFSET | 10 MHz |
| CHANNEL SPACING | 25 kHz |
- iv) Select "CHANNEL BLOCK 2" and enter the following parameters:
- | | |
|-----------------------------|--------------|
| CHANNEL BLOCK | EXCLUDED |
| LOWEST CHANNEL | 0000 |
| HIGHEST CHANNEL | 4095 |
| LOWEST CHANNEL TX FREQUENCY | 410.0125 MHz |
| DUPLEXT OFFSET | -10 MHz |
| CHANNEL SPACING | 25 kHz |

For A Band (380 - 400 MHz)

A) Normal setting:

STEP 4

- i) Press the (USER DEFINED KEY) and set the following parameters:
- | | |
|----------------|---|
| FREQ BAND | 3 |
| OFFSET | 3 |
| DUPLEX SPACING | 0 |
| REVERSE | 0 |

- ii) Select "CHANNEL BLOCK 1" and set the following parameter:
CHANNEL BLOCK INCLUDED
Other Channel Blocks (Channel Block 2, 3, 4) set to "EXCLUDED"

B) Reverse setting:

STEP 4

- i) Press the (USER DEFINED KEY) and set the following parameters:
- | | |
|----------------|---|
| FREQ BAND | 3 |
| OFFSET | 3 |
| DUPLEX SPACING | 0 |
| REVERSE | 1 |
- ii) Select "CHANNEL BLOCK 2" and set the following parameter:
CHANNEL BLOCK INCLUDED
Other Channel Blocks (Channel Block 1, 3, 4) set to "EXCLUDED"

For B Band (400 - 430 MHz)

A) Normal setting:

STEP 4

- i) Press the (USER DEFINED KEY) and set the following parameters:
- | | |
|----------------|---|
| FREQ BAND | 4 |
| OFFSET | 3 |
| DUPLEX SPACING | 0 |
| REVERSE | 0 |
- ii) Select "CHANNEL BLOCK 3" and set the following parameter:
CHANNEL BLOCK INCLUDED
Other Channel Blocks (Channel Block 1, 2, 4) set to "EXCLUDED"

B) Reverse setting:

STEP 4

- i) Press the (USER DEFINED KEY) and set the following parameters:
- | | |
|----------------|---|
| FREQ BAND | 4 |
| OFFSET | 3 |
| DUPLEX SPACING | 0 |
| REVERSE | 1 |
- ii) Select "CHANNEL BLOCK 4" and set the following parameter:
CHANNEL BLOCK INCLUDED
Other Channel Blocks (Channel Block 1, 2, 3) set to "EXCLUDED"

RX VCO frequency adjustment

Preparation

Press Menu key, numeric key [2] and the Rotary knob simultaneously.

The radio terminal enters T1 TEST mode.

1st Local VCO

Note: The VCO used in the CM5000 has no tunable device. No adjustment is required for the VCO.

This section describes verification method.

STEP 1

Set the radio to channel 3200 using numeric keys and confirm.

STEP 2

Check the voltage of test point TP640. The normal voltage is higher than 2 V.
If the voltage is out of the above range, it means the VCO is unlocked.

2nd Local VCO adjustment

Note: The VCO used in the CM5000 has no tunable device. No adjustment is required for the VCO.

This section describes verification method.

STEP 1

Set the radio to channel 3200 using numeric keys and confirm.

STEP 2

Check the Voltage of test point TP644, using high impedance Digital Volt Meter.
The normal voltage of the test point TP644 is higher than 2 V.
If the voltage is out of the above range, it means the VCO is unlocked.

Confirming receiver sensitivity

Note: The Loop Back Test Mode is using on this adjustment procedure. Accordingly transmitter function should work to execute this test mode.

Preparation

Preparation of AEROFLEX Tester 2968

STEP 1

Set the AEROFLEX Tester to T1 LOOP BACK MODE as follows:

T1 Loop Back	ON
Burst Mode	Normal
Signal format	TCH/7.2
RF Level	-110 dBm

STEP 2

Set the AEROFLEX tester channel to 3200.

STEP 3

Press Menu key, numeric key [2] and the Rotary knob simultaneously. The radio terminal enters T1 TEST mode.

STEP 4

Set the tested radio terminal to channel 3200.

STEP 5

Press [*] key for 12.5 kHz offset. CM5000 displays '+' on right side of channel number.

Confirm sensitivity

Note: No manual tunable device in the RF band pass filter. No adjustment is required for receiver.

STEP 1

Confirm that tester BER indication is less than 1%.

Transmit Power Adjustment

The transmit power setting is required after repair of transmitter circuit.

Preparation**STEP 1**

Test connection diagram is shown in figure 11.

STEP 2

Press Menu key, numeric key [9] and the Rotary knob simultaneously.

STEP 3

While the bar graph is shown on the display, press the [EMG] and [Left] key simultaneously. The radio terminal enters RX ADJUST MODE.

STEP 4

Press and hold the Menu key for 5 seconds disregarding the error tone.

STEP 5

Set the radio to channel 3600 using numeric keys.

STEP 6

Confirm the frequency as 390.0125 MHz.

STEP 7

Press the key [BST] on the Control head. The radio terminal enters TX ADJUST MODE.

Adjustment

Adjustment for channel 3600

Setting the channel

STEP 1

Set the radio to channel 3600 using numeric keys.

STEP 2

Set IFR2968 to A Band Normal setting.

Power adjustment on the channel

STEP 1

Press the key [BST] on the Control head.
The the radio terminal switches to TX ADJUST MODE.

STEP 2

Confirm the "CH3600 380.0125 MHz" on the display.

STEP 3

Confirm the "POWER 37 dBm" on the display.

STEP 4

Confirm the "LT" is selected.

STEP 5

Adjust the output power to +37+/-0.5 dBm using the Rotary knob.

STEP 6

Press the [Right] navigation key for course adjustment.

STEP 7

Press the [Up] navigation key to select "FB".

STEP 8

Adjust the output power to +37+/-0.5 dBm using the Rotary knob.

STEP 9

Press the [Right] navigation key for course adjustment.

STEP 10

Press the [Left] navigation key and confirm "POWER 35 dBm" on the display.

STEP 11

Confirm the "LT" is selected.

STEP 12

Adjust the output power to +35+/-0.5 dBm using Rotary encoder

STEP 13

Press the [Right] navigation key for course adjustment.

STEP 14

Press the [Up] navigation key to select "FB".

STEP 15

Adjust the output power to +35+/-0.5 dBm using the Rotary knob.

STEP 16

Press the [Right] navigation key for course adjustment.

STEP 17

Press the [Left] navigation key and confirm "POWER 30 dBm" on the display.

STEP 18

Confirm the "LT" is selected.

STEP 19

Adjust the output power to +30+/-0.5 dBm using the Rotary knob.

STEP 20

Press the [Right] navigation key for course adjustment.

STEP 21

Press the [Up] navigation key to select "FB".

STEP 22

Adjust the output power to +30+/-0.5 dBm using the Rotary knob.

STEP 23

Press the [Right] navigation key for course adjustment.

STEP 24

Press the [Left] navigation key and confirm "POWER 25 dBm" on the display.

STEP 25

Confirm the "LT" is selected.

STEP 26

Adjust the output power to +25+/-0.5 dBm using the Rotary knob.

STEP 27

Press the [Right] navigation key for course adjustment.

STEP 28

Press the [Up] navigation key to select "FB".

STEP 29

Adjust the output power to +25+/-0.5 dBm using the Rotary knob.

STEP 30

Press the [Right] navigation key for course adjustment.

STEP 31

Press the [Left] navigation key and confirm "POWER 20 dBm".on the display.

STEP 32

Confirm the "LT" is selected.

STEP 33

Adjust the output power to +20+/-0.5 dBm using the Rotary knob.

STEP 34

Press the [Right] navigation key for course adjustment.

STEP 35

Press the [Up] navigation key to select "FB".

STEP 36

Adjust the output power to +20+/-0.5 dBm using the Rotary knob.

STEP 37

Press the [Right] navigation key for course adjustment.

STEP 38

Press the [Left] navigation key and confirm "POWER 15 dBm" on the display.

STEP 39

Confirm the "LT" is selected.

STEP 40

Adjust the output power to +15+/-0.5 dBm using the Rotary knob.

STEP 41

Press [Right] key for course adjustment.

STEP 42

Press the [Up] navigation key to select "FB". "FB" should be highlighted by black background.

STEP 43

Adjust the output power to +15+/-0.5 dBm using the Rotary knob.

STEP 44

Press the [Right] navigation key for course adjustment.

STEP 45

After finishing the power adjustment, press and hold the Enter key for 1 second. The "MEMORY" message appears on the display and audible tone is played.

STEP 46

Press [RX] to terminate transmitting.

Adjustment for channel 4000**Setting the channel****STEP 1**

Set the radio to channel 4000 using numeric keys.

STEP 2

Set IFR2968 to A Band Normal setting.

Power adjustment on the channel

See power adjustment for channel 3600.

Adjustment for channel 4400**Setting the channel****STEP 1**

Set the radio to channel 4400 (IFR 0400) using numeric keys.

STEP 2

Set IFR2968 to B Band Normal setting.

Power adjustment on the channel

See power adjustment for channel 3600.

Adjustment for channel 4800**Setting the channel****STEP 1**

Set the radio to channel 4800 (IFR 0800) using numeric keys.

STEP 2

Set IFR2968 to B Band Normal setting.

Power adjustment on the channel

See power adjustment for channel 3600.

Adjustment for channel 5200**Setting the channel****STEP 1**

Set the radio to channel 5200 (IFR 1200) using numeric keys.

STEP 2

Set IFR2968 to B Band Normal setting.

Power adjustment on the channel

See power adjustment for channel 3600.

Adjustment for channel 5600**Setting the channel****STEP 1**

Set the radio to channel 5600 (IFR 1600) using numeric keys.

STEP 2

Set IFR2968 to B Band Normal setting.

Power adjustment on the channel

See power adjustment for channel 3600.

Store the power adjustment

To store the power adjustments, turn off the radio by pressing the [PWR] key.

Receiver Adjustment

The RSSI setting is required after the repair of receiver circuit.

Preparation

STEP 1

Set the IFR2968 to B band Normal setting.

STEP 2

Set the IFR2968 as follows:

Channel	0200
RF level	-70 dBm

STEP 3

Press Menu key, numeric key [9] and the Rotary knob simultaneously.

STEP 4

While the bar graph is shown on the display, press the [EMG] and [Left] keys simultaneously. Then the radio terminal goes into RX ADJUST MODE.

STEP 5

Press and hold the Menu key for 5 seconds disregarding the error tone.

STEP 6

Set the radio to channel 4200 using numeric keys.

STEP 7

Confirm the frequency as 405.0125 MHz.

Adjustment

STEP 1

Confirm the "STAGE LEVEL HI 1" on the display and wait 10 seconds.

STEP 2

Press and hold the Enter key for 1 second.

The "MEMORY" message appears on the display and audible tone is played.

STEP 3

Press the [Up] navigation key and confirm the "STAGE LEVEL HI 2" on the display.

STEP 4

Wait 5 seconds. Then press and hold the Enter key for 1 second.

Then "MEMORY" message appears on the display and audible tone is played.

STEP 5

Set the IFR2968 as follows:

RF level	-90 dBm
----------	---------

STEP 6

Press the [Up] navigation key and confirm the "STAGE LEVEL LOW" on the display.

STEP 7

Wait 5 seconds. Then press and hold the Enter key for 1 second.

The "MEMORY" message appears on the display and audible tone is played.

STEP 8

Press the [Up] navigation key and confirm the "RSSI CHECK" on the display.

STEP 9

Confirm the RSSI is within the -90 ± 2 dBm.

STEP 10

Change IFR2968 RF level to -70 dBm.

STEP 11

Confirm the RSSI is within the -70 ± 2 dBm.

STEP 12

Turn off the radio by pressing the Rotary knob key

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CHAPTER 5

CONNECTOR PIN FUNCTION

Connectors

This section presents the following connectors and their pin functions:

- Microphone connector
- Accessory connectors
- Antenna connector
- GPS antenna connector
- Power connector

Microphone Connector (Panel)

This connector provides the communication with Fist Microphone, Handset and Desk Microphone using 10-pin RJ type connector.

Table 4. Microphone connector pins

No.	Function	Description
1	No connection	
2	No connection	
3	Hook switch input	Microphone off-hook signal (Active Low)
4	Ground	Ground
5	Microphone input	Microphone audio input (-43 dBm@600 ohm with 9 V phantom powered circuit)
6	PTT switch input	PTT switch signal (Active Low)
7	No connect	
8	Handset audio output	Handset audio (no volume control)
9	Analogue 1	Analogue input to A/D converter (for handset)
10	Analogue 2	Analogue input to A/D converter (for handset)

Accessory Connector 1

This connector provides communication with External Speaker, External Microphone, External PTT Switch, External Emergency Switch, Ignition Sense Cable External Alarm Switch, Buzzer and RS-232C interface using 20-pin type connector.

Table 5. Accessory connector 1 pins

No.	Function	Description
1	External Speaker- output	Speaker output (BTL) with Pin 16
2	External Microphone input	
3	External PTT switch input	Microphone off-hook signal (Active Low)
4	External Alarm output	Ground
5	TX Audio input	Microphone audio input (-43 dBm@600 ohm with 9 V phantom powered circuit)
6	Keyfail / Flash input	PTT switch signal (Active Low)
7	Analogue Ground	Ground for analogue input/output
8	Digital Ground	Ground for digital input/output
9	Emergency switch input	To enable Emergency transmission with the Radio turned on (Active Low)
10	Ignition switch input	To turn on the Radio with Ignition input (Active high)
11	RX Audio output	Received RX signal output (no volume control) 775 mVRMS@600 ohm
12	Audio PA Enable input	To on/off Speaker input (SP active when High or Open)
13	SWB+	Switched power supply (less than 1A)
14	Hook switch input	Hook switch signal (High=Off hook, Low=On hook)
15	SCI DTR	To communicate Personal Computer with 0 - 3.3 V interface(DTR), Input to radio unit
16	External Speaker+ output	Speaker output (BTL) with Pin 1
17	SCI CTS	To communicate Personal Computer with 0 - 3.3 V interface (CTS), Output from radio unit
18	SCI RTS	To communicate Personal Computer with 0 - 3.3 V interface (RTS), Input to radio unit
19	SCI RXD	To communicate Personal Computer with 0 - 3.3 V interface (RXD), Output from radio unit
20	SCI TXD	To communicate Personal Computer with 0 - 3.3 V interface (TXD), Input to radio unit

Accessory Connector 2

This connector provides the communication with RS-232C interface using 7-pin type connector.

Table 6. Accessory connector 2 pins

No.	Function	Description
1	GND	Ground
2	No connection	
3	CTS	To communicate Personal Computer with standard RS-232C interface (RTS), Input to radio unit
4	RTS	To communicate Personal Computer with standard RS-232C interface (CTS), Output from radio unit
5	SCI TXD	To communicate Personal Computer with standard RS-232C interface (RXD), Output from radio unit
6	SCI RXD	To communicate Personal Computer with standard RS-232C interface (TXD), Input from radio u
7	GND	Ground

Antenna Connector

This connector will provide the connection with RF Antenna for 380 – 430 MHz band.

Table 7. Antenna connector

Item	Specification
Type of connector	BNC connector
Impedance	50 ohm

GPS Antenna Connector

This connector will provide the connection with GPS Antenna.

Table 8. GPS Antenna connector

Item	Specification
Type of connector	FME connector
Impedance	50 ohm
Power Supply for Antenna	5 VDC Max. 30 mA

Power Connector

This connector provides the connection to the car battery or the power supply via power cable.

Table 9. Power connector

Item	Specification
Type of connector	2 pin special connector
Voltage	13.2 V

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CHAPTER 6

PARTS LISTS AND DRAWINGS

Replacement Parts List

Damaged parts should be replaced with identical replacement parts.
For complete information on ordering required parts and kits, contact your local customer service representative.

Table 10. Spare parts

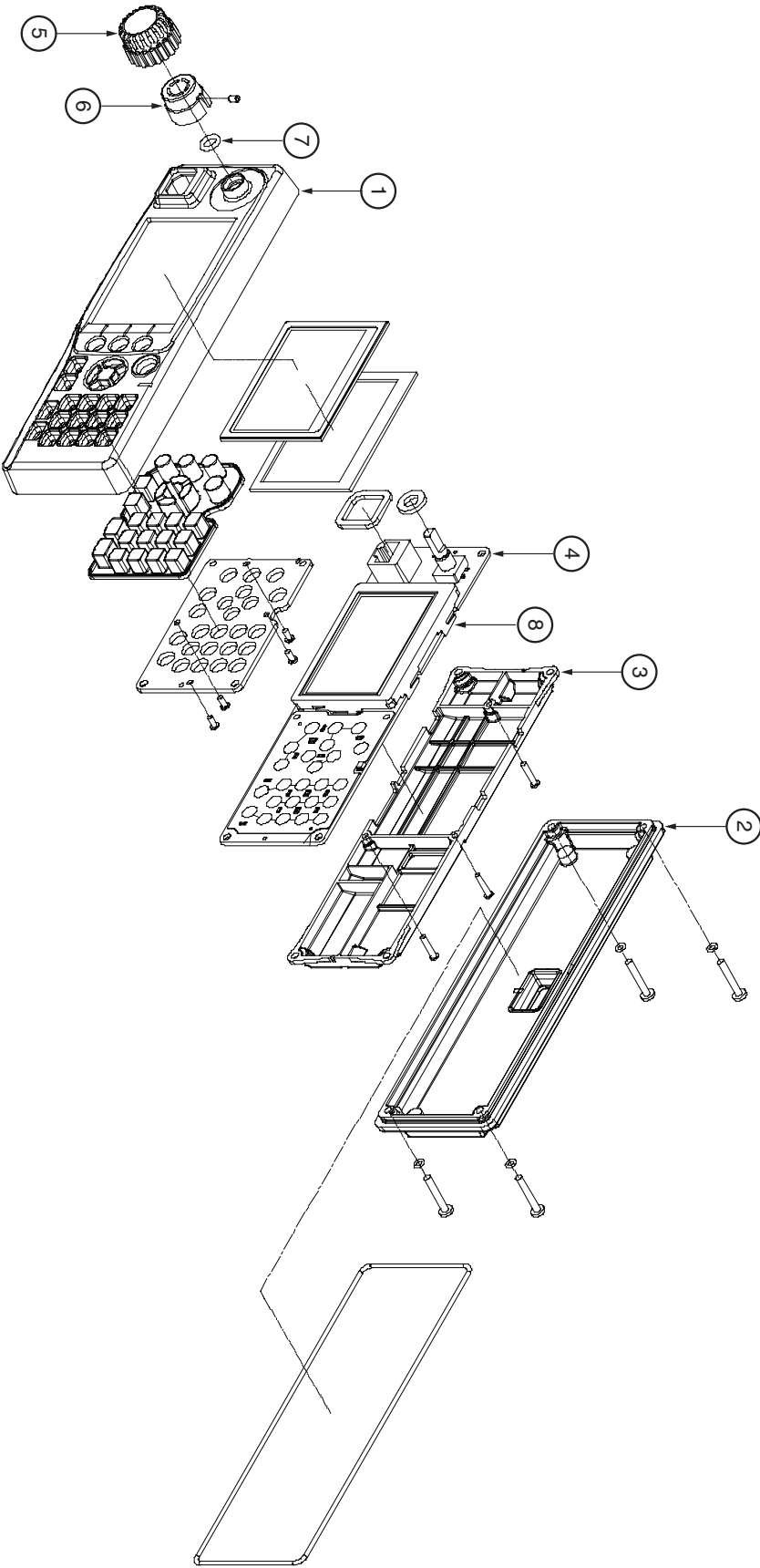
Item		Part number
Control Head Housing		
	Control Head Front Housing Assembly	WAWN4491A
	Control Head Rear Housing Assembly	WAWN4492A
	Control Head Shield Case	WAWN4493A
	Cleartone Control Head Board	8466593A01
Volume Knob Assembly		
	Cleartone Volume Knob Assembly Cap	3866500A01
	Cleartone Volume Knob	3666503A01
LCD		
	Cleartone CM5000 LCD module	7266502A01
IF3G Cables		
	Cleartone cable IF3G to CM5000	3066578B01
	Cleartone cable IF3G to Control Head	3066579B01

Diagrams

- Control Head Assembly

Mechanical Parts List

No.	Description	Part Number
1	Control Head Front Housing Assembly	WAW/N4491A
2	Control Head Rear Housing Assembly	WAW/N4492A
3	Control Head Shield Case	WAW/N4493A
4	Cleartone Control Head Board	8466593A01
5	Cleartone Volume Knob Assembly Cap	3866500A01
6	Cleartone Volume Knob	3666503A01
7	Cleartone Volume Knob O-Ring P-6	0466504A01
8	Cleartone CM5000 LCD module	7266502A01



APPENDIX A

REPLACEMENT PARTS & KITS

Servicing CM5000 Mobile Units

Service for the mobile units is based on the substitution method; a faulty part is replaced by a working one, providing quicker service to the customer. For example, if the controller board is faulty, it is replaced. If the mobile requires more complete testing or servicing than that is available at field level, it is sent to the European Radio Service Centre; where it is serviced, and returned to the Regional Service Centre.

Level 1 Maintenance

This manual covers Level 1 Maintenance: at Level 1 maintenance you replace the transceiver and/or accessories and send the faulty transceiver and/or accessories to higher level of maintenance. For details, please refer to Technical Support and Further Assistance from Motorola.

The CM5000 mobiles are programmed at the factory. They cannot be tuned at the field service level.

Level 2 and Level 3 Maintenance

The Level 2 and 3 maintenance can be only performed at the Motorola Service Center/Depot. Contact your local Motorola G&PS for information.

Service Information

Europe, Middle East and Africa Region

European Radio Support Centre (ERSC)

Motorola European Radio Support Centre is available at:

Motorola European Radio Support Centre ERSC
Tel.: +49 (0)30 6686 1555
Fax: +49 (0)30 6686 1579
Am Borsigturm 130
13507 Berlin
Germany

EMEA Systems Support Centre (ESSC)

The Systems Support Centre is available at:

Telephone: +44 (0) 1256 484448
E-mail: ESSC@motorola.com

Piece Parts

Some replacement parts, spare parts, and/or product information can be ordered directly. If a complete Motorola part number is assigned to the part, it is available from Motorola Radio Aftermarket and Accessory Division (AAD). If no part number is assigned, the part is not normally available from Motorola. If a parts list is not included, this generally means that no user-serviceable parts are available for that kit or assembly.

Parts Identification and Ordering

Request for help in identification of non-referenced spare parts should be directed to the Customer Care Organization of Motorola's local area representation. Orders for replacement parts, kits and assemblies should be placed directly on Motorola's local distribution organization or via the Extranet site Motorola Online at: <https://emeaonline.motorola.com>.

EMEA Test Equipment Support

Information related to support and service of Motorola Test Equipment is available by calling the Motorola Test Equipment Service in Germany at +49 (0) 6128 702179, Telefax +49 (0) 6128 951046, through the Customer Care Organization of Motorola's local area representation, or via the Internet at: <http://www.gd-decisionssystem.com/cte/>.

Asia, Pacific Region

Technical Support

Technical support is available to assist the dealer/distributor in resolving any malfunction which may be encountered. Initial contact should be by telephone wherever possible.

When contacting Motorola Technical Support, be prepared to provide the product model number and the unit's serial number.

Further Assistance from Motorola

You can also contact the Customer Help Desk through the following web address:

<http://www.motorola.com/governmentandenterprise/contactus>.

Piece Parts

Some replacement parts, spare parts, and/or product information can be ordered directly. If a complete Motorola part number is assigned to the part, it is available from Motorola Radio Aftermarket and Accessory Division (AAD). If no part number is assigned, the part is not normally available from Motorola. If a parts list is not included, this generally means that no user-serviceable parts are available for that kit or assembly.

Note on this digital TETRA Terminal: **The CPS has no capability to tune the terminal. Tuning the terminal can only be performed at the factory or at the appropriate Motorola Repair Centre. Component replacement can affect the terminal tuning and must only be performed by the appropriate Motorola Repair Centre.**

Request for help in identification of non-referenced spare parts should be directed to the Customer Care Organization of Motorola's local area representation. Orders for replacement parts, kits and assemblies should be placed directly on Motorola's local distribution organization or via Motorola Online (Extranet).

Latin America Region

Latin America Radio Support Centres

The Customer Support is available through the following service centres:

Warranty and Repairs:

MOTOROLA DE COLOMBIA SERVICE CENTRE

Torre Banco Ganadero
Carrera 7 No. 71-52
Torre B piso 13
Oficina 1301
Bogota- Colombia
(571) 376-6990

MOTOROLA DE MEXICO SERVICE CENTRE

Bosques de Alisos #125
Col. Bosques de las Lomas
CP 05120 Mexico DF
5252576700

Piece Parts:

To order parts in Latin America and the Caribbean contact your local Motorola CGISS representative.

MOTOROLA, INC.

Latin American Countries Region
789 International Parkway
Sunrise, FL 33325
USA 954-723-8959

MOTOROLA DE ARGENTINA

Ave. del Libertador 1855
B1638BGE, Vicente Lopez
Buenos Aires, Argentina
5411-4317-5300

MOTOROLA DE LOS ANDES C.A.

Ave. Francisco de Miranda
Centro Lido, Torre A
Piso 15, El Rosal
Caracas, 1060 Venezuela
58212-901-4600

MOTOROLA DO BRASIL LTDA.

Av. Chedid Jafet
222 Bloco D Conjuntos 11,12,21,22 E 41
Condominio Millennium Office Park
04551-065- Vila Olimpia, Sao Paulo
Brasil
5511-3847-668

MOTOROLA CHILE

Ave. Nueva Tajamar 481

Edif. World Trade Center
Of. 1702, Torre Norte
Las Condes
Santiago, Chile
562-338-9000

MOTOROLA DE COLOMBIA, LTDA.

Carrera 7 #71-52
Torre A, Oficina 1301
Bogotá, Colombia
571-376-6990

MOTOROLA DE COSTA RICA

Parque Empresarial Plaza Roble
Edificio El Portico, 1er Piso
Centro de Negocios Internacional
Guachepelin, Escazu
San Jose, Costa Rica
506-201-1480

MOTOROLA DEL ECUADOR

Autopist Gral. Rumiñahui, Puente 2
Conjunto Puerta del Sol Este-Ciudad Jardin
Pasa E, Casa 65
Quito, Ecuador
5932-264-1627

MOTOROLA DE MEXICO, S.A.

Calle Bosques de Alisos #125
Col. Bosques de Las Lomas
05120 México D.F.
México
52-555-257-6700

MOTOROLA DEL PERU, S.A.

Ave. República de Panama 3535
Piso 11, San Isidro
Lima 27, Peru
511-211-0700

Technical Support:

<https://businessonline.motorola.com>, go to Contact Us to request technical support

Some replacement parts, spare parts, and/or product information can be ordered directly. If a complete Motorola part number is assigned to the part, it is available from Motorola. If no part number is assigned, the part is not normally available from Motorola. If the part number is appended with an asterisk, the part is serviceable by Motorola Depot only. If a parts list is not included, this generally means that no user-serviceable parts are available for that kit or assembly.

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