

# ON-CHANNEL REPEATER (OCR)

Users Manual

**8A535X01**

**Rev. Preliminary**

## REVISION RECORD

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## **ABOUT THIS DOCUMENT**

This document describes the operation of the Futurecom On-Channel Repeater (OCR). It provides setup guidelines and outlines the programming options, which are accessible through the programming software (6A074X01).

### **Notes, Attentions, Important**

Throughout this manual, you will see Notes, Attentions and Important. Their meaning is as follows:



#### **NOTE**

A clarifying statement that expands on the text that follows.



#### **IMPORTANT**

An important statement that must be considered and / or implemented in order to achieve adequate equipment operation.



#### **ATTENTION!**

An instruction that must be followed to insure compliance with the appropriate standards or proper equipment operations.

## SAFETY INFORMATION



### 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. However, there is no guarantee that interference will not occur in a particular installation.



### ATTENTION!

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

#### **USA Users:**

Do not use the On-Channel Repeater in the frequency band 406.0 - 406.125MHz. This frequency band is reserved for use by distress beacons.

## GENERAL 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.



### IMPORTANT

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 Users Manual. **All instructions should be saved for reference in the future!**



### ATTENTION!

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.

This product does not contain customer serviceable components therefore **never** disassemble the product.



### **IMPORTANT**

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.

### **DAMAGE REQUIRING SERVICE**

This product should be serviced by qualified service personnel when:

- Objects have fallen, or liquid has been spilled into the product; or
- The product has been exposed to rain or moisture; or
- The product does not appear to operate normally or exhibits a marked change of performance; or
- The product has been dropped, or the cabinet damaged.

### **RF EXPOSURE**

#### **ATTENTION!**



To satisfy FCC/IC RF exposure requirements, a separation distance specified in Table 1 or more should be maintained between the antenna of this device and persons. To ensure compliance, operations at closer than this distance is not allowed.

#### **RADIO OPERATOR**



Futurecom requires the OCR operator to ensure FCC Requirements for Radio Frequency Exposure are met. The minimum distance between all possible personnel and the antenna must be as specified in Table 1.

**FAILURE TO OBSERVE THE MPE DISTANCE EXCLUSION AREA AROUND THE ANTENNA MAY EXPOSE PERSONS WITHIN THIS AREA TO RF ENERGY ABOVE THE FCC EXPOSURE LIMIT FOR BYSTANDERS (GENERAL POPULATION). IT IS THE RESPONSIBILITY OF THE OCR OPERATOR TO ENSURE THAT MPE LIMITS ARE OBSERVED AT ALL TIMES DURING REPEATER TRANSMISSIONS. THE OCR OPERATOR MUST ENSURE AT ALL TIMES THAT NO PERSON COMES WITHIN MPE DISTANCE FROM THE ANTENNA.**

#### **ATTENTION!**



To satisfy FCC/IC RF exposure requirements, the OCR site operator must comply with FCC/IC requirements for maximum site EIRP radiated power and antenna height limits.

Antenna Gain	dBi	0	2.15	5.15	8.15	11.15	14.15	17.15
	dBd	-2.15	0	3	6	9	12	15
<b>Antenna RF Power</b>								
1 W		18	23	33	46	64	91	128
5 W		40	51	72	102	144	203	286
10 W		57	72	102	144	203	286	404
15 W		69	88	125	176	248	351	495
20 W		80	102	144	203	287	405	571
25 W		89	114	161	227	320	452	639
30 W		98	125	176	249	351	496	700
37.3 W		109	139	196	277	391	552	780

**TABLE 1** OCR UHF MPE Safe Distances in cm for Various Antenna Gains

If the antenna gain is not listed in Table 1, the MPE Safe Distance is calculated as follows:

**Calculation Method for RF Safety Distance r:**

$$S = PG/4\pi r^2 = EIRP/4\pi r^2$$

- Where:
- P: power input to the **antenna** in mW.
  - EIRP: Equivalent (effective) isotropic radiated power in mW.
  - S: power density mW/cm<sup>2</sup>.
  - G: numeric gain of antenna relative to isotropic radiator.
  - r: distance to centre of radiation in cm.

**RF EXPOSURE DISTANCE LIMIT:  $r = (PG/4\pi S)^{1/2} = (EIRP/4\pi S)^{1/2}$**

For General Population/ Uncontrolled Exposure:

S = 0.2 mW/cm<sup>2</sup> for frequency range of 30MHz – 300MHz.

S = f/1500 in mW/cm<sup>2</sup> for frequency range of 300MHz – 1500MHz. f is the minimum used frequency in MHz.

As an example, let us consider a case of minimum frequency f = 380MHz, RF power P = 37.3W and an antenna with gain of 2.15dBi:

P = 37300 mW = 10 log(37300) dBm = 45.717 dBm

EIRP = P + G in dBm = 45.717 dBm + 2.15dB = 47.867 dBm = 10<sup>(47.867/10)</sup> = 61194mW

S = 380/1500 mW/cm<sup>2</sup>

For General Population/bystanders:  $r = (EIRP/4\pi S)^{1/2} = (61194/4\pi(380/1500))^{1/2} = 138.64\text{cm}$ .  
The MPE safe distance is therefore at least 139cm (54.73”).



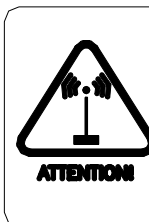
**ATTENTION!**

The MOBEXCOM DVRS Repeater must be restricted to occupational use only to satisfy FCC RF Exposure requirements.

***FCC Label***

This device complies with Part 15 of the FCC Rules.  
Operation is subject to the following two conditions:  
1) This device may not cause harmful interference, and  
2) This device must accept any interference received,  
including interference that may cause undesired  
operation.

***RF Exposure Label***



Restricted to occupational use to satisfy FCC RF exposure limits. See user manual for operating requirements.



## **OCR TECHNICAL DESCRIPTION**

### **MAIN FEATURES**

The On-Channel Repeater (OCR) is a synthesized, microprocessor-based, high performance, RF channel selective repeater with 30 Watt output power capability. It is available in the VHF, UHF and 800/900MHz bands. It is designed to receive a single RF channel, filter and amplify the channel signal and retransmit it. The OCR is used for extending the RF Coverage area of an existing radio site by receiving and re-broadcasting from host to user (downlink) and from user to host (uplink).

The On-Channel Repeater is programmed to receive and transmit on the same frequency.

The OCR operation is programmable either locally from an RS-232 port on the front panel or remotely from a System Controller. The OCR operating parameters, such as power output, sensitivity threshold, CTCSS, mode of operation, frequencies of operation, adjacent channel spacing etc can be configured by the Customer via simple set-up software as described in this manual. The currently programmed operating parameters of the OCR determine its personality. The OCR personality is stored in the EEPROM of the unit. It can be saved on a PC as a personality data file, which can be downloaded on as many OCRs as required.

Additional per channel alarm and monitoring functions are available to indicate any Power, VSWR, Temperature and Synthesizer lock conditions.

The chassis of the OCR is made from aluminum. The rugged construction minimizes microphonics and internal feedback. The OCR installation is performed by simply plugging it into a double Eurocard format 19" EIA rack mount card cage.

## PRINCIPLE OF OPERATION

The OCR consists of four main blocks – Front End, IF section, Power Amplifier and Controller.

The Front End consists of band-pass filtering, low-noise preamplifier and adjustable PIN diode attenuators. The sensitivity of the Front End is -120dBm.

After the Front End, the RF frequency is downconverted to an IF frequency by a mixer stage followed by BP filtering, amplification and another mixer downconverting to a second IF frequency. This IF frequency signal is filtered further by BP filters with BW depending on the programmed channel spacing (25kHz or 12.5kHz respectively).

The IF signal path continues with an Automatic Gain Control Loop (AGC), which maintains constant signal level, irrespective of the input signal level. The filtered and amplified IF signal goes through selective filter, followed by a mixer, which further upconverts it to the programmed OCR transmit frequency (same as the receive frequency). The transmit frequency signal is fed to the power amplifier module where it is filtered and amplified. The driver and power amplifier produce the programmed transmit power output (max 30 Watts). The transmitted power level is compared and adjusted to match its programmed value. The forward and reverse power is monitored continuously and the output power is reduced when the forward and reflected power levels are outside of the programmed range.

The Controller Board controls the operation of the OCR. It contains the microcontroller with Flash memory for the firmware and EEPROM personality storage. Communications with the other modules are facilitated by two RS-232, RS-484 and I2C serial links. One RS-232 serial port is accessible via 8-pin mini DIN connector on the front panel.

The front panel RESET and TX DISABLE inputs are monitored and can be accessed via two front panel holes with a round tool 2.5mm (0.1”) diameter. The front panel indicators (TX DIS, DC ON, TX ON, RX ON, PWR and VSWR) are also controlled by the Controller Board.

## **OCR INSTALLATION**

The OCR is easily installed by plugging it into the Eurocard format card cage which can accommodate up to five OCRs.

The DC supply wiring must be connected to nominal 27.6VDC.

For more information on multi channel options call the Futurecom sales department to obtain a quotation.

## **OCR PROGRAMMING**

### **INTRODUCTION**

The Controller board EEPROM of the OCR contains the programmed Personality Data (PD) of the specific OCR unit. The PD file determines the functionality of the OCR and it can be created and / or modified by using the OCR programming software.

### **CONNECTING AND DISCONNECTING THE OCR TO A PC**

1. Plug the supplied programming cable into the "RS232" connector on the front of the OCR.
2. Plug the other end of the serial cable into the serial port of the PC.
3. Follow the Programming Instructions as described in the next paragraphs.
4. Exit the programming software and only then unplug the serial cable from the OCR.

### **INSTALLING THE PROGRAMMING SOFTWARE**

The programming software can be run either from Windows or MS DOS. Copy the files from the Futurecom supplied disk into a separate directory / folder on your PC. Create a shortcut (Windows) or use the supplied batch file by typing in the path to the .exe file location on the specific PC. Run the programming software by clicking on the shortcut or typing the batch file name.

## **USING THE PROGRAMMING SOFTWARE FOR SETTING UP THE OCR**

### **STARTING UP THE PROGRAMMING SOFTWARE**

After connecting the programming cable to the OCR serial port, run the programming software. The following screen will be displayed:

### **USING THE PROGRAMMING SOFTWARE ON-LINE**

For successful On-Line operation the OCR needs to be properly connected prior to commencing the programming / system setup:

1. The OCR must be plugged into the Futurecom subrack and supplied with proper DC power supply.
2. The RF IN and RF OUT ports need to be connected to the corresponding multicoupling ports or to adequate power rating 50 Ohm loads (or to the test equipment).
3. The DC power supply needs to be turned on.

For successful On-Line operation, the PC RS232 port has to be properly initialized and connected to the OCR by using the provided serial cable. The COM port settings need to be specified the first time you run the programmer on your PC as described below.

Go to the **Options** pull down menu:  
Select **Ports / Modem Setup**:

If connecting directly to the repeater select Direct Access to unit and ensure the correct COM port is selected Exit from the Ports menu and select "Yes" when prompted "Would you like to update the config file?"



## **IMPORTANT**

*The OCR Power Output and CAS Thresholds determine the OCR maximum Gain, which must be at least 10dB lower than the measured overall system isolation. The isolation measurement and gain setting procedure is described in the Setting up the OCR Gain section of this document.*

## **SETTING UP THE OCR MAXIMUM GAIN**

The OCR has the receive and the transmit frequencies the same. The Gain range is 70 to 140dB in OCR mode. However, the gain is limited by the isolation that can be achieved between the rest of the RF system i.e. cables, antennas, filtering etc. The maximum Gain setting must be at least 10 dB lower than the measured overall isolation in order to prevent OCR lock up.

Once the OCR is programmed, installed and connected to the rest of the antenna system, the **Maintenance** screen can be used for measuring the isolation and setting up the gain as described below. No extra test equipment is required.

Open the **Maintenance** screen from the **OCR Setup** pull down menu. The Maintenance screen is not a programming screen. It is used for diagnostic and setup only. The fields seen on the Maintenance screen are described in the previous sections with the exception of the measured data fields shown on the right hand side and marked with “?”.

### **DOWNLINK MAXIMUM GAIN SETTING:**

- Ensure that the correct channel is selected (if the OCR is programmed with more than one channel in the **Channel Data** list).
- Set the desired maximum power output in the **Power Setup** field.
- Make sure the donor site is not transmitting by observing the **?CM CAS** fields (should be **Idle** when no carrier is present).
- Key up the OCR by setting **PTT** to **ON**.
- Read the “own” **?RSSI** level from the **Maintenance** screen
- The difference between the Tx power setting and the received “own” RSSI is the Antenna / system isolation.
- Unkey the OCR by setting **PTT** to **OFF**.
- Key up the Donor site and read the donor **?RSSI** level off the Maintenance screen.
- Set the **RSSI CAS Threshold** to at least 10 dB higher than the measured “own” RSSI level and 6dB lower (better) than the measured Donor RSSI. If the above is not possible, the power output needs to be reduced and the above steps repeated at reduced gain.

(for example if the measured “own” RSSI is -120dBm and the donor RSSI is -90dBm, set the **RSSI CAS Threshold** to -110dBm < **RSSI CAS Th.** < -96dBm)

### **UPLINK MAXIMUM GAIN SETTING:**

- Ensure that the correct channel is selected (if the OCR is programmed with more than one channel in the **Channel Data** list).
- Set the best RSSI level required (usually -115dBm) in the **RSSI CAS Th ON** field.
- Set the power output to the calculated level required to reach the Donor site (allow for at least 6 dB margin).
- Key up the OCR by setting **PTT** to **ON**.
- Read the “own” **?RSSI** level from the **Maintenance** screen

- The difference between the Tx power setting and the received “own” RSSI is the Antenna / system isolation.
- Unkey the OCR by setting **PTT** to **OFF**.
- Set the RSSI CAS Threshold to at least 10 dB higher than the measured “own” RSSI level (for example if the measured “own” RSSI level was -120dBm, set the RSSI CAS Th ON to -110dBm or higher).

## **OCR FRONT PANEL INDICATORS**

The OCR front panel has several LEDs which provide the following indications:

<b>LED Label</b>	<b>LED Color</b>	<b>DESCRIPTION</b>
TX DIS	RED	<p>The TX DIS LED is steady on when transmit is disabled either by:</p> <ul style="list-style-type: none"> <li>❑ Triggering the TX DIS switch which is located above the LED (accessible with a round tool 2.5mm in diameter)</li> <li>❑ Triggering the back panel Tx Disable Input</li> <li>❑ Setting the Operating Mode field to Tx-Disable (in the Maintenance screen)</li> </ul> <p>The TX LED indicator is flashing when one of the synthesizers is being out of lock.</p>
DC ON	GREEN	<ul style="list-style-type: none"> <li>❑ When on it indicates that the OCR is powered up.</li> </ul>
TX ON	GREEN	When on it indicates that the OCR is transmitting.
RX ON	GREEN	When on it indicates that the OCR input signal is above the programmed level
PWR	RED	<ul style="list-style-type: none"> <li>❑ The PWR LED is steadily on when the output RF power is outside of the programmed tolerance.</li> <li>❑ The PWR LED is flashing alternatively with the VSWR indicator when an error is found in the EEPROM of the OCR</li> </ul>
VSWR	RED	The VSWR LED is on when an excessive reflected power is detected on the Tx port



### OCR Specifications

<b>ELECTRICAL SPECIFICATIONS</b>			
	<b>OCR VHF</b>	<b>OCR UHF</b>	<b>OCR 800</b>
Frequency of Operation	136 – 174 MHz	380 – 512 MHz	806 – 960 MHz
Sensitivity	-115 dBm		-113 dBm
Input Carrier Detection Threshold	-115 to -80 dBm		-113 to -80 dBm
Carrier Detection Adjustment Step	1 dB		
Carrier Detection Attack Time	<2 ms		
Max. Gain Range (Programmable) On-Channel Repeater	70 to 140 dB		
AGC Attack Time	< 2 ms		
AGC Decay Time	< 2 ms		
Output Power	1 to 30 W		
Duty Cycle	100%		
Output Frequency Stability	Tracks Input Signal Frequency		
Passband Frequency Stability	+/- 1.5ppm (+/- 0.1 ppm optional)		
Modulation Types	Narrowband FM Voice, P25 Voice and Data		
Channel Spacing	25 kHz / 12.5 kHz		
Selectivity 25kHz / 12.5kHz	>65 / > 55dB		
Adjacent Channel Rejection 25kHz / 12.5kHz	>100dB / >60dB		
Receiver Spurious Response Rejection	> 70 dB		
Receiver Intermodulation	> 70 dB		
Receiver Conducted Spurious Emissions	< -57 dBm		
Transmitter Conducted Spurious Emissions	< -20 dBm		
Transmitter FM Hum and Noise	> 45 dB		
Input / Output Impedance	50 Ohms		
Input / Output VSWR	< 1.5 : 1		
Power Supply Voltage	22 to 28 VDC		
Power Supply Current Drain Standby	< 0.3 A		
Transmit	< 4 A		
<b>MECHANICAL SPECIFICATIONS</b>			
RF Connectors	SMA female		
Environmental	90% humidity @ 50 °C (122°F)		
Operating Temperature Range	-30 to +60°C (-22 to +140°F)		
Dimensions [H x D x W]	260 x 225 x 75 mm (10.25" x 8.86" x 2.95")		
Weight	4.09 kg (9 lb)		