

User's Manual

8M074X01-01

REV. 1

CMDUHF

TABLE OF CONTENTS

	Page
FCC / IC Compliance Statements.....	xi
1.0 Safety Information	1
2.0 General Radio Procedures Operating	3
3.0 Specification	4
4.0 Introduction.....	5
5.0 Main Features	6
6.0 Block Diagram and Description.....	7
6.1 Transceiver.....	7
6.2 Power Amplifier	8
6.3 Controller Board.....	8
7.0 Set Up	9
7.1 Programming Software Installation.....	9
7.2 Channel Module Connections	9
7.3 Mode of Operation Setting	10
7.4 Basics of Gain Setting	11
7.5 Downlink Gain Setting	11
7.6 Uplink Gain Setting	12
8.0 Operation	14
8.1 General	14
8.2 Transmit Disable.....	14
8.3 Reset.....	15
9.0 Cleaning	16

FCC Class A Digital Device or Peripheral - Information to User

NOTE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, can cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WARNING

Changes or Modifications not expressly approved by Futurecom Systems Group Inc. could void the user's authority to operate the equipment.

WARNING

To satisfy FCC/IC RF exposure requirements for transmitting devices, a minimum separation distance should be maintained between the antenna of this device and anyone in the vicinity of the radiating element. The following table shows the minimum distance, as per FCC 1.1310 requirement, for selected values of CMDUHF Tx power settings and antenna / feed cable assembly gains:

Antenna gain [dBi] γ	0	3	6	10	15
CMDUHF Tx Power [W]					
1	18	25	35	55	97
5	39	55	77	122	217
10	55	77	109	173	306
20	77	109	173	244	433
35	102	144	204	322	573
43.6	114	161	228	359	639

Table 1. Minimum distance between CMDUHF Tx antenna and general population (in [cm]).

1.0 SAFETY INFORMATION

The following information may or may not be applicable to your product.

In any case, precautions should always be taken when handling any electrical product.

- This manual contains important safety and operating instructions, therefore keep this manual always on hand!
- Prior to using any product, follow all warning, safety and operating instructions written on the product and in the user's manual. **All instructions should be saved for reference in the future!**
- Always keep product dry, never expose to any kind of moisture.
- **Do Not** expose product to extreme temperatures- as found near a hot radiator or stove.
- **Do Not** expose product to open flames, cigarettes, etc.
- Precautions should be taken to avoid objects falling or liquids spilling onto product.
- **Do Not** incorporate the use of other equipment that is not recommended or sold by the manufacturer. The result may be the risk of fire or electric shock injury.
- Connect DC power cord to DC power source as marked on the product..
- **DANGER** - Never alter the AC cord or plug! If plug does not fit outlet have a qualified electrician install a proper outlet. Failure to do so results in improper connection and increases the risk of electric shock.
- This product does not contain customer serviceable components, therefore **never** disassemble the product.
- Damage Requiring Service - This product should be serviced by qualified service personnel when:
 - A. The power supply cord or the plug has been damaged; or
 - B. Objects have fallen, or liquid has been spilled into the product; or
 - C. The product has been exposed to rain or moisture; or
 - D. The product does not appear to operate normally or exhibits a marked change of performance; or
 - E. The product has been dropped, or the cabinet damaged.
- If an outdoor antenna is connected, make sure the system is always grounded to allow for protection against voltage surge and built-up static charges. Outdoor antennas should always be located away from power lines.

The operator of any mobile radio should be aware of certain hazards common to the operation of vehicular radio transmissions.

A list of possible hazards follows:

1. Explosive Atmospheres

To ensure safety, make sure that the radio is off while fueling the vehicle. When the radio is mounted in the back of the trunk, never have containers of fuel in the trunk of the vehicle..

2. Interference to Vehicular Electronics Systems

Typical types of electronic devices that malfunction are -Electronic fuel injection systems, electronic anti-skid braking systems, etc., The reason for this is due to the lack of protection from radio frequency energy present when transmitting. If the vehicle contains such equipment, consult the dealer of your vehicle and enlist his aid in determining if such electronic circuits perform normally when the radio is transmitting.

3. Dynamite Blasting Caps

Dynamite blasting caps may be caused to explode by operating a radio within 500 feet of the blasting caps. Always obey the "**Turn Off Two Way Radios**" signs posted where dynamite is being used. When transporting blasting caps in your vehicle:

- a. Carry the blasting caps in a closed metal box with a soft lining.
- b. Leave the radio **OFF** whenever the blasting caps are being put into or removed from the vehicle.

4. Radio Frequency Energy

Do not operate the transmitter when a person is outside of the vehicle within two feet of the antenna! Failure to heed this warning may result in burns or related physical injury to the person.

5. Liquefied (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 that:

- a. The space containing the radio equipment shall be isolated by a seal from the space containing the LP gas container and its fittings.
- b. Outside filling connections shall be used for the LP gas container.
- c. The LP gas container shall be vented to the outside of the vehicle.

2.0 GENERAL RADIO OPERATING PROCEDURES

Industry Canada (IC) and the Federal Communications Commission (FCC). rules and regulations must be incorporated in the use of radio systems. Familiarity with these rules by the operator is essential for proper execution of the type of radio operation that is in question. Following these rules helps to eliminate confusion, assures the most efficient use of existing radio channels, and results in a smoothly functioning radio network. When using this unit remember these rules:

1. Emergency calls always have priority over all messages! To interrupt any distress or emergency message is a violation of the IC and FCC rules. When operating the radio make sure that the line is clear before sending messages. **KEEP OFF THE AIR** when an emergency message is being sent through.
2. Use of profane or obscene language is prohibited by Federal law.
3. Sending false call letters, false distress or emergency messages is against the law.
4. IC and FCC demand that conversations are kept brief and content limited only to business. Coded messages are encouraged in order to save time.
5. Only messages that are essential for the business operations are allowed to be sent. Otherwise using the radio to send personal messages is a direct violation of the IC and FCC rules.
6. Conversations between others sharing a channel is regarded as confidential. Repeating anything overheard on the radio is against Federal Law.
7. The IC and FCC requires the operator to transmit station identification at certain times by means of call letters. Refer to the IC and FCC rules for your station's particular type of operation for the proper procedure.
8. No changes or adjustments shall be made to the equipment except by an authorized or certified electronics technician.

3.0 SPECIFICATIONS

Electrical Specifications	CMDUHF
Frequency of Operation	403 – 406.0 and 406.125 – 512 MHz
Sensitivity	-120 dBm
Input Carrier Detection Threshold	-120 to -50 dBm
Carrier Detection Threshold Adjustment Step	.3 dBm
Carrier Detection Attack Time	< 2 ms
Maximum Gain Range (On Channel)	70 to 165 dB 70 to 150 dB
AGC Range	70 dB
AGC Attack Time	< 1 ms
AGC Decay Time	< 1 ms
Output Power	1 W to 35 W
Output Power Tolerance	-0 dB, +1 dB
Duty Cycle	100%
Output Frequency Stability	Tracks Input Signal Frequency
Passband Frequency Stability (Internal TCXO)	+/- 0.5 ppm
Modulation Types	Narrowband FM Voice and Data
Bandwidth	Application Specific
Selectivity	> 75 dB
Receiver Spurious Response Rejection	> 75 dB
Receiver Intermodulation	> 70 dB
Receiver Conducted Spurious Emissions	< -57 dBm
Transmitter Conducted Spurious Emissions	< -20 dBm and < -65 dBc
Transmitter FM Hum and Noise	> 43 dB
Input Impedance	50 Ohms
Output Impedance	50 Ohms
Input VSWR	< 1.5:1
Output VSWR	< 1.5:1
Power Supply Voltage	27.6 VDC +10% / -15%
Power Supply Current Drain Standby	<0.5 A DC
Transmit	<3.7 A DC

Mechanical		Programming		Alarms/Monitoring	
RF Connectors	SMA Receptacles	Frequency of Operation	✓	Power	✓
Environmental	90% humidity @ 50 °C (122°F)	Output Power	✓	VSWR	✓
Operating Temperature Range	-30 to +60°C (-22 to +140°F)	Carrier Detection Threshold	✓	Temperature	✓
Dimensions (W/O connectors and handles)	262 x 76 x 225 mm (10.3" x 3" x 8.9")	Carrier Detection Time-out	✓	Synt. Lock	✓
Weight	3.95 kg (8.7 lb)	Gain	✓		

			DCS/CTCSS	✓		

4.0 INTRODUCTION

This manual describes the Futurecom Channel Module (CMDUHF). The Channel Module is a synthesized, microprocessor-based, high performance radio unit. It is designed to increase the coverage area of an existing radio site by receiving and re-broadcasting from host to user (downlink), and from user to host (uplink).

The operation of the Channel Module is fully transparent to the user of the host radio system. The Channel Module can be monitored and controlled remotely via digital communication with the remote system controller or Computer Aided Dispatch (CAD). This provides high level of radio system reliability.

The exact operation of the Channel Module depends on the operating mode. Most features described in this manual may be enabled or disabled through programming. The features of the Channel Module are always selected to suit the particular radio system that it is extending.

The Channel Module can be programmed and controlled via the connector in the front panel from a laptop computer with installed Futurecom CMDUHF proprietary software .

The unit has six indicators on the front panel, showing the current operating mode. The programming software can be also used to display the current status of the device, and measured values characterizing the received and transmitted signals.

5.0 MAIN FEATURES

The Channel Module is a fully software configurable, synthesized, narrow band device, with 35 Watt output power capability. Its purpose is to receive a single RF channel, amplify and filter the channel signal and re-transmit it.

The Transceiver (TS) stage receives a single channel off air using double heterodyne principle and downconverts the signal to an Intermediate Frequency . The Intermediate Frequency processing performs most of the signal filtering required for a given frequency band and channel spacing. The rigorous filtering allows only the desired signal (channel) to pass and to be amplified assuring that all undesired signals on other frequencies are not transmitted. The filtered signal is upconverted to the output frequency and amplified by the Power Amplifier (PA). The PA has driver and final power stages fully redundant, with automatic switch-over in the case of detected malfunction.

The personality of the unit can be programmed directly from a personal computer via front panel serial port. The Channel Module software resides in Flash memory and can be upgraded serially without opening and retesting the unit. Software upgrade/change can be performed remotely in the same way as personality change.

The chassis of the Channel Module is made of machined aluminum. The rugged construction of the unit minimizes microphonics effects and internal feedback. The unit housing is in standard double Eurocard format. The installation of the Channel Module is performed by simply plugging it into a 19" rack-mounted Futurecom 7V055X01 or 7V055X02 card cage, and connecting RF input and output cables to front panel SMA connectors.

The Channel Module is capable of operating in two different modes. In the typical Repeater mode, the Channel Module transmits on a frequency which is different from the receive frequency. The maximum achievable gain in this mode is 165 dB. The On Channel Repeater transmits on the receive frequency making the Channel Module transparent to the user. The maximum achievable gain in the OCR mode is 150 dB.

The programming software allows to display on the computer screen the measured values of received signal power level, actual transmitted power level, VSWR on the Tx output port, and the internal temperature of the unit.

6.0 BLOCK DIAGRAM AND DESCRIPTION

The block diagram of the Channel Module is shown in 8D074A14 drawing. The Channel Module consists of the following blocks: Transceiver, Power Amplifier and Controller module.

6.1 TRANSCEIVER

Transceiver starts with a band-pass filter that filters out of band unwanted frequencies. It is followed by a low noise amplifier, which can be switched in/out of the signal path under software control. A software-controlled 30 dB attenuator is next. It is used to control input sensitivity and to lower intermodulation products for stronger input signals. (Procedure to set up this attenuator can be found in the following section).

The next two stages consist of a Voltage Controlled Oscillator (VCO), mixer, band-pass filter and an amplifier. These two stages implement double heterodyne down conversion to Intermediate Frequency of 450 kHz. Voltage Controlled Oscillator frequencies are based on a single Temperature Compensated Crystal Oscillator (TCXO).

Proper selectivity of the Channel Module is achieved by the Intermediate Frequency stage. The selectivity is assured by the input filter together with other filters in this stage. The IF signal is also used to produce baseband audio signal and provides Received Signal Strength (RSSI) indication.

The rest of the Transceiver section is mainly an up-conversion circuitry with associated filters. An additional Voltage Controlled Oscillator can be switched into the last mixer. This VCO can be modulated with audio modulation. It can add a programmable subaudible controlling tone.

The output from the Transceiver section is the signal on final output frequency.

6.2 POWER AMPLIFIER

The Power Amplifier is capable of delivering up to 35 W output. A band-pass filter filters out of band unwanted signals. The driver and the power amplifier provide the required output power. The output power level is set under software control. The real output power is measured and compared with the desired output power level. An Automatic Level Control Loop adjusts the real output power to be precisely equal to the preset level.

An output low-pass filter assures that no unwanted higher harmonics are present on the output of the Channel Module.

The reflected power is monitored and the output power is reduced when the reflected power increases.

The driver stage and final power amplifier stages are fully redundant. Internal monitoring system can switch between the main and redundant paths if the detected conditions might indicate abnormal conditions in the PA stages.

6.4 CONTROLLER BOARD

The Controller Board controls the operation of the Channel Module. It contains the microcontroller with Flash program and EEPROM personality storage. Communication with the outside world is facilitated with two RS-232, RS-485 and I²C serial links. One RS-232 port is accessible via 8-pin mini DIN connector on the front panel. Eight digital Input/Output lines are provided for output and outside event monitoring (e.g. room or cabinet door opening). Six analog inputs and four analog outputs are provided as well.

The Controller Board contains DTMF encoder and low-speed data encoder and decoder.

The front panel reset (RESET) and Transmit Disable (TX DIS) inputs are monitored. These two inputs are accessed via two front panel holes with a round tool 2.5mm (0.1”) in diameter. Finally, the front panel indicators are controlled by the Controller Board. These are:

Tx disable	(TX DIS),
DC Supply Power	(DC ON),
Transmitter On	(TX ON),
Receive Signal Detected	(RX ON),
Output power fault	(PWR),
Output VSWR fault	(VSWR).

7.0 SET UP

7.1 PROGRAMMING SOFTWARE INSTALLATION

Futurecom 6A074X01 Programming Software must be installed on a personal computer which will be used for the Channel Module field system installation. The personal computer must run under MS-DOS operating system. Software must be installed only once before the first Channel Module installation.

The following steps must be performed for the Futurecom Channel Module Programming Software installation:

1. Select the hard disk drive where software will reside, e.g. drive C: Determine 3.5 inch floppy diskette on your personal computer, e.g. A:.
2. Switch to root directory by typing **CD\<Enter>**.
3. Create FUTURCOM subdirectory by typing **MD FUTURCOM<Enter>**.
4. Switch to FUTURCOM directory by typing **CD FUTURCOM<Enter>**.
5. Insert the Futurecom Channel Module Programming Software disk into proper floppy drive, e.g. drive A. Type **COPY A:*. *<Enter>**. This step copies software into this directory.

7.2 CHANNEL MODULE CONNECTIONS

The Channel Module must be set up in the following way before field system installation:

1. The Channel Module must be plugged into the Futurecom subrack and supplied with proper DC power supply for all set up procedures.
2. Connect the Uplink and Downlink antennas to the Uplink and Downlink Antenna Ports.
3. Turn on the DC power supply.

7.3 MODE OF OPERATION SETTING

The procedure to set up the mode of operation for the Channel Module is as follows:

1. Make sure that the Futurecom Channel Module Programming Software is installed as described earlier.
2. Connect the Channel Module as described in Channel Module Connections section and power it up. It is recommended that the donor site transmitter is disabled during Channel Module settings!
3. Connect the personal computer to the Channel Module front panel RS-232 connector with Futurecom CM Serial Programming Cable, part number 7W038X61-01.
4. Select the hard disk drive where the programming software is located. To select e.g. drive C type **C:** <Enter>. Switch to FUTURCOM directory by typing **CD \FUTURCOM** <Enter>.
5. Start the Channel Module Programming Software by typing **CMD** <Enter>.
6. Select “Options” field and then select “RS-232” using cursor keys. Press <Enter>. Using cursor keys and <Page Up>, >Page Down> and numeric keypad <->, <+> select the following settings:

<i>Access to unit</i>	Direct
<i>Baud Rate</i>	9600 b/s
<i>Data Bits</i>	8
<i>Stop Bits</i>	1
<i>Parity</i>	None
<i>Comm. Port</i>	Com-1 or Com-2 depending on the personal computer
<i>Baud rate scanning</i>	disable

Press <Esc>. With cursor keys select **Yes** as an answer to *Would you like to update config. file.* Press <Enter>.

7.4 BASICS OF GAIN SETTING

The following Steps set the output power and gains in the Channel Module. (Note that setup must be performed for both the Downlink and the Uplink.)

The basic rule for setting the gain can be summarized as follows:

For OCR Mode (Receiver Frequency equals Transmit Frequency):

The total gain of the Channel Module must always be less than isolation between receive and transmit antennas and cables. A 10dB minimum margin is recommended.

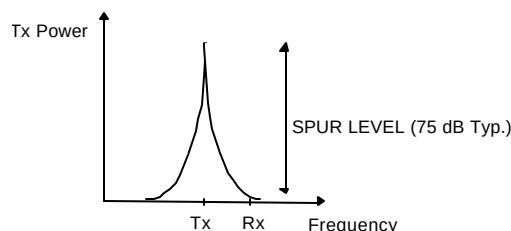
For non-OCR Mode (Receiver Frequency is different from Transmit frequency):

The total gain of the Channel Module must always be less than
 $\text{ANTENNA ISOLATION} + \text{SPURIOUS LEVEL} - 10\text{dB}$

where

ANTENNA ISOLATION = isolation between receive and transmit antennas and cables.

SPURIOUS LEVEL = the difference between transmit output power and spurious of Tx signal on Rx frequency. This difference is typically 75dB.



The normal setting is such that the gain is lower than the isolation by a 10 dB margin. A larger margin accounts for environmental, ageing and other changes in the system.

If this basic rule is not followed, the Channel Module may become permanently locked in keyed-up mode after first activation of the CMDUHF transmitter.

7.5 DOWNLINK GAIN SETTING

Downlink is the direction from the Channel module to a radio unit. The downlink settings are optimized for a maximum transmit power from the Channel Module. Note that the antennas must be connected for this procedure.

1. Select “*Module Setup*” field and then select “*Setup*” using cursor keys. Press <Enter>. Wait for all the fields to be updated. Movement around the screen is done using cursor keys. Modification of values in different fields is done with <Page Up>, >Page Down> or numeric keypad <->, <+> keys. All fields starting with “?” show measured values.

2. Set the frequency of operation in “*Receiver Frequency*” field and “*Transmitter Frequency*” fields to be equal to the Channel Module downlink transmit frequency. Frequencies can be entered by typing the value in MHz in the given field and pressing <Enter>.
3. Set desired output power in “*Tx Pwr Pot*”.
4. Make sure that the donor site is not transmitting!
5. Key up the Channel Module by setting “*PTT*” **ON**.
6. Read “own” “*?RSSI*”. The difference between “*Tx Pwr Pot*” and “own” “*?RSSI*” is the Antenna Isolation.
7. Unkey the Channel Module by setting “*PTT*” **OFF**.
8. Key up the donor site.
9. Read “donor” “*?RSSI*”.

If the “donor” “*?RSSI*” is smaller (i.e. lower RF level) than the “own” “*?RSSI*”, the desired gain cannot be realized and the output power must be lowered. All the above steps must be repeated for the new output power setting until the “own” “*?RSSI*” is ~12 dB smaller than the “donor” “*?RSSI*”.

If the “donor” “*?RSSI*” is larger than the “own” “*?RSSI*”, the Channel Module can be set up. Set “*RSSI CAS Th*” at least 6dB below “donor” “*?RSSI*” level and at least 6dB higher than “own” “*?RSSI*” level.

7.6 UPLINK GAIN SETTING

Uplink is the direction from the Channel Module to the donor base. The uplink settings are optimized for a maximum sensitivity - i.e. Front End attenuator should be set to a minimum setting.

12. Set the frequencies of operation in “*Receiver Frequency*” and “*Transmitter Frequency*” fields to be equal to donor receive frequency. Frequencies can be entered by typing the value in MHz in the given field and pressing <Enter>.
13. Set desired output power in “*Tx Pwr Pot*”.
14. Key up the Channel Module by setting “*PTT*” **ON**.

15. Read “own” “?RSSI”. The difference between “Tx Pwr Pot” and “own” “?RSSI” is the Antenna Isolation.
16. Unkey the Channel Module by setting “PTT” **OFF**.
17. Set “RSSI CAS Threshold” at least 6dB higher than “own” “?RSSI” level. The “RSSI CAS Threshold” level should be as low as possible for maximum sensitivity.
18. Set correct frequencies of operation in the “Receiver Frequency” and “Transmitter Frequency” fields.
19. Exit “Block Diagram Menu” by pressing <Esc>. With cursor keys select **Yes** as an answer to *Exit from CM setup?*. Press <Enter>. With cursor keys select **Yes** as an answer to *Would you like to update the E²PROM?*. Press <Enter>.
20. Select “File” field and then select “Exit” using cursor keys. Press <Enter>. With cursor keys select **Yes** as an answer to *Exit from program*. Press <Enter>.

8.0 OPERATION

8.1 GENERAL

The Channel Module does not require any supervision once it is installed and set up. The status of the unit is indicated by Front Panel Indicators:

- TX DIS Indicator is a dual function indicator.
 - TX DIS Indicator is on when transmit is disabled as described later.
 - TX DIS Indicator is flashing when one of the synthesizers is out of lock (likely due to the Channel Module not being properly programmed).
- DC ON Indicator is a dual function indicator too.
 - DC ON Indicator is on when the Channel Module is supplied by DC power supply.
 - DC ON Indicator flashes shortly when a valid polling serial message is received from a controller.
- TX ON Indicator is on when the Channel Module is transmitting.
- RX ON Indicator is on when the RF input signal is above the programmed “*Rx Level threshold comparator*” level.
- PWR Indicator is a dual function indicator.
 - PWR Indicator is permanently on when the output RF power is outside of the allowed output power tolerance.
 - PWR Indicator is flashing alternatively with VSWR Indicator when an error is found in the personality of the Channel Module.
- VSWR Indicator is on when an excessive reflected power is detected on the Tx Antenna connector at the instant when the transmitter is turned on.

8.2 TRANSMIT DISABLE

The Channel Module transmitter can be disabled by TX DIS switch. TX DIS switch is accessed via the front panel hole with a round tool 2.5mm (0.1”) in diameter. The first push disables the transmitter, the second push enables the transmitter. This function is useful during Channel Module set up and servicing.

8.3 RESET

RESET switch is accessed via the front panel hole with a round tool 2.5mm (0.1”) in diameter. RESET switch is used to reset the Channel Module in an unlikely event of malfunction.

WARNING

Do not apply excessive force on the TX DIS and RESET switches as to not cause damage!

9.0 CLEANING INSTRUCTIONS

Never use an abrasive or a petroleum based solvent cleaner on equipment. The unit can be cleaned using a mild liquid detergent and water or a soft cloth with furniture polish.

