MARK-IV CHANNELIZED RADIO REBROADCAST SYSTEM

MARK-IV NARROWBAND (CHANNELIZED) CLASS A SIGNAL BOOSTER WITH AUTOMATIC OUTPUT LEVEL CONTROL

M4-ChOLC

USER'S OPERATION & MAINTENANCE MANUAL

PRELIMINARY

SUBMITTED BY:
CANAM TECHNOLOGY, INC.
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II. USER'S OPERATIONS & MAINTENANCE

Section A. Introduction

The MARK-IV is a Class A Narrowband (Channelized) Signal Booster module equipped with automatic Output Level Control (ChOLC), for operation under FCC Part 90.219 in the frequency bands of VHF, UHF and 800 MHz.

The MARK-IV module could also be used to retrofit Class B Broadband Bi-directional Amplifiers (BDAs), converting them into Class A Narrowband (Channelized) Boosters compliant with the FCC Part 90.219(d) requirements to transmit outdoors.

M4-ChOLC Key Features:

- Narrowband Class A Signal Booster, per FCC Part 90.219 and 90.7
- Maximum Output Power = 0 dBm.
- Out-of-Band emissions < –13 dBm, compliant with FCC requirements.
- AGC circuit provides a constant output power, regardless of the input power.

This document is the MARK-IV module Operations and Maintenance Manual, intended for the Radio Technical Personnel.

It contains detailed descriptions of each one of the M4-ChOLC subsystems down to their Lowest Replaceable Units (LRU). This manual is intended to be used with the M4-ChOLC Equipment only. It is not to be used with any other equipment unless it is authorized by Canam Technology, Inc.

Canam Technology, Inc provide this document "as is" without any warranty of any kind. This document may contain typographical errors and technical inaccuracies. Canam Technology will not accept any liability from the use and misuse of this manual, the information contained within, or the consequences of any actions resulting from the use of this information.

The user can not make any modifications to the unit(s). Changes or modifications not expressly approved by the party responsible for compliance voids the user's authority to operate the equipment.

Signal boosters such as the M4-ChOLC generate radio signals and, therefore, electromagnetic fields. The technical personnel should have a complete understanding of FCC CFR Title 47 sections 1.1307 and 1.1310. Recommendations are included in this Manual, but they do not substitute the FCC guidelines.

This device may require the use of antennas for proper functioning, depending on the application. The installation of the antennas should be performed by qualified technical personnel. All antennas should be fixed mounted and physically secured to one location. **The people must be away from the antennas at least 0.25 meters to comply with the RF Human Maximum Permissible Exposure limits, as long as the antenna system gain is lower than 33 dBi.** If greater gain is used the separation should be increased, please refer to the FCC Rules.

If service should be performed on the antenna, please shut down the transmitter or lower its power in order to comply with the maximum permissible exposure.

Section B. GLOSSARY OF TERMS

AC: Alternating Current.

Base station: A station at a specified site authorized to communicate with mobile stations.

Broadband Bidirectional Amplifier (BDA): Device that automatically receives amplifies and retransmit on a two-way basis all the signals within the passband of the amplifier's filter.

Narrowband (Channelized) Signal Booster: Device that automatically receives, amplifies and retransmits on a one-way or two-way basis only the discrete frequencies intended for retransmission.

DC: Direct Current.

Downlink: Transmission link from the base station to the mobile station.

Mobile station: A station in the mobile service intended to be used while in motion or during halts at unspecified points. This includes hand carried transmitters.

Rx: Receiver.

Tx: Transmitter.

Uplink: Transmission link from the mobile station to the base station.

Section C. THEORY OF OPERATION

C.1 DESCRIPTION

The **CTI MARK-IV CHANNELIZED REBROADCAST SYSTEM** is designed for multi-carrier two-way rebroadcast systems, where significantly high dynamic range is required.

The ***M4-ChOLC*** is a Narrowband Class A (Channelized or Channel Selective) Signal Booster with a 100 dB Automatic Output Level Control, fully compliant with the FCC requirements to transmit signals outdoors back to the donor sites or basestations.

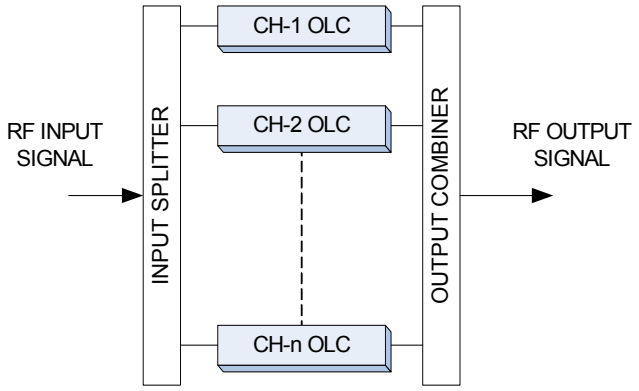

Figure 1: Channelized Rebroadcast System

Per FCC 90.219(d) only narrowband (class A) signal boosters can be used for that application, the broadband BDAs are not allowed to transmit outdoors.

It can also be used as a front-end filter system to retrofit Broadband BiDirectional Amplifiers (BDAs).

When several ***M4-ChOLC*** modules are combined to process multiple channels within a desired band, the RF signals going into the BDA are set at a constant level by the 100 dB Automatic Output Level Control, regardless of their input level, which significantly improves the system dynamic range.

The ***M4-ChOLC*** modules reduce high power carriers that can saturate the BDAs and create Intermodulation (IM) Products in the system. On the other hand, the ***M4-ChOLC*** modules boost up weak carriers that would be otherwise lost in a broadband BDA system. See next Figure 2.

The ***M4-ChOLC*** modules turn a Broadband BDA into a Narrowband Class A "channelized BDA" that can be used to transmit signals outdoors, without the limitations set forth by the FCC in Part 90.219(d).

M4-ChOLC modules can be programmed for processing any communications channel in the two-way mobile radio UHF or 800 MHz SMR bands, while maintaining system flexibility. Multiple modules are combined into a single output signal with Low-Level passive combining, which improves BDA efficiency and cost effectiveness by reducing combiner costs.

The ***M4-ChOLC*** modules are a very cost-effective upgrade to existing BDA systems that both improves their performance and makes them compliant with FCC 90-219(d).

Figure 2 shows, as example, the operation of an integrated system with only four ***M4-ChOLC****s* programmed on F1, F3, F0 and F5 frequencies. The signals on F2, F4 and F6 are filtered out, since there are no ***M4-ChOLCs*** tuned to them.

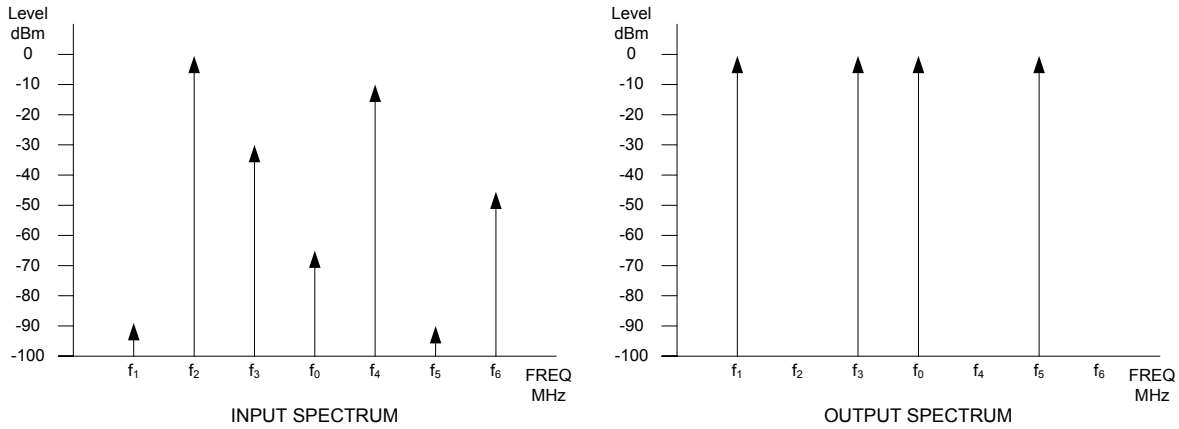

Figure 2: 4-channels Integrated System Input and Output Spectrum

C.2 FEATURES & APPLICATIONS

- ***M4-ChOLC*** modules are a front-end ***Channelized Signal Conditioner System*** (Channel Selective, class A narrowband signal boosters per FCC definition) that effectively and efficiently converts broadband BDAs into Channelized Class A boosters compliant with FCC 90.219(d) rule.
- ***M4-ChOLC*** modules, ***Higher Input Dynamic Range***, reduce the impact of strong interfering input carriers (those that create 3rd order IM products landing right on another system desired channel). Two interfering carriers could be up to -30 dBm at the module's input without causing harmful interference in the desired channel.
- ***M4-ChOLC*** modules, ***Higher Input (Rx) Intermodulation Rejection***, -30 dBm maximum input for two undesired carriers causing 3rd order IM interference.
- ***M4-ChOLC*** modules, ***100 dB Automatic Output Level Control*** equalizes the output signal at a fixed level regardless of the input level ***= improves the system dynamic range*** to feed RF-over-Fiber optic links or remote boosters with constant levels to overcome the link losses and the RF/Optic converter's very high noise figures.
- ***M4-ChOLC*** modules ***Frequency and Phase Tracking*** follow exactly the input signal's frequency and modulation (analog or digital), with minimum delay.
- ***M4-ChOLC*** modules are ***Field-programmable Operating Frequency*** = PLL-based Synthesizer.
- ***M4-ChOLC*** module ***Manual Input (Rx) Threshold and Output Power Level*** controls provide easy field adjustments and Status Indicators (visual LED and Discrete Signals).
- ***M4-ChOLC*** modules, ***Small Foot-print & Simple Installation***,
- ***M4-ChOLC*** stand-alone modules require **only +15 VDC**.

C.3 INPUT (Rx) INTERMODULATION REJECTION

The ***M4-ChOLC*** delivers an outstanding Input (Rx) Intermodulation Rejection, which combined with its Input Sensitivity of -100 dBm allows the module to tolerate strong undesired input carriers of up to -30 dBm with no interference on the desired channel, as per TIA standards. Figure 3 illustrates this case's input spectrum.

This is particularly important for critical applications where the frequency plan contains channels that would create 3rd and 5th order Intermodulation Products landing in-band right on other desired system channel(s), since two or more very strong signals at F_1 and F_2 frequencies impacting the M4-ChOLC's front-end would cause interference on the desired F_0 channel.

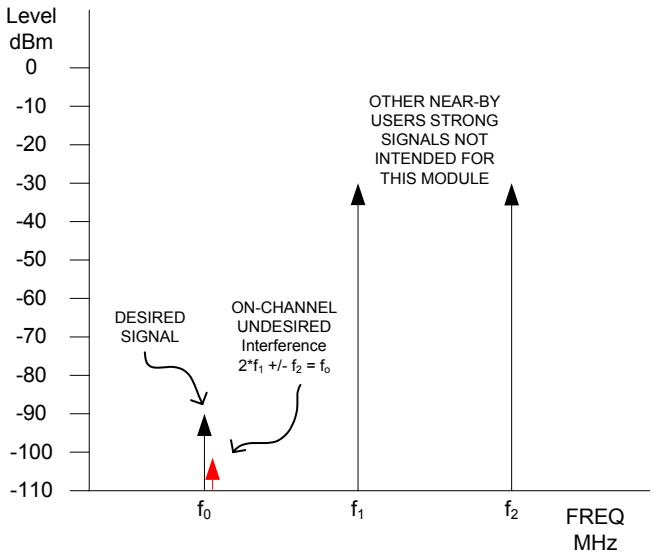

Figure 3: Input (Rx) Intermodulation Rejection 3rd ORDER on-channel IM interference $2*F_1 \pm F_2 = F_0$

C.4 THE CHANNEL PROCESSOR

The architecture of the ***M4-ChOLC*** is based on down&up heterodyne frequency converters, featuring narrowband Intermediate Frequency (IF) filters and Automatic Gain Control signal conditioner.

The output signal reproduces the exact input's frequency and modulation (analog or digital), as received at the module's input.

The next diagram in Figure 4 shows the simplified ***M4-ChOLC*** architecture.

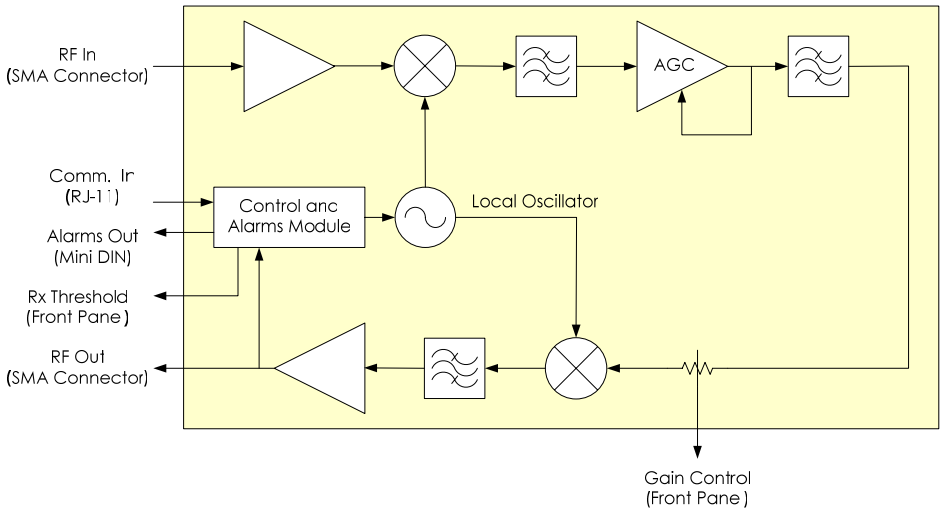

Figure 4: M4-*ChOLC* Block Diagram

C.5 CHANNEL SELECTIVITY

The ***M4-ChOLC*** is a channel selective signal processor that filters and conditions only the desired channel output power level. Other channels are filtered out, rejected and not affected. The Output Signal is equalized to a steady and fixed level, regardless of the input signal level variations.

The following Figure illustrates the ***M4-ChOLC*** operation on $\mathbf{f_0}$ frequency.

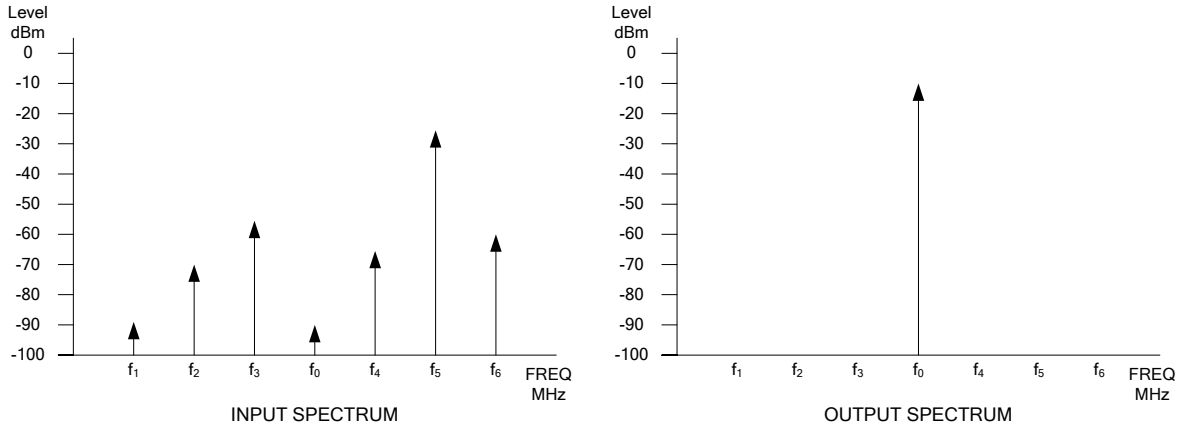

Figure 5: Single *ChOLC* Input and Output Spectrum

C.6 MARK-IV MODULE SPECIFICATIONS

MARK-IV Channelized (Class A Narrowband) Signal Booster module with Automatic Output Level Control – model M4-ChOLC	
• **Channel Specs**	
Frequency range: a. M4-ChOLC-800UL FCC ID: TCJM4-ChOLC-800UL b. M4-ChOLC-800DL FCC ID: TCJM4-ChOLC-800DL c. M4-ChOLC-UHF FCC ID: TCJM4-ChOLC-UHF	 a: 806 – 824 MHz b: 851 to 869 MHz c: 460 to 490 MHz
Frequency Programming Steps	12.5 kHz
Channel Spacing	25 kHz
• **RF Input**	
Input impedance (typ)	50 ohms
Sensitivity for greater than 20 dB output SINAD (DAQ 3.4)	-90 dBm
Maximum input power (composite) for no-damage	-10 dBm
• **RF Output**	
Output impedance (typ)	50 ohms
Output power (maximum) a. M4-ChOLC-800UL FCC ID: TCJM4-ChOLC-800UL b. M4-ChOLC-800DL FCC ID: TCJM4-ChOLC-800DL c. M4-ChOLC-UHF FCC ID: TCJM4-ChOLC-UHF	 0 dBm -2 dBm -5 dBm
Output level adjustment range	10 dB
Maximum output level variation with input level variations within range	+/- 2 dB
Distortion	≤ 4%
Spurious & harmonics outputs	< -13 dBm
Duty cycle	Continuous
• **Field Adjustments and Status Indicators**	
Operating Frequency (serial port interface)	
Input (Rx) Threshold level	
Output Power level	
RF output OK signal (open-collector, "fail-safe" indication)	
DC current draw OK signal (open-collector, "fail-safe" indication)	
Receive Signal Strenght Indicator – RSSI (DC voltage)	
• **Power Requirements**	
Power Supply	+15 VDC
Power Consumption	10 W max.
• **Environmental**	
Operating Temperature range	0° to 50° C
• **Mechanical**	
Module footprint (typical)	273x234x27.2 mm
RF coaxial connectors are "SMA" type, female.	

Section D. INSTALLATION

D.1 Equipment Installation

The mechanical drawing is shown in Figure 6. The M4-ChOLC can be installed in several forms:

a. Up to 14 units can be mounted vertically in a 6RU standard card-cage.
b. Up to 2 units can be mounted horizontally in a 1RU shelf.
c. The modules could also be stack up in a wall-mount enclosure, according to the costumer's needs.

Canam Technology's Equipment is factory configured. All setup and wiring is performed by Canam's Personnel. There is no need to disconnect the equipment unless the units should be serviced.

Warning: if any module should be disconnected, it should only be done by qualified technical personnel.

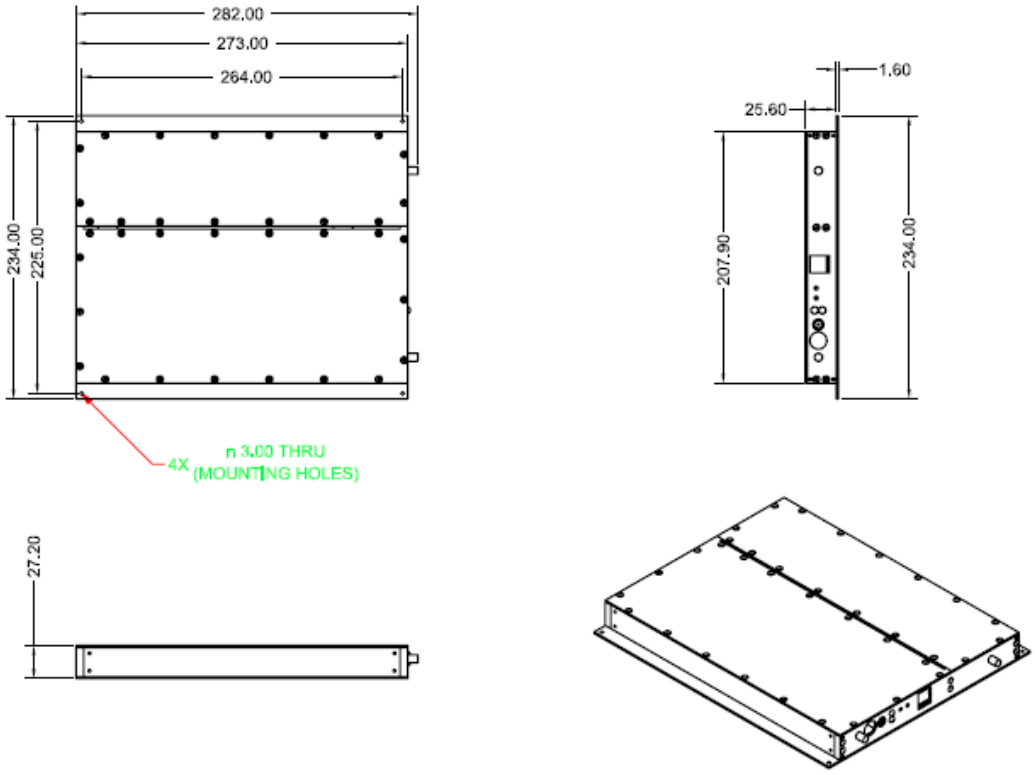

Figure 6: M4-ChOLC Mechanical Specifications (Units in mm)

D.2 Antenna Installation

The Input antenna and output antenna are not included with this equipment. Nevertheless, if this device is used in an application that requires direct connection to an antenna, Canam Technology recommends following the FCC guidelines for its installation:

- Antenna Installation should be performed by qualified technical personnel.
- The installations instructions are for the purpose of complying with FCC RF Exposure and are not optional.
- All antennas (Donor and Service) should be fixed mounted and physically secured to one location.
- Non-building mounted donor antennas must be greater than 10 meters above ground.
- Minimum Separation to any body's part of any person is 25cm, as long as the System Antenna Gain is lower than 33 dBi.
- The Maximum System Antenna Gain should be as follows for each model:
    - For M4-ChOLC-800UL model, G < 33.69 dBi.
    - For M4-ChOLC-800DL model, G < 36.44 dBi.
    - For M4-ChOLC-UHF model, G < 36.86 dBi.

Section E. OPERATION

All the controls and connections of the M4-ChOLC can be access through the front panel, as show in Figure 7.

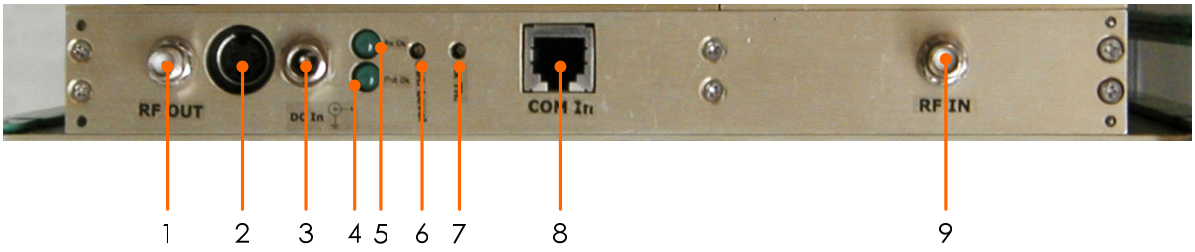

Figure 7: M4-ChOLC Front Panel

Item	Description	Function
1	RF Out	Female SMA Connector used to drive the RF Signal out of the M4-ChOLC
2	Status Indicator Connector, plus alternative DC In.	8 Pins Mini-DIN. Three output status signals are available: a. RSSI b. RF IN&OUT Status Alarm c. DC Status Alarm The DC In could also be supplied at this connector. For the connector pin out and a detailed description refer to the section F.4.
3	DC In	DC Input. The module requires a +15VDC supply.
4	RF Out Ok LED	This visual indicator will be on when there is an RF signal being transmitted within the preset power limits.
5	Rx Ok LED	This visual indicator is on when the Module receives an RF signal above the preset Rx Threshold level.
6	Out Level Adjustment	This adjustment allows decreasing or increasing the preset Module's RF Output Power.
7	Rx Threshold Adjustment	This adjustment is used to increase or decrease the RF level required to trigger the output on.
8	Communications Input Port	This is an RJ-11 connector used to interface a computer's serial port in order to program the module's operating frequency.
9	RF In	Female SMA Connector used to drive the RF Signal into the M4-ChOLC

Section F. M4-ChOLC Adjustments

The equipment adjustments should only be performed by qualified technical personel. These adjustments are set through the system optimization, and they may be changed only during equipment service and repair.

F.1 M4-ChOLC Channel Frequency Programming

The M4-ChOLC Operating Frequency can be changed using Canam Technology's proprietary software application.

WARNING: The application is intended to be used with Canam's M4-ChOLC only. The use of this software with any other equipment may cause the equipment and / or the application to function incorrectly.

Please follow the next steps in order to install it.

1. Go to "My PC", then click on the CD-ROM Drive.
2. Double click on the setup.exe application in the CTI CD-ROM, see Figure 8.

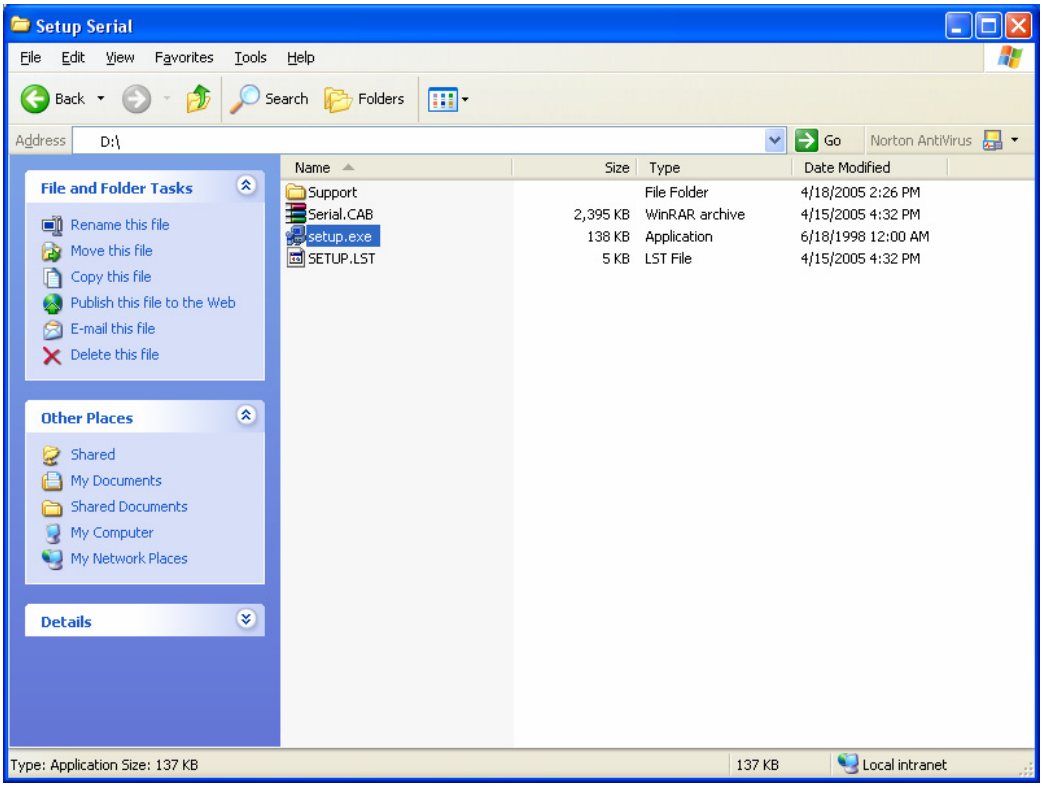

Figure 8: Installing the application utility for the M4-ChOLC

3. Follow the installation instructions that appear on the screen.

After the application has been installed, it can be access by going to Start ► All Programs ► CTI ► Serial. The application main window should appear as shown in Figure 9.

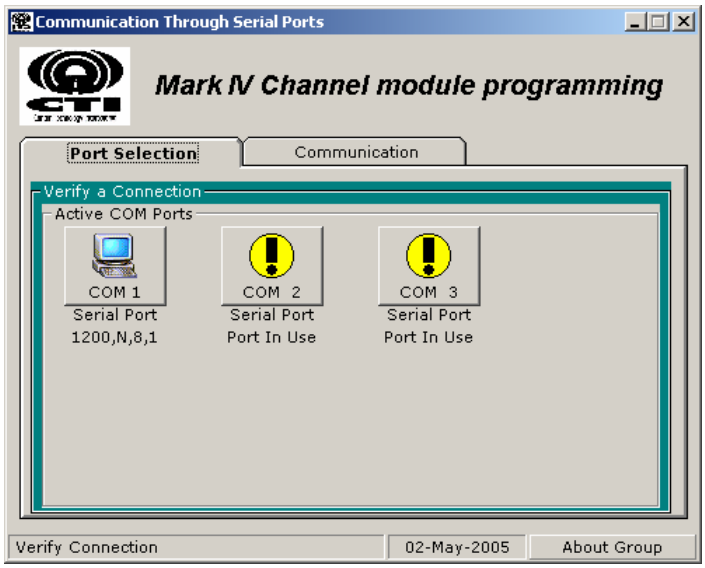

Figure 9: M4-ChOLC Frequency Programming G.U.I. Application

The tab *Port Selection* shows the detected COM ports in the host computer. To choose the desire output port, click on the corresponding icon.

The icon meanings are as follows:

This icon means that the port is available and it can be used to connect to the M4-ChOLC.

This icon means that the port is being used by another application or service. These ports are not available to connect to the M4-ChOLC.

This icon means that the communications port is a MODEM. This port cannot be used to connect to the M4-ChOLC.

NOTE: In order to connect the host Computer with the M4-ChOLC, use the interface cable provided by Canam Technology part number CT-M4-ChOLC-COMCABLE. Connect the PC RS-232 Port to the M4-ChOLC COM IN port. Do not connect a telephone line to the equipment, the port may get damaged.

Once the COM port is selected, the user can change the M4-ChOLC operating frequency. By using the tab *Communications*, it is possible to program the module's operating frequency, as shown in Figure 10.

The frequency is given in MHz, and it can be changed in steps of 12.5, 25, 50 or 100 kHz. After the frequency has been selected or entered, click on the Send button to change the M4-ChOLC's operating frequency.

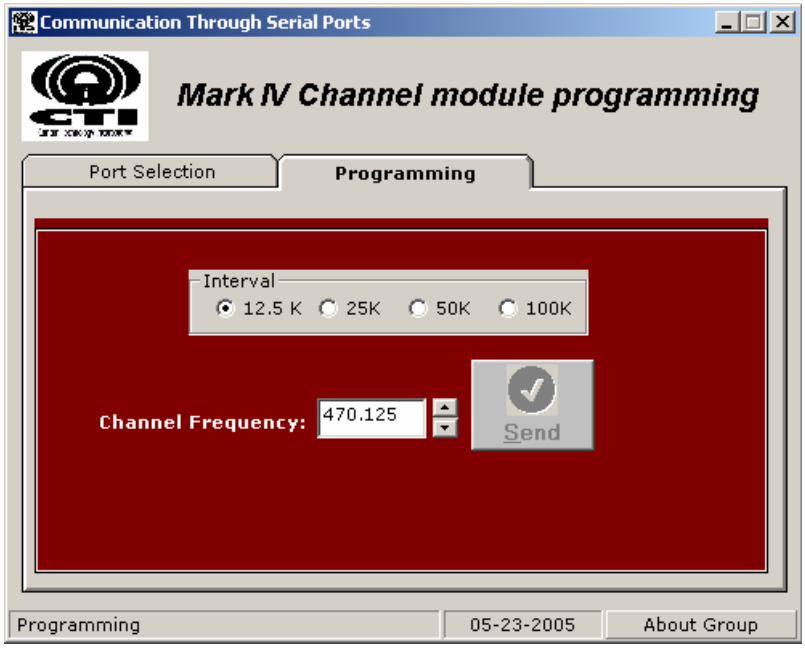

Figure 10: Programming the M4-ChOLC Operating Frequency

F.2 M4-ChOLC Output Level

This front panel potentiometer adjustment can be accessed using a small flat screwdriver.

By turning it clockwise, the output power level will be increased up to the maximum gain.

Turning the potentiometer counter-clockwise, the output power will decrease up to 10 dB, which is the gain control range.

To adjust the Output Power level, use the test circuit shown in Figure 11. Adjust the RF Generator frequency to match the M4-ChOLC operating frequency, and the Generator Power (P_{gen}) to – 50 dBm.

Turn counter-clockwise the RF Power Level adjustment until it reaches the lowest power output.

Using a Spectrum Analyzer or a Communications Service Monitor, measure the M4-ChOLC Output Power, and turn the Out Adjustment clockwise until reaching the desired output power.

After this adjustment, the M4-ChOLC will provide the same Power Output regardless of the input signal power (the input power should not be higher than -10 dBm, otherwise the M4-ChOLC may damage).

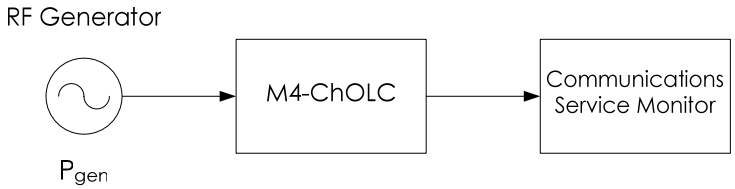

Figure 11: Output Power Adjustment Setup

F.3 M4-ChOLC RX Threshold Level

The Rx Threshold Level is used to set up the Input Power Level required for a signal to be retransmitted by the device. Input signals below this threshold are not amplified.

In order to adjust this level, use the circuit shown in Figure 12. Set the RF Generator frequency to the same M4-ChOLC frequency and its output level to the desired threshold.

Turn the M4-ChOLC Rx Threshold Level potentiometer all the way clockwise. The RX OK Led should be off. There should be no signal present at the output of the M4-ChOLC.

Turn the Rx Threshold Level Adjustment counter-clockwise until the RF OK Indicator turns on and the module delivers the signal out.

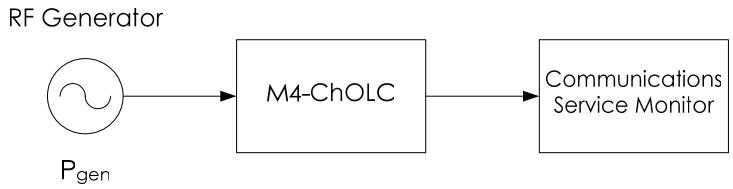

Figure 12: Rx Threshold Level Setup

F.4 M4-ChOLC Status and Alarms

The M4-ChOLC provides TTL Compatible output signals that can be used by a SCADA system to monitor the status of the M4-ChOLC unit.

The signals can be accessed through an 8-pin mini-DIN connector located on the M4-ChOLC Front Panel (Refer to Figure 7). The connector's pin out is shown in Figure 13.

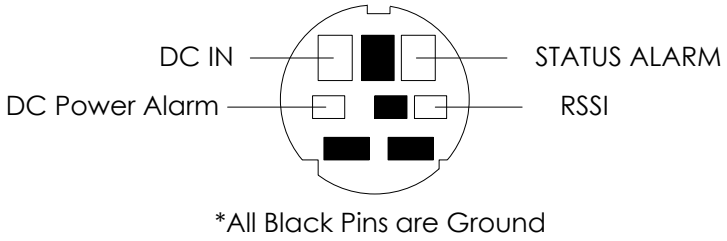

Figure 13: Status/Alarm Connector pin out.

Table 1: Status/Alarm Signal Description

Signal name	Function
DC IN	DC Input. The module requires a +15VDC supply.
DC POWER ALARM	This signal is a "fail safe" type alarm. The Open-Collector is conducting to ground during normal operation, and it will be an open circuit (not conducting) during an alarm condition.
GND	Power Supply Ground or reference for the output signals. This ground pins are connected to the equipment chassis.
RF STATUS ALARM	This signal is a "fail safe" type alarm. The Open-Collector is conducting to ground during normal operation, and it will be an open circuit (not conducting) during an alarm condition.
RSSI	This signal provides a DC level proportional to the RF Input power.

Section G. TROUBLESHOOTING

This section is intended for problem-solving that can be addressed on the field. If the problem is not solved using this guide, do not open the equipment and try to repair it by yourself. Please contact Canam Technology for service and repair.

G.1 DC POWER ALARM

1. Check that the external +15VDC power supply is connected to the correct AC power outlet and it is turned on. Measure the Power Supply DC output using a multimeter to ensure that the 15V are present.
2. If the power supply is connected but no 15V were present, change the power supply to another power outlet. If this solves the problem, repair the power outlet.
3. If there are no 15V at the Power Supply output, replace the power supply.
4. If the 15V are present, check the cable that connects the power supply to the M4-ChOLC. If it is damaged, replace the cable.
5. If cable replacement does not fix the problem, please contact Canam Technology.

G.2 RF STATUS ALARM

1. Use the test circuit shown in Figure 14.
2. Adjust the RF Generator frequency to match the frequency of the M4-ChOLC Module.
3. Adjust the RF Generator Power (P_{gen}) to -50 dBm.
4. If there is no output signal present, verify that the RF Threshold level is properly adjusted. See section F.3 for details.
5. If after adjusting the RF Threshold there is no signal, use Canam's C-PROG software to set the M4-ChOLC Operating Frequency.
6. If no output signal is still present, contact Canam Technology for repair.

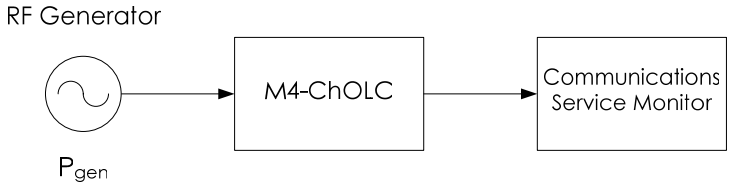

Figure 14: Status alarm troubleshooting test setup

G.3 COM PORT

1. Connect the M4-ChOLC COM Port to the computer RS-232 Port using the interface cable provided by Canam.
2. Open the application C-PROG, click on the button corresponding to the port used to connect the computer.

3. If the message "There isn't connection with the device" appears, make sure that the M4-ChOLC is powered, and try again.
4. If the message "There isn't connection with the device" still appears, change the cable used to connect the M4-ChOLC with the computer.
5. If replacing the cable does not fix the problem, contact Canam for repair.

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