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MCDR INSTRUCTION MANUAL



MCDR Multi-Channel Data Receiver
P/N 10D1068-L, M, H

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MCDR Instruction Manual

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HISTORY

Revision	Changes	Date
C	Corrected max channels from 600 to 640. Removed transmitting references	10/05/2012
B	Updated Figure 2. Corrected mechanical layout J2 location	08/16/2012
A	Added updated images	05/30/2012
O/I	Original Issue	04/20/2012

Section 1: MCDR Multi-Channel Data Receiver

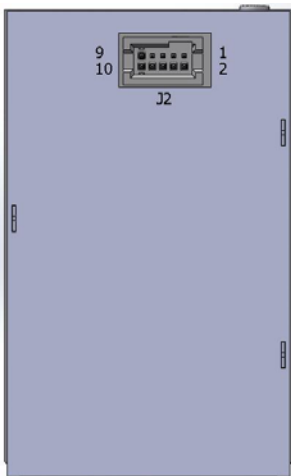
Description

The Multi-Channel Data Receiver (MCDR) is an OEM modular modem for users who need low power and small size with serial communications. The MCDR is a smaller version of the MCDT-R and is fully compatible. The MCDR is equipped with a RS-485 communications port which is a simple, low-cost interface, utilizing few components and allows for daisy-chaining multiple receivers. The MCDR is capable of receiving SEIWG-005 data messages, which includes a distinct ID and a status code, over a selectable frequency range. This frequency is selectable via the synthesizer control circuit, providing a selection of up to 1920 RF channels, depending on the model's frequency range. The MCDR comes in Low-Band, Mid-Band, and High-Band models, having the following frequency ranges:

Low Band	Medium Band	High Band
Channel 001 = 138.025 MHz	Channel 001 = 154.005 MHz	Channel 001 = 162.00625 MHz
Channel 640 = 154.000 MHz	Channel 1600 = 162.000 MHz	Channel 1920 = 174.000 MHz
Channel Spacing: 25 kHz	Channel Spacing: 5 kHz	Channel Spacing: 6.25 kHz

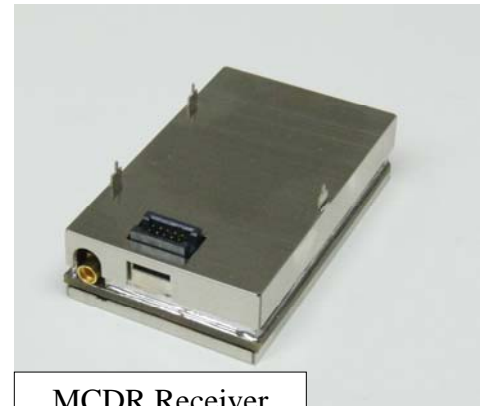
Model Numbers (3 models)

10D1068-L, -M, -H	MCDR-L, -M, -H	MCDR Receiver only; low, mid, or high band
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Antenna: MMCX jack 50 ohm (J1)
(10D1984 MMCX to TNC 3" cable available)

Power Supply:
3.5 VDC to 16.5 VDC Receive



MCDR Receiver

Connections:

J2 - Header Pin (10-pin TFM-105)	MCDR_ Receiver Model
1, 2	Vin [Input] 3.5 to 16.5 VDC
3	Not Used
4	RS485 – B(+) [I/O]
5	RS485 – A(-) [I/O]
6	Same as pins 1,2
7	General I/O
8, 9, 10	GND

Current Draw Approximations:

Mode	Current	Comments
Sleep	20uA	MCDR wakes up on RS485 bus activity
Active	5.0mA	Receiver off / Microprocessor on
Receiver On	35mW @ 3.5VDC 165mW @ 16.5VDC	Receiver on – Waiting for valid RF message
Receiver Active	16.9mA	RF message received – Microprocessor on

Design Features

- ID Code Selection 000-999 for EMIDS, 000-063 for all other formats
- Directional, sensor fault, low battery, tamper, and test status codes for EMIDS format
- Able to receive and transmit MIDS 20-bit or MMIDS / EMIDS 29-bit messages
- MMCX antenna port matched to 50 ohms
- Conformal-coated and shielded circuit assembly

Physical Characteristics

The MCDR is light weight and comes in a compact size. This makes it ideal for mobile applications as well as applications with tight space constraints.

	Receiver Only
Weight	40 g (1.4 oz)
Height	14.4 mm (0.565 in) (0.739 in w/standoffs)
Length	56.4 mm (2.219 in)
Width	34.4 mm (1.355 in)

The shielding on the MCDR has been designed in a way to promote easy PCB integration. The top of the MCDR is equipped with three alignment tabs that can be used as standoffs. By utilizing these pins and a proper connector, you are able to design a board that will hold the MCDR. Dimensions for the MCDR are shown in Figures 2 below.

Connections to the MCDR can be made by connecting to the J2 header and the J1 MMCX jack. The header used on the MCDR is SAMTEC part TFM-105-XX-X-D. The recommended mate is SFM-105-T2-L-D-P from SAMTEC. These are 2 x 5 pin headers with a 50 mil pitch. *See Connections table* above to determine pin outs. Qual-Tron offers a MMCX to TNC cable (10D1984), but any industry-standard, gold-plated MMCX plug should mate to the jack adequately. Carefully aligning and gently rotating the MMCX plug in the jack helps reduce both the possibility of damage to either connector as well as the force required to connect or disconnect.

The serial RS485 I/O driver IC used by Qual-tron is a MAXIM part. The part number is MAX3471EUA+. If the customer also includes this IC from MAXIM in their design, connect pin 6 of the IC to pin 4 on J2 and connect pin 7 to pin 5 on J2. Note: Sometimes RS485 devices are marked with the polarity reversed from normal RS485 standards. If a new or unknown device cannot communicate, try reversing the differential lines usually marked A & B.

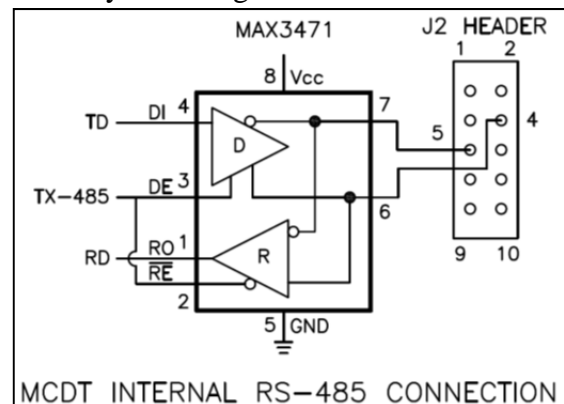
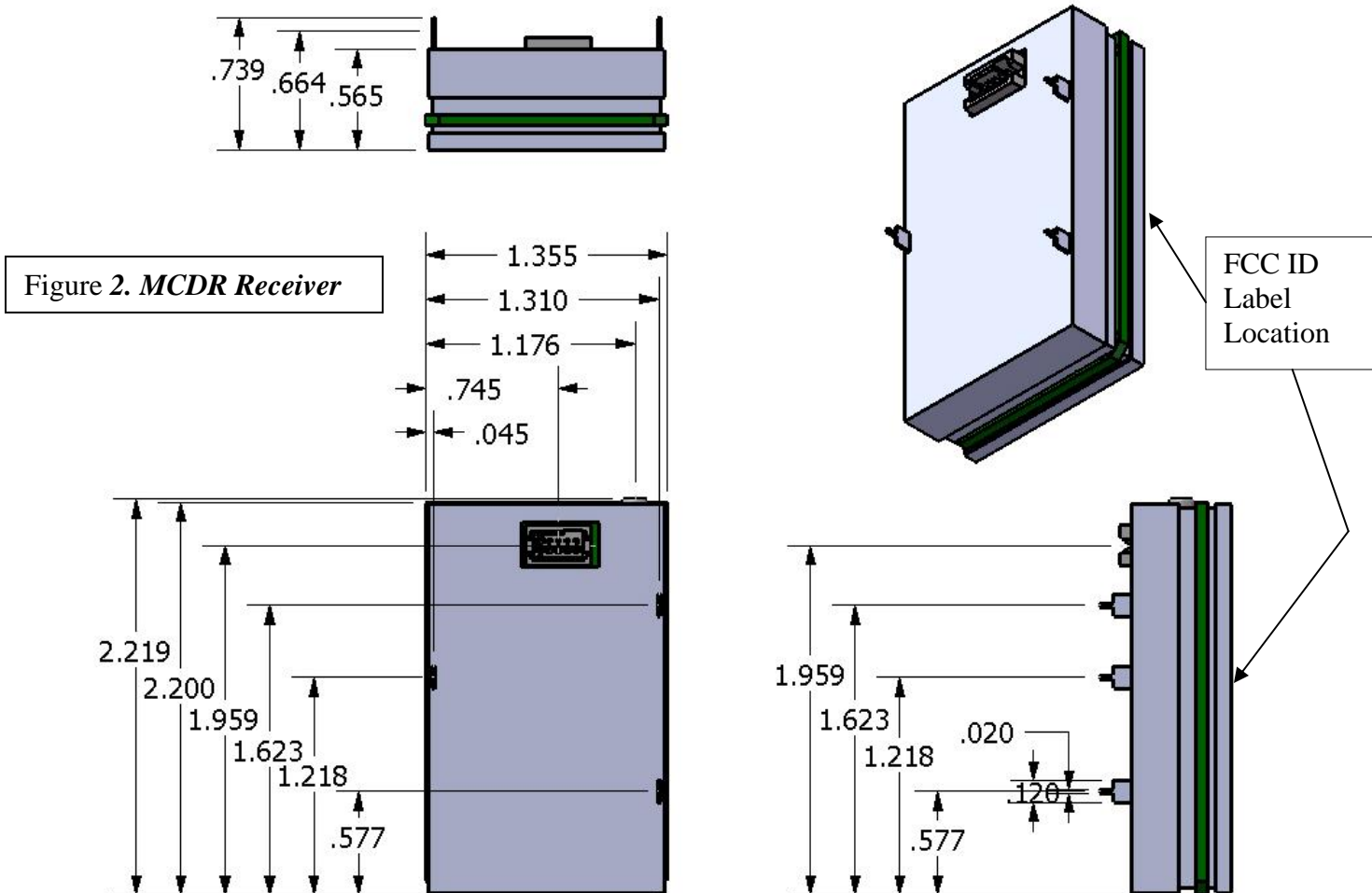


Figure 1. RS485 Circuit



Section 2: MCDR Operation

Using the settings provided in *Section 3: Serial Interface*, open a serial communication program such as HyperTerminal and supply power to the MCDR. A USB to RS485 cable is available that can connect directly to the MCDR. The USB port from a computer is capable of powering the MCDR.

Start Up

When the MCDR is initially powered on, a “BL<CR>” output string is sent to indicate the opportunity for entering the “Boot Loader” mode. The ability to enter the boot loader mode will timeout after 1 second.

The next serial output that is sent after the BL timeout indicates the reason for the reset or restart. It can be one of the following messages: "PWR-ON RST", "EXT RST PIN", "COP RST", "ILLEGAL OP RST", "ICG RST", "LVD RST", or "UNKNOWN RST".

After the reset message, the version information is sent “MCDR 029A 003G<CR>” for example. (*See the VER command for the description*).

NOTE: The “BL” (Boot Loader) response provides the opportunity to enter the programming mode for one (1) second at start up. Sending a “P” (no “<CR>”) will enter the firmware upgrade mode and could cause the firmware to be erased. Therefore, the user is advised not to send any characters to the unit, especially not a character “P” followed by a character “Y” to the MCDR before the version information is received.

Receiving

During normal operation, the MCDR is capable of receiving SEIWG-005 messages via the serial port and via radio frequency. The MCDR assumes a low-power shut-down mode to conserve power when not in use.

Items Required

1. DC Power Source: 3.5VDC receiver to 16.5 Volts
2. Personal Computer with USB or RS232 port
3. 10-pin connector to RS-485 USB cable (QTI part# 10D1978)
4. Serial Communications Program such as HyperTerminal

Setup

1. Set the Channel. (Default CHR 001)
2. Enable receiver, if desired. (Default RCV 1)
3. Enable Push to send messages out serial port, or disable to poll for messages. (Default PSH 1)

RF Link

The operational range of the RF link is dependent upon various conditions. The high frequency of the RF link works best under line of sight conditions. RF range may vary from 0.5 kilometer to 5 kilometers for open areas.

NOTE: Elevating an antenna will increase transmission and/or reception range significantly. The use of relays/repeaters can also be used to increase transmission ranges. Transmitting and receiving antennas should all be oriented in the same direction i.e. all mounted vertically or all mounted horizontally so that they have the same polarization.

Section 3: FCC RF Exposure Limits

This device complies with the MPE (Maximum Permissible Exposure) requirements by providing a safe separation distance of 30 cm between the antenna, including any radiating structure, and any persons when normally operated.

Caution

The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This device is approved with emissions having a source-based time-averaging duty factor not exceeding 50%. Operating at a lower duty cycle than 50% will allow proportionately shorter exposure distance than 30 cm.

Section 4: Serial Interface

The MCDR defaults to a low-power shut down mode with the receiver still operating (if installed). If push is enabled (“PSH 1”), the MCDR will send the message via the serial port upon receiving an RF message, and then return to shut-down immediately. The user may initiate serial communication by sending the MCDR two carriage returns. This is to allow the MCDR time to wake-up from the power-down mode. After 1 minute of inactivity on the serial port, the MCDR returns to low-power shut down mode. If the user has disabled the PUSH setting (“PSH 0”) and a new RF message is received, the MCDR will send its RS485 ID. *See the SID command.* This is used to wake-up the user’s application

processor. Once awake the user can poll to get the new message. *See the NEW command.* If the MCDR is still awake and the MCDR receives a new message, the shut-down mode will not occur until the RS485 serial ID has been sent and acknowledged. The user's application must respond or an infinite loop condition would occur causing the MCDR to never shut down.

The MCDR communicates over RS-485. Commands must be followed by a carriage return (<CR>). Settings are retained only until power is turned off unless the SAV command is used to store them to the unit's flash memory. When sending commands and queries, a two-digit hexadecimal checksum (cs) can be used to check data integrity. Refer to the **Checksum** section after the Command List.

SETTINGS

38400 baud [fixed], No parity, 8 bit, 1 stop bit, No flow control

Message Serial Format

Decoded message is sent via RS-485:

RXM *TT III SS R*<CR> - Received message

TT = Message Type, *III* = ID code, and *SS* = status code; *TT* and *SS* are hexadecimal, and *III* is decimal. *R* is the receive signal strength indicator; see *RSS* command.

Example: RXM 0D 244 0B

Message received – Received message type “EMIDS” with an ID code of 244 and a status code of TEST, FAULT.

MESSAGE TYPE (*TT*)

The message type consists of two (2) hexadecimal characters. The first character shows the parity; the most significant bit will be set if the parity is bad. The second character identifies the type.

	Good Parity	Bad Parity
MIDS	07h	87h
EMIDS	0Dh	8Dh
TRSS	1Dh	9Dh
REMBASS	06h	86h

Message Type Table

NOTE: TRSS and REMBASS message formats available upon request.

Status Code Table

STATUS CODE	ALARM	TAMP/TEST	LOBATT	R>L	L>R	MEANING
00	0	0	0	0	0	RESERVED
01	0	0	0	0	1	RESERVED
02	0	0	0	1	0	RESERVED
03	0	0	0	1	1	FAULT
04	0	0	1	0	0	RESERVED
05	0	0	1	0	1	RESERVED
06	0	0	1	1	0	RESERVED
07	0	0	1	1	1	FAULT, LOBATT
08	0	1	0	0	0	TEST
09	0	1	0	0	1	RESERVED
0A	0	1	0	1	0	RESERVED
0B	0	1	0	1	1	TEST, FAULT
0C	0	1	1	0	0	TEST, LOBATT
0D	0	1	1	0	1	RESERVED
0E	0	1	1	1	0	RESERVED
0F	0	1	1	1	1	TEST, FAULT, LOBATT
10	1	0	0	0	0	ALARM
11	1	0	0	0	1	ALARM, L>R
12	1	0	0	1	0	ALARM, R>L
13	1	0	0	1	1	RESERVED
14	1	0	1	0	0	ALARM, LOBATT
15	1	0	1	0	1	ALARM, L>R, LOBATT
16	1	0	1	1	0	ALARM, R>L, LOBATT
17	1	0	1	1	1	RESERVED
18	1	1	0	0	0	TAMP
19	1	1	0	0	1	RESERVED
1A	1	1	0	1	0	RESERVED
1B	1	1	0	1	1	TAMP, FAULT
1C	1	1	1	0	0	TAMP, LOBATT
1D	1	1	1	0	1	RESERVED
1E	1	1	1	1	0	RESERVED
1F	1	1	1	1	1	TAMP, FAULT, LOBATT

ID CODE (III)

The unit ID code consists of three (3) decimal characters, but only EMIDS messages use all three. MIDS, TRSS and REMBASS are limited to ID codes 000-063. EMIDS uses 000-999.

STATUS CODE (SS)

Status Codes depend upon the message format. MIDS has no status code, and these characters will always be 00. EMIDS status codes are listed in the previous table.

MCDR Serial Commands:

Note: It is recommended that when using a processor to control the MCDR that the format described under **Checksum** be used. This format helps ensure data integrity by greatly reducing communication errors and is more robust for machine to machine (M2M) applications.

- Valid commands will return the command and the argument followed by the word “OK”.
- Invalid commands return “SYNTAX ERROR”.
- Invalid command arguments will return “ERR” at the end of the command and argument.
- Carriage Return represents end of line and causes the line to be processed.
- If command is given with “#” at the beginning, then a two digit checksum is expected before <CR>. Returned string has a checksum if checksum sent.
- Checksum is two’s compliment of the command string (everything before checksum).
- A space is always included between the command and the argument: “CHR <space> 101 <CR>”.

Command List

? ... Brings up the help menu

The current help menu (without checksums) appears as follows:

Commands List:	
HELP/?:	Show this menu
CHR:	Get/Set rcv Chan
CMB:	Clear message buffer
CRF:	Get receive channel in Hz
M2M:	Get/Set Machine to Machine mode
MSG:	Get rcvd msg
NEW:	Get new messages
PSH:	Get/Set push mode
RCV:	Get/Set receive mode
RSS:	Get receive signal strength
RST:	Reset
SAV:	Save Current Parameters
SID:	Get/Set the RS485 ID
SLP:	Enter Sleep mode
SRN:	Get unit serial num
TMP:	Read Temp
VER:	Show versions

CHR... Get/Set the receive channel. (Follow with SAV command.)

Z is the channel number, [1 = DEFAULT]:

Low Band 0-600; Mid Band 0-1600; High Band 0-1920

Get the channel:	CHR<CR>
Returns:	CHR Z<CR>
Set the channel:	CHR Z<CR>
Returns:	CHR Z OK<CR>
Invalid returns:	CHR Z ERR<CR>

CMB... Clear Message Buffer; see MSG command.

Get the frequency:	CMB<CR>
Returns:	CMB OK<CR>

CRF... Get the receive channel as a frequency in Hz. (138000000-174000000)

Get the frequency:	CRF<CR>
Returns:	CRF Z<CR>

M2M... Get/Set machine to machine mode (follow with SAV command). In machine to machine mode all returned messages begin with '#' and end with the checksum before the <CR>. Commands can be issued without '#' and a checksum. **No syntax errors are reported for unknown commands.**

Z = 0: OFF

Z = 1: ON [DEFAULT]

Get M2M mode:	M2M<CR>
Returns:	M2M Z<CR>
Set M2M mode:	M2M Z<CR>
Returns:	M2M Z OK<CR>
Invalid returns:	M2M Z ERR<CR>

MSG... Recall a previous message.

Z (decimal 0-9) is the message with 0 being most recent message and 9 being the oldest message. If the requested message is empty, all the fields will return with zeros.

Returned values: TT (hexadecimal) is the message type, III (decimal) is the ID, SS (hexadecimal) is the status code, and R (decimal) is the RSSI. (See RSS command.)

Get a message:	MSG Z<CR>
Returns:	RXM TT III SS R<CR>
Invalid returns:	MSG Z ERR<CR>

NEW... Read New messages. Use when PUSH is OFF. This returns the oldest unread message. Send "NEW 1" to mark the message as read, so it will no longer be returned with the "NEW" command.

Note: This command can also be used if the PUSH is enabled.

Returned values: TT (hexadecimal) is the message type, III (decimal) is the ID, SS (hexadecimal) is the status code, and R (decimal) is the RSSI.

Poll for a new message:	NEW<CR>
Returns:	RXM TT III SS R<CR>
If no new message Returns:	RXM<CR>
Mark message as read:	NEW 1<CR>
Returns:	NEW 1 OK<CR>

PSH... Get/Set to push new messages out the serial port.

Z = 2: ON (Pushes <CR><CR> prior to sending the new message) Version 0.2.8.A and above.

Z = 1: ON (New messages are pushed out the serial port when received.) [DEFAULT]

Z = 0: OFF (Master must poll for new messages – Receiver sends RS485 ID on receipt of new message when in power-down mode).

Get PUSH mode:	PSH<CR>
Returns:	PSH Z<CR>
Set PUSH mode:	PSH Z<CR>

Returns:	PSH Z OK<CR>
Invalid returns:	PSH Z ERR<CR>

RCV...Get/Set receive mode.

Z = 1: ON (receiver enabled) [DEFAULT]; CAUTION: If no receiver has been installed, the receiver should be disabled to conserve power.

Z = 0: OFF (receiver disabled)

Get receive mode:	RCV<CR>
Returns:	RCV Z<CR>
Set receive mode:	RCV Z<CR>
Returns:	RCV Z OK<CR>
Invalid returns:	RCV Z ERR<CR>

RSS... Get the receive signal strength indicator (RSSI). Returns a positive decimal number (0-9), where higher numbers indicate stronger signal. Good signal strength is 6+. If receiver is disabled, it returns 0 (min).

Note: This command immediately reads the RSSI value, which is useful to determine if a frequency is being used or jammed. The “MSG” command appends the RSSI value that occurred while receiving the message, which is useful in site selection and deployment.

Get RSSI:	RSS<CR>
Returns:	RSS R<CR>

RST... Reset the unit. On start-up the MCDT outputs version.

Reset the unit:	RST<CR>
Returns:	RST OK<CR>

SAV... Save the current parameters in flash memory. Use this to store any parameter changes.

Save current settings:	SAV<CR>
Returns:	SAV OK MCDT<CR>

SID... Get/Set the RS-485 serial identifier. [T = DEFAULT]

Capital character (A-Z). All MCDT’s will respond to X so it should not be used. The purpose and use of this command is described below in **Checksum**.

Get protection:	SID<CR>
Returns:	SID Z<CR>
Set protection:	SID Z<CR>
Returns:	SID Z OK<CR>
Invalid returns:	SID Z ERR<CR>

SLP... Shut down the serial port to conserve power. The MCDT goes to power-down mode immediately after returning the SLP OK command. Note: To reactivate the serial port, send a carriage return or some other ASCII character. Use “SLP 0” when RS-485 bus is shared.

Enter low power mode:	SLP<CR>
Returns:	SLP OK<CR>
Enter low power mode:	SLP 0<CR>
Returns:	<Nothing returned>

SRN... Get the unit serial number.

The serial number is a string up to 8 characters long.

Get serial number:	SRN<CR>
Returns:	SRN Z<CR>

TMP... Get the board temperature in degrees Celsius (decimal), with a tenth degree precision (250 = 25.0C).

Get temperature:	TMP<CR>
Returns:	TMP Z<CR>

VER... Get the unit version.

MCDR is the model, <space>, VVVV is the firmware version (Major.Minor.Build.Rev), <space>, M is the message types supported (0 = standard [MIDS/EMIDS], 1 = custom), B is the frequency band (0 = low, 1 = mid, 2 = high), H is the hardware capabilities (1 = receive only, 2 = transmit only, 3 = both), R is the hardware board revision.

Get version:	VER<CR>
Returns:	MCDR VVVV MBHR<CR>

Checksum

To use checksum begin the command with “#” plus the unit serial ID and end the command with the calculated checksum (cs) value followed by the carriage return <CR>. A command with an invalid checksum or invalid serial ID is ignored and no reply is sent. The checksum is a 2 digit hexadecimal calculated as the 2’s compliment of the sum of the command string including the “#” and serial ID.

Using the checksum also allows and requires using the serial ID. The universal serial ID is X, so all units will acknowledge these commands. The unit will respond with its specific serial ID.

Sample syntax:

Action	With Checksum	Without Checksum
Get receive channel:	#XCHRA8<CR>	CHR<CR>
Returns:	#ACHR 196FF<CR>	CHR 196<CR>
Set receive channel to 2:	#XCHR 256<CR>	CHR 2<CR>
Returns:	#ACHR 2 OKB3<CR>	CHR 2<CR>

Note: “A” is just a sample serial ID, and may be different.

Example checksum C-Code calculator

```
char CRC2sComp( char *buffr, int end) { //creates 2's complement
    int c;
    int calcSum = 0;
    for( c = 0; c <= end; c ++ )
    {   calcSum += buffr[c]; }
    calcSum ^= 0xFF;    //1's complement
    calcSum += 1; //now 2's complement
    return (char)(calcSum);
}
```

Example Checksum

Line to send is "#ACHR 597<CR>"

Convert characters to ASCII values:

(35) + A (65) + C (67) + H (72) + R (82) + <sp> (32) + 5 (53) + 9 (57) + 7 (55)

NOTE: <CR> is not included in calculation.

Sum: $35+65+67+72+82+32+53+57+55 = 518T$ (206h)

1's Complement is bit inversion: $[10\ 0000\ 0110] \rightarrow [01\ 1111\ 1001] = 1F9h$

2's complement is adding 1 to the 1's complement: $1F9 + 1 = 1FAh$

Drop anything higher than the lowest 8 bits: $[1\ 1111\ 1010] \rightarrow [1111\ 1010] = FAh$

The result is FAh, so send line as "#ACHR 597FA<CR>"

Note: Adding the checksum will result in zero for the low byte. ($206h + FAh = 300h$)

Section 5: Maintenance

Operator Maintenance

The MCDT has been designed as low cost low maintenance equipment. All components are conformal coated which reduces the amount of maintenance required. The only required operator maintenance is to inspect the equipment for damage and keep the equipment clean of dirt, grime, and caked on mud.

NOTE: Do not submerge the equipment in water. This could result in damage.

Depot Maintenance

Upper echelon maintenance will be performed by the supplier of the equipment. If the equipment is beyond the user capability to repair, it can be returned to the supplier for test and evaluation. Upon completion of the inspection, the supplier will notify the user if the unit can be repaired. If the equipment is not covered by the warranty, an estimate will be provided for repair costs. If the equipment is not repairable, the supplier will specify replacement costs. (Note: See warranty below for return procedures.)

Equipment Storage

Upon return to the facility, clean equipment as noted in operator maintenance above. After cleaning, return the equipment to the storage cases. Store the unit in a dry environment, preferably at room temperature.

Warranty

Qual-Tron, Inc. guarantees all products to be free from defects in materials and workmanship for 12 months from the date of purchase. Damage due to misuse, accidents, lightning strikes, unauthorized service, environmental conditions beyond the equipment specifications, acts of war or damage other than fair, wear and tear is excluded from this warranty.

Return Procedures

For support and service, please contact the following. To return any material, contact Qual-Tron, Inc. to receive a Return Material Authorization (RMA) number. Once an RMA number has been assigned, ship the material to the address below and reference the RMA number on the packing slip. Qual-Tron will return the equipment as quickly as possible to the user.

QUAL-TRON, INC.

Attn: Sales
9409 E. 55th Place
Tulsa, OK 74145

Ph: 918-622-7052
Fax: 918-664-8557
email: sales@qual-tron.com

Troubleshooting Guide

Defect	Possible Cause	Corrective Action	Stage Area	Empl Site
Will not turn on	Low voltage	Check power supply	X	
Does not receive alarms	Low voltage	Check power supply	X	
	Transmitter & receiver too close to each other	Experiment with antenna combinations (with & without)	X	X
	Frequency	Verify transmitter and receiver are on the same frequency	X	
	Receiver not enabled	Verify receive mode is on	X	
	Wrong message format	Check TRSS mode	X	

Section 6: Frequency/Channel Calculations

Frequency Ranges				
Frequency Range	Frequency		Channel Steps	Max Channels
	Min	Max		
Low	138 MHz	154 MHz	25 kHz	640
Mid	154 MHz	162 MHz	5 kHz	1600
High	162 MHz	174 MHz	6.25 kHz	1920

Channel to Frequency Calculation

Channel * Channel Step + Min Frequency = Frequency for Channel

Examples:

- Low Band Channel 20
- $20 * 0.025 + 138 = 138.5$ MHz
- Mid Band Channel 300
- $300 * 0.005 + 154 = 155.5$ MHz

Frequency to Channel Calculation

$(\text{Frequency} - \text{Min Frequency}) / \text{Channel Step} = \text{Channel for Frequency}$

Examples:

- Low Band 151.5 MHz
- $(151.5 - 138) / 0.025 = \text{Channel } 540$
- High Band 172.5 MHz
- $(172.5 - 162) / 0.00625 = \text{Channel } 1680$

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE CONDITION THAT THIS DEVICE DOES NOT CAUSE HARMFUL INTERFERENCE.

NOTE: QUAL-TRON, INC. IS NOT RESPONSIBLE FOR ANY CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY THE PARTY RESPONSIBLE FOR COMPLIANCE. SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.