

CM UHF HP

Channel Module Product Description

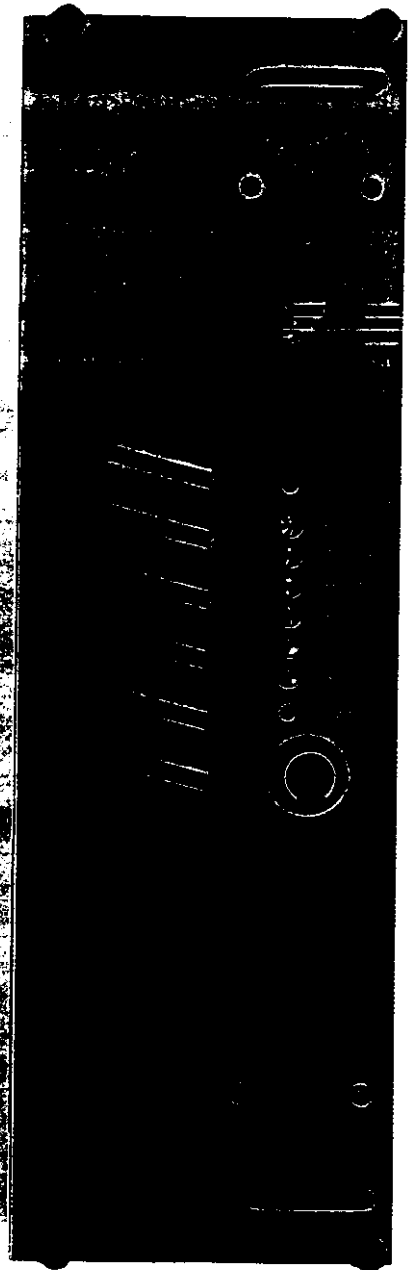
- The Channel Module is an RF channel selective repeater. It can be used in the On Channel Repeater (OCR) or Translator mode. As no baseband demodulation/remodulation process takes place within the Channel Module, signals are amplified with minimal distortion and propagation delays.
- Different filtering characteristics and bandwidths can be provided to ensure compatibility with most types of analog/digital signaling formats and channel spacing.
- When configured in the OCR mode, the input and output frequencies are the same and a gain of greater than 120 dB can be realized.

- When configured in the Translator mode, with different input and output frequencies, a gain of 160 dB is available.

- In either mode, the input threshold's gain and output power are programmable either locally from a RS-232 port on the front panel or remotely from a System Controller. No disassembly is

required to perform these adjustments. A simple set-up program allows programming information to be entered directly in dBm for input threshold/output power and in dB for gain. Together with the capability to monitor RSSI levels, these features minimize the need to use test equipment during system installation and set-up.

- Automatic maximum possible gain set up can be provided as an option.
- In conventional system applications, CTCSS/DCS decoding can be programmed to provide additional protection from interfering signals, ensuring only wanted signals are amplified.
- The chassis of the Channel Module is cast aluminum, designed to provide the high levels of internal shielding required for this application. A double Eurocard format allows five Channel Modules and one Controller Module to be plugged into a single 19" EIA rackmount card cage that is 10.5" (6 rack units) high.
- Additional per channel alarm and monitoring functions are available as detailed in the following table.



Electrical Specifications

CM UHF HP

Frequency of Operation	403-470 MHz
Sensitivity	-117 dBm
Input Carrier Detection Threshold	-110 to -50 dBm
Carrier Detection Threshold Adjustment Step	2 dBm
Carrier Detection Attack Time	<2 ms
Maximum Gain Range (Programmable)	70 to 120 dB
On-Channel Repeater (OCR) Translator	70 to 160 dB
AGC Range	70 dB
AGC Attack Time	<1 ms
AGC Decay Time	<1 ms
Output Power	1 W to 20 W
Output Power Tolerance	-0dB, +1dB
Duty Cycle	100%
Output Frequency Stability	Tracks Input Signal Frequency
On-Channel Repeater (OCR)/Translator	+/-1.5 ppm (+/-0.2 ppm optional)
Passband Frequency Stability (Internal TCXO)	Narrowband FM Voice and Data
Modulation Types	Application Specific
Bandwidth	Application Specific
Selectivity	Application Specific
Receiver Spurious Response Rejection	>70 dB
Receiver Intermodulation	>70 dB
Receiver Conducted Spurious Emissions	<-57 dBm
Transmitter Conducted Spurious Emissions	<-16 dBm and <-40 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	22 to 28 VDC (13.8 VDC*)
Power Supply Current Drain	<0.7 A DC
Standby	<3.5 A (<4.5 A*)
Transmit	

* max 15 W output power.

Mechanical	CM UHF HP
RF Connectors	SMA Receptacles
Environmental	90% humidity @ 50°C (122°F)
Operating Temperature Range	-30 to +60°C (-22 to +140°F)
Dimensions	222 x 225 x 75 mm (8.74" x 8.86" x 2.95")
Weight	4.09 kg (9 lb)

Programming	CM UHF HP
Frequency of Operation	✓
Output Power	✓
Carrier Detection Threshold	✓
Carrier Detection Timeout	✓
Gain	✓
DCS/CTCSS	✓

Alarms/Monitoring	
Power	✓
VSWR	✓
Temperature	✓
Synt. lock	✓

8M046X01-01 REV. 5

User's Manual

CHANNEL MODULE

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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.

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			
	CM VHF HP	CM UHF HP	CM 800 HP
Frequency of Operation	136-174 MHz	403-470 MHz	806-960MHz
Sensitivity	min. -117 dBm		
Input Carrier Detection Threshold	-120 to -50 dBm		
Carrier Detection Threshold Adjustment Step	0.3 dB		
Carrier Detection Attack Time	<2 ms		
Maximum Gain Range On-Channel Repeater (OCR)	70 to 120 dB		
(Programmable) Translator	70 to 160 dB		
AGC Range	70 dB		
AGC Attack Time	0.3/3ms		
AGC Decay Time	0.3/3ms		
Output Power	1W to 20 W		
Output Power Tolerance	-0 dB, +1 dB		
Duty Cycle	100%		
Output Frequency Stability On-Channel Repeater (OCR)/Translator	Tracks Input Signal Frequency		
Passband Frequency Stability (Internal TCXO)	+/-1.5 ppm (+/-0.2 ppm optional)		
Modulation Types	Narrowband FM Voice and Data		
Bandwidth	Application Specific		
Selectivity	Application Specific		
Receiver Spurious Response Rejection	>70 dB		
Receiver Intermodulation	>65 dB		
Receiver Conducted Spurious Emissions	<-57 dBm		
Transmitter Conducted Spurious Emissions	<-16 dBm and <-60 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	13.8V + 10%/-15%	13.8V + 10%/-15%	27.6V + 10%/-15%
DC Power Consumption	Standby	<10W	<10W
	Transmit	<65W	<70W

* Max. 15W Output Power

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	222 x 225 x 75 mm (8.74" x 8.86" x 2.95")	Carrier Detection Time-out	✓	Synt. Lock	✓
Weight	4.09 kg (9.0 lb)	Gain	✓		
		DCS/CTCSS	✓		

4.0 INTRODUCTION

This manual describes the Futurecom Channel Module (CM). 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 rebroadcasting 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 which it is extending.

The unit has six indicators showing the current operating mode. The Channel Module can be programmed and controlled from the front panel as well.

5.0 MAIN FEATURES

The Channel Module is a fully software configurable, synthesized, narrow band device, with 20 Watt output power capability. It is available in VHF, UHF and 800/900MHz bands. Its purpose is to receive a single RF channel, amplify and filter the channel signal and re-transmit it.

The Front End (FE) stage receives a single channel off air using double heterodyne principle and downconverts the signal to an Intermediate Frequency (IF) stage. The Intermediate Frequency performs most of the signal filtering required for a given frequency band and channel spacing. Custom filters are available for customer specific applications. 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 personality of the unit can be programmed directly from a personal computer via front panel serial port or from another CM or OCN. 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 cast aluminum. The rugged construction of the unit minimizes microphonics and internal feedback. The unit is in standard double Eurocard format. The installation of the Channel Module is performed by simply plugging it into a 19" rack mount card cage which is 6 Rack Unit high (10.5") and connecting RF input and output to SMA connectors.

The Channel Module is capable of operating in two different modes; either Translator or On Channel Repeater (OCR). In the Translator mode, the Channel Module transmits on a frequency which is different from the receive frequency. Cross-band Translators are possible. The maximum achievable gain in this mode is 160dB. 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 120dB.

6.0 BLOCK DIAGRAM AND DESCRIPTION

The block diagram of the Channel Module is shown in 8D046A14 drawing. The Channel Module consists of four blocks: Front End, Intermediate Frequency, Power Amplifier and Controller module.

6.1 FRONT END

Front End 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 30dB controlled 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 45.0MHz. Voltage Controlled Oscillator frequencies are based on a common Temperature Compensated Crystal Oscillator (TCXO).

6.2 INTERMEDIATE FREQUENCY

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 signal path continues with an Automatic Gain Control Loop (AGC). The Automatic Level Control Loop maintains a constant signal level irrespective of the input signal level. The IF signal is also used to produce baseband audio signal and provides Received Signal Strength (RSSI) indication.

The rest of the Intermediate Frequency section is mainly an up conversion circuitry with two mixers and 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 subaudible tone. The Channel Module is set up for a Translator mode of operation by programming proper frequency of this Voltage Controlled Oscillator.

The output from the Intermediate Frequency section is the final output frequency.

6.3 POWER AMPLIFIER

The Power Amplifier is capable of delivering up to 20W 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 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.

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), power (DC ON), transmit (TX ON), receive (RX ON), output power fault (PWR) and VSWR fault (VSWR).

7.0 SET UP

7.1 PROGRAMMING SOFTWARE INSTALLATION

Futurecom 6A046X01 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 CM <Enter>.
6. Select "Setup" field and then select "RS-232/access type" 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
	Direct
<i>Baud Rate</i>	9600 b/s
<i>Data Bits</i>	8
<i>Stop Bits</i>	1
<i>Parity</i>	NO
<i>Comm. Port</i>	COM1 or COM2 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. In addition, 10dB margin is recommended.

For Translator Mode (Receiver Frequency is different from Transmit frequency):

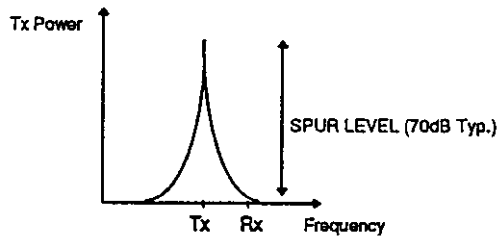
The total gain of the Channel Module must always be less than

ANTENNA ISOLATION + SPUR LEVEL + 10dB

where

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

SPUR LEVEL = The difference between transmit output power and spurious of Tx signal on Rx frequency. This difference is typically 70dB.



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

The Channel Module will remain permanently keyed up after first valid transmission if this basic rule is not followed!

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 "Unit" field and then select "Manual Control" 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 "?" are readings.
2. Set the mode of operation in "Rx/Tx Mode" field to OCR or Translator.

3. Set the frequency of operation in "Rx Ch" field for the OCR mode. Set the frequencies of operation in "Rx Ch" and "Tx Ch" fields to be equal for the Translator mode. All frequencies are equal to the Channel Module downlink transmit frequency. Frequencies can also be entered by typing the number in the given field and pressing <Enter>.
4. Set "FE: Att" between 4 and 8dB. This setting can be higher than 8dB.
5. Set desired output power in "Tx PWR Pot".
6. Make sure that the donor site is not transmitting!
7. Key up the Channel Module by setting "PTT" ON.
8. Read "own" "?RSSI". The difference between "Tx PWR Pot" and "own" "?RSSI" is the Antenna Isolation.
9. Unkey the Channel Module by setting "PTT" OFF.
10. Set the "Rx Ch" frequency to be equal to the donor site transmit frequency. Key up the donor site.
11. Read "donor" "?RSSI".

If the "donor" "?RSSI" is smaller (i.e. smaller RF level) than the "own" "?RSSI", the desired gain cannot be realized and the output power must be lowered and the above steps must be repeated for the new output power setting.

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 "Rx Ch" and "Tx Ch" fields to be equal to donor receive frequency. Frequencies can also be entered by typing the number in the given field and pressing <Enter>.
13. Set "FE: Att" between 4 and 8dB. This setting should be as small as possible but not smaller than 4dB.
14. Set desired output power in "Tx PWR Pot", usually around 1W..

15. Key up the Channel Module by setting "PTT" ON.
16. Read "own" "?RSSI". The difference between "Tx PWR Pot" and "own" "?RSSI" is the Antenna Isolation.
17. Unkey the Channel Module by setting "PTT" OFF.
18. Set "RSSI CAS Th" at least 6dB higher than "own" "?RSSI" level. The "RSSI CAS Th" level should be as low as possible for maximum sensitivity.
19. Set correct frequencies of operation in the "Rx Ch" and "Tx Ch" fields.
20. 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>.
21. 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>.