

**OPERATION & MAINTENANCE**

**OF THE**

**MRC-565 PACKET DATA RADIO**

Rev. F  
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Maiden Rock Communications  
PO Box 575  
Seeley Lake, Montana USA  
Tel: (207) 715 8242

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## GENERAL WARRANTY

***Maiden Rock Communications (MRC)*** warrants that its products conform to the published specifications and are free from manufacturing and material defects for one year after shipment. Warranty-covered equipment that fails during the warranty period will be promptly repaired at MRC's facility in Kent, Washington.

International customers are required to pay shipping costs to the MRC facility, with Seattle as the point of U.S. entry. MRC will pay incoming U.S. duty fees. MRC will pay shipping costs to return the equipment to the customer, with the customer paying all return duty fees.

This warranty is contingent upon proper use of the equipment and does not cover equipment that has been modified in any way without MRC's approval or has been subjected to unusual physical or electrical stress, or on which the original identification marks have been removed or altered.

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## EXPOSURE TO RF RADIATION

The FCC guidelines limit the maximum permitted exposure to RF radiation for Occupational/ Controlled Exposure to 1 mw/sq. cm for frequency ranges of 30-300 MHz. This limit and the following equation for calculating field strength (obtained from OET Bulletin 65) is used to calculate the minimum separation between humans and the transmit antenna based on MPE

$$S = P * G * DC / (4 * \pi * R * R)$$

P = Transmit power in milliwatts = 100,000

G = Antenna gain referenced to an isotropic radiator

= 1.68 (2.2dbi) mobile quarter wave dipole mounted to fender/roof of automobile

= 10.0 (10.0 dbi) fixed 5 element Yagi mounted to top of fixed antenna tower

= 3.3 (5.2 dbi) fixed half wave dipole mounted to fixed antenna tower leg

R = separation required cm

DC = Maximum duty cycle of transmitter = 10 %

S = Power density = 1 milliwatt/square cm

This equation is accurate for the far field of an antenna, but will over-predict power density in the near field. Thus, the near field MPE distances calculated here are “worst case” or conservative.

### Antenna separation for mobile applications:

The typical antenna used in mobile application has a maximum antenna gain of less than 2.2 dBi (¼ wave dipole or ½ wave dipole). To insure safe operation the antenna must be mounted such that the separation between the antenna and any human occupants of the vehicle exceeds .36 meters (14”). The best location for antenna mounting is the center of the vehicle roof. This will provide additional RF shielding between the antenna and the human occupants that reduces the RF exposure to levels well below that specified in FCC OET Bulletin 65.

When working on the antenna and or co-ax cable always disable the transmitter by turning its power off.

### Antenna separation for fixed applications:

For fixed applications, antenna gains and mounting techniques can vary depending on the application. For Yagi antennas whose gain does not exceed 10 dBi, that antenna must be mounted a minimum of .90 meters from any humans occupants. Lower gain antennas, such as side mount dipoles, exhibit lower gain (5.2 dBi) allow closer separations (.52 meters for 5.2 dBi antennas). This will provide RF shielding between the antenna and the human occupants that reduce the RF exposure to levels below that specified in FCC OET Bulletin 65.

When working on the antenna and or co-ax cable always disable the transmitter by turning its power off.

**REVISION PAGE**

**Document Title:** Operation of the MRC-565 Packet Data Radio in a Meteor Burst Network

**Document Number:** MAN-OPS-MRC-565 – Meteor Burst

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E	7/17/2014	Update format, TOC (JW)
F		
G		
H		
I		

## MCC 545B MRC-565 DIFFERENCES

There are several differences between the MCC 545B and the MRC-565. A summary of these differences is given below:

- Number of circuit boards MRC-565 has 2 MCC 545 has 3
- MRC-565 is a software defined radio with no adjustments on CMU board
- Both units have similar power amp boards
- No battery backed up RAM. No PWR FAIL RESTORE message
- New LPM modes
- Ethernet Port with TCP/IP
- USB Host Port for Thumb drive Logging and Data Storage
- USB Device Port for connecting to PC USB port. Requires Driver

For the most part the MRC-565 operator commands are the same as the MCC 545B commands. However, there are a few differences as noted below:

MCC 565	MRC 545
ASSIGN	ASSIGN
ASSIGN,RXn,CHAN,PROTOCOL	NONE
CHAN,TX,RX,MOD-VAL,CHAN	FREQ,TX,RX,CHAN
CHAN,N	FREQ,N
CHAN	FREQ
CAL	NONE
DSP	NONE
IP	NONE
IPCONFIG	NONE
FILE	NONE
FPGA	FPGA
LPM	LP[M
RECEIVERS	NONE
SCALE	SCALE
SP	NONE
SIG	NONE
RXTH	RXTH
TEST,TX	TEST,TX
TRACEERT	TRACEPORT
SDI12	NONE

In the cases where there are similar commands for the MCC 545 and MRC-565, the commands are slightly different. Refer to APPENDIX C for details.

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## ACRONYMS AND ABBREVIATIONS

A/D	Analog-to-Digital
ACK	Acknowledgement
ADC	Analog-to-Digital Converter

AUX	Auxiliary Port
AVL	Automatic Vehicle Location
BPSK	Binary Phase Shift Keying
CR	Carriage Return
CSMA	Carrier Sense Multiple Access
DAC	Digital-to-Analog Converter
DMC	Data, Management and Control
DSP	Digital Signal Processing
DTA	Data Port
ELOS	Extended-Line-of-Sight
ETE	End-to-End Acknowledgement
GMSK	Gaussian Minimum Shift Keying
GPS	Global Positioning System
KBPS	Kilo (1,000) bits per seconds
LED	Light Emitting Diode
LOS	Line-of-Sight
MBC	Meteor Burst Communication
MBCS	Meteor Burst Communication System
MRC	Maiden Rock Communications
MNT	Maintenance Port
NMEA	National Marine Electronic Association
PC	Personal Computer
PCA	Printed Circuit Assembly
PCB	Printed Circuit Board
RAM	Random Access Memory
RF	Radio Frequency
RTCM	Radio Technical Commission for Maritime Services
RX	Receive
SCADA	Supervisory Control and Data Acquisition
SDATA	Sensor Data
SNP	System Network Parameter
SPDT	Single Pole Double Throw
TDMA	Time Division Multiple Access
TX	Transmit
UPDT	Update
UTC	Universal Time Clock
VSWR	Voltage Standing Wave Ratio
XTERMW	Terminal Emulator

# **INTRODUCTION**

---

## 1 INTRODUCTION

The MRC-565 Packet Data Radio can be used in Meteor Burst Communications (MBC) networks or Extended Line of Site (ELOS) networks. Both networks are, packet switched, digital data networks. MBC networks can operate at ranges up to 1200 miles, while ELOS networks operate at ranges up to 100 miles, depending on terrain.

The MRC-565 can operate with two modulation formats:

1. Coherent BI Phase Shift Key (BPSK) Modulation operating at 4 KB/SEC. This format matches the MCC 545B modulation format and is used in Meteor Burst Communications Systems (MBCS). This format provides a more sensitive receiver (typically 6 DB more sensitive than GMSK at 9.6 KB/SEC) required for good performance in the MBCS
2. Non Coherent Gaussian Minimum Phase Shift Key (GMSK) Modulation operating at 9.6 KB/SEC. This format matches the MCC 545C's modulation format and is typically used in Extended Line of Site Systems (ELOS). It offers a higher thru put than the BPSK modulation at the expensive of sensitivity.

The radio is FCC type accepted for operation with either modulation in Low Band VHF 40-50 MHZ band with an authorized bandwidth of 20 KHZ.

The MRC-565 is frequency synthesized. Three MRC-565 models cover the range of frequencies from 40 to 50 MHZ. Each model has a unique FCC Type acceptance number as noted below:

MRC-565-40-43	Frequency Range	40-43 MHZ	FCC ID	2ABUV-MRC565-40-43
MRC-565-43-47	Frequency Range	43-47 MHZ	FCC ID	2ABUV-MRC565-43-47
MRC-565-47-50	Frequency Range	47-50 MHZ	FCC ID	2ABUV-MRC565-47-50

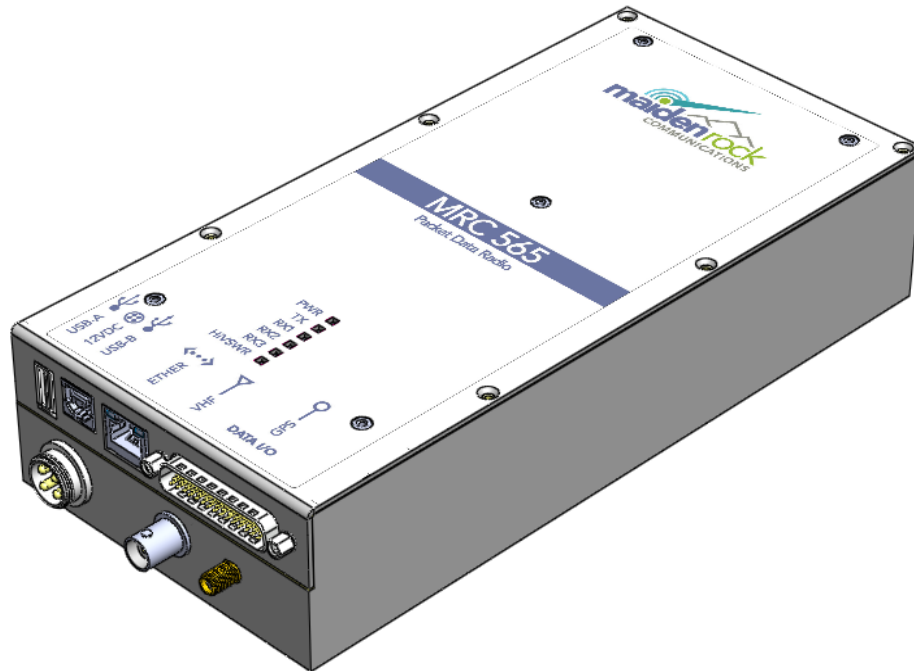
Each model is unique and cannot be modified in the field. Once a unit has been set up as one of the three models, it cannot be set to operate in another model's frequency range (prevented by firmware), without returning to the factory for modification and recalibration.

In addition, radios are set up and calibrated at specific frequencies to match a customer's authorized frequency or frequencies. Once calibrated, the authorized frequencies are locked into the software and operation beyond the authorized frequencies is not allowed. If a customer wishes to change his authorized frequencies, he must return the unit back to factory for recalibration and possible model change.

**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, may 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 or her own expense.

The MRC-565 is packaged in a aluminum, weather-resistant enclosure that measures 9.4”L X 4.5”W X 2.00” H and weighs 3.5 pounds. A drawing of MRC-565 enclosure is given in Figure 1.



**Figure 1. MRC-565 Packet Data Radio**

The MRC-565 has two Printed Circuit Assemblies:

1. A Communications Management Unit (CMU)

The CMU contains an embedded 32-bit controller for managing all the network functions associated with a packet switched data network and for interfacing to a variety of peripheral devices. It also contains an RF Analog to Digital Converter (ADC), a Field Programmable Gate Array (FPGA), an a Digital Signal Processor (DSP) to perform all receive and transmit functions without the need for any Analog Signal Processing requiring physical tweaking or adjustments. In addition, it has a built-in test capability that automatically monitors the operating integrity of the unit at all times.

2. A 100 watt Power Amplifier (PA)

A power amplifier is used to boost the RF TX level of the CMU from 0 DBM to 50DBM (100 watts) using a 5 stage power amp. This amplifier contains an agc that maintains a fixed

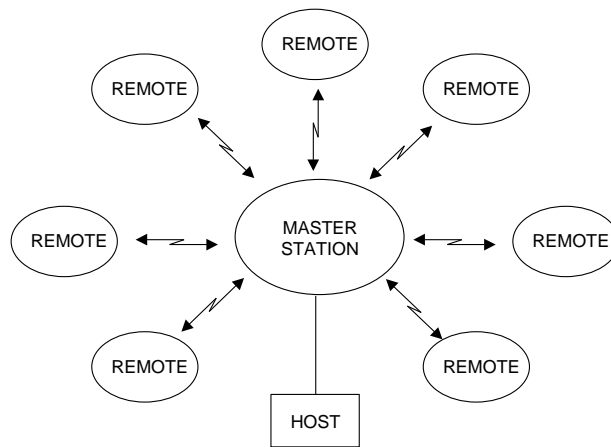
power level of 100 watts under varying DC voltage levels over a temperature range of -30 to +60 C. As noted above the PA is factory tuned to operate over 3 frequency bands.

## 2 NETWORKS

### 2.1 Meteor Burst Communications

A meteor burst communication (MBC) network operates seamlessly between ground wave and meteor burst for the transmission of digital data. Ground wave will generally cover distances up to about 100 miles and meteor burst seamlessly extends this coverage to 1,000 miles. Ground wave provides instantaneous communications while meteor burst reflects signals off the ionized trails created by micro meteors entering the atmosphere at a height of 60 miles above the earth's surface. These trails, called bursts, are random but predictable in number, and last from a few milliseconds to several seconds. During this brief period, information is exchanged between a master station and a remote station. MBCS is a natural time division multiplexed (TDMA) system, therefore thousands of remote stations can operate into one master station on a single frequency.

In its simplest form, a Meteor Burst network consists of one master station operating in a star configuration to all remote stations located within its RF communication range of 1,000 miles.



The master station is an MRC-525 and the remote stations are MRC-565's or MCC MCC-545's. The MRC-565 is a replacement radio for the earlier MCC MRC-545 which is out of production. The master station is normally connected to a host computer in a Data Center or a customer's office. The master station operates on either a single frequency for half-duplex or two frequencies for full-duplex.

The master station operates in the "probing" mode and the remote stations operate in the "transponder" mode. That is, when a remote station hears a probe signal from the master station it responds by transmitting the data stored in its buffer. The remote stations can be programmed to respond at specific time intervals (e.g., hourly) or on events that may have occurred at the remote station site. Programming may be done on-site with a laptop.



The RF protocol for this type of network is called Meteor Burst Protocol (MBP). There are two types of stations:

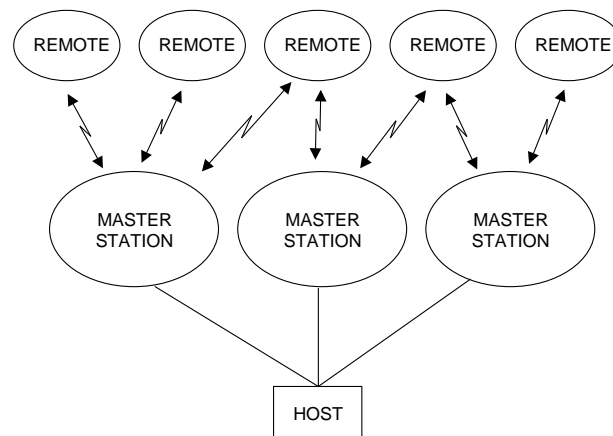
Master  
Remote

Master stations and Remote stations are defined with:

ROLE = PROBE for Masters

ROLE=TRANSPOND for Remotes

Multiple master stations are interconnected into a clustered star configuration as shown below.



The remote stations may be assigned to a specific master station or they can be programmed to transmit their data to whichever master station probe is received. Multiple master stations will significantly improve the latency of the network because of the additional RF links available to each remote station.

## 2.2 Extended Line of Site Systems

The MRC-565 can also operate in Extended Line-of-Sight (ELOS) networks using ground wave. The range of communication by ground wave is primarily determined by diffraction around the curvature of the earth, atmospheric diffraction, and troposphere propagation.

The RF protocol for these types of networks is called Line of Site (LOS). All radios in these networks are defined with:

ROLE = LOS

There are 4 types' radios:

Base  
Repeater  
Remote

The Base is always connected to a Host computer where data is being collected. Repeaters are similar to Bases, but they do not have a Host connection. They repeat data collected from Remotes to a Base which then sends the Data to the Host.

Remote stations connect to either a Base or a Repeater. When they have data to send in, they transmit data directly to the Base or Repeater in carrier sense multiple access mode. They do not wait for a probe from a Base or Master like a MB remote does.

The majority of this manual is devoted to Meteor Burst Networks. With a few Master Stations and a lot of Remotes.

The remainder of this manual is organized in the following four sections

### Section 3.0 DESCRIPTION

This section provides both a physical description and a functional description of each module in the MRC-565. The detailed technical specifications for each printed circuit board assembly (PCA) and the organization of the memory is provided.

### Section 4.0 INSTALLATION

Site selection and general installation guidelines are provided in this section, including instructions for cabling, antenna, and power source connections. Power up procedures, initialization and functional test procedures are described that should be performed prior to placing the MRC-565 on-line within the network.

### Section 5.0 OPERATION

This section describes all the operating procedures for the MRC-565. All commands and operational parameters are described for data collection, supervisory control, messaging and interpreting system operational statistics. It also contains the list of all commands, along with description and a few commonly used command printouts.

### Section 6.0 THEORY OF OPERATION

This section provides overall review of the functioning of the CMU and the PA circuit board assemblies. It describes the block diagram details of each printed circuit board.

### Section 7.0 MAINTENANCE

### APPENDIX A TABLE OF COMMANDS

APPENDIX B    FACTORY DEFAULTS

APPENDIX C    EVENT PROGRAMMING

APPENDIX E    INSTALLATION DETAILS

APPENDIX E    INTEROPERABILITY WITH OTHER MRC PRODUCTS

### **2.3 Related Documents**

Additional documents and application notes that may be helpful in the operation of an MRC-565 Packet Data Radio are given below. They can be obtained from MRC.

1. Operations of the MRC-525 Operators and Maintenance Manual Rev. F, September 30 2013.
2. Application Note: CR10X Data Acquisition, January 25, 2014
3. Application Note: CR1000 Data Acquisition, February 23, 2014.
4. Application Note: SDI-12 Data Acquisition, May 24, 2014.

# **DESCRIPTION**

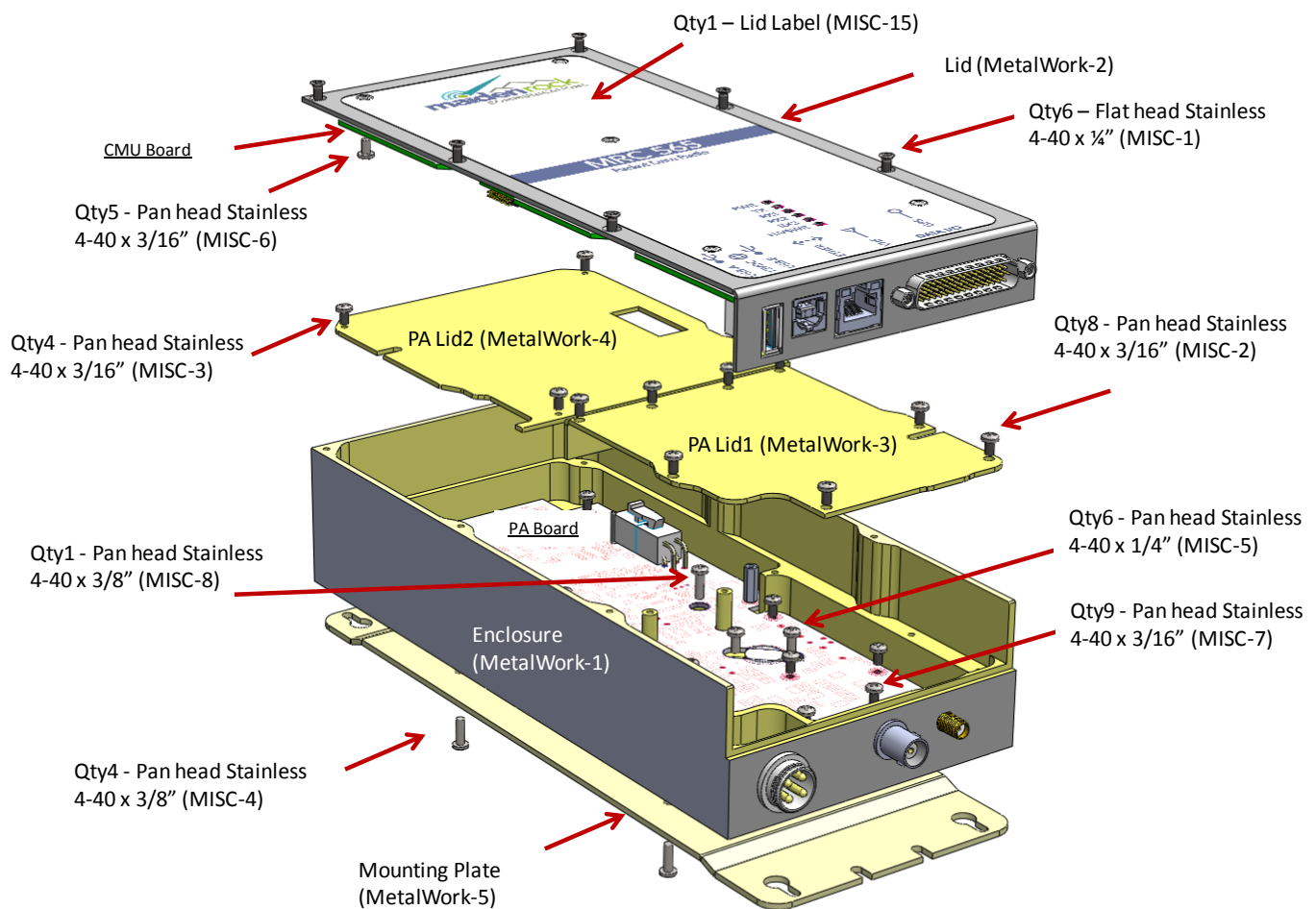
---

### 3 DESCRIPTION

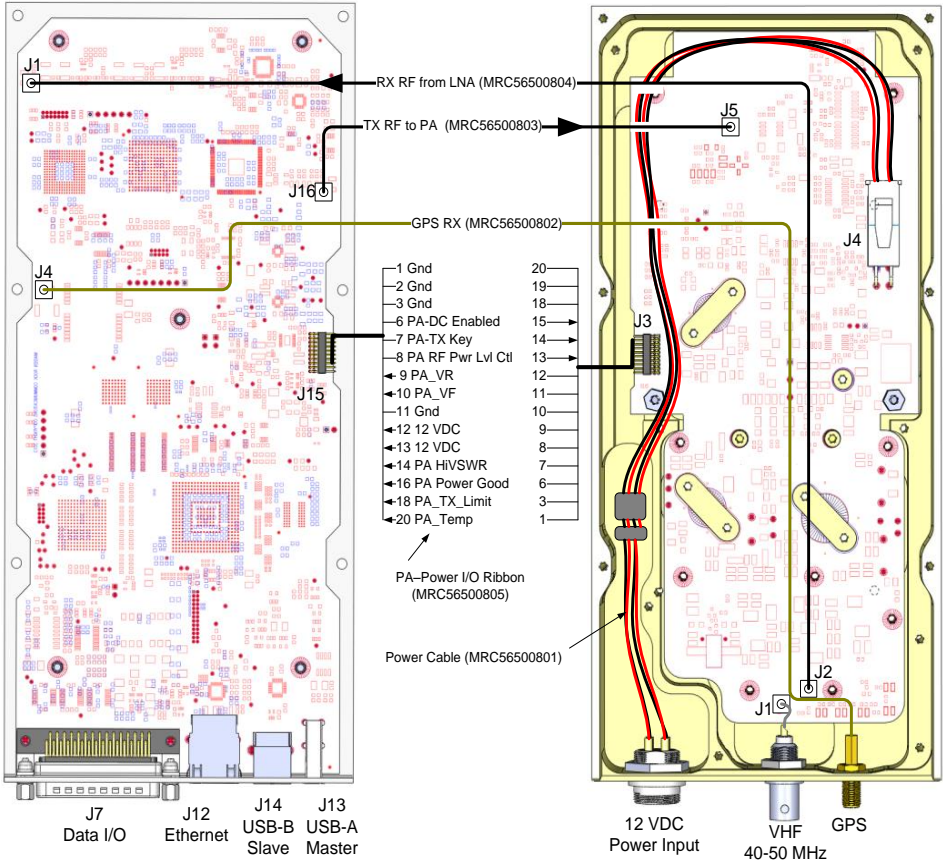
#### 3.1 General

The MRC-565 Packet Data Radio provides packet switched communications from fixed sites to a central Host. It can be used for data collection, supervisory control, sending and receiving messages, or other custom applications. The unit's low standby-power consumption (<1 watt) makes it ideal for operating in remote locations where only solar power is available.

An exploded view of the chassis is shown in Figure 2. A simplified wiring diagram is shown in Figure 3.



**Figure 2. Exploded view of MRC-565**



Maiden Rock Comm			
MRC565 WIRING DIAGRAM			
ISS	FORM NO	DWG NO	REV
C			
SCALE	NOT TO SCALE	SHEET	1 OF 3

**Figure 3. MRC-565 Wire Diagram**

**3.2 Printed Circuit Board Assemblies**

The MRC-565 contains two printed circuit board assemblies as shown in Figure 2.

1. Communications Management Unit (CMU) MRC-56500300
2. 100 Watt Power Amplifier (PA) MRC-56500301

### 3.2.1 Communications Management Unit (CMU)

The CMU contains a Host Processor and a Software Defined Radio that contains a Digital Signal Processor (DSP) . The Host processor is used to control the wire side protocols and interfaces as well as the Over the Air protocols. The main microprocessor is a Motorola-based, embedded processor located on a single PCB that contains:

- 512K x 16 of non-volatile flash memory for program storage
- 512K x 16 of non-volatile flash memory for parameter storage
- 32M x 16 of low power dynamic RAM for data storage
- 3 External RS-232 I/O ports
- Ethernet Adaptor
- USB-A Host Port for Thumb Drive Memory Devices
- USB-B Device Port for connecting MNT port Laptop
- Internal TTL GPS port GPS can be added to the CMU as an option.
- Transmitter communication port
- Receiver communication port
- 12-bit 16 channel A/D converter (6 channels are available for external sensors)
- Real-time clock (w or w/o an internal battery)
- Power fail detection circuitry
- Digital Signal Processor with D/A converters
- 4 Optically isolated digital inputs
- 2 Solid State SPST Relay Outputs with a current rating of .5 amps

All I/O ports are RS 232 compatible (+/- 5V) and can be programmed to adapt to various customer protocols. The DATA port contains full flow control hardware lines. The A/D converter measures TX forward and reverse power, battery voltage, antenna noise voltage, transmitter board temperature, and 6 channels of 0-5V external sensor inputs.

An internal battery is optional. This battery can be used to maintain the clock circuit whenever power is removed from the unit. This battery is not required for operation of the unit. If the battery is not present, it will be necessary to enter that date and time whenever the DC voltage is removed from the unit. The low power modes will operate without the battery.

A Digital Signal Processor (DSP), a Field Programmable Gate Array (FPGA), a D/A converter, and a A/D converter form the Software Designed Radio. The DSP is composed of a receiver portion and a transmitter portion. The receiver RF signal is amplified and routed to the A/D converter used to digitize the RF signal at the RF frequency. The FPGA provides a digital down conversion (DDC) of the digital RF signal. The converted signals are fed to the DSP for demodulation of the BPSK or GMSK signal.

The transmitter portion is implemented with an AD 9957 Quadrature Digital Upconverter (QDUC). The AD9957 functions as a universal I/Q modulator and agile Upconverter. The AD9957 integrates a high speed, direct digital synthesizer (DDS), a high performance, high speed, 14-bit digital-to-analog converter (DAC), clock multiplier circuitry, digital filters, and

other DSP functions onto a single chip. It provides baseband upconversion for data transmission in the Low Band VHF band. The RF output ( 0 DBM) is routed to the Power Amplifier (PA), via a short coax cable.

### 3.2.2 Power Amplifier (PA)

A single power amplifier board is used to amplify RF output from the CMU board to the final 100 watt output. A special DC power switch is used to control the rise and fall times of the RF power output. A duty cycle limiter circuit limits the duty cycle of the power amplifier to 10%. A temperature sensor is also located on this board for monitoring the internal temperature of the MRC-565. This temperature reading may be transmitted to the Host for maintenance purposes.

The 100 watt power amplifier is mounted inside an aluminum enclosure to provide RF shielding between the CMU and the high power output. This board contains a T/R switch for half-duplex operation, a harmonic low pass filter, and a dual directional coupler and AGC circuit for power level control. The coupler measures forward and reverse power. If the VSWR exceeds 3.0:1, the power amplifier automatically shuts down. The power amplifier's parameters are also transmitted to the Host for maintenance purposes. The antenna port of the T/R switch connects directly to the COAX connector mounted on the MRC-565 front panel. The receive port of the T/R switch is routed through a low pass filter to the Receiver COAX Connector. A short COAX cable connects the PA receive port to the CMU receive port.

### 3.3 Detailed Specifications

The detailed specifications for each of the printed circuit board assemblies are given in Tables 2.1 through 2.4.

**Table 1. MRC-565 General Specifications**

CHARACTERISTIC	SPECIFICATION
Dimensions (excluding mtg bracket)	9.4"L X 4.5"W X 2.0"H
Weight	3.5 lbs.
Temperature Range	-30° to 60° C (-22° to 140° F)
Power Requirements	12 V <sub>DC</sub> Nominal (11-16 V <sub>DC</sub> )
LPM = Low Power Mode LPM,SP = Signal Present wake up LPM,Alarm = DC PWR Alarm Clock wake up LPM,PWR = No DC PWR Alarm Clock wake up  Cannot enter LPM,PWR unless TXQ empty	Receiver Current LPM,OFF 120 ma @ 13.0 VDC LPM,SP: 80 ma @ 13.0 VDC LPM,ALARM 65 ma @ 13.0 VDC LPM,PWR 2 ma @ 13.0 VDC  Transmit Current 20 Amps Nominal (100 msec)

**Table 2. MRC-565 Receiver Specifications**

CHARACTERISTIC	SPECIFICATION
Frequency (Three models)	



40-43 MHZ 43-46 MHZ 46-50 MHZ	+/- .0005% Synthesized 10KHz steps
Modulation: Type Rate Format	BPSK 4 kbps NRZ
Noise Figure	< 7 dB minimum
Sensitivity: Bit Error Rate < 10 <sup>-3</sup> at 4 kbps	-120 dBm
IF Bandwidth (3/80 dB)	13/40 KHz typical
RF Bandwidth (3 dB)	13 MHz typical
Signal Acquisition Time	< 5 msec
3 <sup>rd</sup> Order Intercept Point	>- 15 dBm
Image Response Attenuation	> 70 dB minimum
Spurious Response Attenuation	> 70 dB minimum
SP Threshold	Adjustable from -130 to -100 dBm
Noise Blanker	> 20 dB Reduction in Impulse Noise
I/O	MRC Standard (Refer to Section 3.2)

**Table 3. MRC-565 Transmitter Specifications**

CHARACTERISTIC	SPECIFICATION
Frequency (Three Models) 40-43 MHZ 43-46 MHZ 46-50 MHZ	+/- .0005% Synthesized 5KHz steps
RF Power Output	> 100 Watts at 12-16 V <sub>DC</sub> Input
Load VSWR	< 3:1 Rated Power (shut down if >3:1)
Harmonic Levels	70 dB below Unmodulated Carrier
Modulation: Type Rate Format	BPSK 4 kbps Diff
Spurious	> 70 dB below Unmodulated Carrier
Transmit Modulation Spectrum	10 KHz offset – 25 dBC 50 KHz offset – 63 dBC
Tx Duty Cycle	10 % Max without shutting down transmitter
T/R Switch	Solid-State Switching Time < 100 microseconds
I/O	MRC Standard (Refer to Section 3.2)
High VSWR Protection	Withstands Infinite VSWR

**Table 4. MRC-565 Microprocessor Specifications**

CHARACTERISTIC	SPECIFICATION
Main Processor	Motorola MC68332FC 32-bit Embedded Controller

Memory:	Program Storage Data Storage Parameter Storage	512K x 16 non-volatile Flash memory 32M x 16 static Dynamic RAM 512K x 16 non-volatile Flash memory
Jumper:	JP1 JP2 JP3	Watchdog Disable m(install to disable WD) Ignition Bypass (install to disable IGN ON) Power By Pass (Does not let 12V shut down)

### 3.4 Memory Organization

The MRC-565 has three types of memory:

**Program Memory (PM):** The Program memory is non-volatile Flash (512K X 16). It contains the MBNET200 image software, bootstrap, configuration and application software. These programs are installed at the MRC facilities at the time of shipment. The information stored in the Program memory is referred to as “factory defaults”.

**Parameter Memory (CPM):** The Parameter memory is non-volatile Flash (512K X 16). It contains the configuration data for the unit such as the customer number, the serial number and ID of the MRC-565 and the authorized FCC frequencies it may use. This information is normally programmed into the unit prior to shipment. The Script files are also stored in Parameter memory, either at the MRC facilities or on site.

**Data Memory (RAM):** The Data memory is volatile Dynamic RAM (32M X 16). Date, time, executable programs, command parameters and program dynamic data (messages, data, position, etc) are all stored in RAM during normal operations.

During normal operation, the MRC-565 software uses the data and configuration parameters stored in RAM. If the data information in RAM is lost or corrupted, for whatever reason, the configuration parameters can be retrieved from Parameter memory. This ensures uninterrupted operation.

The RAM contents will be lost under the following conditions:

1. The Boot command is issued.
2. Power is removed from the unit.
3. The watchdog timer initiates a restart.

The software will detect these events and will copy the parameters and configuration values from Parameter memory back into RAM when operation is resumed.

If the contents of Parameter memory become invalid, the unit will revert to the factory defaults in Program memory.

### 3.5 Front Panel LEDs

The six LEDs on the front panel provide the operator with a quick assessment of the unit's operational status. See Figure 4.



PWR	Flashes for about 2 seconds during power on. Then flashes once per second when SW starts
RX1,RX2,RX3	Flashes for 2 seconds on power up, then flashes whenever a signal is received
TX	Flashes during Tx when the RF Output power is > 50 watts
HIVSWR	Flashes during Tx when the VSWR > 3:1 is detected (means bad antenna, RF power turned off)

**Figure 4. MRC-565 Front Panel**

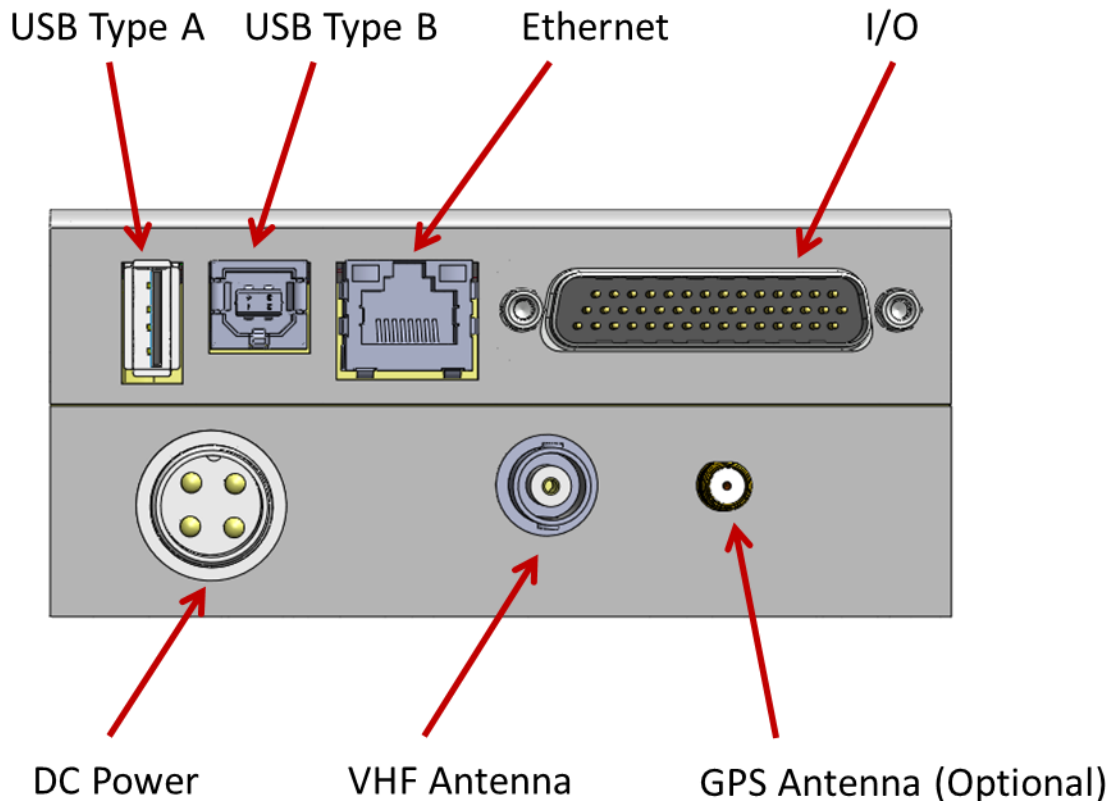
# **INSTALLATION**

---

## 4 INSTALLATION

### 4.1 Cable Connections

There are a maximum of seven cable connections to be made to the MRC-565 as shown in Figure 5.



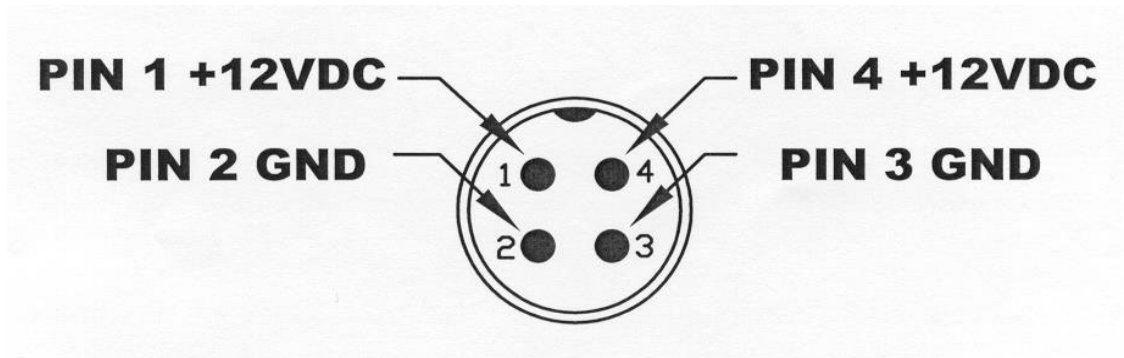
**Figure 5. MRC-565 Connector Panel**

#### 4.1.1 DC Power

The MRC-565 requires a power source that can deliver up to 20 amms of pulsed power (100 msec) from a +12 V<sub>DC</sub> to +16V<sub>DC</sub> power source.

The 20 amp current draw will cause a voltage drop to occur at the transmitter input, resulting in reduced transmit power, unless the power cable to the source is sized appropriately. MRC recommends using two #16 AWG wires for both the power and ground and a cable length that does not exceed 10 feet. If a longer cable is required, use #14 AWG. MRC provides a standard

6 foot power cable with lugs for connecting to a 3/8" battery post (Part No. 14001350-01). The power connector pins are shown in Figure 6 as follows:



**Figure 6. DC Power Connector**

Note the indent is at top of plug. The +12V inputs are on top side of connectors. Be careful not to try and plug the cable into the connector in reverse order so that +12V is on bottom. If plugged in backwards the +12V is shorted to ground (on PA board) and the DC line fuse will blow and or a trace on the Power Amp board may burn out. Do not force.

#### **4.1.2 VHF Antenna**

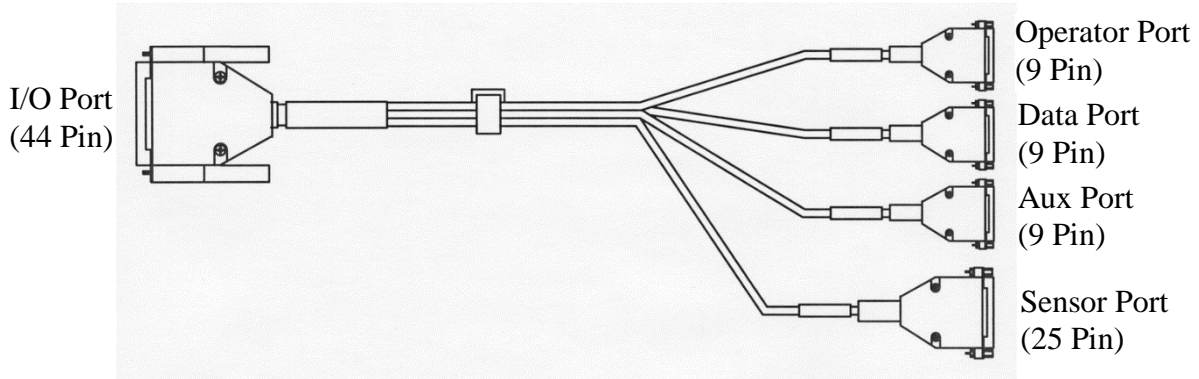
Connect the antenna cable to the BNC RF connector. RG-223 may be used for cable lengths under 50 feet. Use a large diameter cable (RG-214) for cable lengths up to 100 feet. Refer to Appendix B for proper cable length.

#### **4.1.3 GPS Antenna (Optional)**

An external GPS antenna is required when the internal GPS receiver is used. Connect the GPS antenna cable to the SMA connector on the front panel. The antenna port has a 3.3 VDC on the center pin to power the GPS antenna,

### 4.1.4 I/O Port

The 44 pin I/O connector on the front panel includes three RS-232 ports and one Sensor port. MRC provides a standard cable harness that breaks out these four ports as shown below:



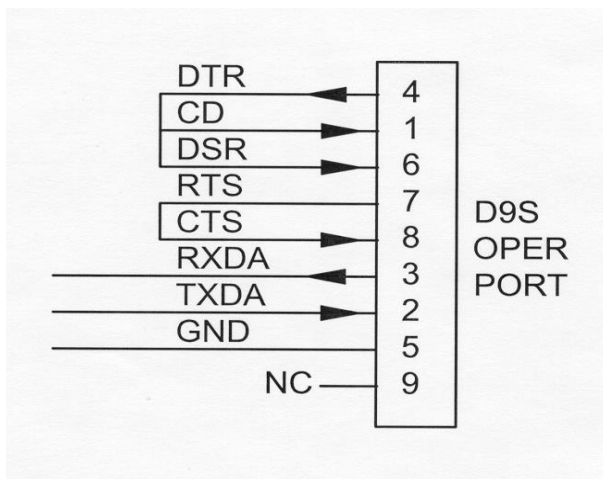
**Figure 7. MRC-565 44 Pin I/O Cable**

A drawing showing the pin out for the 44 pin connector is given in [Appendix](#) below. A description of each of the other connectors is given below. A description of the various ports is given below.

#### 4.1.4.1 Operator Port

The Operator Port is normally connected to a local operator terminal using a standard RS-232 straight thru cable with a 9-pin male D connector to 9-pin female D connector. Normally, only 3 wires (pins 2, 3 and 5) are required when connecting to the operator port. The port is wired to support handshaking where required such as when using a modem. RS 232 levels are +/- 5V.

OPERATOR PORT – 9S	
Pin	Signal
1	CD
2	Tx Data
3	Rx Data
4	DTR
5	Ground
6	DSR
7	RTS
8	CTS
9	Not Used

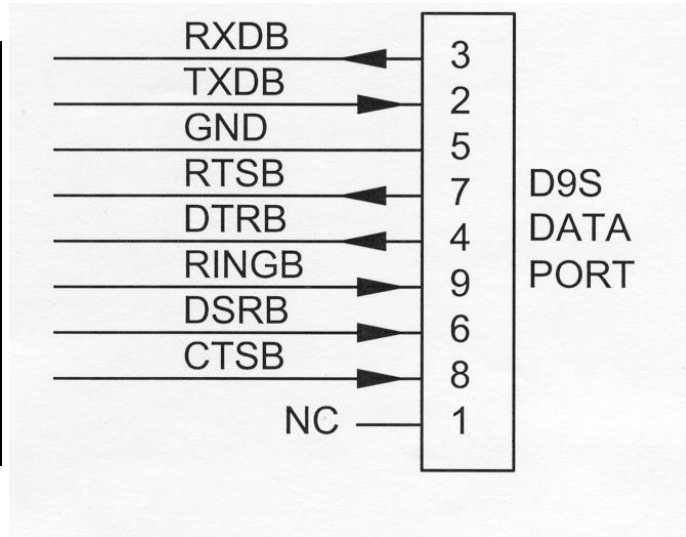


The Operator Port will display all warnings, messages, data report, and alerts.

**4.1.4.2 Data Port**

The Data Port may be used for connecting to a data logger, GPS receiver or other serial input device using a standard straight thru RS-232 cable with a 9-pin male D connector to 9-pin female D connector. Refer to Section 4.0 for more information on interfacing to data loggers or other serial input devices. All signals are RS232 (+/- 5V) levels.

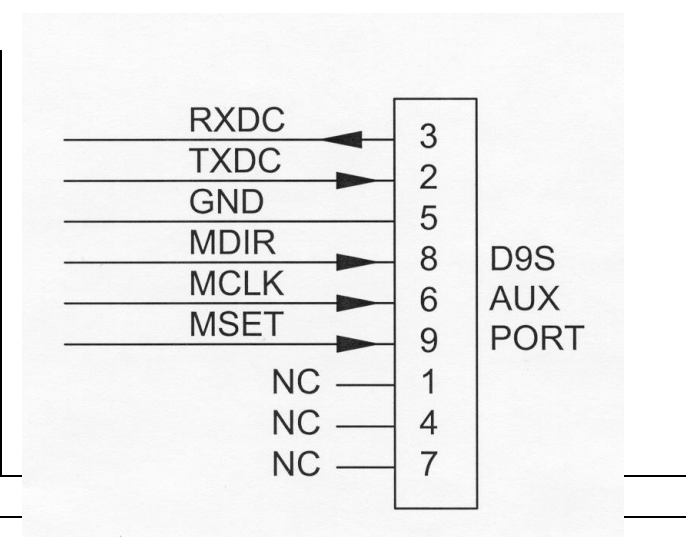
DATA PORT – 9S	
Pin	Signal
1	Not Used
2	Tx Data
3	Rx Data
4	DTR
5	Ground
6	DSR
7	RTS
8	CTS
9	Ring



**4.1.4.3 Aux Port**

The AUX PORT may be connected to any serial input device using a standard straight thru RS-232 cable with a 9-pin male D connector to 9-pin female D connector. This port is also used for interfacing to MRC test equipment (pins 6, 8, and 9).

UX PORT – 9S	
Pin	Signal
1	Not Used
2	Tx Data
3	Rx Data
4	Not Used
5	Ground
6	MCLK (3.3V CMOS)
7	Not Used
8	MDIR (3.3V CMOS)
9	MSET (3.3V CMOS)



**IMPORTANT**

The AUX port connector has three extra pins (pins 6, 8, and 9) whose signals do not conform to the RS-232 standard. These are for MRC test purposes. These pins will NOT interfere with a normal 3-wire RS-232 connector (pins 2, 3, and 5).



**4.1.4.4 Sensor Port**

The Sensor port is used as a general purpose Supervisory Control and Data Acquisition (SCADA) interface requiring limited I/O in lieu of a full data logging capability. Use a mating cable with a 25-pin male D connector for access to the various functions. For convenience, this cable may be routed to a terminal block for interfacing to the various sensors and other external devices. The Sensor Port contains:

- SDI-12 Input/output and ground
- Four (4) Optical Isolated Discrete Inputs. All 4 inputs share a common ground.
- Two (2) Optical Solid State Switches which are normally open.
- Six (6) Analog inputs
- +12V Current limited to .50 amps
- Switched + 12V Current limited to .5 AMP
- TX Key Test Point
- SP Test Point

A pin out of the Sensor Port is given below.

<b>SENSOR PORT</b>	
<b>Pin</b>	<b>Signal</b>
1	Optocoupled input #1 positive 2K Input R, 2 V threshold
2	SDI-12 Data
3	Optocoupled input #2 positive 2K Input R, 2 V threshold
4	Optocoupled input #2 return
5	Optocoupled input #3 positive 2K Input R, 2 V threshold
6	Det RF for Chan #3
7	Optocoupled input #4 positive 2K Input R, 2 V threshold
8	Det RF for Chan #2
9	Ground
10	Solid State Relay #1 + (.5 Amp rating)
11	Solid State Relay #1 -
12	Signal Presence (SP) 3.3V Logic
13	Solid State Relay #2 + (.5 Amp rating)
14	Solid State Relay #1 -
15	TX KEY 3.3V Logic
16	+5V Reference (10 ma Max +/- 2%)
17	Analog Input #1 ( 0 to 5 V) ±1%
18	Analog Input #2 ( 0 to 5 V) ±1%

19	Analog Input #3 ( 0 to 5 V) $\pm 1\%$
20	Analog Input #4 ( 0 to 5 V) $\pm 1\%$
21	Analog Input #5 ( 0 to 5 V) $\pm 1\%$
22	Analog Input #6 ( 0 to 5 V) $\pm 1\%$
23	+12V Switched (.5A Max)
24	+12V (0.5A Max)
25	Det RF for Chan #1

#### 4.1.5 USB-A Port

A USB Host port can be used for storing TRACE log files or Data Reports. It can also be used as a Configuration Management Unit (CIM) for reading and writing SCRIPT files.

#### 4.1.6 Ethernet Port

An Ethernet Port that supports TCP/IP protocol is used to connect the MRC-565 to a wired Wide Area Network (WAN). This eliminates the need for a router and terminal server to route data back to a Host Computer.

There are two commands required to set up the Ethernet Port for operation. Enter the following command to check the configuration:

#### IPCONFIG

the response will

The Ethernet port factory defaults to an IP address of

192.168.10.1

To change the IP address enter the following command

IPCONFIG,E1,nnn.mmm.ppp,qqq E1 is the Ethernet port.

To enable the port use the following command:

ASSIG,function1,n,protocol

where E1F1 is the function, n is the port number, and p is the protocol

The function can be ASCII,MSC,or MSC2

The port can be 4,5,6,or 7

A complete description of the TCP/IP protocol is given in [Section .](#)

## 4.2 Power-Up Sequence

Connect a laptop, with XTERMW installed, to the Operator Port (MNT). The Operator Port settings of the MRC-565 is programmed with the following factory default configuration at the time of shipment:

Baud rate	9600
Data bits	8
Stop bit	1
Parity	no
Protocol	ASCII
Flow control	none

When the unit first turns on after applying power the PWR, RX1, RX2, and RX3 front panel LED's will turn on for about 2 seconds. This indicates that +12V is applied to the unit and that the internal 3.3V regulators have turned on. At this point, the main control software is booting up. After a few more seconds, the PWR LED will start flashing and the other LED's should turn off. This flashing indicates that the main control software is running and the following messages should be printed on the operator (MNT) port.

### 03/20/14 08:00:50 MNT port 0

```

          /  /  /  /
         /  /  /  /
        /  /  /  /
       /  /  /  /
      /  /  /  /
     /  /  /  /
    /  /  /  /
   /  /  /  /
  /  /  /  /
 /  /  /  /
/  /  /  /
Maiden Rock Comm, LLC
*****
*****
*****
*****
MRC-565 Packet Data Radio
Copyright (C) 2014 Maiden Rock Comm, LLC
All Rights Reserved
CMU Version 1.01.0057 03/15/14 07:30 AM
DSP Version 02.10 140221a_fc
FPGA Version 01.20 140216_ab
CPLD Version 43 01/27/14a
    
```

The software versions numbers for the CMU (Coldfire processor), DSP, FPGA, and the CPLD are displayed. These numbers will change as newer versions of the software are developed. The CPLD is an Altera Complex Programmable Logic Device. It is a single chip device used to interface the various I/O functions with the Cold Fire Processor.

With the exception of the CPLD, all versions of software can be updated via the Operator Port. The CPLD requires direct connection of the Altera Blaster to the board.

### 4.3 Description of Critical Device Parameters for a MB Network

Most of the parameters used in a MB network do not have to be changed from there Factory Defaults for normal operation. However, a few critical parameters must be set to obtain proper operations. These are described below. These commands should be included in the **SCRIPT** file used to program the unit as described in Section 4,4 below.

#### 4.3.1 Device

The MRC-565 can be programmed to operate as a REMOTE, BASE, or MASTER. To check the Device Type enter the following command:

**DEVICE [ENTER]**

If the device is not a REMOTE and you want to change it to a REMOTE enter

**DEVICE,REMOTE [ENTER]**

**SAVE [ENTER]**                      SAVE stores the Device type into FLASH memory.

The MRC-565 is always a REMOTE device in a MBC network. It may be any of the three types in an LOS network.

#### 4.3.2 Role

ROLE is used to set the Operating Mode and the RF Protocol for the device. There are four modes:

PROBE	Used if device is set up as a Master Station
TRANSPOND	Used if device is a Remote Station in a MBC network
SILENT	Used if device is set up to listen only (No Tx)
LOS	Used if device is set up as a Remote Station in a LOS network

To determine the operating ROLE for the device type the following command:

**ROLE [ENTER]**

In a MBC network, the Role for all remotes is defined with the following command:

**ROLE,TRANSPOND,High #,LOW#,MB**                      for auto MB/LOS select.

ROLE,TRANSPOND,MB

for MB only

In the MB mode, the remote will respond to every idle probe from the Master and Transmit if it has data to send Data or its time for it to check in.

When a Remote station is close to a Master station (<60 miles) the unit will probably hear the Master station IDLE probe continuously. To prevent the Remote from responding to every Idle probe (which occur about every 25 msec) the unit will automatically switch to a LOS mode. In the LOS mode, the remote will not respond to every Idle probe, but will respond to every N probes, where N is a Random number. The Random number prevents multiple remotes that are operating LOS to the Master from interfering with each other. Note that LOS mode is not the LOS protocol used in Line of Site only network.

The two numbers in the ROLE command are used to determine when a remote unit will switch operation between MB and LOS. The high number is the number of Idle probes received per minute it takes to switch from MB mode to LOS mode. The low number is the number of Idle probes received per minute it takes to switch back to MB mode. The defaults settings for these numbers is:

HIGH = 100

LOW = 50

Note that since the IDLE probes occur every 25 msec, there are 40 Idle probes per minute, so it would take about 2 ½ minutes to switch to LOS protocol when default settings are used.

### 4.3.3 Radio ID Number

Every unit in a Meteor Burst Communications System has a 16-bit ID. This allows up to 65,536 unique ID numbers. The MRC-565 ID number will already be programmed into the unit by MRC prior to shipment. Enter the command **ID** [ENTER] and the unit ID number will be displayed on the operator terminal. Contact your System Administrator to register this ID in the network configuration database. In some cases this number will be “locked” and cannot be changed in the field, you can type **LOCK** to determine if the ID is locked or not.

Under some circumstances, the ID may have to be changed on-site. It can only be done if the ID is not locked. In that event, this action must be coordinated with both MRC and your System Administrator. Failure to do so may result in data or messages being misrouted or lost.

To change the ID use the following command:

**ID,nnnnn,mmmmm{,aaaaaa},INIT** [ENTER]

where **nnnnnn** is the unit ID, **mmmmm** is the master station assignment and **aaaaaa** is the master select mode (FIXED, AUTO, PREF, MULTI). Obtain the proper master station

assignment and select mode from your System Administrator. The MRC-565 will save this ID and will use it whenever the unit is powered up or reset.

<b>MODE</b>	<b>DESCRIPTION</b>
PREF	Unit connects to the <b>mmmm</b> Master for the NDOWN period (set with SNP command). After NDOWN period unit will connect to the Master that it has received the most syncs from. <b>In this mode the unit can communicate with only one Master at a time.</b>
AUTO	Unit connects to the <b>mmmm</b> Master, if it's not successful it switches to another Master. It will stay with that Master as long as it can communicate with it. <b>In this mode the unit can communicate with only one Master at a time. This is the preferred mode for LOS networks</b>
FIXED	Connectivity will be fixed to the <b>mmmm</b> Master. <b>In this mode the unit can communicate with only one Master at a time. This is the preferred mode for networks with a single master.</b>
MULTI	<b>In this mode the unit can connect to any multiple Masters, This is the preferred mode for Meteor Burst Networks. The format for this mode is:</b>

**ID,nnnn,1,MULTI,INIT [ENTER]**

You can also change the mode for the ID by typing

**ID,aaaaaa**

#### 4.3.4 Frequency and Modulation Parameters

The MRC-565 will already be programmed with the authorized frequencies to be used in your network. These frequencies are stored in parameter memory and cannot be changed. Verify that the correct frequency is configured by entering the command:

**CHANNEL (cr)**

This will show you the “Active” TX and RX Frequency pair and frequency pairs for up to 20 channels that were programmed at the factory.

The following table will be displayed for the SNOTEL network:

```
+CHANNEL 01/01/00 01:08:29
Primary Channel TX mhz   RX mhz   Mod-Val  Bit rate  Modulation
                07  41.6100  40.6700    1        4K      bpsk25
Channel Table:
Channel TX mhz   RX mhz   Mod-Val  Bit rate  Modulation
```

00	40.5300	41.6100	1	4K	bpsk25
01	41.5300	41.5300	1	4K	bpsk25
02	40.5300	41.5300	1	4K	bpsk25
03	41.5300	40.5300	1	4K	bpsk25
04	40.6700	40.6700	1	4K	bpsk25
05	41.6100	41.6100	1	4K	bpsk25
06	40.6700	41.6100	1	4K	bpsk25
>07*	41.6100	40.6700	1	4K	bpsk25
08	41.6100	40.5300	1	4K	bpsk25
09	41.5300	40.6700	1	4K	bpsk25

+

You can select any frequency pair from the frequency table by entering the following commands:

**ASSIGN,RX1,n**      Where n is the channel number you want to assign to RX1.

**CHANNEL, n**      Where n is the desired channel number

For example: To select channel 7 above enter:

**ASSIGN,RX1,7**

**CHANNEL, 7**

The active channel is the one with > in front and \* after the channel number, 07 in this case.

The table above shows all the assigned channels and is Locked into each MRC radio before it leaves the factory. Operation on channels beyond those listed is not possible without sending it back to the factory for reprogramming.

#### 4.3.5 Select Site Name

A descriptive name may be given to the site where the MRC-565 is being installed. The selected site name must be coordinated with your System Administrator. To enter a site name use the following command:

**SITE NAME, XXXXXX [ENTER]**

where XXXXXX may have a maximum of 32 alpha-characters.

#### 4.4 Enter Script Files

The MRC-565 must be programmed with the parameters that “fit” the network that it is being used in. This programming is accomplished by loading “Script file” from your PC into the MRC-565 using the Operator (MNT) port. The Script File can also be downloaded into a Remote Station via RF from the Master Station.

If a script file have not been programmed into the MRC-565 and it must be changed, a new file can be loaded from your operator terminal using XTERMW software. One script file uniquely programs the MRC-565 to operate as a remote station in your specific network. Other script files define application programs that are performed by the station.

For example, the application for a remote station may be as a mobile unit reporting position data or as a fixed site reporting sensor data.

The procedure for loading the script file is described below:

1. Install the MRC-565 Meteor Burst CD (or diskette), with the script file on it, into your laptop or equivalent, and load the script file into your XTERM subdirectory.
2. Start XTERMW and open a connection at the correct baud rate and COM port (typically COM1, 9600 baud. All other parameters are defaults.
3. Type **“factory,default,init”** to load the default parameters into the MRC-565. The MRC-565 has a very large Flash memory for storing station parameters, as such it takes longer (90 seconds)to erase than it does to erase the MCC 545 flash memory (30 seconds)
4. Choose “Execute Script” from the “scripts” pull down menu.
5. Select the appropriate script file in the XTERM subdirectory. Double click the file name to start execution.

The commands in the script file will be executed one at a time until the end of the file is reached. Press the “up arrow” key to scroll up and review the command responses. If any commands result in BAD COMMAND, BAD PARAMETER, or similar message, the script file may have an error in it.

You may verify that the correct configuration file has been loaded by entering the three commands: **ASSIGN**, **SNP**, and **CONFIG**. A typical script file for a remote operating in a MBC network connected to a CR10X Data Logger is given below.)

#### **IMPORTANT**

**The SAVE command must be performed at this time. Failure to do so will result in the loss of any new configuration data in RAM that you may have entered during initialization.**

The **CONFIG** command may be used to confirm that the MRC-565 has been configured correctly for the network it is operating in. For example, if your MRC-565 is being used in a Meteor Burst network the following configuration parameters will be displayed on your operator terminal when you enter **CONFIG** [ENTER].

DATE	2/17/14	TIME	13:58:16
------	---------	------	----------



DEVICE TYPE	REMOTE	ROLE	TRANSPOND,100,50,MB
ID	00500,00001,MULTI	DEFAULT DEST.	0
MODULATION	BPSK25	TRANSMIT KEY	STARTED
BIT RATE	4K	MESSAGE HOLD	OFF
DUPLEX MODE	HALF DUPLEX	SCHEDULE	ACTIVE or EMPTY
SERIAL	1	TX LIMIT	200
CHECK IN	900	STAT RPT INT.	24
LOS CHECKIN	5	DUTY CYCLE	10%
LOS RETRY	2	POS	30,TXT,NMEA
POLL	OFF	SOURCE RELAY	OFF
BASE	0,0	REPEATER	OFF
PULSE	OFF	POSRPT	OFF
HOURLIES	ON	NETMON	ON
ENTEK MDP	OFF	RCT	OFF
RXTYPE	MRC-565	REMOTE TYPE	COMM
SUBST	OFF		
SCALE B: 0.062500, D: 0.018800, T: 0.000353			
MAINTENANCE CONSOLE DEVICE			

#### 4.5 RF TEST

A very thorough RF test can be made by entering the command **TEST** [ENTER]. **TEST** causes the processor to turn the transmitter ON and measures the forward and reverse RF power that is being transmitted. It also measures the battery voltage under load and the antenna noise voltage.

The following response will be displayed on the operator terminal:

```

Syncs   Xmits   Acks   pwr-fwd  pwr-rev  v-bat   det-rf   resets
XXXX    YYYY    ZZZZ   AAAA     BBBB     CCC     DDD      EEE

```

- where:
- XXXX = # of sync patterns received from the master station.
  - YYYY = # of transmissions made by the MRC-565.
  - ZZZZ = # of Acknowledgements received from the master station.
  - AAAA = Forward power in watts. This should be greater than 80 watts.
  - BBBB = Reflected power in watts. This should be less than 5 watts.
  - CCC = Battery voltage under load (while transmitting). This should be greater than 10.6 V<sub>DC</sub>.
  - DDD = Received signal strength in dBm. This will normally be the noise level at the antenna and should read about -120..
  - EEE = Number of times the radio has rebooted.

**NOTE**

**The forward RF power should be at least 80 watts if the battery voltage is normal. If it is lower than 80 watts check for proper cabling to the power source. (see Section 3.2.2.1).**

**If the reverse RF power is greater than 5 watts check the antenna and coaxial cabling for proper installation.**

**If both the forward and reverse power are low, the transmitter may be automatically shutting down due to an antenna VSWR greater than 3:1. Check the antenna and coaxial cabling for proper installation.**

**If the DET RF is greater than -115 dBm (for example, -110 dBm), the unit will still perform properly but the latency time of the link will be increased. Refer to Section 3.1 for reducing site noise conditions.**

**An overall figure of merit for the link performance is the XMIT to ACK ratio. If this ratio is 3:1 or lower, the overall performance will be very good.**

**This completes the initialization and power-up sequence of the MRC-565. The unit is now ready for operation. Refer to Chapter 4 for detailed operating instructions.**

# **OPERATIONS**

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## 5 OPERATIONS

This chapter covers the basic operating procedures for the MRC-565 as it's used in a Meteor Burst network. The MRC-565 is programmed using Script Files that contain the specific system parameters for operating in the meteor burst mode. These are loaded into the MRC-565 at the MRC facilities prior to shipment. The script files may also be loaded and/or modified at the customer's site. You should always reset to factory default parameters by typing

**FACTORY,DEFAULT,INIT** prior to loading any new script files.

It is assumed at this point that the appropriate script file has already been loaded into the unit, as part of the installation procedures outlined in Section 4.0, and that the unit is configured properly and operational within its network. This chapter describes the various commands that are available to the operator for modifying the station configuration parameters to accommodate specific applications, sending and receiving messages and interfacing to peripheral devices for data collection and supervisory control.

### 5.1 Getting Started

#### 5.1.1 Command Entry and Editing

You must enter carriage returns after every command. A list of all the operator commands are given in Appendix B

When a command is accepted, the operator terminal will print the system time. Before you begin you should familiarize yourself with the special editing functions that you can use when entering commands:

[DEL] Deletes last character entered.

[CTRL] Prints command line on next line down.

[CTRL]-R Repeats last command line

\X Removes current line from command buffer.

[CR], [LF] or [ENTER] Terminates line and causes the command entered to be executed.

### 5.1.2 HELP Command

Entering **HELP** [ENTER] produces a single page display of all the commands used in the operation and maintenance of the MRC-565. To obtain descriptive information about a particular command and how it is used by the MRC-565 enter the command type. For example: **HELP, ASSIGN** [ENTER].

### 5.1.3 System Time and Date

The MRC-565 has its own internal clock that is periodically synchronized to the nearest second with the master station. The master station receives the correct date and time from either its Host, GPS, or RTCM broadcast. The master station then periodically broadcasts this date and time information to all remotes for synchronizing their internal clocks. If required, the date and time may be initialized using the following commands:

**DATE, mm/dd/yy** [ENTER]  
**TIME, hh:mm{:ss}** [ENTER]

In a Meteor Burst network the internal battery that is used to back up the Real Time Clock chip is not installed so time and date must be entered at site whenever power is applied to unit. The internal clock will be maintained during all Low Power Modes.

The date and time of day maintained in the Master Station (MRC-525 or the MCC 520B) is transmitted to all Remote Stations between the times of 00:10:00 and 00:50:00 of each day, time keeping all units in a network on the same time reference. If the time of day received at a Remote Station differs by more than two minutes from the internal Remote clock, the Remote will set its clock to the received time of day.

To manage time properly, each Master Station and Remote Station must know how its own time zone relates to UTC and the system time. This relationship is established by relating its time zone to known reference points. UTC is always referenced to GMT; however, system time can be referenced to any desired time zone.

The time zone offset is defined with the following command:

**TIME ZONE,UTC, Local Time Offset**

Always set UTC Offset to 0, the local time offset should be set to the time zone offset (+/- TZ) the remote station is from the master station time zone.

### 5.1.4 Factory Default Parameters

When you type

## FACTORY,DEFAULT,INIT

The unit restores the factory default parameters. A complete list of Factory Defaults is included in **Appendix B**.

The station configuration parameters are usually entered by loading a configuration script file as described in **Section 4.4**. It is also possible to enter these commands one at a time from the operator port. This section describes some of the key commands. Refer to Appendix A for a complete list of commands.

In order for the MRC-565 to operate correctly in your network, it must be properly configured. Configuration requirements will vary from application to application, therefore refer to your systems manual or consult your systems manager for correct settings.

Use the commands described in this section to set the configuration as per required. You may use the **CONFIG, ASSIGN, SNP** and **CR10X** commands to verify proper configurations have been set.

## 5.2 Configuring the MRC-565 Manually

The critical configuration parameters are:

- Radio ID                                Sets unique radio up to 65,000
- Channel                                 Sets frequency, modulation type, and channel number.
- Device Type                             Remote, Master, Base
- Device Role                             Probe, Transpond, LOS, Silent
- I/O Port Assignment//Drivers Port function, number, and protocol
- Low Power Modes                      Power modes to reduce DC power used in receive modes
- IP Configuration                      Ethernet Configuration

Parameters or operational states set by these commands are retained and will determine the way in which the MRC-565 will interact with other equipment at the site and with the communications network.

Most configuration parameters can be viewed with the **CONFIG, ASSIGN, SNP** and **CR10X** commands. You should use these commands to verify that the configuration is correct. If it is not correct, use the appropriate command(s) to correct the configuration, and then enter the "save" command to write the configuration parameters into the CPM.

### 5.2.1 Setting the Radio ID

In command descriptions, the parameter "name" is the assigned Station name. The name is the numeric Station ID. For more information on MRC-565C operation as either a Remote or Master Station, refer to Section 4.2.1. Station IDs, represented by "nnnn", can be assigned as follows:

2 – 254 Master Station  
 256 – 4095 Remote

Verify the ID is set correctly with the following command:

**ID [ENTER]**

If it is not correct, refer to **Section 4.3.3** for instructions on how to set it.

This will show you the “Active” TX and RX Frequency pair and frequency pairs for up to 20 channels that were programmed at the factory.

**5.2.2 Radio Frequencies and Modulation Format**

As noted in Section 4.3.4 above, the MRC-565 will already be programmed with the authorized frequencies to be used in your network. These frequencies are stored in parameter memory and cannot be changed. Verify that the correct frequency is configured by entering the command:

**CHANNEL (cr)**

The following table will be displayed for the SNOTEL network:

```
+CHANNEL 01/01/00 01:08:29
Primary Channel TX mhz RX mhz Mod-Val Bit rate Modulation
                07 41.6100 40.6700 1 4K bpsk25
Channel Table:
Channel TX mhz RX mhz Mod-Val Bit rate Modulation
00 40.5300 41.6100 1 4K bpsk25
01 41.5300 41.5300 1 4K bpsk25
02 40.5300 41.5300 1 4K bpsk25
03 41.5300 40.5300 1 4K bpsk25
04 40.6700 40.6700 1 4K bpsk25
05 41.6100 41.6100 1 4K bpsk25
06 40.6700 41.6100 1 4K bpsk25
>07* 41.6100 40.6700 1 4K bpsk25
08 41.6100 40.5300 1 4K bpsk25
09 41.5300 40.6700 1 4K bpsk25
```

+

You can select any frequency pair from the frequency table by entering the following commands:

**ASSIGN,RX1,n** Where n is the channel number you want to assign to RX1.

**CHANNEL, n** Where n is the desired channel number

### 5.2.3 Device Type

The MRC-565 can operate as either a Remote Station, Master, or Base Station. Use the DEVICE command to select the mode you require.

For normal MRC-565 Remote Station operation, enter:

**DEVICE,REMOTE**

As a Remote Station, the device will respond to Master Stations (usually MRC 525 or MCC 520) every time they hear an IDLE probe. If they hear the Master IDLE probes continuously they will revert to a pseudo Line of Site Role and limit how often they respond to the IDLE.. If they hear the Master intermittently, they will operate in a Meteor Burst (MBC) role and generally respond to all IDLE probes if they have something to transmit or its time for them to check in. Refer to the command "ROLE" to set how and when devices choose a ROLE.

For MRC-565 operation as a Master Station, enter:

**DEVICE,MASTER**

As a MASTER the MRC-565 must operate in Halfduplex mode, with a delay between transmissions of at least 1000 msec.

For MRC-565 operation as a Base Station, enter:

**DEVICE,BASE**

BASE operation is used exclusively in ELOS networks. BASE stations are usually connected to a back office host computer through a wired network connection (Ethernet)

Select the Operating Channel

As noted in the section above, the operating frequencies and modulation formats have already been locked into the unit at the factory, according to our authorized operating channels.



## 5.2.4 Setting the Operating Role

To see what ROLE the device is set to enter:

### **ROLE**

In a MBC network, the ROLE is usually set to the following as described in Section 4. Above.

### **ROLE,TRANSPONFD,100,50,MB**

A detailed description of the ROLE command is given in **Section 4.3.2** above.

## 5.2.5 Setting the Power Mode

The MRC-565 has several power modes that determine the DC Power consumed when the unit is in the non-transmit state. These modes do not affect the DC power consumed when in the transmit state.

There are four Low Power Modes.

### 5.2.5.1 LPM,OFF

In this mode the unit operates without going to low power modes. A typical current draw for this mode is about 130 ma, although during certain software functions the current may get as high as 180 ma. These function include FALSH download. The current can be reduced about 20 ma if the Ethernet interface is not required. To turn off the interface use the turn off any ports that use the Ethernet port using the ASSIGN command.

### **ASSIGN,E1F1,OFF**

### 5.2.5.2 LPM,SP

In this mode, the CF and DSP processors operates in a low power mode. The receiver front end is always active, and will produce an interrupt that wakes up the DSP when RF energy is detected in the receiver bandwidth (10 kHz). When the DSP receives a wakeup interrupt, it will demodulate the received signal and start looking for the Correlation pattern that is the front end of all MBNET 200 data frames. When Correlation is detected, the DSP will wake the CF by raising the DSP\_SP. In this manner the MRC-565 can operate in a relatively low power mode while still able to respond to received signals from the Master. Once the unit receives and processes the Received data, it will go back to the LPM.

It should be noted that unit will be in the LPM even if the TXQ has data to send. This means there is relatively low receive current even when there is data to send as opposed to the MCC 545B LPM which operates at full receive current until all data is sent.

An interrupt timer is built into the hardware that wakes up the CF and DSP every 10 seconds. This allows an operator typing on the keyboard (holding down the "period" key for about 10 seconds to wake the unit up. Applying an external voltage to the Ignition input (IN2+) can also be used to turn on the power within 10 seconds of applying the voltage.

This mode has the advantage that the receiver is always active, which means that it can respond to Master station Idle probes at any time. Wake up time to a receive signal is a few milliseconds

### **5.2.5.3 LPM,ALARM**

This mode is the same as LPM,SP except that when there is no data to transmit, the entire radio receiver is turned off, and current drops to about 50 ma. This mode also uses an interval timer to wake up the CF processor every 10 seconds. In addition to the timer an internal alarm clock can also be programmed to wake the CF up at a specific interval. Use the following command to set an alarm clock interval:

**PTW,NN**

Applying an external voltage to the Ignition input (IN2+) can also be used to turn on the power within 10 seconds of applying the voltage.

Where NN is a wake up interval in seconds. Wake up time from this mode is less than 1 second.

### **5.2.5.4 LPM,PWR**

In this mode the CF is held in LPM,SP state until all data is transmitted. It then turns power off to all internal circuitry except the Alarm clock. In this mode the internal timer is not powered on, so the only way to wake up the unit is to set the PTW to wake up the unit at a specific interval using the following command:

**PTW,NN**

Where NN is the wake up interval.

In this mode you must also set a power time out interval which turns power off:

**PTO,XXX**

Where XX is the time before power is turned off.

You can also turn power onto to the unit by applying an external voltage(+3 to +12V) to the Ignition input (IN2+) can also be used to turn on the power at any time.

A summary of the power modes and the expected current while operating in each mode.

MODE	DESCRIPTION	Current	WU TIME
LPM,OFF	LPM off with Ethernet on	130ma	NA
LPM,OFF	LPM off with Ethernet off	110ma	NA
LPM,SP	Rx on, CF halted, power on	75 ma	3 MSEC
LPM,ALARM	Rx off, CF halted, power on	50 ma	300 MSEC
LPM,PWR	Rx off, CF halted, power off	2 ma	3 SECONDS

### 5.2.6 Selecting Network Parameters

MRC recommends using the given default network parameters (values that are set on power-up or after reset). If you choose to change these parameters, first review the discussion in this Section and in Section 4.8.5, then use the following commands to change to the desired settings:

**SNP**{,pname,value}

where "pname" is the network parameter and "value" is a limit dependent on "pname". The "pname" parameters are as follows:

**TTL** – Time-to-live in minutes (default is 120 minutes); this is the time limit for a message to reach its destination before it is deleted from the queue.

The time-to-live parameter input is truncated to a 10-minute boundary. If you enter 60 through 69, the TTL for the next message will be 60 minutes. A resultant value of 0 (parameter range 0 – 9) means the message will never time out.

**TTR** – Time-to-retransmit in minutes (default is 30 minutes); i.e., the message is retransmitted if it has not reached its destination within this time frame.

**NUP** – Neighbor-up threshold (default is 2 acquisitions); the number of times a Station must hear from another Station within a one minute time interval before it becomes a neighbor.

**NDOWN** – Neighbor-down threshold in minutes (default is 120 minutes); if there is no communication with a neighboring Station within the set time, the route to that neighbor is ignored. Setting NDOWN to 0 maintains the routing to the neighbor indefinitely.

**RDOWN** – Remote-down threshold in minutes (default is 2 minutes); if there is no communication with a Remote Station within the set time, the Remote is declared down and is removed from the Remote table. Setting RDOWN to 0 keeps a Remote defined indefinitely.

**OTL** – Outstanding text limit (default is 20 texts); the number of messages a Station is allowed to send to another Station without an end-to-end acknowledgment.

**CONNP** – MASTER OPERATION ONLY - Connectivity message precedence (default is 1 precedence); information on changes in the connectivity table is given highest precedence (automatic feature).

**ETEAP** – End-to-end ACK message precedence (default is 2 precedence); the acknowledgment of a message when it reaches its final destination is given highest precedence.

**HTO** – History file timeout in minutes (default is 5 minutes); maintains information for duplicate filtering.

**TEXTL** – MASTER OPERATION ONLY - Text size in segments (default is 32 segments).

**FLOODP** – MASTER OPERATION ONLY - Partial "flooding" precedence level (default is A precedence). Messages of this precedence level and above are transmitted over all routes of minimum length; messages below this precedence are not sent over all minimum length routes, but are sent only over the routes where the shortest transmit queues exist.

**MBHOP** – meteor burst link hop weight (default is 1 hop). Defines the number of network hops to associate with a meteor burst Master Station link when determining the minimum path to use in routing a message. MBHOP should be set high enough to prevent a meteor burst Master Station link to be chosen over a line-of-sight Remote to Remote link in a network that is predominantly line-of-sight.

**INF** – MASTER OPERATION ONLY - Infinity hop quantity (default is 8 hops). Defines the width of the network in hops plus one to determine when connectivity to a node is broken. Should be as low as possible to minimize auto-connectivity traffic in the network, but large enough to not erroneously flag nodes as being offline.

**RELAY** – MASTER OPERATION ONLY - Relay function specification (default is ON). Specifies whether the MC-565 should act like a Remote in terms of relay functionality (i.e., does not share connectivity table with other Masters).

**DATAP** – Priority of data reports initiated at the MRC-565 (default is Y precedence). When used in any data collection network, this setting defines the precedence of data reports generated asynchronously by the equipment itself. Typically, it should be lower than operator entered messages and commands.

### 5.3 Local Area Network Configuration

The MRC 525 has two groups of Network setup commands – **IPCONFIG** and the enhanced **ASSIGN** commands. Each group of commands has several options, as shown below and in the command summary table at the end of this chapter. The **IPCONFIG** commands set up IP addresses for the Ethernet ports. The **ASSIGN** commands were enhanced to include the Ethernet and RX's. The RX port numbers are the Channel Numbers selected in **CHANNEL** command. With careful planning, MRC-525s can be configured in the shop and installed without needing additional setup commands. The usual method, however, is to configure each site while the technician is at the site, using pre-configured script files entered using XTERMW software. The technician then verifies operation of each port before leaving the site.

A task in the MRC-525 then monitors each port once per second and establishes a connection with the external equipment. Usually the RS-232 ports and Ethernet ports are permanent connections that are always connected, but the external equipment may be powered on or off. The monitor task will re-establish ports that are turned off when they come back on again.

It should be noted that the Ethernet port is non functional when operating in any of the Low Power Modes (LPM) described in Section 5.2.5 above. Whenever any LPM are turned on, the Ethernet Port will be placed in low power state. In addition removing Ethernet Port from the Assign command will also turn the port off and place it in low power mode.

#### 5.3.1 I/O Configuration Commands

##### 5.3.1.1 Port Settings Using ASSIGN Command

The **ASSIGN** command is used to control the port settings and has been enhanced over the MCC 545B to include not only the serial data ports but also the Receiver and Ethernet ports.

ASSIGN Command Summary

#### ASSIGN, FUNCTION, PORT, PROTOCOL, TIMEOUT

where:	Function =	MNT, DTA, ALT, POS, E1F1, E1F2, E1F3, E1F4, RX1, RX2, RX3	(RS-232 Port Functions) (Ethernet1 Functions) (RF Receiver Functions)
	Port =	0, 1, 2, 3 4, 5, 6, 7 0, 1, 2	(RS-232 ports) (Ethernet1 Ports) (Rx Channels)
	Protocol =	ASCII, MSC, MSC2, CR10X, CR1000, MBNET, PKT, PAKBUS, SERPKT, APCL5, GPS, RTCM, M12RTCM,	

M12DIFF, TRAN, UAIS, GYRO, SOUNDER, PHAROS, H350,  
DIRECT, GENERIC, AEI, HOTBOX, DRIVERS.MPL

Timeout = Optional timeout value in seconds.

Examples: ASSIGN, DTA, 1, MSC2, 5  
 ASSIGN, E1F1, 4, ASCII, 30  
 ASSIGN,RX1,0 where the last number is the channel number described above.  
 ASSIGN.ALT,2,IPC1  
 ASSIGN,POS,3,IPC2

A typical printout from entering:

**ASSIGN.**

Task	Port	Protocol	T/O	Type	State	Baud	P	D	S	F	IP Address	Port	TP	PT
MNT	0	ASCII	30	SERIAL	Open	9600	N	8	1	N				*
ALT	2	IPC1	30	SERIAL	Connected	115200	N	8	1	N				
DTA	1	MSC2	30	SERIAL	Open	9600	N	8	1	N				
POS	3	IPC2	30	SERIAL	Connected	115200	N	8	1	N				
E1F1	4	ASCII	30	ETHERNET	Connected						192.168.10.1	04000		
FTRC	12	TRACEFILE	30											
RX1	00	MBNET		LB VHF										
RX2	01	MBNET		LB VHF										
RX3	02	MBNET		LB VHF										

**5.3.1.2 Ethernet Port Configurations Settings**

The **IPCONFIG** commands is used to set up IP address for the Ethernet port.

**IPCONFIG Command Summary**

**Description**

IPCONFIG	Display IP Settings
IPCONFIG,ALL	Display ipconfig, arp and routing
IPCONFIG,{E1},OFF	Disable Operation on a port
IPCONFIG,PORT,192.168.16.30	Enable operation , supply IP address
IPCONFIG,PORT,DHCPC,{ON,OFF}	Enable/Disable DHCP Client on a port
IPCONFIG,GATEWAY,192.168.16.2	Define IP Gateway for all ports
IPCONFIG,SUBNETMASK,255.255.255.0	Define subnet mask
IPCONFIG,MAC1,00-CF-54-85-CF-00	Enter port 1 MAC Address

The MRC 565 has one Ethernet Port, E1. You can connect to the Ethernet Port by connecting a laptop computer’s Ethernet port to the front panel Ethernet Connector. Use the Operator RS232 Port to set the IP as shown below.

- **IPCONFIG,E1,192.168.10.1**      Factory default

Set the IP address of the Laptop to a fixed address:

- IP ADDRESS            192.168.10.10
- MASK                    255.255.255.0
- GATEWAY              Don't care

Before you can connect to an Ethernet Port, ensure that an Ethernet Port is assigned using the following command.

**ASSIGN,E1F1,4,ASCII,30**

This assigns Ethernet Function E1 to Port 4 using ASCII protocol. Note that this port is not the MNT function.

You can now start XTERM. In XTERM:

Select Device Type MCC 6100 SDR.

Set to connect to IP 192.168.10.1

Set the Port Number to 4000

An Ethernet connection to the MRC 565 is much faster than the RS 232 ports and really speeds up the download of the Operating System (OS) software.

### 5.3.2 Scheduling MRC-565 Events

The **SCHED** command allows you to schedule automated command "events". An "event" simply consists of giving one or more commands a trigger time. When the MRC-565's real-time clock reaches the trigger time, the scheduler invokes the command as though you had entered it from the MRC-565's operator terminal.

Two different types of time trigger options are provided for command scheduling: **INTERVAL** and **TIME**. The **INTERVAL** trigger allows you to schedule a command to be invoked at periodic intervals within a 24-hour time period; the **TIME** trigger allows you to schedule a command to be invoked only once at a specified point within a 24 hour period. The command schedule list is restarted each time the real-time clock reaches midnight.

To display the current schedule list, enter:

**SCHED**

To add a new command to the schedule list, enter:

**SCHED,type,time{ OFFSET,time },command**

where: type = INTERVAL or TIME (I or T)  
 time = hours:minutes:seconds  
 OFFSET,hh:mm:ss = time offset from specified timeframe (optional)  
 command = any MRC-565 command (with parameters)

To remove command event(s) from the schedule list, enter:

**SCHED,DEL,xxx**

where: xxx = ALL (erases entire schedule)

or

= schedule list number (removes single scheduled event from the schedule list)

You can schedule several command events to trigger at the same time, however, you cannot force one command to execute before or after another. After assigning command events to the schedule, the order of commands displayed in the schedule list is the order in which the events will trigger for any given trigger time (i.e., an event with a low schedule number occurs before an event with a higher schedule number).

### 5.3.3 Setting Timeout Duration

There is one programmable time limit for the I/O port input on the MRC-565. MRC recommends using the pre-programmed default timeout parameter. If you choose to change the timeout the time limits may be set by entering the number of seconds, from 0 to 32767. Enter a 0 to turn off the time limit.

Command	Description
<b>STT,secs</b>	The Set Teleprinter Timeout command sets the time limit for characters at the maintenance terminal. Default is 60 seconds (1 minute).

### 5.3.4 Defining Data Relays

The ambient noise conditions at a remote station site may sometimes be excessive and a poor communication path to the Master Station will result particularly if the remote station is operating in a meteor burst mode. To overcome this problem, another MRC-565 may be placed in a nearby quiet location and used as relay station between the MRC-565 at the noisy site and its master station. When used as a relay, the MRC-565 will concentrate the data reports it receives from one or more neighboring remote sites and forwards the data to the Master Station.

In this mode, the MRC-565 must be defined as a Master Station. The relay will then receive Group data reports from other MRC-565 units located in noisy or un secure locations and repackage them and forward them to the Master Station. A relay can handle sixteen GROUP reports. These reports can be in any combination; i.e., four groups from each of four Remote units, one group from each of sixteen Remote units or any combination in between. Substitution



tables must be established in both the relay unit and at the Master Station to manage the relay function.

When a designated GROUP report is received at the relay, it will substitute its own ID and group number in the report as defined in its substitution table and forward the data to an MRC-520B Master Station using the MRC-550C RF format rather than the standard MRC-565 message format. When the relayed data is received at the MRC-520B it reconstructs the original data report based on its own substitution table and route the report as required.

The following command is used to define the entries in the substitution table for a relay unit:

```
SUBST,relay_id,relay_group,remote_id,remote_group
```

where: relay\_id is the relay unit's ID  
 relay\_group is the data group report number at the relay  
 remote\_id is the originating Remote unit's ID  
 remote\_group is the data group report number at the originating Remote unit

### 5.3.5 Scaling A/D Readings

The MRC-565 contain a 12 bit A/D converter that is used to measure 16 analog voltages input including:

Battery Voltage 0- 20VDC  
 Power Amplifier Forward Voltage VF VF = 5.2 V when Power = 100 watts  
 Power Amplifier Reverse Voltage VR  
 Power Amplifier Temperature  
 Six Internal Regulated Voltages  
 Six External Voltages (ADC1 – ADC6)

Table 5.2-1 below lists the various parameters.

The MRC-565 automatically converts the raw readings from its A/D converter to calibrated engineering units for operator use. The scale factor and offset values for the first ten parameter are preset in the software and should not be changed. The final 6 parameters are external parameters that are input through the I/O connector. (Refer to Section 4.4.1.4)

Entering the following command will produce a table of A/D readings along with their scale and offset values as well as Raw and Cal values for each parameter

#### SCALE

16 parameters are read by the A/D converter as noted below.

**Table 5. MRC-565 Scaling Factors**

CHAN	SCALE	OFFSET	RAW ADC	SCALED ADC
VBAT	0.0048800	0.0000	2551.0000	12.448880
PA_VF	0.0000221	0.0000	0.0000000	0.000000
PA_VR	0.0000221	0.0000	0.0000000	0.000000
PATEMP	0.2250000	-58		
3.3V	0.0012207	0.0000	2695.0000	3.2897865
1.8V	0.0012207	0.0000	1454.0000	1.7748978
1.5VCFC	0.0012207	0.0000	1134.0000	1.3842738
3.3DSP	0.0012207	0.0000	2675.0000	3.2653725
1.6DSPC	0.0012207	0.0000	1256.0000	1.5331992
1.2VFPGAC	0.0012207	0.0000	967.00000	1.1804169
ADC1	1.0000000	0.0000	0.0000000	0.0000000
ADC1	1.0000000	0.0000	0.0000000	0.0000000
ADC1	1.0000000	0.0000	0.0000000	0.0000000
ADC1	1.0000000	0.0000	0.0000000	0.0000000
ADC1	1.0000000	0.0000	0.0000000	0.0000000
ADC1	1.0000000	0.0000	0.0000000	0.0000000

Scale factors and offset values are dependent on the range of input voltages for these parameters.

The input voltage at the I/O connector must not exceed 5.00 VDC. A 12 bit A/D converter is used to convert the input voltage to a digital value from 0 to 4095. Scale Factor is set using the following formula:

$$\text{Scale Factor} = (5.0/4095) * 1/\text{INPUT DIVIDER} = .0012207 * 1/\text{INPUT DIVIDER}$$

Where the INPUT DIVIDER is the voltage attenuator at the ADC input required to keep the maximum input voltage below 5.00 VDC

Use the following command to change scale and offset values for each of the external inputs:

**SCALE,ADCn,SCALE,OFFSET**

### 5.3.6 Selecting the Burst Monitor

The MRC-565 has a unique meteor burst monitoring capability that allows monitoring the number of characters received, the RF signal level and other parameters on each reception.

To turn on the burst monitor and to record statistics on a meteor burst link, type:

**MON{,d{,r}}**

The two optional parameters are designed to limit the printout. The burst monitor generates two or three lines of printout for every burst. This could conceivably create hundreds of pages of

printout a day in a network environment. The first parameter is the duration character count limit. Only meteors lasting long enough to deliver "d" characters will be monitored. The second parameter is the received character count limit; if at least "r" characters are received on the burst, a monitor line will be generated. The default values are 100 for "d" and 1 for "r". For example, to limit the printout, but still receive some maintenance benefit from the monitor, enter:

**MON,500,100**

This will limit the printout to meteors that have a duration character count greater than 500, or a received character count greater than 100. These parameters may be adjusted as desired.

The command **MONOFF** turns off the burst monitor

### 5.3.7 Controlling the Hourly Statistics Report

By default, an hourly statistics report is generated on the maintenance terminal port on the hour. This report consists of the same statistic reports generated by the **BINS**, **MEM**, and **STAT** commands.

The hourly report can be disabled by entering the command:

**HOURLIES,OFF**

The hourly report can be re-enabled by entering the command:

**HOURLIES,ON**

### 5.3.8 Reading Internal Sensor Values

The MRC-565 radio has the capability to read certain sensor values, e.g. Internal rechargeable battery (-03 only), internal temperature, etc.

Following are the most commonly used commands to read these sensor values, please note that some commands are only available on -03 radios. For a more detailed description of this feature, refer to Section 4.7.

<b>COMMAND</b>	<b>DESCRIPTION</b>
EVENT,STATUS,PATEMP	Reads the internal PA temperature of the unit
EVENT,STATUS,BAT	Reads the unloaded battery (external) of the radio
EVENT,STATUS,LBAT	Reads the loaded battery (external) of the radio
EVENT,STATUS,ADC1 { thru DC6}	

### 5.3.9 Power Turn On

The MRC-565 has the ability for the radio to be powered off by the CF Processor. This can be used to turn the radio off under electronic control for purposes of reduction standby operating current.

An external control signal (e.g. car ignition, data logger, etc) connected to the I/O port is used to turn the unit on.

This external signal (+3 to 12VDC voltage) is applied to the optical isolated port 2, available on the 25 pin connector (I/O Port). There is an internal 2000 ohms resistor to limit the current. To connect the control signal to IN2, apply +V to IN2+ (Pin 3 on DB-25 connector) and -V (ground) to IN2- (Pin 4 on DB-25 connector).

To enable the power off feature, use the following command to set the Power Time Out (PTO) in seconds to turn the radio off after the IN2 is removed.

**PTO,xxx                    where xxx is the timeout in seconds.**

**NOTE**

**PTO command must not be used (i.e. set to PTO,OFF) if JP2 is installed.**

### 5.3.10 Saving and Restoring the Configuration

To aid your understanding how the MRC-565 operational configuration is saved and restored it is helpful to understand the hardware and design philosophy of the MRC-565.

The MRC-565 is designed to operate unattended in a variety of environments where power may be applied continuously or intermittently. The goal is for the unit to continue to operate without loss of messages, data or configuration even if power is randomly turned on and off. Therefore the software is designed to operate continuously, to save all operational information when power is off and to resume operation from that point when power is restored.

To support this philosophy, the MRC-565 has three types of memory:

**PROGRAM MEMORY (PM)  
CONFIGURATION PARAMETER (CPM)  
RAM**

The **PM** is non-volatile flash memory that has been programmed with the MRC-565's operational software (OS). This software contains the initial values of all operational parameters. The values are referred to as the "factory defaults" because they are programmed into the MRC MRC-565 operating system software at the factory. The **PM** can only be modified by replacing the operating system using the flash download. (Consult XTERMW manual to learn how to download a new flash into the **PM**.)

The **RAM** contains all the dynamic data for the MRC-565. All data logger data, positional data, and messages entered into the MRC-565 are stored in RAM. Also, all command parameters are stored in **RAM**. But **RAM** is volatile and can only retain information while power is applied. Turning off or disconnecting power will cause all **RAM** information to be lost.

During normal operation, the MRC-565 software operates from the data and the parameters that are stored in **RAM**. Unfortunately, there are always situations when the **RAM** data may be lost or corrupted due to total discharge of the battery, software crash or operator error. Since we do not want to lose our configuration data during these situations, we have a third type of memory.

The third type of memory, **CPM**, is also nonvolatile flash memory and retains data even when power is removed. The MRC-565 retains a copy of all the programmed configuration parameters in **CPM**. The MRC-565 will write configuration parameters, which have been entered from the operator port, into CPM when the **SAVE** command is entered. Only values that have changed are written into **CPM**. Whenever the unit radio **ID** is changed the MRC-565 will automatically **SAVE** the configuration. A validation checksum is used by the MRC-565 to verify the data in CPM is correct. If the checksum is invalid, the unit will revert to factory defaults.

When the MRC-565 ships from the factory it is programmed with the following default configuration: the Operator Port (port 0) is set for 9600 baud, 8 data bits, 1 stop bit, no parity, ASCII protocol and no flow control. This provides a known starting point for communicating to the unit from a terminal or computer. From this starting point, the user can program the unit **ID** and other operational parameters and then use the "Save" command to write them to **CPM**. As soon as the parameters are entered they take effect.

#### **CAUTION**

**Once the software is rebooted or is restarted due to a SW crash, power cycle, operator BOOT, all changes will be lost unless they were previously saved in CPM.**

## **5.4 Sending and Receiving Messages**

The MRC-565 is a packet data radio and therefore enables an operator to send and receive messages to all units within the network.

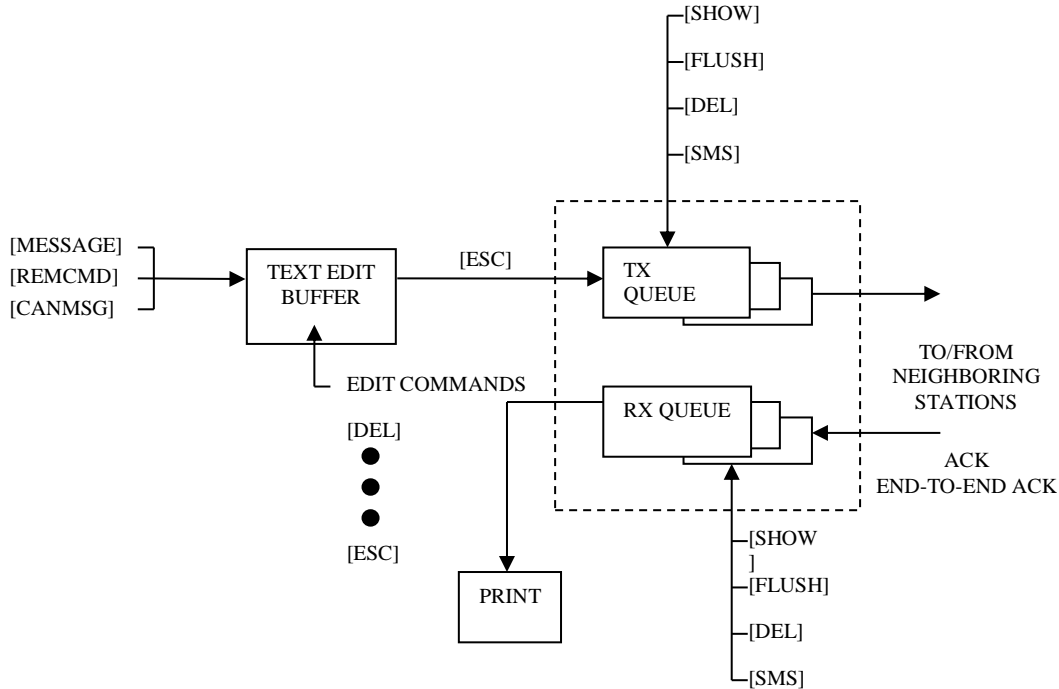
The messages may be entered from an operator terminal that is connected to the MNT PORT of the MRC-565. There are three basic message types: (1) free-form text messages, (2) canned messages and (3) commands. The general format for all messages is shown below:

**MESSAGE, R** , dest 1, dest 2, ...dest n

where: R = Message priority; A is highest, Z is lowest.

dest = ID of the station(s) to which the message will be sent.

The message text is then entered and edited in the TEXT EDIT BUFFER. They are then transferred to one or more TX QUEUE buffers for transmission to the designated destinations. The diagram below depicts the general flow of messages within the MRC-565 software and the various commands associated with each step in the process.



**Figure 7. Message Flow and Associated Commands**

The following operations are explained in this section:

SECTION	OPERATIONS
5.3.1	Entering and Deleting Messages
5.3.2	Editing Messages
5.3.3	Sending Messages
5.3.4	Sending Commands
5.3.5	Sending Canned Messages
5.3.6	Receiving Messages
5.3.7	Examining Message Status
5.3.8	Examining and Revising Message Queues

**5.4.1 Entering and Deleting Messages**

All messages are composed and edited in the TEXT EDIT BUFFER. Messages may be 3,570 characters in length. When composing the message press [ENTER] at the end of each 80 character line.

There is a default destination programmed into the MRC-565 during the installation and initialization of the unit when it is first brought on-line in the network. If a message is not given a specific destination it will be sent to the default destination only.

To enter a message:

1. Type MESSAGE. The operator terminal will respond with ENTER TEXT. The MRC-565 will now be in the compose and edit mode.
2. Enter a message up to 3,570 characters in length, pressing [ENTER] at the end of each 80 character line.
3. Press the [ESC] key. The message will now be transferred to a Tx queue and will be automatically transmitted to the default destination at a priority level R.

The following message will be displayed, or printed, on the operator terminal:

```
hh:mm:ss Message No: name:ss,nnnn chars, nnn segments
hh:mm:ss ROUTING name :sss TXT sss/nn TO: name
```

If you wish to send a message to multiple destinations, and at a different priority level, type

```
MESSAGE, R, dest1, dest2, ...dest n
```

where: “R” is any priority level from A to Z. A is the highest and Z is the lowest.

“Dest” is the numerical ID of the stations to which the message will be routed.

#### NOTE

**If you also want to send the message to your default destination you must enter its station numerical ID as one of the destination parameters (“dest1”, “dest2”, etc.) as specified above.**

Three other special editing functions may be used:

1. To Retransmit the Previously Entered Message

To retransmit a previously entered message simply depress the [ESC] key after the operator terminal prints ENTER TEXT and before any other key is depressed. The previous message entered into the TEXT EDIT BUFFER will then be sent to the destinations that are now designated in the MESSAGE command.

2. To Revise the Previously Entered Message

To revise a previously entered message press [CTRL]T after the ENTER TEXT prompt to revise a previously entered message or to recover from an aborted session. The previous message will be displayed with the cursor placed at the end of the message. You may now resume editing the message.

3. To Delete a Message

To delete a message after it has been placed in the Tx Queue, type



**DELMSG, ID: sss**

where: ID is the numerical station ID  
 sss is the message serial number

The operator terminal will print the date and time, followed by MESSAGE DELETED.

### 5.4.2 Editing Messages

The following editing functions may be used from the keyboard while the message is in the TEXT EDIT BUFFER.

KEY	FUNCTION
[DEL]	Deletes the last character entered.
[CTRL]R	Prints the current line of text on the next line down.
[CTRL]I	Performs a fixed tab function
\	Removes the current line from the edit buffer.
[ENTER]	Performs a carriage return and line feed.
[LF]	Performs a carriage return and line feed.
[CTRL]X	Removes the current line from the edit buffer and places the cursor at the end of the previous line.
[CTRL]T	Prints the contents of the edit buffer & puts cursor at the end of text.
[CTRL]D	Erases the entire contents of the edit buffer.
[CTRK]A	Aborts the edit mode and returns to the command mode. A "+" indicates the command mode.
[ESC]	Leaves text edit mode and queues the message for transmission.

### 5.4.3 Sending Messages

Messages are automatically stored for transmission with the [ESC] key. Each message will be placed in the Tx Queue in accordance with its assigned priority. Messages of equal priority are placed in the Tx Queue in the order received from the TEXT EDIT BUFFER.

The following display will appear on the operator terminal as the MRC-565 stores and routes a message:

```
hh:mm:ss Message No: name:ss,nnnn chars, nnn segments
hh:mm:ss ROUTING name :sss TXT sss/nn TO: name
```

Messages are transmitted in packets and are routed to their destination in a store and forward manner, using the most efficient routing within the packet switched network. The originating station will receive an acknowledgement (ACK) if the message has been received successfully by the first routing station.

mm/dd/yy hh:mm:ss TXTMSG ACK name:sss, xxxx CHARS FROM name

When the entire message has been delivered to its final destination an end-to-end acknowledgement will be displayed on the operator terminal:

hh:mm:ss END-TO-END ACK OF name:sss FROM name

If the end-to-end ACK is not received within the specified time-to-live limit, the MRC-565 will purge the message from the Tx Queue and display the following message:

hh:mm:ss MESSAGE TIME-TO-LIVE EXPIRED, MSG.NO:sss, DESTN: name

You must then reenter the message. Continued failure to successfully transmit a message indicates that something may be wrong with the equipment or the link (e.g., excessive noise interference).

#### 5.4.4 Sending Remote Commands

Commands may be sent to any station within the network. The entry of a command is similar to the MESSAGE command described in Section 4.3.1.

**REMCMD, R, dest1, dest2, ... destn**

where: R = priority level  
 dest = numerical ID of destination station(s)

The operator is then prompted to enter the text of the command using the message editor. Once the command is entered, press the [ESC] key to send the command. The operator terminal will display:

hh:mm:ss **Message No:** name:sss, nnnn chars, nnn segments

A response will be received from the destination station(s) if it was successfully received.

#### 5.4.5 Sending Canned Messages

The MRC-565 may be placed into a canned message mode for automatic transmission of a repetitive message to an assigned neighboring station. In the canned message mode no more

than 25 messages may be placed into the Tx Queue at one time. You may either send an edited text message or a message that is generated from the alphabet.

To enter a canned message generated from the alphabet, enter:

**CANMSG,id,msg length{,min.queue depth}{,total number of messages }**

where “id” is the neighboring station ID, the message length is from 1 to 3000 characters and the queue depth is from 1 to 25. The default queue depth is 5. Additional canned messages will be automatically injected if the number of canned messages in the queue falls below the minimum queue depth.

To enter an edited canned message, enter:

**CANMSG,id**

where “id” is the neighboring station’s ID. After composing your message press the [ESC] key. The MRC-565 will automatically route up to 25 copies of the canned message to the destination station.

Each canned message will be acknowledged by the selected neighboring station. No end-to-end acknowledgement will be received.

If the **TOTAL** parameter was entered the canned message mode will stop when the desired number of messages have been transmitted.

To manually terminate the mode, enter:

**CANMSG OFF,id**

Canned messages are normally not printed at the destination station. To print canned messages as they are received, enter:

**CANMSG MODE,PRINT**

To turn off the print mode, enter:

**CANMSG MODE,NO PRINT**

#### 5.4.6 Receiving Messages

When a new message is received it is announced by the following display:

hh:mm:ss RECEIVING name:sss TXT sss/nn FROM name ROUTED TO: name

The MRC-565 then generates an ACK of the message packet and transmits the ACK to the neighbor from whom the message was received:

```
hh:mm:ss TXTMSG ACK name:sss, nnnn CHARS FROM name
```

When the destination MRC-565 receives a complete message, it displays the following message:

```
hh:mm:ss MSG RECEIVED name:sss, xxxx CHARS
text.....
**end-of-message**
```

where “name:sss” is the message serial number.

Messages are deleted as they are displayed or printed unless they are being forwarded to further destinations.

### 5.4.7 Examining Message Status

The status of all messages may be examined while they are still in the Tx Queue. (Note: once an end-to-end acknowledgement is received for a message it is deleted from the queue).

To examine a message, enter:

```
SMS {,ID}
```

### 5.4.8 Examining and Revising Message Queues

There are two types of queues for transmitting and receiving messages:

QUEUE NAME	DESCRIPTION
TXQ (Transmit Queue)	This queue is used for transmitting all messages. There is a separate transmit queue for each neighboring station in the network. For example, if you enter a message for DEST1 That message is placed in DEST1’s transmit queue.
RXQ (Receive Queue)	This queue is used for all received messages. There is a separate receive queue for each neighboring station in the network. For example, to examine message statistics from NODE5, examine the receive queue from NODE5.

To examine the contents of either queue, type:

```
SHOW TXQ,ID or SHOW RXQ,ID
```

You must specify the queue by entering the station ID. For example, SHOW TXQ,006 prints statistics for all messages being transmitted to station 006.

You can only examine the receive and transmit queues for neighbor stations in the network.

To delete the contents of the transmit and receive queues, you must specify the exact queue by entering a station name:

**FLUSH TXQ,id** or **FLUSH RXQ,id**

For each message deleted, the terminal prints:

Id:sss unlinked {and deleted}

The “and deleted” text appears only if the message is not present in another queue. When all messages have been deleted, the terminal prints:

queue flushed

To delete a specific message, enter:

**DEL MSG,id:sss**

The terminal prints:

Message deleted

To delete all messages from all queues, enter:

**FLUSH MSG**

For each message deleted, the terminal prints:

Id:sss deleted

Entering the FLUSH MSG command deletes all messages in all queues for every node of the network, including connectivity and end-to-end acknowledgment messages.

## 5.5 Sensor I/O Port

A limited data acquisition capability is built in to the MRC-565 for those applications when a full data logger capability is not required. The following capability is provided:

- 4 optically isolated inputs for discrete ON/OFF functions
- 6 analog voltage inputs (0 to 5V)
- 2 solid state switches

In addition, +12V<sub>DC</sub> is supplied for sensor power and a +5V reference voltage for sensor excitation is available.

The Sensor port interface is a 25-pin male D connector. The connector pin outs and their respective functions are shown below.

The analog voltages are routed to a 12-bit analog-to-digital converter (ADC) which provides a resolution of +/-0.1% and an accuracy over temperature of  $\pm 1\%$ .

<b>SIGNAL PORT</b>	
<b>Pin</b>	<b>Signal</b>
1	Optocoupled input #1 positive (500 ohm resistor)
2	SDI-12 Data
3	Optocoupled input #2 positive (500 ohm resistor)
4	Optocoupled input #1,2,3,&4 return
5	Optocoupled input #3 positive (500 ohm resistor)
6	Det RF Channel 3
7	Optocoupled input #4 positive (500 ohm resistor)
8	Det RF Channel 2
9	Ground
10	SS Relay Out #1 - .5 Amp Rating
11	SS Relay Out #1 +
12	Signal Presence SP
13	SS Relay Out #2 - .5 Amp Rating
14	SS Relay Out #2 +
15	TX Key
16	+5V Reference (10 ma max) +/- 2%
17	Analog Input #1 ( 0 to 5 V)
18	Analog Input #2 ( 0 to 5 V)
19	Analog Input #3 ( 0 to 5 V)
20	Analog Input #4 ( 0 to 5 V)
21	Analog Input #5 ( 0 to 5 V)
22	Analog Input #6 ( 0 to 5 V)
23	+12V Switched (.5 A Max)
24	+12V (0.5A Max)
25	Detected RF Channel 1

A 25-pin terminal block is a convenient means for interfacing to the various sensors and control points.

## **5.6 Data Loggers Interface**

Any data logger that MRC supports and has an RS-232 interface may be connected to any one of the 3 ports on the MRC-565. Normally, the Data or AUX Port is used. You may connect to either port using a 9-pin “D” type connector:

PIN	FUNCTION
2	TX Data
3	RX Data
5	Ground

Three commands are required to configure the Data Port for proper operation with the particular data logger being used:

```
ASSIGN,DTA,OFF [ENTER]
ASSIGN, DTA, 1, type [ENTER]
```

The first command clears any previous assignments that still may be in effect for the DTA Port. The second command assigns a specific type of data logger and protocol to the DTA Port. The specific type of data loggers that MRC supports may be obtained from MRC or your System Administrator.

The following section explains the interface of Campbell Scientific Data LoggerS to MRC-565.

## 5.7 CR10X Data Logger

The MRC-565 RF Modem can be used with the Campbell Scientific CR10X data logger to transmit data from a remote site to a destination in a Meteor Burst (MB) or Line-Of-Sight (LOS) network. Because of the unique timing of a MB system, the MRC-565 does not provide a real-time connection between a CR10X and a PC running a data collection program as a pair of dedicated phone modems would. The connection is a packet store-and-forward type instead.

The design approach used was not to add the MRC-565 to the list of modems supported by the CR10X, but to add the CR10X to the list of data loggers supported by the MRC-565. Each CR10X data-array recorded in the final storage is treated as a data logger packet by the MRC-565. Packets are acquired by the MRC-565 from the CR10X, and delivered through the MB network to another MRC-565 or master station. The packets are then “printed” on one of the RS-232 ports at the destination unit in a format that is compatible with all the other supported data loggers.

In this type of system, the central data system does not “poll” each remote for its data. Instead, each remote MRC-565 gets the data from the locally attached CR10X using an internal data acquisition schedule and CR10X driver software module, then routes it to a particular destination. The MRC-565 driver module uses the CR10X telecommunications commands to read the data from the final storage. It is then the responsibility of the central data system to store and process the data as it arrives from each remote site.

Because of the flexibility of both the CR10X and the MRC-565, several parameters must be setup to define the operation of the data acquisition process used to get data from the CR10X to the MRC-565. The following sections show the command structure as it relates to the CR10X driver, and then discusses each command in detail.

### 5.7.1 CR10X Commands

The following tree diagram shows the commands used to set up and configure the CR10X data Logger drivers in the MRC-565 RF Modem.

An example is: **CR10X,ACQMODE,ALL**.



<p>CR10X</p> <ul style="list-style-type: none"> <li>— ,ACQMODE,ALL             <ul style="list-style-type: none"> <li>— ,CURRENT</li> <li>— ,LAST,N</li> </ul> </li> <li>— ,SETPTR,DATE,TIME</li> <li>— ,INTERVAL,N             <ul style="list-style-type: none"> <li>— ,OFF</li> </ul> </li> <li>— ,ORDER,FIFO             <ul style="list-style-type: none"> <li>— ,LIFO (not avail)</li> </ul> </li> <li>— ,GROUP,MRC-565A             <ul style="list-style-type: none"> <li>— ,CR10X</li> </ul> </li> <li>— ,TIME,MRC-565A             <ul style="list-style-type: none"> <li>— ,CR10X</li> </ul> </li> <li>— ,MAXQ,NNN</li> <li>— ,SCALE,CR10X             <ul style="list-style-type: none"> <li>— ,INT (or MRC-565A)</li> </ul> </li> <li>— ,REGISTER,N             <ul style="list-style-type: none"> <li>— N,DDD</li> </ul> </li> <li>— ,STAT</li> <li>— ,RESET</li> <li>— ,SECURITY,1111,2222,3333</li> <li>— ,SIGNATURE</li> <li>— ,MODEM ENABLE</li> </ul>	<p>Display CR10X configuration parameters</p> <p>Get all reports since previous scan</p> <p>Get only the current (last) data group</p> <p>Get only the last ‘N’ data groups (backsup ‘N’ data groups from the last one)</p> <p>Manual set up of last data pointer in the MRC-565</p> <p>Scan interval in seconds</p> <p>Scan only when UPDT command is entered</p> <p>Get final storage data in FIFO order</p> <p>Get final storage data in LIFO order</p> <p>Let MRC-565 assign group numbers</p> <p>Get Group Number from 1<sup>st</sup> stored sensor</p> <p>Use MRC-565 internal Time</p> <p>Get time from 2<sup>nd</sup> and 3<sup>rd</sup> sensor</p> <p>Set maximum number of reports to queue for each scan of the CR10X</p> <p>Scale sensors in cr10X Hex units</p> <p>Scale sensors in integer Hex units</p> <p>Read internal storage register ‘N’</p> <p>Set internal storage register ‘N’ to ‘DDD’</p> <p>Read and display CR10X internal pointers and error statistics.</p> <p>Reset CR10X internal error statistics.</p> <p>Enter CR10X Internal Security Codes</p> <p>Read and Display Current CR10X programs Signature.</p> <p>Enable/Disable use of ME/Ring control</p>
--	--

### 5.7.2 Parameter Default Values

Default values are set up to support systems already deployed in the field. These are defined to allow only the last single data group to be read each time the **UPDT** command is entered or scheduled in the MRC-565. The time tag will use internal MRC-565 date and time, it is assumed the day and time are not stored in the CR10X data arrays, scaling will be in CR10X Hex format, transmission in FIFO order, group assignment by the MRC-565 and the maximum queue depth

will be 200. The use of MODEM ENABLE is normally off and the RING line is tied high to keep the CR10X in an active state.

The current values are viewed by entering **CR10X**<Enter> as shown in the following example.

```
+cr10x 04/08/14 10:43:12
ACQMODE   = ALL
INTERVAL  = OFF
ORDER     = FIFO
GROUP     = CR10X
TIME      = CR10X
MAXQ      = 3
SCALE     = CR10X
MODEM ENABLE = OFF
```

### 5.7.3 Acquire Mode

There are three modes used by the MRC-565 for controlling data acquisition from the CR10X. These are "ALL", "CURRENT", and "LAST,N".

The **CR10X,ACQMODE,ALL** mode will read all the data recorded in the Final Storage area starting from the last location read by the MRC-565. This is useful where all the data for each site is important, not just the most-recent data. This mode lets the CR10X gather data for a while then the MRC-565 can acquire all that was stored later. For example, you might want the CR10x to store data every hour, but have the MRC-565 acquire and transmit all of it at midnight. For each scan, the MRC-565 will read as many data reports as it can, limited by the **CR10X,MAXQ,NN** setting, and the amount of available memory. These two limits are discussed below in the memory management paragraph.

The **CR10X,ACQMODE,CURRENT** mode will only get the very last single data group stored in the Final Storage area with each scan. It assumes there is only one group for each data interval. This is compatible with systems already installed in the field.

The **CR10X,ACQMODE,LAST,N** mode will read the last "n" data groups each time a scan is scheduled. The value of "n" is set to the number of groups in each reporting interval. This mode is useful when you want to be able to change the reporting interval remotely, and the cr10X program cannot be modified. For example, you can setup the CR10X program to record data every minute, but have the MRC-565 acquire the most recent data every hour. You can then change the MRC-565 acquisition scan timing to any interval from one minute to 24 hours without modifying the CR10X program.

#### 5.7.4 Data Retrieval Pointer Initialization

The **CR10X,SETPTR,XXXX** command is used to control where the next data will be read from the CR10X Final Storage. The MRC-565 maintains an internal pointer for reading data. This pointer is accessed each time the MRC-565 requests data from the CR10X. The CR10X records data in a “circular ring buffer” mode and will reuse memory locations as long as it remains operational. If required, as in the case where older data was lost, when data must be re-read from the CR10X and retransmitted by the MRC-565, the internal MRC-565 data pointer can be modified to point to the start of the required data. In addition, when an MRC-565 is replaced, but the CR10X still has data, it will be necessary to set the pointer in the new MRC-565 to the last known location of the old MRC-565.

There are two variations of this command. The form allows the operator to set the pointer to a numerical location. This may be known, and can be read using the **STAT** command shown below. The **CR10X,SETPTR,DATE,TIME** form will search through the CR10X Final Storage memory and set the pointer to the first data array that is equal to or greater than the given date and time. The search uses a binary algorithm, and will take a few seconds to locate the desired data point. This search mode can only be used if the CR10X has recorded the group number, date and time in the first three locations of each data array as discussed below in the Group ID Assignment and Time of Day paragraphs.

#### 5.7.5 Update Interval

The update **CR10X,INTERVAL,N** sets up the number of seconds between scans of the data from the CR10X. If **N** is set to **OFF**, then the MRC-565 internal **SCHED** command can be used to schedule **UPDT,TX** commands at any particular time, or interval. When set to a number from 1 to 32767 seconds, an internal timer triggers an **UPDT,TX** type of action at the desired interval. The interval is synchronized with time-of-day so that an interval of 10 seconds (for example) falls on 0, 10, 20, 30, 40, 50 seconds of each minute. The interval can be set more often than data is recorded in the Final Storage, and if there is no new data since the last scan, nothing will get queued.

#### 5.7.6 Transmission Order

The order of transmission is currently limited to FIFO, but provision has been made for a later version to support LIFO.

#### 5.7.7 Group ID Assignment

The group ID can be assigned in the CR10X data arrays, or can be assigned by the MRC-565. Each group can contain from 1 to 16 sensor data values. The MRC-565 mode will assign group number 2 to each group report by default. This is for compatibility with older systems deployed in the field.

The CR10X mode uses the group ID assigned in the CR10X by using the **P80,p1,p2** instruction in the CR10X DLD File, where the 1st parameter selects Final Storage area 1, and the 2nd parameter defines the group (array ID) number. These can be assigned from 0 to 15.

### 5.7.8 Time of Day

To send the MRC-565 time to the CR10X, enter (or schedule) a **UPDT,TIME** command. This will not be done when a time probe is received from the master station, as it might cause a skip in the data acquisition cycle. It should be scheduled to happen at a convenient time of day or interval using the MRC-565 **SCHED** command such that data will not be lost if the time advances or retards across an acquisition interval. If the time update is more than +/- two minutes from the current CR10X time, then a time resync message will be transmitted to the default destination.

### 5.7.9 Time Tagging

The time tag assigned to each group report can be taken from the MRC-565 internal date and time as the data is read, or it can use a CR10X internal time stored in the data array.

To use the CR10x internal time, the date and time in the CR10X DLD File must be set up in each group as the first two sensor values of the group using the code "110" in the **P77** instruction. This records the Julian day as the first sensor, and the Hour/Minute as the second sensor. The maximum number of sensors would then be 18, and actual data would be in sensors 3-18 for 16 values. The MRC-565 will use sensor slots 1-16 for this data rather than 3-18. The time tag is placed in the data report header.

If the MRC-565 time is used, actual sensor data can be recorded in sensors 1-16. If the data array has the time in each record, but you use the MRC-565 time stamp, then the 1st two sensors which actually contain the CR10X date and time will be treated as the 1st two sensor values. There is no option to skip the 1st two data array values in this case, except to use the CR10X time tag mode.

### 5.7.10 Memory Management

Each time the MRC-565 reads data from the CR10X, it saves the last data pointer accessed in the CR10X's Final Storage RAM. This is used at the next scheduled update interval to get the next data values without missing anything.

If there is no new data recorded in the Final Storage area when the MRC-565 scans, then nothing is transmitted. The MRC-565 will try again at the next interval. The interval can be set from 1 to 32767 seconds. A good typical value to use is 60 seconds.

The MRC-565 limits the amount of data read from the CR10X to prevent overflowing its' transmit memory queue. Each time a group is read, the available memory is checked, and if it goes below 600 Queue blocks, then the MRC-565 will stop reading data from the CR10X until the next scan interval. As data is transmitted, memory will get freed up for the next interval.

The **CR10X,MAXQ,N** setting is used to limit the number of group reports created with each scan. For example, if **MAXQ** is set to 20, each scan will read, at most, 20 group reports. 20 more will be read at the next interval, etc. There is no provision for limiting the length of the transmit queue as in the MRC-550 data acquisition unit. In effect, limiting the transmit queue length can be accomplished by setting the **SNP,TTL,NN** time to purge reports older than the given number of minutes.

### 5.7.11 Data Scaling

Two data formats are supported, and must agree with the setup of the internal CR10x Program. Only the low-precision format is currently supported.

The **CR10X,SCALE,CR10X** format will use the Campbell Scientific floating point format and assumes the sensors are calibrated in engineering units within the CR10X.

The **CR10X,SCALE,INT** format assumes each sensor is calibrated in integer mV, and formats the data in 2's complement integer Hexadecimal format by truncating the fractional part of the floating point number. Example: CR10X outputs 103.7, MRC-565 truncates it to 103, then converts it to hex 0067. The value -103.7 will be converted to hex FF99. The cr10X maximum low-precision values are 13 bits where +6999 is converted to hex 1B57 and -6999 is converted to hex E4A9. The MRC-565 uses 16 bits for each sensor data value, but the MRC-550B/C (and some customers) is limited to 12 bits of significance.

### 5.7.12 Modem Enable

By default, the use of the MODEM ENABLE line is turned OFF and the RING line is tied high to keep the CR10X awake. For applications that require very low power, the CR10X can go to sleep between operations, and must be woken up to communicate with it. This mode is enabled in the MRC-565 by the command: **CR10X,MODEM ENABLE,ON**. When the MRC-565 wants to communicate with the CR10X, it raises the RING line, and waits for the CR10X to raise the ME line. The ME line must be tied to the RTS line of the MRC-565. Once the ME line is high, the MRC-565 lowers the RING line and begins its command sequences. When the last command is completed, the MRC-565 sends an "E<cr>" command to the CR10X to put it back to sleep.

### 5.7.13 Setting/Reading CR10X Internal Registers

The CR10X has internal registers that are used to hold data while it is being manipulated prior to being output to final storage memory. The MRC-565 can read these registers using local or remote commands and transmit the contents back to the originator of the remote command. In addition the contents of the registers can be changed via remote command. This capability allows the CR10X internal program to access a register value as a parameter that can be changed remotely. Some uses might include controlling switches, motors, software options, final storage update rate, input scan rate, etc.

To read a register use the command **CR10X,REGISTER,N** where "n" is the register number. The result will be displayed as follows:

```
+cr10x,register,1 01/08/99 10:42:37
[+12.355 ]
```

The current value in the register is shown within the square brackets.

To change a register use the command **CR10X,REGISTER,N,XXXX** where "n" is the register number and "XXXX" is the new contents in decimal or "0xHHHH" is the new contents in hexadecimal. The following example shows the old value in square brackets followed by the new value.

```
+cr10x,register,1,10.4 01/08/99 10:42:49
[+12.355 ] +10.400
```

Reading CR10X Internal Pointers and Error Statistics:

The **CR10X,STAT** command will read and display the CR10X internal pointers and error counters. The following example shows the response format:

```
+cr10x,stat 01/08/99 10:39:44
R10185 F62262 V3 A1 L10151 E00 02 00 M0256 B+3.1117 C2858
MRC-565A DPTR:08219 008 09:42, CR10X Start:007 04:09 End:008 10:39
```

The first line of the response is the "A" command response from the CR10X. It shows "R"xxxx the current data pointer, "F"xxxx the number of filled memory locations, "A"xx the storage area number, "L"xxxx the last modem pointer, "E"xx xx xx error statistics, "M"xxxx memory size, and "B"xxxx internal battery voltage. The "C"xxxx is a checksum value and not otherwise useful.

The second line is the MRC-565 current data pointer value, the Julian day and time (hr:mn) of the report at that location, the day and time of the oldest and newest report in the CR10X Final Storage memory. The values on this line depend on the format of the data arrays having the Julian day and time in the first two sensor locations as discussed in the "Time Tagging" paragraph above.

Resetting CR10X Internal Error Statistics:

The **CR10X,RESET** command will zero the CR10X internal error counters.

```
+cr10x,reset 01/08/99 10:41:48
R10253 F62262 V3 A1 L8219 E00 00 00 M0256 B+3.1117 C3042
MRC-565A DPTR:08213 008 09:42, CR10X Start:007 04:11 End:008 10:41
```

This format is the same as for the **STAT** command shown above. Note that the error counter has been zeroed.

#### 5.7.14 Entering CR10X Security Codes

The CR10X uses security codes that are set up within the source code of the stored program. When these are included in the source code, and their values are non-zero, then access will be inhibited as described in section 1.7 of the CR10X Operators Manual. Of the 3 codes used, the MRC-565 needs code 1 and 3. Code 1 inhibits downloading and uploading operations, while code 3 inhibits all telecommunications operations except those required to allow setting up a connection to the CR10X. To enter the codes, use the command

**CR10X,SECURITY,XXXX,YYYY,ZZZZ**

Where *xxxx* is code 1, *yyyy* is code 2 and *zzzz* is code 3.

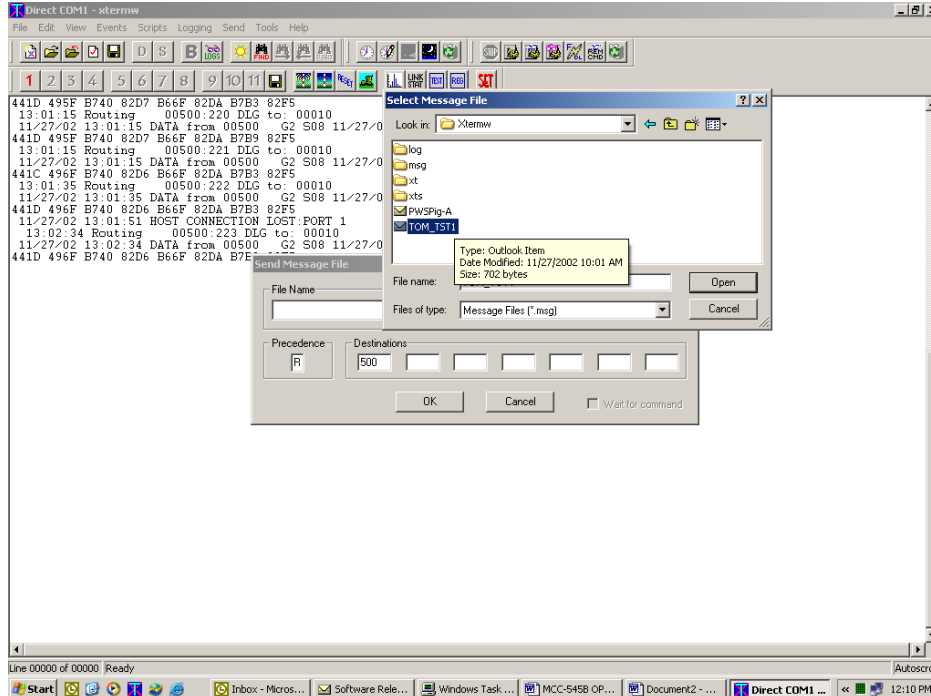
#### 5.7.15 Downloading a CR10X .DLD Program

A new or revised CR10X internal program can be transmitted to an MRC-565 which will then download it to the CR10X and tell the CR10X to compile and run it. The program source, in ".dld" format must be copied into a message (or multiple messages if longer than 3500 bytes) that starts with "**\$CR10X,DOWNLOAD,**" as the first 16 characters is the message fragment. Note: the last character must be a comma following the message fragment identifiers. Do not forget to use caps on all letters and to include the comma after **DOWNLOAD**. You should edit the .DLD files to remove all unnecessary information in order to reduce the size of the message as much as possible. Any program lines preceded with a ";" are comment lines and can usually be eliminated.

Following is the procedure to download a ".dld" file into the CR10X using XTERMW.

You can use Base/Master Station to send this file to the Remote Station, or you can connect to the Operator Port (MNT) directly to the Remote Station.

1. Modify the ".dld" file to start with "**\$CR10X,DOWNLOAD,**"
2. Save the ".dld" file as ".msg" file, which starts with "**\$CR10X,DOWNLOAD,**" .Go
3. "Send" and to "Message File..."
4. Enter the destination ID, Browse to the desired ".msg" file and click Open



The maximum message file length including the 16 character header must be no greater than 3500 characters. If the file length is larger than this, it can be reduced in length by editing it to remove comment lines and blank lines, or use XTERM DOS Version for larger files. (XTERM DOS can be obtained MRC upon request.) When an MRC-565 with a device driver assigned to the CR10X receives the message in this format it will be sent to the CR10X, compiled, and begin executing. A status message will be returned to the unit that originated the download message indicating whether the compilation was successful.

If the program is different than the previous program, the memory in the final storage area will be deleted, otherwise it will be left untouched. Refer to the Campbell Scientific documentation for details on exactly when the data is deleted or not.

### 5.7.16 Replacing an MRC-565 to an Operational CR10X

When an MRC-565 is connected to a CR10X that has been previously collecting data, the data pointers in the MRC-565 must be set to the current data point in the CR10X. If this is not done, the MRC-565 pointers will begin retrieving data from location 1 in the data logger. If this is not done then the data retrieved will either be all the data collected since installation or the data at the time the CR10X memory last filled and rolled back to re-use memory from location 1.



1. Before connecting the MRC-565 data cable to the CR10X, enter the **CR10X,INTERVAL,OFF** and **CR10X,MAXQ,1** commands to disable the automatic data acquisition.
2. Connect the MRC-565 data cable to the CR10X, then enter the **CR10X,STAT** command to read the current pointer from the CR10X.

```
+CR10X,STAT 03/27/04 14:11:48
```

```
R+2113. F+2112. V5 A1 L+2113. E00 00 32 M0256 B+3.1027 C2967
MRC-565A DPTR:1563 331 12:26, CR10X Start:331 10:04 End:331
13:15
```

This report will show the MRC-565 pointer (DPTR:) and the current and maximum CR10X pointer. It also shows the start and end dates for the data set in the CR10X. Note that it does not contain the year when the data was acquired. This is why we position the pointers using the actual pointers, rather than the data report date.

3. Enter the **CR10X,SETPTR,xxxxxx** command to set the pointer in the MRC-565 and the CR10X to the desired point Enter the **CR10X,STAT** command again to verify the pointers.
4. Return the Interval and Maxq settings to the desired values to begin automatic reporting, e.g. **CR10X,INTERVAL,60** and **CR10X,MAXQ,200**.
5. If it is necessary to recover data from the CR10X and automatically transmit it to the Host, follow the instructions in the following section.

### 5.7.17 Replaying Data from a CR10X

Data can be replayed from a CR10X by determining where the current data pointer is in the CR10X, calculating the approximate location of the start of the data to be replayed and then setting the pointer to that location. (Note: The MRC-565 and CR10X have commands for setting the pointer by date and time, but this only works if all the data in the CR10X is for the current year. If the CR10X cannot locate the proper data, you may lose control of the CR10X, Then, do NOT use these commands.)

To locate the position of the current data pointer, determine which master station the remote is reporting to and send a **CR10X,STAT** command to the remote. The remote command response will contain the current pointers (“R”) (Command responses will not be immediately received in a meteor burst system):

```
11/27/02 14:36:17 Command response received from 00500
#CR10X,STAT 11/27/02 14:36:10
# R+2377. F+2376. V5 A1 L+2377. E00 00 32 M0256 B+3.1027 C3003
# MRC-565A DPTR:2377 331 13:39, CR10X Start:331 10:04 End:331 13:39
```

To now replay the data, determine the current pointer and note the date and time of the pointer reading. Each site uses about 50 words of CR10X final storage per hour, therefore determine how many hours you want to move the pointer back. Multiply by 50 and subtract the result from the current point. Send the new pointer to the remote with the **CR10X,SETPTR,nnnnnn** command. The remote will send back the new pointer setting:

```
11/27/02 14:42:41 Command response received from 00500
#cr10x,setptr,2300 A1 L+2300 C0884
# 11/27/02 14:42:33 Completed
# 11/27/02 14:42:31
# R+292750. F+2453. V5 A1 L+2454. E00 00 32 M0256 B+3.1027 C2991
# MRC-565A DPTR:291200 331 13:33, CR10X Start:331 10:04 End:331 13:46
```

In this example, the pointer was set back from 292750 to 291200- about 31 hours.

**NOTE 1**

**2043 will report four groups hourly and will use about 70 words per hour.**

**NOTE 2**

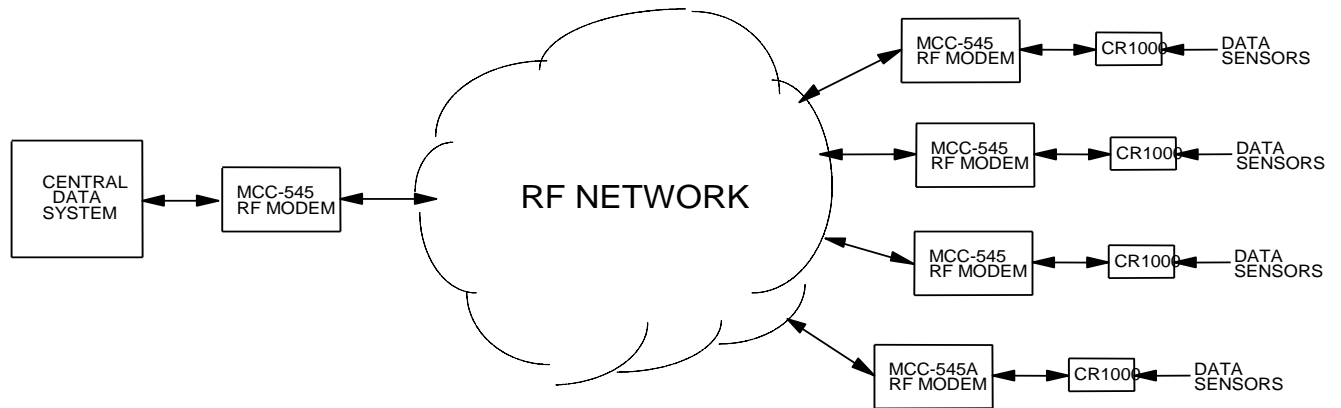
**If the pointer calculation goes negative the pointer has wrapped around. Add the maximum pointer value to the negative pointer ("F"?) to determine the proper value.**

## 5.8 CR1000 Data Logger

The MRC-565 Packet Data Radio (hereafter called the radio) can be used with the Campbell Scientific CR1000 data logger to transmit data from a remote site to a destination in a Meteor Burst (MB) or Line-Of-Sight (LOS) network. Because of the unique timing of a MB system, the radios do not provide a real-time connection between a CR1000 and a PC running a data collection program as a pair of dedicated phone modems would. The connection is a packet store-and-forward type instead.

Each CR1000 table data array recorded in the final storage is treated as a data logger packet by the radio. Packets are acquired by the radio from the CR1000, and delivered through the MB network to another relay radio or master station. The packets are then "printed" on one of the RS-232 ports, or Ethernet port at the destination unit in a format that is compatible with all the other supported data loggers.

In this type of system, the central data system does not "poll" each remote for its data. Instead, each remote radio gets the data from the locally attached CR1000 using an internal data acquisition schedule and CR1000 driver software module, then routes it to a particular destination. The radio's driver module uses the Campbell Scientific PakBus Network Layer and SerPkt serial port protocols to read the data from the CR1000 Tables. Data is reformatted into the SDATA and MBNET standard format for transmission. It is the responsibility of the central data system to store and process the data as it arrives from each remote site.



**Figure 8. Typical Data Acquisition System**

Because of the flexibility of both the CR1000 and the radio, several parameters must be setup to define the operation of the data acquisition process used to get data from the CR1000 to the radio RAM data transmit queues. The following sections show the configuration and control command structure as it relates to the CR1000 driver, and then discusses each command in detail.

The MRC-565 interface to the CR1000 using Campbell Scientific PAKBUS protocol. A PAKBUS ID must be assigned to the MRC-565 before communications can occur. You can assign the ID with the following command:

**PAKBUS,ID,nnn**

Where nnn is the ID. You can use any ID from 1-4095, but it must be different than the ID used for the CR1000. The CR1000 is typically programmed with ID = 1. To verify the MRC-565 ID enter the following command:

**PAKBUS**

The following data is returned:

PAKBUS 05/07/14 14:46:28

ID :nnn

Interval : 60

INF : 15

MyHop : 4

MyLstVer : 0

PakID IsRt Hops Port LinkState Sessions Age Modem IsCtl Isand BInt

### 5.8.1 CR1000 Driver Configuration Command Summary:

The following list shows the commands used to set up and configure the CR1000 data Logger drivers in the Packet Data Radios. Each command is detailed in the pages following.

CR1000	Display CR1000 configuration parameters
CR1000,ACQMODE,ALL	Get all reports since previous scan
CR1000,ACQMODE,CURRENT	Get only the current (last) data group
CR1000,ACQMODE,LAST,N	Get only the last 'N' data groups (backs up 'N' data groups from the last one)
CR1000,SETPTR, CR1000,SETPTR,DATE,TIME	Manual set up of last data pointer(s) in the RADIO. Set all data pointers to this Date and Time. DATE={mm/dd/yy} TIME={hh:mm}.
CR1000,SETPTR,RECORD,GROUP	Set GROUP data pointer to this RECORD number. GROUP = integer 1-16, RECORD = integer 0-4,294,967,295. Note: Use CR1000,STAT to determine valid groups and group record pointers.
CR1000,INT,N	Scan interval in seconds
CR1000,INT,OFF	Scan only when UPDT command is entered
CR1000,ORDER,FIFO	Get final storage data in FIFO order
CR1000,ORDER,LIFO	(not avail)Get final storage data in LIFO order
CR1000,GROUP,545	Not implemented. Group numbers come from CR1000 only.
CR1000,GROUP,CR1000	
CR1000,TIME,545	Use radios internal Time
CR1000,TIME,CR1000	Get time from CR1000 BMP-5 packet.
CR1000,MAXQ,NNN	Set maximum number of reports to queue for each GROUP in the CR1000.
CR1000,SCALE,CR1000	Not available. Scale sensors in CR1000 HEX only.
CR1000,SCALE,INT	
CR1000,STAT	Read and display CR1000 beginning, current and end group pointers and time stamps.
CR1000,SECURITY,1111,2222,3333	Enter CR1000 Internal Security Codes ( <b>Not Currently implemented</b> )
CR1000,MODEM ENABLE	Enable/Disable use of RI/ME control
CR1000,TSWATH,BEGIN,END,{TX}	Hole collection using date and time. This command Will set all group record pointers to the begin time Where: BEGIN = {mm/dd/yy,hh:mm} and END = {mm/dd/yy,hh:mm}. The optional TX, if ncluded, will transmit SDATA reports. Note: Use CR1000,STAT to determine valid date and time stamps.
I	
CR1000,TABLEDEF	Show current tables and fields that are programmed into the CR1000.
CR1000,GETTIME	Display current CR1000 date and time.

CR1000,STATUS,ALL  
 CR1000,STATUS,FIELD NAME

Displays all Status fields in list form.  
 Display CR1000 Status Table fields and values.  
 Where: FIELD NAME is a required parameter.  
 FIELD NAME, if included, will display value of the  
 named CR1000 Status Table field. Note: FIELD NAME  
 is an ASCII label of a variable in the table.

CR1000,PUBLIC,ALL  
 CR1000,PUBLIC,FIELD NAME,{xxx}

Displays all Public fields in list form.  
 Display CR1000 Public Table fields and values.  
 Where: FIELD NAME is a required parameter.  
 FIELD NAME, if included, will display value of the  
 named CR1000 Status Table field. Note: FIELD NAME  
 is an ASCII label of a variable in the table.  
 Xxx is an optional parameter. If it is used it will  
 Replace the original value of that public field.  
 If it is not used then the current value of the  
 Field will be displayed.

**Default Values**

Default values are set up to support systems already deployed in the field. These are defined to collect all data groups to be read each time the **UPDT** command is entered or scheduled in the radio. The time tag will use internal CR1000 date and time CR1000 table data arrays, scaling will be in CR1000 Hex format, transmission in FIFO order, group assignment by the CR1000 and the maximum queue depth will be 20. If connected to the CSI port, MODEM ENABLE must be "ON" for communication to take place directly between the radio and CR1000. If the RS-232 port is used then set CR1000, MODEM ENABLE, OFF.

The current values are viewed by entering **CR1000**<Enter> as shown in the following example.

```
+cr1000 09/26/05 09:21:28
ACQMODE      = ALL
INTERVAL     = OFF
ORDER        = FIFO
GROUP        = CR1000
TIME         = CR1000
MAXQ         = 20
SCALE        = CR1000
MODEM ENABLE = OFF
Table Name   Fields  Nsens  NumRecs  LastRec#  FirstRec#  Interval  Signature
Status       98    1208    1         0         0         0        3292
Group1       1     16     3280      0         0        120     D10D
Group2       1     16     3280      0         0        120     D4C5
Group3       1     16     3280      0         0        120     E83A
Group4       1     16     3280      0         0        120     ED CD
Group5       1     16     3280      0         0        120     5B49
Group6       1     16     3280      0         0        120     B453
Group7       1     16     3280      0         0        120     D629
Group8       1     16     3280      0         0        120     F9DF
Group9       1     16     3280      0         0        120     3332
Group10      1     16     3280      0         0        120     A325
Group11      1     16     3280      0         0        120     FE23
Group12      1     16     3280      0         0        120     B14B
Group13      1     16     3280      0         0        120     833E
Group14      1     16     3280      0         0        120     2896
Group15      1     16     3280      0         0        120     6D25
Group16      1     16     3280      0         0        120     99E4
Public       3      3         1         0         0         0        D9AE
```

+

### 5.8.2 Acquire Mode:

There are three modes used by the radios for controlling data acquisition from the CR1000. These are "ALL", "CURRENT", and "LAST,N".

The **CR1000,ACQMODE,ALL** mode will read all the data records in each Table, starting from the last location pointers set into the radio. This is useful where all the data for each site must be transmitted, not just the most-recent data. This mode lets the CR1000 gather data independently and lets the radio acquire and transmit the data as the MB RF Link permits. For example, the user might want the CR1000 to store data every hour, but have the radio acquire and transmit all of it at midnight, or have the radio acquire and transmit data as soon as possible. For each scan of final storage the radio will read as many data reports from each Table in the CR1000 as it can. The command **CR1000, MAXQ, NN** sets the maximum number of data reports to be acquired per scan. These limits are discussed below in the memory management paragraph.

The **CR1000,ACQMODE,CURRENT** mode will acquire and transmit only the last or most recent data record in each Table for every scan of the CR1000's final storage.

The **CR1000,ACQMODE,LAST,N** mode will read the last "n" data records from each Table each scan of the CR1000's final storage. This mode is useful when you want to be able to change the reporting interval remotely, and the CR1000 program cannot be modified. For example, you can setup the CR1000 program to record data every minute, but have the radio acquire the most recent data every hour. You can then change the radios acquisition scan timing to any interval from one minute to 24 hours without modifying the CR1000 program.

### 5.8.3 Data Retrieval Pointer Initialization

The normal data collection method is to set the pointers to the last or most-recent data record, then let the radio collect and transmit data whenever new data has been recorded into the CR1000 final storage. The pointers will also be set to the most recent data report if the radio resets. Power failures and subsequent recovery will leave the pointers where they were at the time of the failure and continue from that point in a 545B, but will be lost in a 565 radio.

The radio maintains an internal pointer for accessing each data Table in the CR1000. These pointers are accessed each time the radio requests data from the CR1000. The CR1000 records each data Table in a "circular ring buffer" and will reuse memory locations when the Table gets full. The size of each Table can be displayed using the CR1000 command. The size value uses the field name MAXRECORDS. It should be noted that the pointers increment from 0 - 4,294,967,294 but the "circular ring buffer" MAXRECORDS limit is a much smaller number. Any time stamps prior to the oldest, or beyond the newest of the actual records stored will not be valid.

The **CR1000, STAT** will display the start, current, end and time stamps pointers for each Table.

```
+cr1000,stat 02/21/14 15:46:33 Waiting...
```

-----First-----			-----Current-----			-----Last-----			
Grp	Date	Time	Record	Date	Time	Record	Date	Time	Record
01	02/21/14	13:00	00000000	02/21/14	15:00	00000003	02/21/14	15:00	00000002
02	02/21/14	13:00	00000000	02/21/14	15:00	00000003	02/21/14	15:00	00000002
03	02/21/14	13:00	00000000	02/21/14	15:00	00000003	02/21/14	15:00	00000002
04	02/21/14	13:00	00000000	02/21/14	15:00	00000003	02/21/14	15:00	00000002
05	01/01/90	00:00	00000000	01/01/90	00:00	00000000	01/01/90	00:00	00000000

The **CR1000, SETPTR, DATE, TIME** command is used to control where the next data will be read from the CR1000 Final Storage using a date and time stamp value. The **DATE** and **TIME** parameters must be within the start and end pointers time stamp boundaries. For instance, assume the Table data record pointer is pointing at the last record entry which happens to be 3000. The user can not, in this example, set the pointer to a number larger than 3000, or cannot set the date/time values to a time beyond the time stamp of the last record. The **CR1000, SETPTR, DATE, TIME** command will search through the CR1000 Final Storage memory and set the pointer to the first data array that is equal to or greater than the given date and time. The search will take a few seconds to locate the desired data point.

The **CR1000, SETPTR, XXXX, G** command allows the operator to set the pointer to a numerical location where **XXXX** is a record number and **G** is a group number (1-16). This may be known, or can be read using the **CR1000, STAT** command. (545B Radios Only)

#### 5.8.4 Data Retrieval Hole Collection

Data retrieval “hole” collection refers to the process of collecting data that was missed during the normal operation of data acquisition. For example, if several data reports were missed last week, they can be retrieved without having to retransmit all of the data from the missing data to the present time. The “hole” is referred to as a “swath”. There are two commands for this purpose. One command is used to specify the swath in terms of date and time, and the other command specifies the swath in terms of record numbers in the final storage. The random data “hole” collection process does not interfere with normal sequential data collection.

The **CR1000, TSWATH, BEGIN-DATE-TIME, END-DATE-TIME, {TX}** command is used to specify a time-swath. The begin and end times are each given as both a date and time. For example, the command, **CR1000, tswath, 12/01/02, 00:00, 12/01/02, 12:00, TX** will collect and transmit all data records for all tables from midnight to noon on 12/01/02. The optional **TX** indicates the data is to be transmitted. If the **TX** is omitted the data will be displayed on the maintenance port but not transmitted.

#### 5.8.5 Update Interval

The command **CR1000, INTERVAL, N** sets up the number of seconds between scans for data from the CR1000 final storage. If **N** is set to **OFF** then the radio internal **SCHED** command can be used to schedule **UPDT, TX** commands at any particular time or interval. If **N** is set to a number from 1 to 32767 seconds, an internal timer triggers an **UPDT, TX** type of action to scan

the final storage at the desired interval. The interval is synchronized with time-of-day so that an interval of 10 seconds (for example) falls on 0, 10, 20, 30, 40, 50 seconds of each minute. The interval can be set more often than data is recorded in the Final Storage and if there is no new data since the last scan, nothing will get queued for transmission.

### 5.8.6 Transmission Order

The order of transmission is currently limited to FIFO, but provision has been made for a later version to support LIFO.

### 5.8.7 Group ID Assignment

The group number is calculated from the order that the Data Tables are created inside the CR1000 Basic program. The first Table defined is group 1, the second Table is group 2, etc. There can be up to 16 Data Tables, and each Table can have up to 16 sensors. The sensor values must be limited to 16 bits each. The CR1000 Basic program should use FP2 or UINT2 as the data type for each sensor.

### 5.8.8 Time of Day

To send the radio time to the CR1000 enter (or schedule) an **UPDT, TIME** command. The time update does not automatically happen when a time probe is received from the master station, as it might cause a skip in the data acquisition cycle. The **UPDT, TIME** should be scheduled to happen at a convenient time of day or interval using the radios **SCHED** command so data will not be lost if the time advances or retards across an acquisition interval. If the time update is more than +/- two minutes from the current CR1000 time then a time-resync message will be transmitted to the default destination.

### 5.8.9 Time Tagging

The time tag assigned to each group report can be taken from the RADIO internal date and time as the data is read, or it can use a CR1000 internal time stored in the data table. Use of the CR1000 internal time is the normal option. Each record of each data table record is time-tagged with a unique data and time tag. If the radios time is used, the date and time from the table will be ignored, and the actual radios local time (at the moment of readout from the CR1000) will be used.



### 5.8.10 Memory Management

Each time the radio reads data from the CR1000, it saves the last data pointer accessed in the CR1000's Final Storage RAM. This is used at the next scheduled update interval to get the next data values without missing data.

If there is no new data recorded in the Final Storage area when the radio scans then nothing is transmitted. The radio will try again at the next interval. The interval can be set from 1 to 32767 seconds. A good typical value to use is 30 seconds.

The radio limits the amount of data read from the CR1000 to prevent overflowing its' transmit memory queue. Each time a group is read, the available memory is checked, and if it goes below 600 Queue blocks, the radio will stop reading data from the CR1000 until the next scan interval. As data is transmitted memory will get freed up for the next scan interval. In addition, the radio is limited to a maximum of 200 messages at a time because of the way it assigns message numbers to each message. These are limited from 1-200, and cannot be duplicated.

The **CR1000, MAXQ, N** setting is used to limit the number of group reports input to be less than or equal to a set limit. For example, if **MAXQ** is set to 20, each scan will read enough to bring the total to 20 group reports.

### 5.8.11 Data Scaling

Two data formats are supported and must agree with the setup of the internal CR1000 program. Only the low-precision format is currently supported. The **CR1000,SCALE,CR1000** option will use the Campbell Scientific floating point format and assumes the sensors are calibrated in engineering units within the CR1000.

The **CR1000,SCALE,INT** format assumes each sensor is calibrated in integer mV, and formats the data in 2's complement integer Hexadecimal format by truncating the fractional part of the floating point number. Example: CR1000 outputs 103.7, the radio truncates it to 103, then converts it to hex 0067. The value -103.7 will be converted to hex FF99. The CR1000 maximum low-precision values use 13 significant bits where +6999 is converted to hex 1B57 and -6999 is converted to hex E4A9. The radio uses 16 bits for each sensor data value.

### 5.8.12 Modem Enable

For applications that require very low power, the CR1000 can go to sleep between operations. By default the use of the ME line is turned ON and the RING line must be pulled high to wake up the CR1000. This mode is enabled in the radio by the command: **CR1000, MODEM ENABLE,ON**. When the radio wants to communicate with the CR1000, it raises the RING line, and waits for the CR1000 to raise the ME line. The ME line must be tied to the RTS line of the radio. Once the ME line is high the radio lowers the RING line and begins its command sequences. When the last command is completed the CR1000 goes back to sleep.

When a CR1000 is connected to other CS-I/O-enabled devices, it will be necessary to use an interface adapter available from CSI, such as the SC105. This device manages the RI/ME lines internally, so this option must be turned off in the radio using the command:

**CR1000, MODEM ENABLE, OFF.**

### 5.8.13 Reading CR1000 Internal Pointers and Error Statistics

The **CR1000,STAT** command will read and display the CR1000 internal pointers and error counters. The following example shows the response format:

```
+cr1000,stat 09/22/05 09:06:20

  /-----First-----\ /-----Current-----\ /-----Last-----\
Grp  Date   Time   Record  Date   Time   Record  Date   Time   Record
===  =====  =====  =====  =====  =====  =====  =====  =====  =====
  01 08/19/05 09:19 00000000 09/22/05 09:06 00047490 09/22/05 09:06 00047489
+
```

### 5.8.14 Displaying Status Table Data

Data in the Status Table can be displayed, but cannot be “set”. To display a single value in the Status Table, use the command: **CR1000, STATUS, field-name**.

Example:

```
+CR1000,STATUS,OSVERSION 02/23/14 12:27:11 CR1000.Std.26.2013.08.27.02
```

To display a list of all status values, use the command **CR1000, STATUS, ALL**.

Example:

```
+cr1000,status,all 02/23/14 11:09:56 Waiting...
OSVersion          CR1000.Std.26.2013.08.27.02
OSDate             130827
OSSignature         56366
SerialNumber        51256
RevBoard            019.008
StationName         51256
PakBusAddress       1
ProgName            CPU:CR1000.CR1
StartTime           2D68A731:01312D00
RunSignature         50227
ProgSignature        9141
Battery             12.03465
PanelTemp           26.46690
WatchdogErrors      0
LithiumBattery       3.45162
Low12VCount         0
Low5VCount          0
CompileResults      CPU:CR1000.CR1 -- Compiled in SequentialMode.

StartUpCode         0
```

## OPERATIONS

ProgErrors	0
VarOutOfBound	0
SkippedScan	0
SkippedSystemScan	0
ErrorCalib	0
MemorySize	4194304
MemoryFree	8284
CPUDriveFree	479744
USRDriveFree	0
CommsMemFree	9251505
FullMemReset	0
DataTableName	Tb11
SkippedRecord	0
DataRecordSize	43715
SecsPerRecord	3600.00000
DataFillDays	1821.45837
CardStatus	No Card Present.
CardBytesFree	-1.00000
MeasureOps	139
MeasureTime	28800
ProcessTime	40716
MaxProcTime	6093450
BuffDepth	0
MaxBuffDepth	0
LastSystemScan	2D6B396C:00989680
SystemProcTime	5355
MaxSystemProcTime	5985
PortStatus	00000000
PortConfig	Input
SW12Volts	00000000
Security	0
RS232Power	00000000
RS232Handshaking	0
RS232Timeout	0
CommActiveRS232	FFFFFFFF
CommActiveME	00000000
CommActiveCOM310	00000000
CommActiveSDC7	00000000
CommActiveSDC8	00000000
CommActiveCOM320	00000000
CommActiveSDC10	00000000
CommActiveSDC11	00000000
CommActiveCOM1	00000000
CommActiveCOM2	00000000
CommActiveCOM3	00000000
CommActiveCOM4	00000000
CommConfigRS232	4
CommConfigME	4
CommConfigCOM310	4
CommConfigSDC7	4
CommConfigSDC8	4
CommConfigCOM320	0
CommConfigSDC10	4
CommConfigSDC11	4
CommConfigCOM1	0
CommConfigCOM2	0
CommConfigCOM3	0
CommConfigCOM4	0
BaudrateRS232	-9600
BaudrateME	-9600
BaudrateSDC	115200
BaudrateCOM1	0
BaudrateCOM2	0

```

BaudrateCOM3          0
BaudrateCOM4          0
IsRouter              00000000
PakBusNodes           50
CentralRouters        0
BeaconRS232           0
BeaconME              0
BeaconSDC7            0
BeaconSDC8            0
BeaconSDC10           0
BeaconSDC11           0
BeaconCOM1            0
BeaconCOM2            0
BeaconCOM3            0
BeaconCOM4            0
VerifyRS232           0
VerifyME              0
VerifySDC7            0
VerifySDC8            0
VerifySDC10           0
VerifySDC11           0
VerifyCOM1            0
VerifyCOM2            0
VerifyCOM3            0
VerifyCOM4            0
MaxPacketSize         1000
USRDriveSize          0
TCPPort               6785
pppInterface          0
pppIPAddr             0.0.0.0
pppUsername
pppPassword
pppDial
pppDialResponse       CONNECT
IPTrace               0
Messages
CalGain               0.00000
CalSeOffset           0
CalDiffOffset         0

```

### 5.8.15 Displaying and Setting Public Table Data

To display a single value in the Public Table, use the command: CR1000,PUBLIC,field-name.

#### Example:

```
+CR1000,PUBLIC,PROGVER 02/23/14 12:33:27 308.10001
```

To display a list of all status values, use the command CR1000,PUBLIC,ALL.

#### Example:

```
+CR1000,PUBLIC,ALL 02/23/14 12:31:02 Waiting...
Flag                00000000
PROGINIT            1.00000
PROGVER             308.10001
BATT                12.03430
PRECIP              0.00000
TB_TOTAL            0.00000
AIR_TEMPC           -94.36020
SOLAR               0.00000
WIND_SPD            0.00000
```

WIND_DIR	-nan
RH	100.00000
BARO_PRES	-1.67392
ENCL_RH	-43.71719
BARO_HG	8.62277
LBatt	0.00000
CSI_R	308.10001
DEW_PT	-37.50831
SVP	0.02434
PVP	0.02434
Sthpv	-nan
NetRad	8.51829
NetRad_cor	8.51829
WS_MS	0.00000
Scratch1	0.00000
Scratch2	0.00000
Scratch3	0.00000

### 5.8.16 Downloading a Program

A new or revised CR1000 internal program can be transmitted to a radio which will then download it to the CR1000 and tell the CR1000 to compile and run it. The program source, in ".CR1" format must be copied into a message (or multiple messages if longer than 3500 bytes) that starts with "\$CR10X,DL,xx,yy," as the first 18 characters followed by the source text. "xx" is the message fragment sequence number with a leading zero and "yy" is the total number of fragments with a leading zero. Note: the last character must be a comma following the message fragment identifiers. The "\$CR10X" type string must be used even though the actual data logger may be either a CR10X or a CR1000. The radio software will handle the download in the proper way for whichever logger is ASSIGNED to the port at the time.

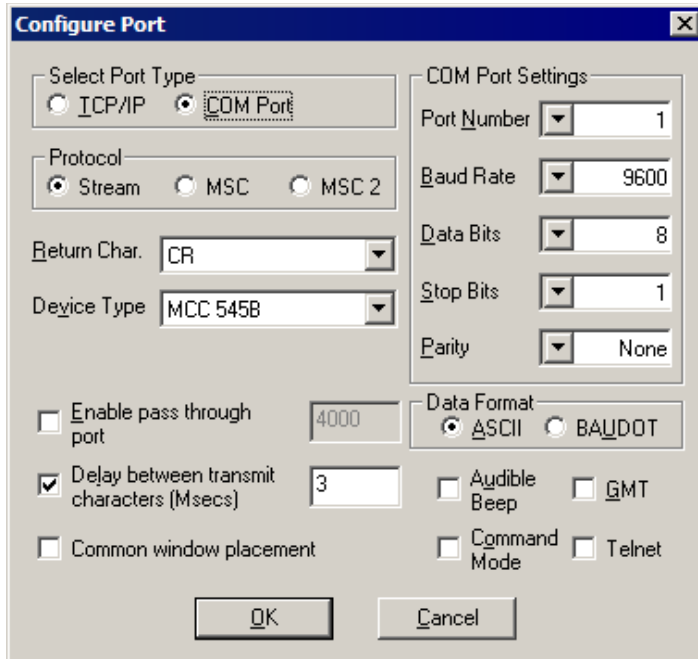
The maximum message file length including the 18 character header must be no greater than 3500 characters. If the file length is larger than this, it can be reduced in length by editing it to remove comment lines and blank lines, or made into multiple fragmented messages. When a radio, with a device driver assigned to the CR1000, receives the message in this format the message will be sent to the CR1000. The CR10TD will compile the new program and begin execution. A status message will be returned to the unit that originated the download message indicating whether the compilation was successful or not.

#### **WARNING:**

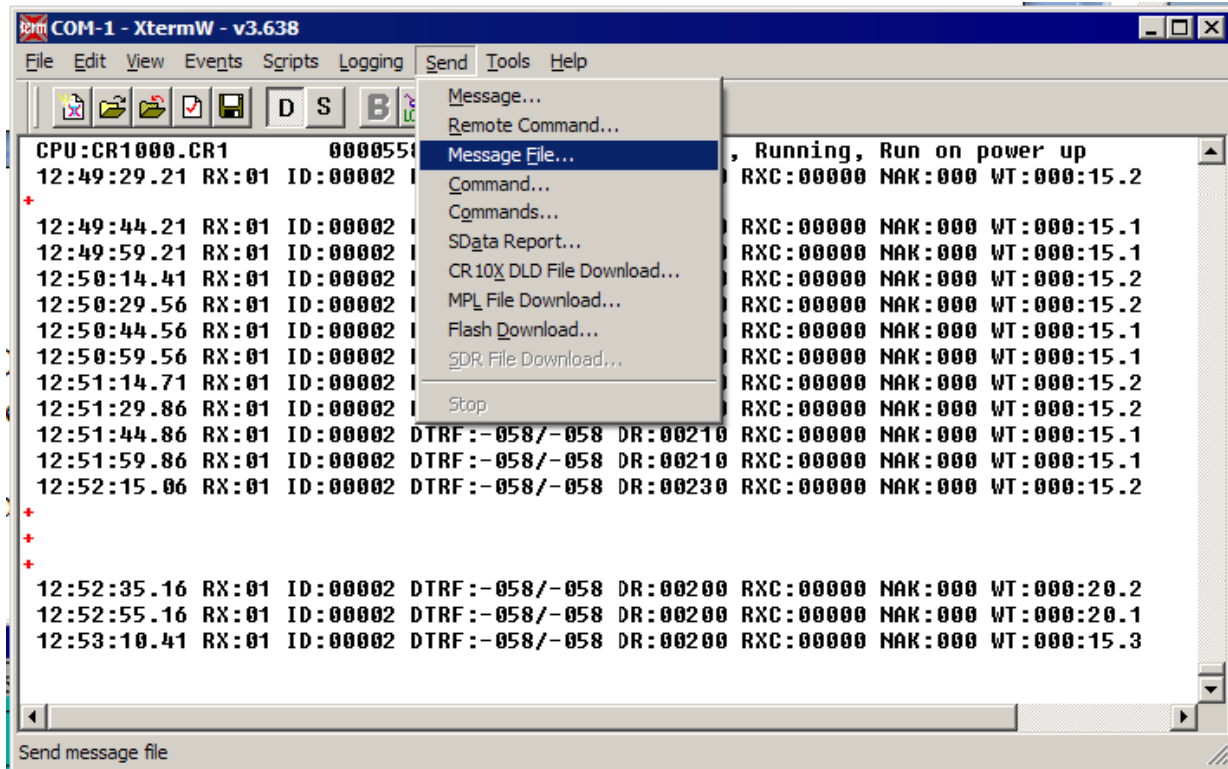
The 565 radio software does not have a way to get the filename from Xtermw at the time of the download so there can only be one program in the data logger memory at a time. Its name will be "CPU:CR1000.CR1" by default. When the program is downloaded all of the previous final storage data records will be deleted. This must be done to ensure the data records exactly match the table definitions of the new program, and there is no easy way to determine whether the tables are the same or not from the source code at the time it is downloaded.

If Xtermw is used to send the message file, each fragment's filename must use the ".MSG" extension. The Xtermw main popup menu can send the file using the "Send/Message File" menu option. Xtermw also has a "CR10X FILE DOWNLOAD" option in the "SEND" menu that should NOT be used because most versions of Xtermw do not properly operate that transaction.

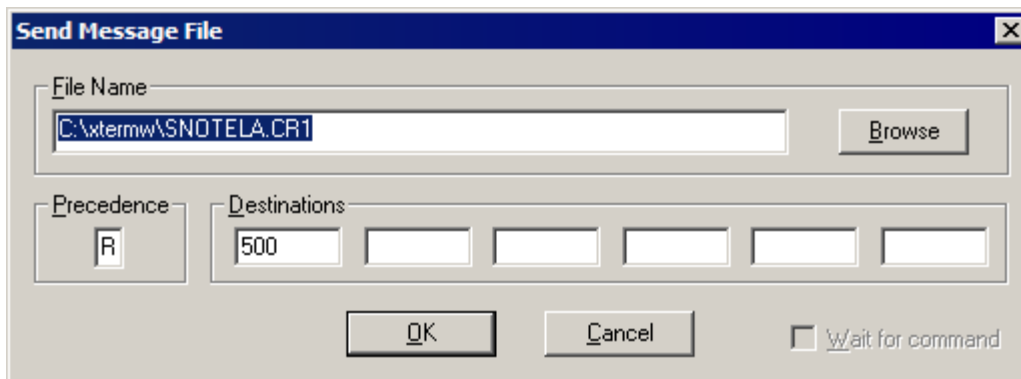
Before starting a download be sure to set some delay between characters in the connection configuration settings dialog box. In the box below this is checked and set to “3”. Failure to do this can cause corruption in the file or script to be downloaded.



The following screen image shows the popup window to get to the file selection point when sending a ".MSG" file.



The Send Message File window will pop up next.



Use the “Browse” button to navigate to the desired file name or type in its path directly. Enter a message priority “A – Z” and the ID of the radio. Click on “OK” to send the message. If the file was fragmented into more than one piece, be sure to send the pieces in proper sequence.

The radio ID in the Destination field must be set to a valid ID. This can be the radio that Xtermw is connected to, or it can be a remote radio with Xtermw connected to a Base. Each message will be routed to the destination radio and when the last message fragment arrives, that destination radio will delete the old file and data tables, then download the new file and launch the new program. The radio will create a return message to the sending radio that indicates success or failure of the download.

For example:

02/21/14 12:22:05 Command response received from 00500  
 # 02/21/14 12:19:54 CPU:CR1000.CR1 Downloaded to PakID:00001 OK

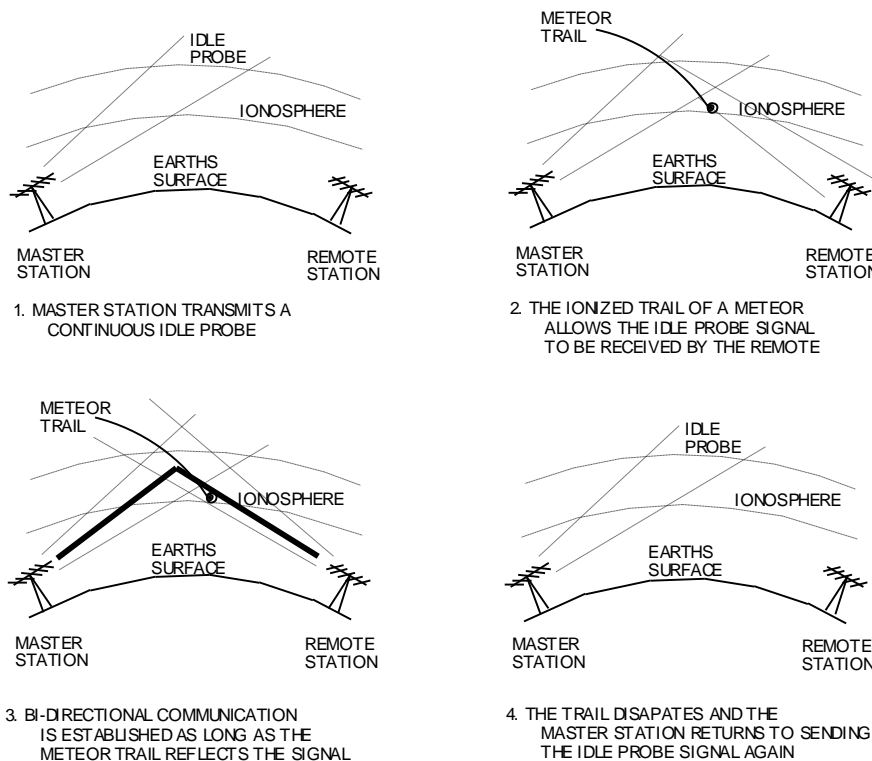
Note that the PakID is the ID of the data logger attached to the destination radio.

### 5.9 SDI-12 Sensors

Support for collecting data from sensors using the SDI-12 protocol is described in this document in three sections. These are:

1. Data Collection
2. Data Logging
3. User Interface.

The MRC-565 (hereafter referred to as the radio) is a data radio whose primary use is as a telemetry modem that acquires data from data loggers or sensors and transmits that data to a Host Data System using the Meteor Burst RF Link protocol. The Meteor Burst link protocol uses ionized air molecules in the Ionosphere to re-transmit radio signals beyond Line of Sight.



Legacy Systems have used the CSI CR10X and CR1000 Data Loggers as the interface to all sensor devices. The radio periodically polls the data logger for any new data and then transmits it to a Master Station radio as the meteor trails randomly allow a communication path. The data logger's record the data making it possible to remotely interrogate them for collecting data reports if they are not stored in the central data system for some reason.



The radios can have SDI-12 sensors directly connected offering the possibility of eliminating the data loggers in locations where the source-point data logging requirement is not required.

### 5.9.1 Data Collection

The data collection process usually requires a smart processor to connect to each data logger and extract the recorded data. In many cases the data loggers have the required software to access sensors and perform the calculations to convert the reading into engineering data values. Sensor development has led to devices that do their own data calculations and use the simple SDI-12 protocol to send that data to data recorders.

The MRC-565 radio can collect data from SDI-12 sensors then transmit it to the central data system. This is usually done on a periodic basis, every hour for example. The radio organizes the data measurements into message packets called Sensor Data (SDATA) Reports for transmission to a master station. Each SDATA report can hold from 1 to 16 data values of 16 bits each. These can be in integer (hex) or CSI-Floating-point format. Each SDATA report has a unique group number (0-15) and data/time tag. The 565 radio can hold up to 200 of these group reports while waiting for meteor trail communication opportunities to deliver them to the master station, or during brief network outages.

### 5.9.2 Setup

This section gives a general description of how the radio's commands are used to adapt the radio to the SDI-12 paradigm used by the sensors. The User Interface section below gives the details of each radio command.

The radio commands define a Sensor Definition Table and create a data collection and transmission schedule. The SDI-12 protocol is used to give the radio control of and access to the sensors and their data measurements. The sensors also require commands to configure and calibrate them. The sensor setup will be described by the documentation provided by each Manufacturer and is not discussed here.

The Sensor Definition Table is built in the form of a two dimensional matrix with rows and columns. There is a row for each unique combination of sensor-address and SDI-12 command type, and columns for selecting the SDI-12 command and expected number of measurements.

Data Collection ID	Sensor Address	Data Set Name	SDI-12 Command	Number of Values
1	0	Weather	M1	7
2	0	Rain	M2	3
3	1	Moisture	M	5
4	2	Snow Pillow	M	4

**Figure 9. Example Sensor Table**

Some sensors will output several measurements with one SDI-12 command. Others can, or will, require several SDI-12 commands to collect all of the data measurements. The extended SDI-12 commands can be used to collect some particular measurements that are specific and pertain to different features or capabilities of that sensor. The transparent mode will be used to control and configure sensors.

When one sensor has several sets of data that require different SDI-12 commands to access, it will be necessary to use the same sensor address in several rows of the table as in row 1-2 of the example table. The row number becomes the collection ID for data collection and reporting purposes. The columns of each row are configured parameters to define a sensor address, a data set reference name, SDI command required and number of expected measurements.

The **SDI, SEN, ID, ADDR, MTYPE, NVAL** command creates the table rows.

The **EVENT, GROUP, N, SDI[R:M], SDI[R:M], SDI[R:M]...** command “maps” which data values in the Sensor Table are to be combined into each SDATA group message. The number ‘N’ is the group number (1-16).

Each parameter following ‘N’ is a data value ID. There can be from 1 to 16 data values. The data values can be pre-defined radio values (see radio HELP,EVENT command) or they can be SDI-12 sensor measurements.

Using the pre-defined name of SDI[] in the command will specify a row [R] and measurement number [M]. For example SDI[3:2] specifies row 3 and measurement 2. In this way, any measurement can be reported in any group number and slot. There can be up to 16 groups with 16 values each for a total of 256 values per radio (or data collection site). The format of the group SDATA reports are exactly the same as those created for data logger sites. Both data logger reports and SDI sensor reports can be created for one site, but the total is limited to 16 groups and the data groups can not contain SDI measurements and Vice Versa.

As an example we could define two group SDATA reports from the Example Table:

```
EVENT, GROUP, 1, SDI [1:1], SDI [1:2], SDI [1:3], SDI [1:4], SDI [1:5], SDI [1:6], SDI [1:7],
SDI [2:1], SDI [2:2], SDI [2:3]
```

```
EVENT, GROUP, 2, SDI [3:1], SDI [3:2], SDI [3:3], SDI [3:4], SDI [3:5], SDI [4:1], SDI [4:2],
SDI [4:3], SDI [4:4]
```

After the Sensor Table and Group definitions are completed, they are saved in the configuration Flash Memory with all the other radio setup command parameters.

### 5.9.3 Periodic Data Collection

After the Sensor Table is set up, a schedule needs to be created to tell the radio when to collect the data and when to build and transmit the SDATA reports.

A data collection command is periodically scheduled which uses the row number to trigger the collection of data for that row. The data measurements that are returned by the sensor are stored in the sensor table. Up to 64 measurements for each row can be stored.

The **SDI, COLLECT, 1, 2, 3, 4, ...** command triggers data collection for all the rows in that command. Once all the data is collected and stored in the table for one SDI, COLLECT command the radio can go to the next scheduled command. There can be several commands scheduled to collect all the data for each reporting interval.

Following the data collection commands, the commands to build and transmit each SDATA group report are scheduled. This is the **EVENT, UPDT, G** command where 'G' is the desired GROUP number.

The schedule is also saved in the radios configuration Flash memory. An example for our Sensor Table might be:

```
SCHED, INTERVAL, 1:0:0, SDI, COLLECT, 1, 2, 3, 4
SCHED, INTERVAL, 1:0:0, OFFSET, 15, EVENT, UPDT, 1
SCHED, INTERVAL, 1:0:0, OFFSET, 15, EVENT, UPDT, 2
```

This will repeat every hour and take up to 15 seconds to collect the data, then create the SDATA reports.

To summarize: (1) the Sensor Table and Groups are defined, (2) the schedule commands are created, (3) this is SAVE'd in the configuration Flash memory, and (4) the radio periodically collects and then transmits the data to its Master station.

#### 5.9.4 Data Logging

The 565 is not a data recorder, but does have the ability to log trace files. A USB memory stick can be plugged into the front of the 565 and set up to log the maintenance port trace output. This will log all the SDATA reports as they are created. The USB device can be exchanged for a new one when it is filled. The USB device can then be delivered to the Customer for data analysis. The USB device has a DOS 6.2 file format with a new log file for each day. The user will have to provide software to extract the data from the log files.

The 565 cannot look back in this file in real-time to re-transmit old SDATA reports as of the initial software release, but that could be implemented in the future if/when required.

#### 5.9.5 User Interface

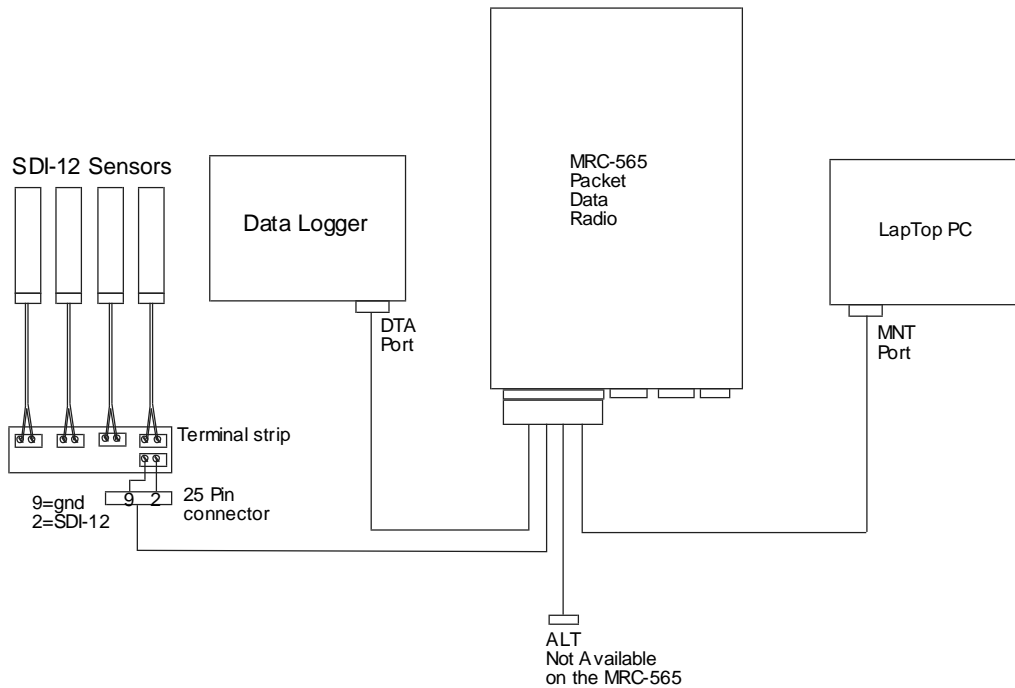
The MRC-565 has a RS-232 communication port for local user interface. If the breakout cable is supplied, the 9-pin connector labeled "MNT" is the correct port. A direct connection to the front panel of the MRC-565 USB connector can be used with a proper USB/RS-232 adapter cable.

A terminal server program, such as XTERMW.EXE provides a text-based operator command interface to the radio Operating system. The commands required to operate the SDI-12 capability are documented in the next section. There is a HELP command to list all commands, then the HELP,xxxx command will give a brief description of each (xxxx) command.

A “transparent” user command is provided to let users configure their sensors if that is required. This command takes any command format and passes it to a sensor on the SDI-12 line. The first character of the command is the sensor address.

See the SDI,CMD,xxxx... command in the next section. This capability gives a technician the ability to visit a site and perform some (maybe not all) diagnostic operations without disconnecting a sensor or using the sensor Manufacturers software to communicate with the sensor.

Since all user commands are also capable of being sent from the central host system to any radio in the network, these commands can provide some unscheduled manipulation and status interrogation of the SDI-12 sensors. In a Meteor burst system the use of remote commands may require additional software such as XTERMW.EXE, DATACENTER.EXE or DDD.EXE. These are documented elsewhere.



**Figure 10. Test Bench Connection Diagram**

**5.9.6 MRC-565 Commands**

The following commands are used with SDI-12 Sensor data collection. The setup commands are listed first followed by the control and status type real-time commands.

**5.9.6.1 SDI**

Show the Sensor Table settings and values.

**5.9.6.2 SDI, SEN, N, ADDR, NOMENCLATURE, MTYPE, NVAL**

Define a Sensor Table entry where:

- N entry or Row number (1-64)
- ADDR Sensor address (0-9) or (A-Z) or (a-z)
- Nomenclature 18 character Text name for this entry
- MTYPE Measurement Type (M or M1-M9 or MC or MC1-MC9)  
(C or C1-C9 or CC or CC1-CC9)
- NVAL Maximum number of values returned

Example setup script:

```
+SDI, DEL, ALL
+SDI, SEN, 1, 0, Measurement, M, 9
+SDI, SEN, 2, 0, Concurrent, C, 9
+SDI
Sensor Definitions
Num ADDR Measurement Name MTYPE NVAL
==== =====
1 0 Measurement M 9
2 0 Concurrent C 9
```

+

**5.9.6.3 SDI, SEN, DEL, ALL**

Deletes all of the entries in the Sensor Table. This is used in script files where a new script is being loaded. If this is not done first then there may be residual data or definitions that were not meant to be there.

**5.9.6.4 SDI, SEN, DEL, N**

Delete only entry 'N' from the Sensor Table. All other entries are left untouched.

### 5.9.6.5 EVENT, GROUP, GN, SDI[1:1], SDI[1:2], SDI[1:3]...

Define a new Event Group or replace the old Event Group with this GN where:

GN	New Group number (1-16)
SDI[x:y]	Each entry specifies which Sensor Table entry (x) and which measurement number (y) (1-64) to record in that slot of the SDATA message. There is a maximum of 16 slots in each SDATA message. They will be formatted as 16-bit CSI floating point numbers.

Example: EVENT,GROUP,1,SDI[1:1],SDI[1:2],SDI[1:3]<CR>

### 5.9.6.6 SDI, COLLECT, 1, 2, 3...

This command triggers the data collection of each Sensor Table entry listed as a parameter. Up to 10 sensor table numbers can be given in each command. The command processing will scan the table and immediately collect all type 'M' sensor measurements if finds. It will start all type 'C' concurrent measurements it finds then wait for them to complete, and finally collect the data from the sensors. All the data collected is stored in the Sensor Table rows for the given sensors and can be viewed with the SDI command.

### 5.9.6.7 EVENT, UPDT, G

The EVENT, UPDT command runs the SDATA group building function for the G group number given. One SDATA group report is created for each UPDT command. The SDATA builder extracts data from the Sensor Table. This command should be scheduled after the COLLECT command has completed gathering all the sensor data. The data measurements remain in the table and can be looked at or transmitted again without updating if that is appropriate for the particular sensor.

### 5.9.6.8 SCHED, I, TIME, ANY COMMAND TEXT

The command scheduler can hold up to 50 entries and has several options as shown by its HELP text below.

```
+HELP, SCHED 05/15/14 19:05:35
SCHED Show Schedule
SCHED, DEL, N      Notes: N is the sched item number
SCHED, DEL, ALL   TOD can be hh:mm:ss or mm:ss or ss
SCHED, I, TOD, <cmd-string>
SCHED, I, TOD, OFFSET, TOD, <cmd-string>
SCHED, T, TOD, <cmd-string>
SCHED, T, TOD, OFFSET, TOD, <cmd-string>
```

To schedule data collection for our sensors and transmission of the GROUP SDATA report we could enter the following commands:

```
SCHED,I,30:0,SDI,COLLECT,1,2
```

```
SCHED,I,30:0,OFFSET,15,EVENT,UPDT,1
```

The first command schedules data collection of sensor table items 1 and 2 every 30 minutes and 00 seconds. The second command schedules the event group 1 to be created and send every 30 seconds with an offset of 15 seconds to give time for the data collection to complete.

### 5.9.7 SDI, CMD, COMMAND TEXT

Transparent Mode command. This command will output the text to the SDI-12 data line exactly as typed with the ‘!’ character appended to the end. The first character must be a sensor address and the remaining characters should be some valid basic or extended SDI-12 Command. The ‘!’ character should not be entered.

Example: SDI,CMD,0V<cr>

A list of the basic SDI-12 commands is given at the end of this document. Some Sensor Manufacturers have their own special commands for setup and calibration which this transparent mode is designed to support. These commands are not saved in the radio configuration flash memory so if the sensor does not retain it in a power cycle it will be lost. If this command is entered as a real-time-scheduled command it will be saved in the configuration flash memory.

### 5.9.8 SDI, TRACE, {OFF/ON}

The SDI,TRACE command is useful for debugging the setup and operation of the radio with the sensors.

The example below shows a data collection from a sensor testing device that was set up to emulate a sensor. The trace output can get to be a lot of information and should not be left on for long periods or its output can overrun the radio output memory and cause the radio to reset. Be careful using this command option.

Characters enclosed in the “<>” characters are transmitted out of the radio. Characters enclosed in the “[ ]” characters are received by the radio. The time tag is in hundredths of seconds.

Example with TRACE,ON

```
+sdi,collect,1
20:14:44.59 <BREAK>
20:14:44.60 <MARK>
20:14:44.62 <OM!>
20:14:44.69 [00056(cr) (lf)]
```

```

20:14:49.22 [0(cr) (lf) ]
20:14:49.23 <BREAK>
20:14:49.24 <MARK>
20:14:49.27 <0D0!>
20:14:49.34 [0+0.0(cr) (lf) ]
20:14:49.35 <BREAK>
20:14:49.36 <MARK>
20:14:49.40 <0D1!>
20:14:49.46 [0+1.0(cr) (lf) ]
20:14:49.48 <BREAK>
20:14:49.49 <MARK>
20:14:49.52 <0D2!>
20:14:49.59 [0+2.0(cr) (lf) ]
20:14:49.60 <BREAK>
20:14:49.61 <MARK>
20:14:49.64 <0D3!>
20:14:49.71 [0+3.0(cr) (lf) ]
20:14:49.72 <BREAK>
20:14:49.73 <MARK>
20:14:49.77 <0D4!>
20:14:49.83 [0+4.0(cr) (lf) ]
20:14:49.85 <BREAK>
20:14:49.86 <MARK>
20:14:49.89 <0D5!>
20:14:49.96 [0+5.0(cr) (lf) ]

```

### 5.9.9 SDI-12 Command/Response List

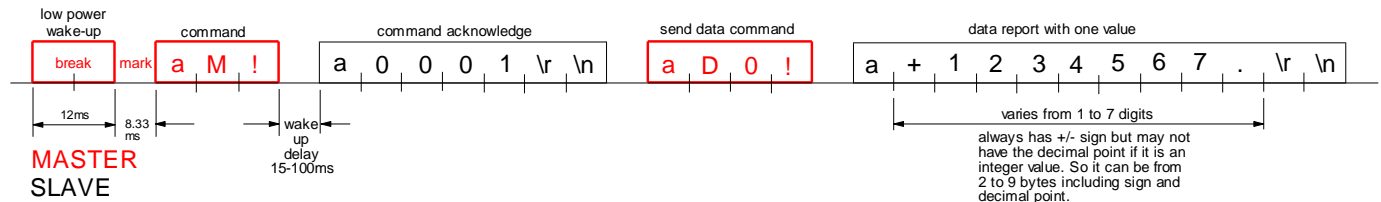
Name	Command	Response
Break Continuous	spacing for 12 ms	None
Acknowledge Active	a!	a<CR><LF>
Send Identification	aI!	allccccccmmmmmmvvvxxx...xx<CR><LF>
Change Address only if	aAb!	b<CR><LF> (support for this command is required the sensor supports software changeable addresses)
Address Query	?!	a<CR><LF>
Start Measurement*	aM!	atttn<CR><LF>
Start Measurement + CRC*	aMC!	atttn<CR><LF>
Send Data a<values><CRC><CR><LF>	aD0! ... aD9!	a<values><CR><LF> or
Additional Measurements*	aM1! ... aM9!	atttn<CR><LF>
Additional Measurements + CRC*	aMC1! ... aMC9!	atttn<CR><LF>
Start Verification*	aV!	atttn<CR><LF>
Start Concurrent Measurement	aC!	atttnn<CR><LF>
Start Concurrent Measurement + CRC	aCC!	atttnn<CR><LF>
Additional Concurrent Measurements	aC1! ... aC9!	atttnn<CR><LF>
Additional Concurrent + CRC	aCC1! ... aCC9!	atttnn<CR><LF>



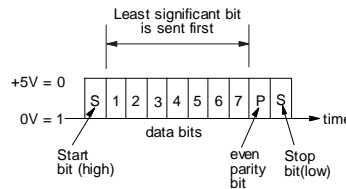
Continuous Measurements	aR0! ... aR9!	a<values><CR><LF> (formatted like the D commands)
Continuous Measurements + CRC	aRC0! ... aRC9!	a<values><CRC><CR><LF> (formatted like the D commands)

\*These commands may result in a service request.

### 5.9.10 Serial Port Command and Response Diagrams



Data Port Byte Stream Timing Diagram



Data Byte Format

Figure 11. Data Port Byte Stream Timing and Data Byte Format

The Diagrams above summarize the type of command/response that is used in the SDI-12 protocol. The data rate is always 1200 baud. The BREAK signal is a minimum of 12ms at +5V followed by at least 8.33ms of a MARK signal at 0V. The purpose of the BREAK is to wake up all the sensors on the line.

The “line” is a single wire in tri-state mode where the Recorder is master and the Sensors are slaves. Only one device can transmit at a time, the master device always initiates communication, and the slaves always respond to commands addresses to them, are received correctly, and are valid in format and content.

The first byte of each command and response is a 1-byte sensor address. Valid addresses are 0-9, A-Z and a-z. The last byte of a command is always a ‘!’ character. Response strings always begin with the sensor address and end with <cr><lf>.

Each byte has 1 start bit, 7 data bits, 1 parity bit and 1 stop bit. The start bit is +5V. The data and parity bits are Negative polarity where a ‘0’ is +5V and a ‘1’ is 0V. The stop bit is 0V. The bytes that a device sends should have no space between them, but the protocol allows up to 1.66ms between bytes.

Sensors should respond to a command in 15ms, but they can take up to 100ms to wake up from a sleep state and respond to the first command after the BREAK. The master (in this case the MRC-565 Radio) will retry commands if it gets no response. The first timeout is 100ms and subsequent retries will time out after 20ms. The MRC-565 basic timing internal clock is 10ms per “tick” so all of the timing is rounded up to the next 10ms tick.

## 5.10 Generic Data Logger

The MRC-565 includes a set of device drivers for its serial ports. These have been customized for various external devices over the years as the requirements became known. The SDATA command was created to allow a simple text-based interface to send data groups to the MRC-565 for transmission to the master. Any customer that could configure their data report to meet this format could interface his data logger with no change in the MRC-565 software. From 1 to 16 groups can be input, and there can be from 1 to 16 sensors per group. Each sensor data value is formatted into a 16-bit binary value for transmission, then converted to engineering units by the Data Center or Host software.

Some date loggers have a complex and non-configurable interface protocol, and cannot meet any of the currently implemented protocols, but they can output data reports on a serial port as if it were connected to a line printer. The GENERIC data logger driver has been created for this type of interface. Some things can be setup by user commands to configure the report parsing, within a limited set of constraints, and allow the MRC-565 to create SDATA type messages from the ASCII text reports.

The following sections describe what can be done to adapt the MRC-565 to a variety of report formats.

### 5.10.1 Typical Report Formats

A typical report printed by a data logger has one line, or a set of lines for each report. There are usually two types, single-line reports, and multiple-line reports. An example of each type would be as shown below:

Single line report examples:

```
123.4 19.8 33 99 -1089.45 ....<cr><lf>
```

or

```
10/14/02 09:15:00 +123.4 +19.8 +33 +99 -1089.45 ....<cr><lf>
```

Note that the report ends with carriage return and linefeed characters, and may or may not print a date and/or time. The data fields are usually separated by blanks, and the data values may or may not contain a sign or decimal point. The line is usually output by the data logger as the report is placed into the devices' memory in real-time. There is no provision for error checking, but if the serial port cable is wired correctly with shielding, etc., it may be reliable enough.

Multiple line report examples:

No time tag	With time tag	With Sensor Labels
123.4<cr><lf>	10/14/02 09:15:00<cr><lf>	Date/Time: 10/14/02
09:15:00<cr><lf>		
19.8<cr><lf>	+123.4<cr><lf>	AC Voltage +123.4<cr><lf>
33<cr><lf>	+19.8<cr><lf>	DC Voltage +19.8<cr><lf>
99<cr><lf>	+33<cr><lf>	Pulse Count +33.0<cr><lf>
1089.45<cr><lf>	+99<cr><lf>	Error Code +99.0<cr><lf>
	-1089.45<cr><lf>	Pressure -1089.45<cr><lf>

If the generic device driver software is set up to "poll" for data by outputting a command string, then the data report may need to be processed as a multiple line report even when the data logger outputs only one line. This can happen if the data logger "echoes" the polling command. The generic device driver will "see" the echoed command as part of the data report response.

### 5.10.2 Setup and Configuration

The MRC-565 generic data logger driver can configure the following:

- Report type (single-line, multi-line)
- Group ID Number (Auto generated, Location in report, Fixed)
- Date (Auto generated, Location in report, Format of date characters)
- Time (Auto generated, Location in report, format of time characters)
- Sensor Values (Auto free-format, Location in report)
- Poll command definition
- Start-of-report definition
- Remote Commands

Each operator command begins with the command name and port number as shown in the following command. Example: **GENERIC,1,TYPE,AUTO**.

### Selecting The Generic Protocol for a Port

The **ASSIGN** command is used to define the device driver to use on a port. As an example, the command **ASSIGN,DTA,1,GENERIC,5** will assign the DTA function to use port 1 (the DATA port), and run the **GENERIC** data logger device driver with a 5 second timeout. Use the **SETBAUD,DTA,9600** command to specify a baud rate for the port. Any port (0-3) can be used, and multiple ports can select the generic device driver at the same time. Port 0 is usually reserved for an operator terminal, and port 3 is an internal GPS port. That means ports 1 and 2 are open for external devices.

### 5.10.3 Viewing the generic device driver setup

Enter the **GENERIC** command with no parameters to display the current setup for all active ports. The following example response shows a typical setup with only port 2 set up for generic operation.

```
+generic 12/11/01 10:54:32
  Rpt Group..... Date..... Time..... Sensor.....
P Type Type N L# S E Type L# S E Type L# S E Type L# S E
= ===== == == == == ===== == == == ===== == == == ===== == == ==
2 LINE FIXED 02 00 00 00 LINE 01 10 16 LINE 01 18 25 LINE 02 22 32
  Report:DATE/TIME: Date:YY/MM/DD Time:HH:MM:SS
```

From the report one can see that only port 2 is configured, and the other ports have a report type of OFF. The Group section has 5 fields: Type, Number, Line number, Start column, End column. This line shows the group is fixed at group number 2. The Date, Time and Sensor sections each have 4 fields: Type, Line number, Start column, End column. The date is on line 1 between columns 10 and 16. The time is on line 1 between columns 18 and 25. The first sensor value is on line 2 between columns 22 and 23, and the remaining lines of the report will each contain 1 sensor value between columns 22 and 23.

The line following the port 2 line shows additional options for that port. Shown here are the start-of-report string, the date format, and the time format. Only options selected will be shown on this line. All of the settings in this generic driver table are saved in the non-volatile memory of the MRC-565.

**Report Type: GENERIC,P,TYPE,{AUTO,LINE,OFF}**

This command selects whether the report is in a single line format or multiple line format. AUTO specifies single line with free-format, and LINE specifies the multiple line format. The OFF option is provided to turn off a previously set-up port.

Reports are parsed from sets (bursts) of characters read into a 1024 byte buffer. The end of the data set will be signaled by a timeout period with no more characters being received. The timeout is taken from the ASSIGN command described earlier. When each set is finished being processed, the input buffer is cleared to wait for the next set of characters.

### 5.10.4 AUTO Format

For the simplest AUTO report type, with no group number, date or time stamp, each line will be parsed from left to right using blanks and commas as delimiters between data values. The carriage return and line feed characters are also ignored. The first group report will take up to 16 data values, then the next 16 go into group 2, the next 16 into group 3, and so on until the last character has been reached.

For example see the following set of characters:

```
1      2      3      4      5      6      7      8      9      10<cr><lf>
11     12     13     14     15     16     17     18     19     20<cr><lf>
21     22     23     24     25     26     27     28<cr><lf>....timeout
```

This character set will create two groups where the values 1-16 will go into group 1, and the values 17-28 will go into group 2. Each report will be time and date stamped using the current time of the MRC-565. Up to 256 data values can be parsed into 16 groups using this format as long as the total number of characters in each set does not exceed the buffer size( including all delimiters).

An Example of an AUTO format with a date and time stamp is:

```
10/15/01 12:00:00<cr><lf>
1      2      3      4      5      6      7      8      9      10<cr><lf>
11     12     13     14     15     16     17     18     19     20<cr><lf>
21     22     23     24     25     26     27     28<cr><lf>....timeout
```

Another example:

```
10/15/01 12:00:00 1      2      3      4      5      6      7<cr><lf>
8      9      10     11     12     13     14     15     16     17<cr><lf>
18     19     20     21     22     23     24     25     26     27<cr><lf>
28<cr><lf>....timeout
```

For these two formats with date and time above, the port should be setup for an AUTO report type, then select a date and time option that locates the date and time fields on line 1. Use the sensor setup command to indicate that the 1<sup>st</sup> sensor is located either on line 2 as in the 1<sup>st</sup> example or on line 1 as in the second example. The AUTO formatting will use the first two "fields" found as the date and time, then use the remaining fields as the sensor data.

### 5.10.5 MULTI-LINE Format

For the LINE (multi-line) report type, the first "line" includes all the bytes from the beginning of the buffer to the first carriage return. Any line feed characters are ignored. The 2<sup>nd</sup> line is all the bytes from one past the carriage return to the next carriage return and so forth to the end of the set of characters. The report ends with the last character received prior to the timeout period with no more bytes being received. This example shows that each line holds only one sensor value. Reports with both labels and data that have multiple values per line are not yet supported by the generic driver, but it is possible to report multiple sensors per line when there are no line labels present on each line.

One example of a multi-line report from the AANDERAA 3660 data logger is shown below:

```
Date/Time: 1.12.11 18:57:50
```

00 Battery Voltage	12.7	Volt
01 Reference	699	
02 Wind speed	79.4	m/s
03 Wind gust	79.4	m/s
04 Wind direction	359.6	Deg.M
05 Air temperature	48.8	Deg.C
06 Relative humidity	101.6	% RH
07 Air pressure (QNH)	1089.6	hPa
08 Visibility	3002.9	m
09 Sunshine duration	1023.0	min
10 Net atm. radiation	2120.4	W/sqm
11 Rainfall	204.6	mm

From the above report one can see that the date is on line 1 in columns 12-19, and is in year-month-day format. The time is also on line 1 in columns 21-28. Sensor data then starts on line 2 and repeats on subsequent lines in columns 25-30. The label fields are ignored.

**Group Number:**     *GENERIC, P, GROUP, AUTO*  
                           *GENERIC, P, GROUP, LINE, Line Number, Start, End*  
                           *GENERIC, P, GROUP, FIXED, Line Number*

The AUTO group numbering will start at group number 1 and increment by 1 for each 16 sensor values. The LINE option allows the group number to be within the data at the given line number and between the given start and end column numbers. The FIXED option will use the Line Number parameter as the first group number then increment by 1 for each 16 sensor values.

**Date:**                *GENERIC, P, DATE, AUTO*  
                           *GENERIC, P, DATE, LINE, Line Number, Start, End,{FORMAT}*

The AUTO date option will use the MRC-565 internal Date. The LINE option allows the date to be within the data at the given line number and between the given start and end column numbers. The FORMAT is optional, and shows a "template" of the date format. It can be "MM/DD/YY", "YY/MM/DD", "MMDDYY", "YYMMDD". If the format is not given it will default to the "MM/DD/YY" format.

**Time:**                *GENERIC, P, TIME, AUTO*  
                           *GENERIC, P, TIME, LINE, Line Number, Start, End,{FORMAT}*

The AUTO time option will use the MRC-565 internal time. The LINE option allows the time to be within the data at the given line number and between the given start and end column numbers. The FORMAT is optional, and shows a "template" of the time format. It can be "HH:MM:SS", "HH:MM", "HHMMSS", "HHMM". If the format is not given it will default to the "HH:MM:SS" format. The MRC-565 SDATA reports are only time-tagged with month-day-hour-minute. Year and seconds are not transmitted.

**Sensor Values:**    *GENERIC, P, SENSOR, AUTO*  
                           *GENERIC, P, SENSOR, AUTO, Line Number, Start*  
                           *GENERIC, P, SENSOR, LINE, Line Number, Start, End*

In AUTO mode, sensor values are delimited by blanks or commas and there may be several per line. If the line number parameter is not given (example 1 above) then data is assumed to start on the 1<sup>st</sup> line of the report. If the line number is given, data can start on other than the 1<sup>st</sup> line. In addition, if the start parameter is given, data can begin in a column other than the 1<sup>st</sup> column. For example you may have a report such as the following:

```
10/14/02 09:15:00 +123.4 +19.8 +33 +99 -1089.45 ....<cr><lf>
```

Notice it has a date, time, then data values on the same line. In this case you would use a GROUP,P,SENSOR,AUTO,1,18 command to locate the start of the sensor data, and use the "auto" method of locating the rest of the data.

In LINE mode, Sensor values will start on the given line number and start-end columns, then will repeat, either in free format, or one value per line, depending on the report type.

**Polling:**                    *GENERIC, P, POLL, Poll String, Interval*

The polling feature can be used for data loggers that do not print a data report unsolicited, but require some command string to be sent to request the next report. The poll string can be any printable ASCII characters up to 20 bytes in length. The INTERVAL parameter is given in decimal and is the number of seconds between outputting the poll string. If a poll is output, the response string from the data logger will be parsed in the same manner as when there is no poll string required. If the data logger echoes the poll string, this will look like part of the report and must be accounted for in the setup. To handle data loggers that need to wake up from a low-power mode, the poll string will be preceded by a carriage return and line feed, and the poll string will be followed by another carriage return and line feed.

Polling using binary (non-printable-ASCII) characters is not yet supported.

**Start of Report:**        *GENERIC, P, REPORT, Report String*

The report string allows the definition a fixed string of printable ASCII characters that is at the beginning of each new set of report characters. This is useful for ignoring bursts of non-report text. Each report is started with the report string and ends with the timeout parameter. If the cable between the data logger and MRC-565 is connected part way through the output of one report, and the report string text is "missed", then a partial report will not be created.

**Remote Commands:**    *GENERIC, P, COMMAND, Command String*

Some support for remotely commanding and configuring a generic data logger is provided using this command format. If the data logger can accept commands as a single line of text (no embedded <cr><lf>) without having to be locally present at the data logger to type keys into a menu, then this capability may be just the ticket. When a remote command is received by the MRC-565, it will output the *Command String* bytes to the data logger preceded and followed by

a carriage return and line feed. The response text, up to 1024 bytes, will be captured and returned to the originating modem as a remote command response message.

**Example Script:**

```
generic,1,type,auto
generic,1,group,auto

generic,2,type,line
generic,2,group,fixed,2
generic,2,sensor,line,2,22,32
generic,2,date,line,1,12,19,YY/MM/DD
generic,2,time,line,1,20,29,HH:MM:SS
generic,2,poll,off
generic,2,report,Date/Time:

generic,3,type,off
generic,0,type,off

assign,dta,off
assign,alt,off

assign,dta,2,generic,5
setbaud,2,9600

assign,alt,1,generic,2
setbaud,1,9600

generic
save
```

## 5.11 Event Programming

The MRC-565 supports customer-programmed event logic. Discrete and analog inputs can be monitored by the event program to detect "*events*" which then perform a defined "*action*". Actions may include the controlling of discrete output signals, incrementing counters, setting timers, transmission of canned messages and issuance of various reports. This means that customers are somewhat independent of factory reprogramming from MRC and that MRC-565 behavior can be readily modified in the field. It also means that operators now have limited power to make the MRC-565 react to various field-programmable conditions.

The operator sets up the event program when installing the MRC-565 or during maintenance and operation. Because the event program is implemented via operator commands, it can be entered not only at a local maintenance console, but also via the remote command capability. The event programs are stored within a non-volatile table in the MRC-565 battery-backed-up RAM. They are not lost due to external power failure. When the external power is restored, they will be enabled to respond to events again.

Programming is usually done by creating a "script file" of the required event commands, and loading these into the MRC-565 using XTERM or any other terminal emulator software.



Several input/output lines are available directly from the processor card of the MRC-565 modems. In addition, an I/O expander card (XIO) can be optionally used which uses 3 lines to implement a high-speed serial link for accessing the signals of the expander card.

Refer to APPENDIX D for details on Event Programming.



# **MAINTENANCE**

## 6 Maintenance

Maintenance of the MRC-565 has been reduced dramatically because of the use of a Software Define Radio (SDR). Proper operation is guaranteed through the verification and or adjustment of a few software and hardware parameters. These parameters are described in the following sections.

### 6.1 Script Files

It is critical that the proper script files are loaded before operation begins. These script files configure the MRC 525 for operation in its specific location. Script files are loaded using XTERM and can be enter from either the front panel COM port or the Ethernet connector. This can be done either locally or at a remote connection that has an Ethernet connection to the Master. Refer to the XTERM manual for details on loading script files.

Of all the parameters that are entered through the script files, only three are unique to each station. These are:

- ID
- SERIAL NUMBER
- SITE NAME

It's best to setup script files for each Master with these three parameters and then use and INCLUDE STATEMENT to add all the common parameters as a file name.

If all are blinking, the internal Power Supply must be working properly, however it's a good idea to measure this voltage as noted in the next step.

### 6.2 Measuring Voltage Levels

There are several voltage regulators on the CMU board. All have test points for measuring values. A list of test points and there location is shown below.

In addition the following command can be used to verify several of the voltages:

**SCALE**

**TP TABLE**

## 6.3 Setting Up and Calibrating the MRC-565 Radio Parameters

### 6.3.1 CMU Adjustments

There are two calibration commands required to set up a CMU to make the radio portion function properly. These adjustments are set up and saved in the factory or repair center and require the use of calibrated RF test equipment. These commands are not to be used at the installation site. A special password sequence must be used to save a new value to any of the parameters. For troubleshooting purposes, these values can be overwritten on a temporary basis without the password sequence.

The following values are stored in EEPROM, and are not changed in any operational circumstance, including factory default command or loading a new operating system. Use the following commands to view and change these parameters.

**CAL** Prints out the current cal values

**CALRAND** Returns value for use in saving CAL parameters

Specific CAL parameter commands:

1. **CAL, FREQCAL,nnn** Calibrates the freq of the 19.2MHz TCXO
2. **CAL, ADCGAIN,nnn** Calibrates the ADC1 (J2) rx sig strength, default 47

It's a good idea to measure and record the 19.2 MHz Reference Oscillator (TCXO) . Connect a scope probe connected to TP and plugged into the BNC connector of a counter with a stable clock reference (<1 PPM) to make this measurement. The oscillators must be within +/- 2PPM of the desired frequency of 19.20 MHz. AT 19.2 MHz this is about +/- 5 Hz. If any frequency is off by more than 5 Hz, you must calibrate it with the following command:

**CAL, FREQCAL,nnn**

Change nnn around the value 510 to achieve the desired results.

The RSSI values for the receiver can be adjusted by connecting a calibrated signal generator to each receiver input and the typing **MM** to read the value the values in DB. You should adjust the RSSI value at an input level of -106 DBM at the receiver input. At this level **MM** should read -106.

You can calibrate the readings by connecting a signal generator to RX Input at J1 and using the following commands to adjust the gain number.

**CAL, ADCGAIN,nnn** Calibrates the ADC rx sig strength, default 47

The other cal parameters should not be changed.

Once you enter the Cal parameters noted above, you should save these values, so that when the SW reboots or power is removed from the MRC 525, the parameters are saved. To SAVE Cal parameters enter the following commands:

**CALRAND**                                    **to obtain a CALRAND#**

**CAL,SAVE,CALRAND#**        **to save the values**

Once you have saved these parameters, enter the following command to display the cal parameters.

**CAL**

Record the results.

### **6.3.2 Power Amp Adjustments**

The MRC-56500301 Power Amplifier is factory tuned to the customer specific frequencies at the factory. These parameters should not be changed in the field.

# APPENDIX A: COMMANDS

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## APPENDIX A: COMMANDS

All implemented MRC-565 commands are listed in the Table below alphabetically for ease of reference. However, many commands are used in conjunction with others. These functional groups are given below. You may also type **HELP** or **HELP,command** to receive an explanation of any listed command.

The commands with a \* in front are stored in Parameter Memory. The most critical commands are in **BOLD** text.

STATION CONFIGURATION COMMANDS		STATUS COMMANDS	MESSAGE COMMANDS
* <b>ASSIGN</b>	RCT	BINS	CANMSG
	REMOTE TYPE	CLS	CANMSG MODE
* <b>CHANNEL</b>	RXTYPE	<b>CONFIG</b>	CANMSG OFF
* <b>CHECKIN</b>	SAVE	*HOURLIES	COMPRESSION
CLOSE PORT	<b>SCALE</b>	MEM	DEL MSG
CONNECT	<b>SCHED</b>	MODE	DQE RXQ
<b>DATE</b>	SERIAL	MON	DQE TXQ
* <b>DESTINATION</b>	*SET BAUD	MONOFF	FLUSH MSG
* <b>DEVICE</b>	*SNP	NETMON	FLUSH RXQ
* <b>DUTY CYCLE</b>	*SOURCE RELAY	<b>STAT</b>	FLUSH TXQ
HOST MODE	START	*STAT TIME	*HOLD
* <b>ID</b>	STOP	T	MESSAGE
<b>IP</b>	STT	TEST	*MSG
<b>IPCONFIG</b>	SUBST		*PRINT
LOGOFF	TIME		REMCMD
LOGON	TIME ZONE		
*LOS CHECKIN	* <b>TXLIMIT</b>	<b>POSITION LOCATION COMMANDS</b>	
*MODULATION		*POS	RED



NEW PASSWORD IPC POSRPT RTCM

OPEN PORT S”n”  
PASSWORDMODE

**MODE CONTROL COMMANDS**

\*CORPAT \*HALF DUPLEX  
\*FULL DUPLEX \*ROLE

**MASTER SIMULATOR COMMANDS**

\*P

**MAINTENANCE COMMANDS**

BOOT SHOW TXQ  
RESET SMS  
REV UPDT  
SHOW RXQ

**DUAL MASTER STATION COMMANDS**

SWCTL

**UTILITY COMMANDS**

HELP

**DATA LOGGER COMMANDS**

SDATA  
\$PENTM

**CR10X COMMANDS**

CR10X	CR10X,ORDER	CR10X,SETPTR
CR10X,ACQMODE	CR10X,REGISTER	CR10X,SIGNATURE
CR10X,GROUP	CR10X,RESET	CR10X,STAT
CR10X,INTERVAL	CR10X,SCALE	CR10X,TIME
CR10X,MAXQ	CR10X,SECURITY	CR10X,UPLOAD

**MASTER MODE COMMANDS**

*BASE	POLL	SHOW RXQ
CONFIGURATION	PRG	SHOW TXQ
LISTM	REMOTE STAT	SML

MM  
NET

\*REPEATER  
SHOW REMOTES

SMS

\* Parameters/settings specified by these commands are stored in Parameter Memory (CPM). Changes specified by these commands take effect immediately but are lost when the unit is rebooted unless the **SAVE** command is issued to write the changes to the non-volatile Flash memory. Changing the unit ID automatically saves the entire configuration.

**MRC-565 Command List**

<b>MRC-565 COMMANDS TABLE</b>																											
COMMAND	DESCRIPTION	PARAMETERS	RANGE																								
<p><b>*ASSIGN</b> {,function,port,protocol {,timeout}}</p> <hr/> <p style="text-align: center;"><b>NOTE</b></p> <p>{function, port and protocol} information for all ports (except internal port 3) are stored in CPM; this information for port 3 and all timeout information is stored in RAM.</p>	<p>Control allocation of user interface functions among physical device channels. When no parameters are entered, displays I/O configurations. Port definitions are as follows:</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%; text-align: right;">Port</td> <td style="width: 15%;"></td> <td style="width: 70%;">I/O Connector</td> </tr> <tr> <td style="text-align: right;">0</td> <td></td> <td>OPERATOR PORT</td> </tr> <tr> <td style="text-align: right;">1</td> <td></td> <td>DATA PORT</td> </tr> <tr> <td style="text-align: right;">2</td> <td></td> <td>AUXILIARY PORT</td> </tr> <tr> <td style="text-align: right;">3 (internal)</td> <td></td> <td>DIAGNOSTICS PORT</td> </tr> <tr> <td colspan="3"> </td> </tr> <tr> <td style="text-align: right;">Port</td> <td></td> <td>Ethernet / USB Connector</td> </tr> <tr> <td style="text-align: right;">4-7</td> <td></td> <td>ETHERNET1 (IP PORT</td> </tr> </table> <p>4000)</p> <hr/> <p style="text-align: center;"><b>NOTE</b></p> <p>It is possible to “lose control” of the MCC-565 software by assigning control functions to ports with no devices attached or by turning off control functions. For example, if you turn off the Operator Port (<b>ASSIGN,MNT,OFF</b>), you will not be able to enter commands or view printouts from the MRC-565. You must open the Power Cycle the MRC-565 to enable the Operator Port.</p>	Port		I/O Connector	0		OPERATOR PORT	1		DATA PORT	2		AUXILIARY PORT	3 (internal)		DIAGNOSTICS PORT				Port		Ethernet / USB Connector	4-7		ETHERNET1 (IP PORT	<p>function = user interface function</p> <p>port = physical device channel</p> <p>protocol = link level protocol</p>	<p><b>MNT, DTA, ALT, POS,E1F1,E1F2,E1F3,E1F4,CR10X,CR1000</b></p> <p><b>0=OPERATOR,1=DATA,2=AUX, 4-7= Ethernet</b></p> <p><b>ASCII,MSC,MSC2,PKT,FWS,CR10X,CR10XTD,CR1000, PAKBUS,SERPKT,APCL5,GPS,RTCM,M12RTCM,M12DIFF,TRAN,UAIS,GYRO,SOUNDER,PHAROS,H350,DIRECT,GENERIC,AEI,HOTBOX, drivers.MPL</b></p>
Port		I/O Connector																									
0		OPERATOR PORT																									
1		DATA PORT																									
2		AUXILIARY PORT																									
3 (internal)		DIAGNOSTICS PORT																									
Port		Ethernet / USB Connector																									
4-7		ETHERNET1 (IP PORT																									

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
		timeout in seconds	<b>0 – 32767</b>
<b>ASSIGN,RXn,Channel,Protocol</b>	RXn = Receive Number 1,2,3. (All use same ADC) Channel = Channel Number Default is all RX1, RX2, and RX3 assigned Refer to Channel Command to set frequencies	Channel = 0 to 20 Protocol = OFF,MBNET	
<b>*BASE{,nnn,nnn}</b>	Set/display range of Master Station IDs reserved for use as Base Stations. <b>In MB networks set BASE to OFF.</b>	nnn = lowid,highid <b>OFF</b> = no Bases	<b>2 – 253</b>
<b>BINS</b>	Print link distribution statistics		
<b>BOOT</b>	Cold start of Station software. All volatile memory is lost.		
<b>CANMSG,name,len{,Qsize}{,count}</b>	Automatically generate a test message of specified length that repeats until turned off with <b>CANMSG OFF</b> command. You can compose the message by entering only the destination name (not message length or minimum queue depth). Destination node must be a neighbor node. <b>CANMSG</b> cannot contain more than 25 messages in its queue. If the number of canned test messages in queue falls below minimum queue depth, additional canned messages will be injected.	nnnn = Station ID Master = <b>1 – 4095</b> Remote = <b>256 – 4095</b> len = number of characters in message Qsize = min. # of canned messages in queue count = total number of canned messages to generate	<b>1 – 4095</b>  <b>1 – 3000</b>  <b>0 – 25</b>  <b>0 – 9999</b>
<b>CANMSG MODE {,mode}</b>	Set reception of canned test messages to two of the following states: <b>PRINT</b> – print all test messages <b>NO PRINT</b> – does not print test messages	mode = <b>PRINT</b> <b>NO PRINT</b>	
<b>CANMSG OFF,nnnn</b>	Turn canned test message mode off	nnnn = Station ID Master = <b>1 – 245</b> Remote = <b>256 - 4095</b>	<b>1 – 4095</b>

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>CHANNEL</b>	Shows the Active Transmitter and Receiver frequency and the frequency table where up to 21 frequency channels can be defined.  There are three frequency bands.		
<b>CHANNEL,xxx.xxxx,yyy.yyy y,aa,bb</b>	Select Frequencies, Modulation Value, and Channel for the Transmitter and the Receiver.	<b>xxx.xxxx</b> = Transmitter Frequency <b>yyy.yyyy</b> = Receiver frequency <b>aa</b> = mod_val <b>bb</b> = Channel Table Channel Number	<b>xxx.xxxx</b> = 40.000 – 50.000 MHz <b>yyy.yyyy</b> =40.000 – 50.000 MHz <b>aa</b> = 1 - 6 <b>aa</b> = <b>1-6</b> <b>bb</b> = 0 - 20
<b>CHANNEL,zz</b>	Sets operating Channel from the list frequency channels under frequency table.	<b>zz</b> = Channel Table Channel Number	<b>zz</b> = 0 - 20
<b>*CHECKIN{,ii}</b>	Select check-in interval in seconds	ii = interval	<b>1 – 65535</b>
<b>CLEARBINS</b>	Clear hourly bins		
<b>CLEARLINKSTAT</b>	Clear link stats		
<b>CLOSE PORT,function {,function,...}</b>	Close specified MRC-565 port from operation. You can enter more than one port name to close, using commas to separate the names on the same line.  <hr/> <b>CAUTION</b> The <b>OPEN/CLOSE PORT</b> commands directly affect MRC-565 network activity and message flow. Do <b>NOT</b> use these commands unless directed to do so by your System Administrator. <hr/>	function = user interface function	RS-232 functions <b>MNT, POS, ALT, DTA</b> Ethernet1 func. <b>E1F1, E1F2, E1F3, E1F4</b> USB functions <b>U1F1, U1F2, U1F3, U1F4</b>
<b>CLS</b>	Print current values, then clear link statistics (see		

<i>MRC-565 COMMANDS TABLE</i>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
	<b>LINKSTAT).</b>		
<b>CONFIG,{ }</b>	Show current configuration parameters report.  <b>NOTE</b> Configuration in CPM may differ unless the SAVE command is used after configuration changes are made.	NONE  ALL  SCRIPT	Lists Summary Table of parameters  Lists all parameters in list format  Lists all parameters in a SCRIPT format
<b>CONFIGURATION</b>	List major Master Station configuration settings.		
<b>CONNECT,{id1...id10}</b>	Limits Remote-to-Master connectivity for lab and field network configuration. Up to 10 Master IDs can be set. The radio will only communicate with the other radios in its connect list.	id = Master Station <b>OFF</b> = no limitation	<b>1 – 65,500</b>
<b>CORPAT</b>	Without parameters, display report of available correlation patterns and indicate usage.		
<b>CORPAT,RX,action</b> {,pppp...}	Define Receiver correlation patterns to recognize. Pattern 1 is the default and is the only pattern recognized if no others specified. Up to 16 pre-defined patterns are recognized.	action = <b>ON</b> – define patterns or <b>OFF</b> – use only default pattern pppp = pattern number; <b>ALL</b> means recognize all patterns	<b>1 – 8</b>
<b>CORPAT,TX,pppp</b> {, <b>ALWAYS</b> }	Define Transmitter correlation pattern to send. Pattern 1 is the default and is the only pattern recognized if no other specified. Up to 16 pre-defined patterns may be used.	pppp = pattern number <b>ALWAYS</b> means use specified pattern instead of received	<b>1-- 8</b>

<i><b>MRC-565 COMMANDS TABLE</b></i>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
		pattern	
<b>CR10X</b>	Display CR10X configuration parameters		
<b>CR10X,ACQMODE,mode</b>	Set CR10X acquisition mode - Get all reports since last <b>UPDT</b>	mode = <b>ALL</b> – get all reports since last update <b>CURRENT</b> – get only the current data report <b>LAST,n</b> – get last “n” data reports	
<b>CR10X,GROUP,source</b>	Specify source of data report group assignment.	source = <b>565</b> – 565 assigns group numbers; CR10X internal group number matches data array <b>CR10X</b> – CR10X assigns group numbers; 565 gets group number from first sensor	
<b>CR10X,INTERVAL,n</b>	Acquisition scan interval in seconds. <b>OFF</b> disables acquisition scan	n = seconds	<b>0 – 32767</b>
<b>CR10X,MAXQ,nnn</b>	Set maximum number of reports to queue for each scan of the CR10X	nnn = number of reports	<b>1 – 200</b>
<b>CR10X,REGISTER,n{,ddd}</b>	Read/Set internal storage register.	n = register number ddd = value	<b>1 – 28</b> Signed floating point number (see CR10X manual)

<i><b>MRC-565 COMMANDS TABLE</b></i>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>CR10X,RESET</b>	Reset CR10X internal error counters to zero		
<b>CR10X,SCALE,type</b>	Define sensor scaling type.	type = <b>545C</b> – data scaled in integer hexadecimal units <b>CR10X</b> – data scaled in Campbell Scientific floating point format	
<b>CR10X,SECURITY,nnnn,nnnn,nnnn</b>	Enter CR10X Internal Security Codes. See CR10X manual. If CR10X program contains security codes, this command (with correct security codes) must precede any other command for CR10X to respond.	nnnn = security code	<b>0 - 9999</b>
<b>CR10X,SETPTR,date,time</b>	Manual set up of last data pointer in the MCC-6100	date = mmddy time = hhmm	mm = <b>1 - 12</b> dd = <b>1 - 31</b> yy = <b>0 - 99</b> hh = <b>0 - 23</b> mm = <b>0 - 59</b>



<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>CR10X,SIGNATURE</b>	Read and Display Current CR10X program signature. The Signature is a checksum of program bytes.	Signature = checksum	<b>0 - FF</b> (hex)
<b>CR10X,STAT</b>	Read and display CR10X internal pointers and error statistics.		
<b>CR10X,TIME,source</b>	Specify source of data report group timestamp.	source = <b>545B</b> – 545B assigns timestamp <b>CR10X</b> – CR10X assigns timestamp; MCC-6100 gets timestamp from second and third sensors	
<b>CR1000</b>	Show current settings		
<b>CR1000,ACQMODE,{CURRENT,ALL,LAST,N}</b>	Set CR1000 acquisition mode - Get all reports since last <b>UPDT</b>	mode = <b>ALL</b> – get all reports since last update <b>CURRENT</b> – get only the current data report <b>LAST,n</b> – get last “n” data reports	
<b>CR1000,SETPTR,MM/DD/YY,HH:MM</b>	Set the CR1000 pointer to a specific date & time		
<b>CR1000,INTERVAL,{off,n}</b>	Sets the CR1000 Scan interval to off or to nnn seconds	n	<b>0-32767</b>
<b>CR1000,GROUP,{CR1000}</b>			
<b>CR1000,TIME,{CR1000}</b>			
<b>CR1000,MAXQ,nnn</b>			
<b>CR1000,SCALE,{CR1000,INT}</b>			

<i><b>MRC-565 COMMANDS TABLE</b></i>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>CR1000,PUBLIC</b>			
<b>CR10XTD,STAT</b>			
<b>CR10XTD,RESET</b>			
<b>CR10XTD,SECURITY,xxxx,yy yy,zzzz</b>			
<b>CUSTID,nnnnn</b>	Display/Set customer id for this radio.	nnnnn= customer ID	<b>1-99999</b>
<b>DATE{,mm/dd/yy}</b>	Set system date. If no parameters are given, show current date. If parameters are given, DOS calendar will also be updated.	mm = month dd = day yy = year	<b>1 – 12</b> <b>1 – 31</b> <b>0 – 99</b>
<b>DEL MSG,nnnn:sss</b>	Delete specified message.	nnnn = Station ID sss = message serial #	<b>1 – 255</b>
<b>*DESTINATION{,nnnn....}</b>	Set default message/data destination(s). For MB operation enter <b>0</b> to use source routing at the Master Station.	nnnn = <b>OFF, 0</b> or Station ID: Master = <b>1 – 245</b> Remote = <b>256 – 4095</b>	<b>0 – 4095</b>
<b>*DEVICE{,type}</b>	Select device type mode of operation (i.e., the MRC-565 acts as a Remote, Base, Repeater, etc.).  MAK  ETE	type = <b>MASTER</b> <b>REPEATER,{ID}</b> <b>BASE,ETE,{on,off}</b> <b>REMOTE,</b> <b>{MAK,{ON,OFF}},</b> <b>{ETE,{ON,OFF}}</b>	
<b>DQERXQ,nnnn:sss</b>	Delete specified message from the receive queue	nnnn=Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b> sss = msg serial number	<b>1 – 4095</b>  <b>1 – 245</b>
<b>DQETXQ,nnnn:sss</b>	Delete specified message from the transmit queue	nnnn=Station ID Master = <b>1 – 245</b>	<b>1 – 4095</b>

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
		Remote = <b>256 – 4095</b> sss = msg serial number	<b>1 – 245</b>
<b>DSP</b>	SHOWS DSP IMAGES STORED IN FLASH		
<b>DSP,WATCHDOG,ON OR OFF</b>	SETS WD TIMER TO RESET DSP IF NO RX WITHING 5 MINUTES	ON OFF	
<b>*DUTY CYCLE</b> {,percent,{ max burst length in bytes}}	Set/display transmitter duty cycle (default is 10%). Duty cycle increases in increments of 5%.	percent = <b>1 – 100</b>	<b>1 – 100</b>
<b>EVENT</b>	Show Event Table.		
<b>EVENT,DEL,ALL</b>	Delete Event Table.		
<b>EVENT,DEL,n</b>	Delete Event Number 'n'.		
<b>EVENT,RESET,ACTION</b>	Define an action to be taken at power-up/reset.		
<b>EVENT,{DIOHI,DILOW,DI OFLASH},BIT,DURATION,H OLDOFF,ACTION</b>	Define an event that looks for a discrete input line to go to a high/low level.	<b>DIOHI</b> = Scan discrete input signal for high condition. <b>DILOW</b> = Scan discrete input signal for low condition. <b>Bit-name</b> = Name of discrete input signal to be scanned for high level. (single or multiple inputs) <b>Duration</b> = Number of clock ticks for the input signal to settle at the high level before clearing an event <b>Holdoff</b> = Number of	

<b>MRC-565 COMMANDS TABLE</b>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
		clock ticks for the analog input signal to settle at the low level to be armed for detecting the next event. <b>Action</b> = MCC-6100 action to be taken when the event is declared. See actions below.	
<b>EVENT</b> ,{ADCHI,ADCLOW,ADCFLASH},CHAN,LEVEL,DURATION,HOLDOFF,ACTION	Define an event that looks for an analog input signal to go at or above a high level, <b>or</b> to go at or below a low level	<b>ADCHI</b> = Scan A-to-D converter channel(analog input signal)for high condition <b>ADCLOW</b> = Scan A-to-D converter channel(analog input signal)for low condition <b>Level</b> = Signal level for the event to trigger at or above (for hi-level), <b>or</b> at or below (for low-level) which the analog input signal must persist in order for an event to be declared. Scaled in Engineering Units.	

<i><b>MRC-565 COMMANDS TABLE</b></i>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>EVENT</b> ,{IFGT,IFLT,IFEQ},BIT1,BIT2,ACTION	Test whether a time, counter or accumulator is greater than/less than/equal to another timer, counter or accumulator.	<b>IFGT</b> = If this parameter is greater than second parameter. <b>IFLT</b> = If this parameter is less than second parameter. <b>IFEQ</b> = If this parameter is equal to second parameter. <b>Bit1</b> = Name of a timer, counter or accumulator to test. <b>Bit2</b> = Name of a timer, counter or accumulator to test Bit1 against. <b>Action</b> = MCC-6100 action to be taken when event is declared. See actions below.	
<b>EVENT</b> ,CONT,ACTION	The CONT (Continue) event is used to define multiple actions to an event. An event definition command can be followed by any number of CONT commands and are considered to be an extension of the previous event command.		
<b>EVENT</b> ,DO,ACTION	The DO event is used where an unconditional action is required. This type of event is not connected to other event lines as the CONT is. It is independent and will be initiated every time the event monitor executes the script item.		
<b>EVENT</b> ,TEXT	Show Event Text Message Table		

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>EVENT,TEXT,{TEXT ITEM NUMBER, MESSAGE or COMMAND TEXT}</b>	Add a new text string into the text table. This command will replace an existing item if one already exists with the same item number.	<b>TEXT</b> = Define a Text string command. <b>Item-number</b> = Item number to be created or replaced by this command. <b>Message text</b> = Body of the text. Can be up to 40 characters, and will be converted to upper case. The text is used by the TXT or CMD action to send a text message or issue a local command.	<b>TEXT= 1-40 MESSAGE</b> TEXT = upto 40 Chars.
<b>EVENT,TEXT,DEL,ALL</b>	Deletes all previously defined text items.		
<b>EVENT,TEXT,DEL,TEXT ITEM NUMBER</b>	Deletes a specific item from the text table. This command makes the given item be a null message. The other text string items in the table are not affected.		
<b>EVENT,DISPLAY,TEXT ITEM NUMBER</b>	Display a specific item from the text table.		
<b>EVENT,XDISPLAY,Acc#</b>			
<b>EVENT,GROUP</b>	Show Group Table		
<b>EVENT,GROUP,DEL,ALL</b>	Delete all Group definitions. Clears the group table.		
<b>EVENT,GROUP,DEL,GROUP-NUMBER,bit/chan list</b>	Delete a specific group definition from the group table. This does not cause the other defined groups		

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
	to be renumbered. Note: use channel/F(x.xx) for CSI Flt Point Example: EVENT,GROUP,1,FPWR/F A0/F(0.1)		
<b>EVENT,INVERT,DEL,{ ALL, ITEM NUMBER }</b>			
<b>EVENT,INVERT,INPUT BIT LIST</b>			
<b>EVENT,TESTBITS,DEL,{ ALL, ITEM NUMBER }</b>			
<b>EVENT,TESTBITS,INPUT BIT LIST</b>			
<b>EVENT,SELFTEST,N,action</b>			
<b>EVENT,UPDT,GROUP NUMBER</b>	Produce an immediate SDATA group report when the command is entered.	UPDT = Update sub-command; i.e. issue a group sensor data (SDATA) report. Group-number= Group number to be reported in an SDATA report.	Group Number = <b>1-16</b>
<b>EVENT,STATUS,{CHANNEL,BIT}</b>	Display an immediate value for any discrete input bit or any ADC channel.		
<b>EVENT,STATUS,GROUP,TIMERS,COUNTERS,ACCUMULATORS}</b>	Show current values		
<b>EVENT,ACTION</b>	Immediate command Where ACTION = TXT,40 CHAR TEXT Msg CMD,N – Execute Local Command, N=Text String Number ERROR MESSAGE – Send Wayside error message to Host DISPLAY,N – Display Text on Operator Terminal CAN,NNN		

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
	POS MARK COLLISION SET{/N,/T},BIT or SET,{Tn,Cn,An},ttt CLR{/N},BIT or CLR,{Tn,Cn,An} PULSE,BIT,HI,LOW,COUNT UPDT,GROUP-NUMBER {INC,DEC},Cn {ADD,SUB,MUL,DIV,AND,OR,XOR},An – Acc and Constant MOV,{Tn,Cn,An},{Tn,Cn,An} ADCIN,CHAN,An,Fmul - Read ADC Channel into Accumulator  Where CHAN = FPWR,RPWR,BAT,LBAT,IBAT,DETRF,TEMP,TXC,RXC,A CK,PROBE,REMOTE, ADC1-ADC6,XADC1-XADC6,SS/ch/loc Where BIT = (inputs)DTR RTS IN1 IN2 IN3 IN4 (inputs)XIN1,XIN2...XIN32, XINPB (outputs)DSR CTS RING MCLK MDIR MSET RO1 RO2 SW12V (outputs)Xout1,XOUT2...XOUT10 (Status Bits)BIT0 ... BIT15 (Timers)T1,T2...T8 (Counters)C1,C2...C8 (Accumulators)A1,A2...A24 (Logical Operators) '&'=AND, ' '=OR, '!'=NOT		
<b>FACTORY,DEFAULT,INIT</b>	Restores the factory default parameters.		
<b>FILES</b>	Show current working drive and directory.		
<b>FILES,x</b>	Change current working drive.		
<b>FILES,{CD,CHDIR}{,dir}</b>	Change or report current working drive and directory.		



<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>FILES</b> ,{MD,MKDIR},dir	Make new directory.		
<b>FILES,DIR</b> {,dir}	Lists files in current or specified directory.		
<b>FILES</b> ,{RD,RMDIR},dir	Deletes (removes) a directory.		
<b>FILES,COPY</b> ,src,dst	Copies a file.		
<b>FILES,MOVE</b> ,src,dst	Moves a file.		
<b>FILES</b> ,{DEL,ERASE},file	Deletes a file or directory.		
<b>FILES,REN</b> ,src,dst	Rename a file or directory.		
<b>FILES,TEST</b> ,file,len	Create a test text file of specified length.		
<b>FILES,TYPE</b> ,file	Displays the contents of a file.		
<b>FLOODTIMEOUT</b> {,tt}	Displays or sets flood timeout in minutes.		
<b>FLUSHMSG</b>	Delete all messages from all queues.		
<b>FLUSHRXQ</b> {,name}	Delete all messages from “name” from RX queue.		
<b>FLUSHTXQ</b> {,name}	Delete all messages from “name” from TX queue.		
<b>*FULL DUPLEX</b>	Set MCC-6100 in full-duplex mode.  <b>IMPORTANT</b> Use this command only if directed to do so by your System Administrator. When set to full-duplex mode, the MCC-6100’s receiver is disabled by the built-in Tx/Rx switch.		
<b>GATEWAY</b>	UAIS MSC port Gateway mode on,off		
<b>GENERIC</b>	Show settings		
<b>GENERIC</b> ,Port,TYPE,{AUTO,LINE,OFF}	This command selects whether the report is in a single line format or multiple line format. AUTO specifies single line with free-format, and LINE specifies the multiple line format. The OFF option is provided to turn off a previously set-up port.		
<b>GENERIC</b> ,Port,GROUP,AUT	The AUTO group numbering will start at group		

<b><i>MRC-565 COMMANDS TABLE</i></b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>O</b>	number 1 and increment by 1 for each 16 sensor values.		
<b>GENERIC,Port,GROUP,LINE,1stGrpNo,START,END</b>	The LINE option allows the group number to be within the data at the given line number and between the given start and end column numbers.		
<b>GENERIC,Port,GROUP,FIXED,GrpNo</b>	The FIXED option will use the Line Number parameter as the first group number then increment by 1 for each 16 sensor values.		
<b>GENERIC,Port,GROUP,SCALE,{FLOAT,INT}</b>	The SCALE option will scale sensor values by the factor given. (Default scale is “1”.)		
<b>GENERIC,Port,DATE,AUTO</b>	The AUTO date option will use the MCC-6100 internal Date.		
<b>GENERIC,Port,DATE,LINE,LineNo,START,END{,MM/DD/YY}</b>	The LINE option allows the date to be within the data at the given line number and between the given start and end column numbers.	The FORMAT is optional, and shows a “template” of the date format. It can be “MM/DD/YY”, “YY/MM/DD”, “MMDDYY”, “YYMMDD”. If the format is not given it will default to the “MM/DD/YY” format.	
<b>GENERIC,Port,TIME,AUTO</b>	The AUTO time option will use the MCC-6100 internal time.		
<b>GENERIC,Port,TIME,LINE,LineNo,START,END,{,HH:MM:SS}</b>	The LINE option allows the time to be within the data at the given line number and between the given start and end column numbers.	The FORMAT is optional, and shows a “template” of the time	

<b><i>MRC-565 COMMANDS TABLE</i></b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
		format. It can be “HH:MM:SS”, “HH:MM”, “HHMMSS”, “HHMM”. If the format is not given it will default to the “HH:MM:SS” format.	
<b>GENERIC,Port,SENSOR,AUTO</b>	In AUTO mode, sensor values are delimited by blanks or commas and there may be several per line.		
<b>GENERIC, P, SENSOR, AUTO, 1stSenLineNo, START</b>	If the line number is given, data can start on other than the 1 <sup>st</sup> line.		
<b>GENERIC, P, SENSOR, LINE,1stSenLineNo,START,END</b>	if the start parameter is given, data can begin in a column other than the 1 <sup>st</sup> column.		
<b>GENERIC,Port,POLL,OFF</b>			
<b>GENERIC,Port,POLL,POLLSTRING,Interval</b>	The polling feature can be used for data loggers that do not print a data report unsolicited, but require some command string to be sent to request the next report. The poll string can be any printable ASCII characters up to 20 bytes in length. The INTERVAL parameter is given in decimal and is the number of seconds between outputting the poll string.		
<b>GENERIC,Port,REPORT,OFF</b>			
<b>GENERIC,Port,REPORT,Report String</b>	The report string allows the definition a fixed string of printable ASCII characters that is at the beginning		

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
	of each new set of report characters. This is useful for ignoring bursts of non-report text. Each report is started with the report string and ends with the timeout parameter.		
<b>GENERIC</b> ,Port,COMMAND, Command String	If the data logger can accept commands as a single line of text (no embedded <cr><lf>) without having to be locally present at the data logger to type keys into a menu, then this capability may be just the ticket. When a remote command is received by the MCC-6100, it will output the <i>Command String</i> bytes to the data logger preceded and followed by a carriage return and line feed. The response text, up to 1024 bytes, will be captured and returned to the originating modem as a remote command response message.		
<b>HALFDUPLEX</b>	Set MCC-6100 in half-duplex mode. (default setting)		
<b>HELP</b> {,command}	Display help information on specified command. If no parameter entered, all commands are sequentially displayed in alphabetical order.	command = valid MCC-6100 command	
<b>*HOLD</b>	Select message hold mode.		
<b>HOLDOFF</b> {,n}	Time to hold off selecting a Master Station in minutes.		
<b>HOST MODE</b> {,mode}	Define host mode functionality in composite networks when host link is not available.	<b>STOP</b> = stop transmitting if host connection lost <b>CONTINUE</b> = keep transmitting if host connection lost, but set bit flagging loss in	

<i><b>MRC-565 COMMANDS TABLE</b></i>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
		probe <b>OFF</b> = ignore host connection state; keep transmitting and do not set bit flagging loss in probe	
<b>HOSTSEGFWD</b> {,on,off}	Enable/Disable multi-Master segment mode.		
* <b>HOURLIES</b> {,action}	Turn on/off hourly statistics.	action = <b>ON</b> – enable <b>OFF</b> – disable	
<b>HTTL</b> {,n}	Set Host port timeout in minutes.		
If device = Remote: Normal operation * <b>ID</b> {,nnn,mmm{,mode} {,INIT}}	Set MRC 525’s assigned Master Station ID to number “nnn”. When no parameters are given, current ID is displayed. When system is already initialized, you must enter the <b>INIT</b> parameter to change ID. <b>INIT</b> gives “OK” to save configuration and reboot unit with new ID. ID changes are automatically saved with the entire configuration in CPM. “mode” parameter (if used) specifies initial connectivity with specified Master. <b>AUTO</b> means no connectivity established. <b>PREF</b> means Remote considers connectivity established. <b>FIXED</b> (Default) means connect only with specified Master. <b>MULTI</b> means Remote can connect to multiple Master Stations.	nnn = Remote ID mmm = Master ID mode mode = <b>AUTO</b> , <b>PREF</b> , <b>FIXED</b> , or <b>MULTI</b> <b>INIT</b> = initializes ID change	<b>256 – 4095</b> <b>1 – 245</b>
<b>NOTE</b> Remote and Master IDs are kept in CPM, and mode is kept in RAM.	<b>NOTE</b> If command does not change the ID or Master Station, the <b>SAVE</b> and reboot are not performed.		

<b>MRC-565 COMMANDS TABLE</b>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
<b>ID,mode</b>	Change “mode” as discussed above without affecting ID; no reboot performed.	mode = <b>AUTO, PREF, FIXED, or MULTI</b>	
If device = Master: <b>*ID{,nnn{,INIT}}</b>	Set MRC-565’s assigned Master Station ID to number “nnn”. When no parameters are given, current ID is displayed. When system is already initialized, you must enter the <b>INIT</b> parameter to change ID. <b>INIT</b> gives “OK” to save configuration and reboot unit with new ID. ID changes are automatically saved with the entire configuration in CPM.  <hr/> <p style="text-align: center;"><b>CAUTION</b></p> If you enter <b>INIT</b> , you will lose all current message information. <hr/>	nnn = assigned Master ID <b>INIT</b> = initializes ID change	<b>1 – 245</b>
<b>INICHECK,{SCRIPT}</b>	Check CIM signature with current configuration signature and reports results. If the <b>SCRIPT</b> option is entered, automatically run script from CIM if signatures are not equal.		
<b>INIPRINT</b>	Display command lines saved in the CIM.		
<b>INIRUN</b>	Force scripting from the CIM.		
<b>INISTOP</b>	Stop writing command lines to CIM. This command terminates the <b>INIWRITE</b> command.		
<b>INIWRITE</b>	Copy all Command lines, following this one, to the CIM. Use the <b>INISTOP</b> command to finish copying lines to the CIM.  <hr/> <p style="text-align: center;"><b>NOTE</b></p> Commands entered after INIWRITE are not processed by the MCC-6100 but redirected to CIM		

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
	until the INISTOP command is entered.		
<b>IP</b>	Show Port IP address.		
<b>IPC or IPCONFIG</b>	Show only IP Settings IPCONFIG,E1,{off,192.168.16.30} IPCONFIG,E1,DHCP,{ON,OFF} IPCONFIG,E1,DHCPSERVER,{ON,OFF} IPCONFIG,GATEWAY,192.168.16.2 IPCONFIG,SUBNETMASK,255.255.255.0 IPCONFIG,TXRATE,{10,100}		
<b>LINKSTAT</b>	Show the complete linkstat table. The up arrow “^” next to the unit ID denotes the current neighbor(s). The dash “-” means that the unit(s) is declared as neighbor down, or is being received over the RF link.		
<b>LINKSTAT</b> ,{M}asters, {B}rief			
<b>LINKSTAT</b> ,{R}emotes, {B}rief			
<b>LINKSTAT</b> ,{U}p,{B}rief			
<b>LINKSTAT</b> ,{D}own,{B}rief			
<b>LINKSTAT</b> ,id1,id2, , , id1-2. . . {B}rief			
<b>LIST</b>	Show all Nodes with Monitor on.		
<b>LISTM</b> {,nnnn...}	Display Remotes with burst monitor bit set (all Remotes or given IDs up to 12).	nnnn = Station ID Master = <b>1 – 245</b> Remote = <b>256 - 4095</b>	<b>1 – 4095</b>
<b>LOCATION</b> {lat,lon,{alt(meters)}}}	Set/display the position information (latitude, longitude). You can enter the location information manually to calculate distance, etc from the other radios when there is no GPS connected physically to	Format example>47:14.1234N, 122:16.7812W	

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
	the radio. The radio will not transmit the position information if there is no GPS connected, you can use “UPDT, POS” to transmit your location information. Example: 47:14.1234N,122:16.7812W,12.89		
<b>LOCK</b> ,{ID,CHANNEL,CONF IG}	Lock the ID, Channel, Config settings. Valid radio ID must be entered to lock the ID structure. Valid frequency CHANNEL must be entered to lock the Channel structure. Valid Serial Number, Customer ID, DSP image must be entered to lock the Channel structure.		
<b>LOGOFF</b>	Used to disallow operator commands with automatic 10 minute timeout for LOS role and 60 minute timeout for <b>TRANSPOND</b> role. Logs you off, disables ALL following operator commands except <b>LOGON</b> , <b>\$PENTM</b> , or <b>SDATA</b> .		
<b>LOGON</b> ,password	<b>LOGON</b> used to allow operator commands. To log onto a unit, enter the <b>LOGON</b> command followed by the current password. This will remain in effect for a timeout period (10 or 60 minutes depending on operating mode), or until you log off. Default = MCC-6100	Password = 3-20 character password	<b>A-Z, 0-9, -</b>
<b>*LOS CHECKIN</b> {,ii,rr}	Select check-in interval (in seconds) and retry count for LOS operation.	ii = interval rr = retry	<b>1 – 65535</b> <b>1 – 65535</b>
<b>LPM</b> {,OFF} LPM,SP	Turns LPM OFF LPM,SP  Receiver Front End fully operational. Main Processor and DSP go to lowest power state, Ethernet turned off. DSP and CF wake up when FPGA detects a signal above FPGAHI	LPM,OFF LPM,SP1	



<b>MRC-565 COMMANDS TABLE</b>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
	<p>threshold. Timer and Alarm can also turn everything on. Estimated Receive Current is 80ma. An internal Timer will wake up main processor for 1 sec every 10 seconds to allow a keypad entry to wake up device. Tapping a key continuously for up to 10 seconds will wake up device for 20 seconds after last keypad entry.</p> <p><b>LPM,ALARM</b> Same as SP except Receiver front (DSP,ADC,RX CLOCK) turns off if nothing in TXQ. CPLD Timer or Alarm turns everything back on. Estimated Receive Current is 60ma. When TXQ has data, same current as in LPM,SP</p> <p><b>LPM,PWR</b> Same as SP2 except Power to entire radio is turned off. Alarm clock or Ignition wire set to (2 to 12V). Estimated Current is 2 ma. This mode is the same as that in 545B.</p>	<p>LPM,SP2</p> <p>LPM,PWR</p>	
<b>MAINTMON</b> ,id	Define Maintenance monitor node ID.		
<b>MEM</b>	Show usage of dynamic pool memory.		
<b>MESSAGE</b> {,p{,dest1...destn}}	Enter a message with text editor. Message priority and destination are optional parameters. After entering message, press [ESC] to queue for transmission. If you do not enter a destination ID, the MCC-6100 automatically sends your message to its default destination (set with the <b>DESTINATION</b> command). If you want to use source routing, enter	<p>p = priority dest1...destn = destination(s) name = node name nnnn = Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b></p>	<p><b>A – Z, 0 – 9</b></p> <p><b>A – Z, 0 – 9</b> <b>1 – 4095</b></p>

<i>MRC-565 COMMANDS TABLE</i>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
	<b>0</b> for the destination.		
<b>MM</b> {,count,{HIST,DIST}}	Print current value of RF signal on Receiver in dBm.		
<b>MODE</b>	Print operating mode information.		
<b>MON</b> {,d{,r}}	Turn on burst monitor. Only meteors lasting long enough to deliver “d” characters will be monitored. If at least “r” characters were received, a monitor line is generated.	d = duration character count limit r = received character count limit	<b>0 – 32767</b> <b>0 – 32767</b>
<b>MONITOR</b> {action{,nnn {,nnn,...,nnn}}}	Control monitoring of individual units and print burst statistics. Overrides <b>MONOFF</b> command and causes monitor lines to print for each reception from this unit.	action = <b>ON</b> – enable <b>OFF</b> – disable nnn = units to be monitored <b>ALL</b> – default Master = <b>1 – 245</b> Remote = <b>256 - 4095</b>	<b>1 - 4095</b>
<b>MONOFF</b>	Turn off burst monitor		
<b>*MSG</b>	Display and delete top operator message in receive queue when message <b>HOLD</b> is enabled.		
<b>MSTUP,ID</b>	Force Master Neighbor up		
<b>MSTDOWN,ID</b>	Force Master Neighbor down		
<b>MSTSEL</b>	Force Master selection. Used in LOS Protocol only		
<b>NET</b>	Display network routing table for all selected neighbors. <b>NET</b> – no neighbors <b>NET1,2</b> – 1,2, etc., neighbors <b>NET,all</b> – all neighbors		
<b>NETMON,ON,OFF}</b>	Network monitor		
<b>NEWPASSWORD,old password, new password</b>	Used to change the password. The <b>NEW PASSWORD</b> command is used to change the internal stored password. You must be logged on and know	password = 3-20 character password	<b>A-Z, 0-9, -</b>

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
	the old password. The password will automatically be saved.		
<b>NHL</b> ,starthour,duration	24 hour noise history - 5min averages - hourly averages - date stamp		
<b>NHHA</b> ,starthour,duration	Noise history hourly averages - hourly averages - date stamp		
<b>NHCLR</b>	Clear noise history buffer.		
<b>OPEN PORT</b> ,port	Resume activity on specified closed port. You can enter more than one port name to open, using commas to separate the names on the same line.  <b>CAUTION</b> The <b>OPEN/CLOSE PORT</b> commands directly affect MRC-565 6100 network activity and message flow. Do <b>NOT</b> use these commands unless directed to do so by your System Administrator.	function = user interface function	RS-232 functions <b>MNT, POS, ALT, DTA</b> Ethernet1 func. <b>E1F1, E1F2, E1F3, E1F4</b> Ethernet2 func. <b>E2F1, E2F2, E2F3, E2F4</b> USB functions <b>U1F1, U1F2, U1F3, U1F4</b>
<b>*P</b> {,?/sec/ <b>OFF</b> }	LOS MODE only. Configures MRC-565 for pulse probe mode. If no parameters are entered, transmit single pulse probe. Enter transmit single pulse probe. Enter <b>P</b> ,? to display current pulse probe mode settings. Enter <b>P</b> ,xxx to send a single periodic probe once every “xxx” seconds. Enter <b>P</b> , <b>OFF</b> to turn off	? = current settings sec = periodic pulse period (in seconds) <b>OFF</b> = turn off periodic pulse mode	

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
	periodic pulse mode (you can still transmit single pulses with <b>P</b> ).		
<b>PAKBUS</b>	Show PAKBUS Protocol Settings. Use with CR1000		
<b>PAKBUS, ID, n</b>	Sets PAKBUS ID	n	N = 1 to 4095
<b>PAKBUS, INT, mm</b>	Route Broadcast Interval	mm	MM= 1 to 3600
<b>PAKBUS, INF, iii</b>	Max # of hops in network	iii	Iii= 1 to 100
<b>PASSTHRU</b>	Show settings PASSTHRU, P1#, P2# PASSTHRU, OFF, P# PASSTHRU, OFF		
<b>PASSWORDMODE, action, password</b>	Used to enable/disable use of passwords. Default is disabled. To enable or disable the operation with passwords, enter this command giving the desired action along with the current password for the unit. This will trigger an automatic “save” operation. If set to the ON mode, the state of the unit will be set to “logged-off”. All operator and remote commands except scheduled commands, <b>\$PENTM</b> commands, and <b>\$DATA</b> commands will respond with “ACCESS DENIED!”. You will not be able to turn off the mode without first logging on.	action = <b>ON</b> – enable <b>OFF</b> – disable password = 3-20 character password	<b>A-Z, 0-9, -</b>
<b>POLL, {OFF, {interval, offset, duration, retry} }</b>	Define/display polling schedule for Base/Repeater Station.	interval = polling interval in seconds offset = offset from top of minute duration = length of poll retry = retry count for	<b>1 – 86400</b> <b>1 – 59</b> <b>1 – 10</b> <b>1 – 99</b>

<i><b>MRC-565 COMMANDS TABLE</b></i>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
		failed polls	
<b>PORTROUTING</b> {,ON,OFF}			
<b>*POS</b> {,interval,format,protocol}	Display/initialize internal MRC 565 timing for reporting GPS position data. Specify update period in seconds, in either binary or text format, using given protocol.	interval = reporting interval in seconds format = display format protocol = GPS unit protocol	<b>0 – 65535</b>  <b>BINARY, TEXT NMEA, ARNAV, TAIP, TRANSAS</b>
<b>POS,LOCAL</b> {,interval}	Display/initialize timing for local output of position reports on MNT and DTA ports as well as sending them.	interval = reporting interval in seconds; <b>OFF</b> disables local output	<b>1 – 86400</b>
<b>POS</b> {additional commands}	POS,COPY,Port# POS,AUTO,miles,min seconds,max seconds POS,AUTO,{ON,OFF} POS,GPS,Cc,p POS,HIGH - Precision POS,LOW - Precision POS,HDOP,OFF POS,HDOP,ON, x.x, y.y - WHERE: low=x.x high=y.y POS,HOLD,{ON,OFF} POS,LOCK,on,speed(m/s),dist(m) POS,SPEED,mm - manual test speed over-ride POS,SCALE,f.ff - rrc scaling POS,RXDIFF,OFF POS,RXDIFF,ON,{ALL,MASTER}		
<b>POSRPT</b> {,action}	Enable/disable echoing of intercepted position	action =	

<b>MRC-565 COMMANDS TABLE</b>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
	<p>reports to local MNT and DTA ports. Also used to enable/disable duplicate filtering and control format of these reports.</p> <hr/> <p style="text-align: center;"><b>IMPORTANT</b></p> <p>Do not use <b>POSRPT,ON</b> command at a Base Station.</p> <hr/>	<p><b>ON</b> – enable  <b>OFF</b> – disable  <b>DUPL,ON</b> – enable duplicate filtering  <b>DUPL,OFF</b> – disable duplicate filtering  <b>FORMAT,LONG</b> – output report on two lines  <b>FORMAT,SHORT</b> – output report on one line  <b>DIST,nnn</b> – set minimum distance for reporting</p>	
<b>PRE</b>	Shows status of preamble bits in the TX frame.		
<b>PRE,TOTAL BYTES,NUMBER NULLS,BIT PATTERN</b>	Define your own preamble pattern of 1's and 0's.	<p>BIT PATTERN =                      1 = 01010101                      2 = 00110011</p>	
<b>PRG,ID,ID,ID,.....</b>	Purge Master ID defs		
<b>*PRINT</b>	Enable messages to print as they are received.		
<b>PRIORITY,message type,p</b>	Priority for GLOF Reports F	<p>message type =  <b>FLOOD, ALERT, ROUTINE</b>                      p = priority</p>	<b>A – Z, 0 – 9</b>
<b>PTO</b>	Power Time Out      Power Down Delay in seconds		<b>Off, 1-34,464</b>
<b>PTW</b>	Power wakeup      Power wakeup interval in seconds		<b>1-86000</b>
<b>RCT,{on,off}</b>	Remote Control Terminal		
<b>REMCMD</b>	With the text editor, enter a command to be sent to a	p = priority	<b>A – Z, 0 – 9</b>

<i>MRC-565 COMMANDS TABLE</i>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
,p,dest1 {,...destn}	Remote. After entering command, press [ESC] to send the command.	dest1...destn destination(s) name = node name nnnn = Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b>	<b>A – Z, 0 – 9</b> <b>1 – 4095</b>
<b>REG</b>	Show Registration data		
<b>REG,TX</b>	Transmit REG report to Default Destination		
<b>REMDOWN,ID</b>	Force Remote Neighbor down		
<b>REMOTES{,n}</b>	Maximum number of remotes	n= # of remotes	<b>1-4095</b>
<b>REMUP,ID</b>	Force Remote Neighbor up		
<b>REMOTE STAT {,nnnnn...}</b>	Display transmit/receive statistics for all Remote Stations or for given IDs (up to 12).	nnnn = Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b>	
<b>REMOTE TYPE{,aaaaa}</b>	Display/set communication characteristics of the unit. Determines how certain statistics are reported and how remote commands/messages are framed.	aaaaa = <b>COMM</b> <b>DATA</b> <b>PACKET</b>	
<b>RESET</b>	Resets the DSP and FPGA Processors. Does not affect CF		
<b>REV</b>	Display part and revision numbers of the: Main Processor CF DSP Processor FPGA Processor. CPLD Gate Array		
<b>*ROLE{,role{,low,high} {,mode}}</b>	Define role played in network, either <b>SILENT</b> (never transmits), <b>TRANSPOND</b> (responds to probes), <b>PROBE</b> (actively probes), or <b>LOS</b> (line of sight)	role = <b>SILENT, LOS,</b> <b>TRANSPOND</b> or <b>PROBE</b>	

<b>MRC-565 COMMANDS TABLE</b>																																																																																			
COMMAND	DESCRIPTION	PARAMETERS	RANGE																																																																																
<b>NOTE</b> Role is kept in CPM, and low,high and mode are kept in RAM.	<p>mode. If role is set to <b>TRANSPOND</b>, the low and high parameters can be used to specify the threshold values for automatic meteor burst vs. line of sight modes of operation and the mode parameter can set the starting mode (meteor burst or line of sight).</p> <p>Thresholds are specified in idle probes per minute. To prevent <b>LOS</b> operation altogether, set the low threshold to <b>1000</b> if the unit's Master is half duplex or <b>5500</b> if it is full duplex.</p>	<p>low = threshold for switching from <b>LOS</b> to <b>MB</b> mode in idle probes per minute</p> <p>high = threshold for switching from <b>MB</b> to <b>LOS</b> mode in idle probes per minute</p> <p>mode = <b>MB</b> or <b>LOS</b></p>	<b>0 – 32767</b>  <b>0 – 32767</b>																																																																																
<b>RR</b> ,{on,off}	Remote Relay On or Off																																																																																		
<b>RTCM</b> {,nnn}	Define time latency in seconds between beacon receiver and local time. Without parameter, display report of satellites in view by beacon receiver.	nnn = latency in seconds	<b>0 – 59</b>																																																																																
<b>RXSTAT</b>	Shows stats for each receiver that is defines	Up to 3																																																																																	
<b>RXTYPE</b>	Display Receiver Type MRC-565																																																																																		
<b>RXTH</b>	Display Receiver Threshold																																																																																		
<b>SAVE</b>	Save <b>CONFIG</b> parameters in CPM. Reboot of MCC-6100 (or restart due to software failure) returns unit to configuration saved in CPM.																																																																																		
<b>SCALE</b>	<p>Chan</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Chan</th> <th style="text-align: left;">Scale</th> <th style="text-align: left;">Offset</th> <th style="text-align: left;">Raw ADC</th> <th style="text-align: left;">Cal Value</th> </tr> </thead> <tbody> <tr> <td>VBAT</td> <td>0.0048800</td> <td>0.0000</td> <td>2598.0000</td> <td>12.678240</td> </tr> <tr> <td>PA_VF</td> <td>0.0000221</td> <td>0.0000</td> <td>1.0000000</td> <td>0.0000221</td> </tr> <tr> <td>PA_VR</td> <td>0.0000221</td> <td>0.0000</td> <td>0.0000000</td> <td>0.0000000</td> </tr> <tr> <td>PATEMP</td> <td>0.8820000</td> <td>0.0000</td> <td>0.0000000</td> <td>0.0000000</td> </tr> <tr> <td>3.3V</td> <td>0.0012207</td> <td>0.0000</td> <td>2686.0000</td> <td>3.2788002</td> </tr> <tr> <td>1.8V</td> <td>0.0012207</td> <td>0.0000</td> <td>1450.0000</td> <td>1.7700150</td> </tr> <tr> <td>1.5VCF</td> <td>0.0012207</td> <td>0.0000</td> <td>1132.0000</td> <td>1.3818324</td> </tr> <tr> <td>3.3DSP</td> <td>0.0012207</td> <td>0.0000</td> <td>2671.0000</td> <td>3.2604897</td> </tr> <tr> <td>1.6DSP</td> <td>0.0012207</td> <td>0.0000</td> <td>1218.0000</td> <td>1.4868126</td> </tr> <tr> <td>1.2VFP</td> <td>0.0012207</td> <td>0.0000</td> <td>976.00000</td> <td>1.1914032</td> </tr> <tr> <td>ADC1</td> <td>1.0000000</td> <td>0.0000</td> <td>0.0000000</td> <td>0.0000000</td> </tr> <tr> <td>ADC2</td> <td>1.0000000</td> <td>0.0000</td> <td>0.0000000</td> <td>0.0000000</td> </tr> <tr> <td>ADC3</td> <td>1.0000000</td> <td>0.0000</td> <td>0.0000000</td> <td>0.0000000</td> </tr> <tr> <td>ADC4</td> <td>1.0000000</td> <td>0.0000</td> <td>0.0000000</td> <td>0.0000000</td> </tr> <tr> <td>ADC5</td> <td>1.0000000</td> <td>0.0000</td> <td>0.0000000</td> <td>0.0000000</td> </tr> </tbody> </table>	Chan	Scale	Offset	Raw ADC	Cal Value	VBAT	0.0048800	0.0000	2598.0000	12.678240	PA_VF	0.0000221	0.0000	1.0000000	0.0000221	PA_VR	0.0000221	0.0000	0.0000000	0.0000000	PATEMP	0.8820000	0.0000	0.0000000	0.0000000	3.3V	0.0012207	0.0000	2686.0000	3.2788002	1.8V	0.0012207	0.0000	1450.0000	1.7700150	1.5VCF	0.0012207	0.0000	1132.0000	1.3818324	3.3DSP	0.0012207	0.0000	2671.0000	3.2604897	1.6DSP	0.0012207	0.0000	1218.0000	1.4868126	1.2VFP	0.0012207	0.0000	976.00000	1.1914032	ADC1	1.0000000	0.0000	0.0000000	0.0000000	ADC2	1.0000000	0.0000	0.0000000	0.0000000	ADC3	1.0000000	0.0000	0.0000000	0.0000000	ADC4	1.0000000	0.0000	0.0000000	0.0000000	ADC5	1.0000000	0.0000	0.0000000	0.0000000		
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ADC4	1.0000000	0.0000	0.0000000	0.0000000																																																																															
ADC5	1.0000000	0.0000	0.0000000	0.0000000																																																																															



<b>MRC-565 COMMANDS TABLE</b>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
	ADC6      1.0000000   0.0000   0.0000000   0.0000000 +		
<b>SCALE</b> ,parameter,value{,offset}	Display set A/D scaling factors for the unit. Factors depend on type of receiver and power supply used in the MCC-6100.	parameter = <b>VBAT</b> – battery voltage <b>PA_VF</b> – PA Fwd Pwr <b>PA_VR</b> – PA Rev Pwr <b>PA_TEMP</b> - PA Temp <b>3.3V</b> <b>1.8V</b> <b>1.5VCFC</b> <b>3.3VDSP</b> <b>1.6VDSPC</b> <b>1.2VFPGAC</b> <b>ADC1, . . . ADC6</b> value = scale factor	
<b>SCHED</b>	Display all scheduled commands		
<b>SCHED</b> {,basis, hh:mm:ss {, <b>OFFSET</b> ,hh:mm:ss}, command string}	Schedule execution of the specified command string. If timeframe basis = <b>INTERVAL</b> , the command string will be executed whenever the specified time interval elapses during the day. If timeframe basis = <b>TIME</b> , the command string will be executed at the specified time. The <b>OFFSET</b> option allows specification of an offset from the timeframe basis.	basis = <b>TIME</b> or <b>INTERVAL</b> hh - hours mm - minutes ss - seconds	<b>0 – 23</b> <b>0 – 59</b> <b>0 – 59</b>
<p style="text-align: center;"><b>IMPORTANT</b></p> <p>Up to 50 commands can be scheduled. Do not schedule commands that require user interaction (such <b>MESSAGE</b></p>			

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
and <b>REMCMD</b> ), or any commands that change port configurations.			
<b>SCHED,DEL,nn</b>	Delete specified schedule item number. If nn = <b>ALL</b> , the entire schedule will be cleared.	nn = schedule item number	<b>1 – 50</b>
<b>SDATA,g,c,time stamp, value...</b>	Enter an MCC-550C data report directly from the serial I/O port. Up to 16 values may be entered. Use the <b>LINK</b> command to route the data. Enter 00000000 in Time Stamp to use current time.	g = group number c = sensor count  time stamp = mdddhhmn  value = ASCII hex sensor value	<b>1 – 4</b>  <b>1 – 16</b>  mm <b>1 – 12</b> dd <b>1 – 31</b> hh <b>0 – 23</b> mn <b>0 – 59</b>  <b>0 – FFFF</b>
<b>SERIAL{,sss}</b>	Set next packet serial number. Parameter “sss” is serial number of last packet transmitted.	sss = message serial number	<b>1 – 255</b>
<b>SERIALNUMBER{,sn}</b>	Display/Set serial number of this modem		
<b>*SET BAUD</b> {,function,baud,parity,data,stop,flow}	Adjust baud rate and flow control of specified port. When no parameters are entered, this command displays I/O configurations.	function = user interface function  baud = baud rate parity data stop flow = flow control	<b>ALT,C&amp;S,DTA,MNT,MSG,POS</b> <b>50-115200</b> <b>O/E/N</b> <b>5/6/7/8</b> <b>1/2</b> <b>Y or N</b>

<b>MRC-565 COMMANDS TABLE</b>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
<b>SHOW REMOTES</b>	Display ID and assigned 520/525 of each Remote in system.		
<b>SHOW RXQ</b> ,nnnn	Display contents of receive queue for the originating Station.	nnnn = originating Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b>	<b>1 – 4095</b>
<b>SHOW TXQ</b> ,nnnn	Display contents of transmit queue for the destination Station.	nnnn = destination Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b>	<b>1 – 4095</b>
<b>SIGNALPRESENT</b> {,dBm}	Display/Set Signal Present threshold in dBm.	dBm = <b>-0 to -130</b>	
<b>SIG</b> ,Block,-dbm	Enter the threshold in dbm for each block. MANUAL AUTO	Block = DSP FPGAHI FPGALO	
<b>SITENAME</b> {,name}	Display/Set Site name		<b>30 characters</b>
<b>SML</b> {,nnnn}	Display names and serial numbers of message packets in specified message list. If parameter is not entered, all message packet names and numbers are displayed.	nnnn = destination Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b>	<b>1 – 4095</b>
<b>SMS</b> {,nnnn}	Display status of message packet in specified message list.	nnnn = Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b>	<b>1 – 4095</b>
<b>*SNP</b> {pname,value}	Set network parameters. See range column for values entered for each parameter.	pname = <b>TTL</b> time-to-live (truncated to nearest 10 minute boundary)  <b>TTR</b> time-to-retransmit	<b>0 – 2550</b> min. default = <b>120</b>  <b>0 – 255</b> min. default = <b>20</b>  <b>1 – 255</b> acq.
<p style="text-align: center;"><b>NOTE</b></p> <p>Some network parameters are only for use in Master Operation mode (<b>RDOWN</b>, <b>CONNP</b>, <b>TEXTL</b>, <b>FLOODP</b>, <b>INF</b>, <b>RELAY</b>).</p>			

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<p><b>NOTE</b>  <b>TTL, TTR, NUP, NDOWN, RDOWN, OTL, HTO, TEXTL, CONNP, ETEAP, FLOODP, RELAY</b> and <b>INF</b> are kept in CPM; <b>DATAP</b> and <b>MBHOP</b> are kept in RAM.</p>		<b>N UP</b> neighbor up	default = <b>20</b>
		<b>N DOWN</b> neighbor down (minutes or number of transmissions)	<b>1 – 255</b> min. or transmissions default = <b>20</b>
		<b>R DOWN</b> Remote down	<b>0 – 32767</b> default = <b>1440</b>
		<b>OTL</b> outstanding text limit	<b>1 – 255</b> default = <b>20</b>
		<b>CONNP</b> connectivity msg. precedence	<b>0 – 9, A – Z</b> default = <b>1</b>
		<b>ETEAP</b> End-to-End ACK precedence	<b>0 – 9, A – Z</b> default = <b>0</b>
		<b>HTO</b> history file timeout	<b>1 – 255</b> min. default = <b>120</b>
		<b>TEXTL</b> text size in segments	<b>5 – 255</b> default = <b>32</b>
		<b>FLOODP</b> partial flooding precedent	<b>A – I</b> default = <b>A</b>
			<b>2 = 255</b> hop default = <b>8</b>

<b>MRC-565 COMMANDS TABLE</b>			
COMMAND	DESCRIPTION	PARAMETERS	RANGE
		level  <b>INF</b> infinity hop quantity  <b>RELAY</b> relay function control. Use <b>3333</b> in MB networks  <b>DATAP</b> priority of data reports created by 6100  <b>MBHOP</b> meteor burst link hop weight for meteor burst links	Master,Remote  <b>A – Z</b> default = <b>Y</b>  <b>1 – 99</b> default = <b>1</b>
<b>*SOURCE RELAY</b> {,nnnn}	Specify source routing table of one entry. The designated Station will receive all information sent without an explicit destination specification. If set to <b>OFF</b> , such information is discarded.	nnnn = Station ID Master = <b>1 – 245</b> Remote = <b>256 – 4095</b>	
<b>START</b>	Turn transmitter on.		
<b>STAT</b>	Display RF statistics report.		
<b>*STAT TIME</b> {,xx}	Set interval (in hours, starting at midnight) when MCC-6100 automatically transmits statistics to Master Station.	xx = interval	<b>1 – 24</b> hours
<b>STOP</b>	Turn transmitter off.		
<b>STT</b> ,secs	Set command timeout (in seconds). Default is 15 seconds.	secs = time limit before reset ( <b>0</b> -off, <b>&gt;0</b> -on)	<b>0 – 32767</b>

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>SUBNET</b> {,code}	Display/Set subnet code.		
<b>SUBST</b> ,rrr,g1,nnn,g2	Substitute Remote unit information in data reports received from a relay unit.	rrr = relay ID g1 = relay grp# nnnn = Remote ID g2 = Remote grp#	<b>1 – 245</b> <b>0 – 15</b> <b>256 – 4095</b> <b>1 – 4</b>
<b>SUBST,DEL,ALL</b>	Delete entire substitution table		
<b>SUBST,DEL</b> ,rrr,g1	Delete entry in substitution table	rrr = relay ID g1 = relay grp#	<b>1 – 245</b> <b>0 – 15</b>
<b>SWCORR</b>			
<b>SWCTL</b>			
<b>SWMON</b>			
<b>T</b>	Show current date/time.		
<b>TOD</b>	Display Time of Day and Date		
<b>TEST</b>	Displays RF Statistics with TX Keyed		
<b>TEST</b> {,Tx}{,bit pattern,duration,interval}	Send test transmission and return updated statistics.	Bit pattern= 1 = random 2 = all 1's 3 = all 0's 4 = 01010101 5 = 00110011 6 = 00001111 7 = PN9 Sequence CW= no modulation Duration of Tx key Interval is best fit	1-7 & CW         10-10000  30-60000
<b>TESTMODE</b> {,ON,OFF}	Show/set test mode		
<b>TIME</b> {,hh:mm:ss}	Set system time. If no parameters are specified, show current time. If parameters are given, DOS calendar will also be updated.	hh – hours mm – minutes ss – seconds	<b>0 – 23</b> <b>0 – 59</b> <b>0 – 59</b>

<i><b>MRC-565 COMMANDS TABLE</b></i>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>TIMEPROBE</b>	Show current setting		
<b>TIMEPROBE,OFF</b>	Do NOT transmit time probes		
<b>TIMEPROBE,SLOW</b>	Tx Slow Time Probes Like 520B		
<b>TIMEPROBE,FAST</b>	Tx Time Probe once a minute		
<b>TIMESYNC</b>	Show current setting		
<b>TIMESYNC,ON</b>	Sync to ALL Master ID's		
<b>TIMESYNC,OFF</b>	Do Not Sync to Any Master ID's		
<b>TIMESYNC,ID1,ID2...ID10</b>	Sync only to ID's in this list		
<b>TIMESYNC,GPS</b>	Use UTC from GPS		
<b>TIMESYNC,RTCM</b>	Use UTC from RTCM Beacon Receiver		
<b>TIMEZONE{,UTC,sys}</b>	Set local time zone offsets from UTC time (GMT) and system time.	UTC = offset from GMT sys = offset from system time	<b>-12 – 12</b> <b>-12 – 12</b>
<b>TIMEZONE{,+/-UTC,+/-System}</b>	Set/Display UTC and System Time Zone Offsets		
<b>TRACE{,action}{data stream}{,port#}</b>	Diagnostic command used to enable/disable detailed analysis of the specified data stream.	action = <b>ON</b> – enable <b>OFF</b> – disable data stream = <b>RF,GPS,DSP,RTCM, IDLE,NOISE,DEBU G,IPC,TX,RX,Port #</b>	
<b>TRACE,PORT,n</b>	Change output port	n = port number	
<b>*TX LIMIT{,count}</b>	Set limit on number of transmissions allowed in a 15-minute period (in minutes).	count = # of transmissions period = minute	<b>0, 3-32767</b>
<b>UPDT{,function,parameters}</b>	Send update message to data logger type device.	<b>NOTE:</b> Read sensors but do not transmit data read	

<b>MRC-565 COMMANDS TABLE</b>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
		<b>TX:</b> Read sensors and transmit data read  <b>TIME:</b> Set time of Data Logger (CR10X or CR1000)  <b>TEST:</b> Operate component in GLOF test mode: <b>ALERT</b> <b>FLOOD</b> <b>HORN</b> <b>GATE</b> <b>WARNING</b> <b>OUT:</b> Set output register: <b>BYTE</b> <b>BIT,BITNUMBER</b> <b>BITS,STARTBIT,ENDBIT</b>  <b>ARM:</b> Enable alarm activation <b>DISARM:</b> Disable Alarm activation <b>RESET:</b> Reset alarm condition	<b>RM:</b> Routine message format <b>RMP:</b> RMP Message format          value appropriate to the register: <b>0 – 255</b> <b>1 – 8 (bit); 0 - 1</b> <b>1 – 8 (bits); 0 - 255</b>
<b>USB,{on,off}</b>	Turn USB Clock On or OFF Default = on		
<b>VERBOSE{,ON,OFF}</b>	Show/set full/partial command mnemonic		



<i>MRC-565 COMMANDS TABLE</i>			
<b>COMMAND</b>	<b>DESCRIPTION</b>	<b>PARAMETERS</b>	<b>RANGE</b>
<b>VDUREV</b>	Show SW Rev of VDU		

# APPENDIX B: FACTORY DEFAULTS

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**APPENDIX B: FACTORY DEFAULTS**

The following is a list of MRC 565 Parameters that are installed after typing:

**FACTORY,DEFAULT,INIT**

To obtain a list of parameters settings in SCRIPT format for the MRC 565 type:

**CONFIG,SCRIPT**

```

ASSIGN,MNT,0,ASCII,30
ASSIGN,E1F1,4,ASCII,30
ASSIGN,RX1,0
ASSIGN,RX2,1
ASSIGN,RX3,2
BASE,OFF
CAL,ADCGAIN,50
CAL,FREQCAL,510
CAL,CAPTURETHRESH,6
CAL,TRRXLEVEL,255
CANMSGMODE,NOPRINT
CHECKIN,45
CHAN,41.6100,40.6700,1,0
CHAN,41.6100,40.6700,1,1
CHAN,41.6100,40.6700,1,2
CHAN,0
COMPRESSION,OFF
CONTENTION,OFF
CONTENTION,TRACE,OFF
CONTENTION,MIN,62
CONTENTION,MAX,620
CONNECT,OFF
CR10X,ACQMODE,ALL
CR10X,INTERVAL,OFF
CR10X,ORDER,FIFO
CR10X,GROUP,CR10X
CR10X,TIME,CR10X
CR10X,MAXQ,20
CR10X,SCALE,CR10X
CR10X,ME,OFF
CR10XTD,DLOG PORT,-1
CR10XTD,ACQMODE,ALL
CR10XTD,INTERVAL,OFF
CR10XTD,ORDER,FIFO
CR10XTD,GROUP,CR10XTD

```

CR10XTD,TIME,CR10XTD  
 CR10XTD,MAXQ,20  
 CR10XTD,SCALE,CR10XTD  
 CR10XTD,ME,ON  
 CR1000,ACQMODE,ALL  
 CR1000,INTERVAL,OFF  
 CR1000,ORDER,FIFO  
 CR1000,GROUP,CR1000  
 CR1000,TIME,CR1000  
 CR1000,MAXQ,20  
 CR1000,SCALE,CR1000  
 CR1000,ME,OFF  
 CUSTID,00000  
 DEST,00000  
 DEVICE,REMOTE,MAK,ON,ETE,ON  
 DITHER,ON  
 DUTYCYCLE,15,3500,4  
 ETE,ON  
 01/01/00 18:16:07  
 Mode:OFF, Errors:20, Test:0/FIXED, History:5  
 Gcrc:0, Bcrc:0, Gfec:0, Bfec:0, Corrected:0  
 History by Neighbor ID:  
     C:0.00000, T/A: 0.000, MeanErrs: 0.000, Sdev: 0.000  
     FEC State:OFF  
     C:0.00000, T/A: 0.000, MeanErrs: 0.000, Sdev: 0.000  
     FEC State:OFF  
 GATEWAY,OFF  
 HOLDOFF,0  
 HOSTMODE,OFF  
 HOSTSEGFWD,OFF  
 HOURLIES,OFF  
 HTTL,2  
 ID,00500,00002,FIXED,INIT  
 IPCONFIG,E1,192.168.10.1  
 IPCONFIG,E1,DHCP,OFF  
 IPCONFIG,GATEWAY,OFF  
 IPCONFIG,E1,SUBNETMASK,255.255.255.0  
 LPM,OFF  
 LPM,KEYB,10  
 LPM,REMC,10  
 LPM,STOP,3  
 NETMON,ON  
 PAKBUS,ID,0000  
 PAKBUS,INT,60  
 PAKBUS,INF,15  
 PAKBUS,MYHOP,4

POLL,OFF  
 POS,30,TEXT,UBX  
 POS,AUTO,OFF  
 POS,LOW  
 POS,HDOP,OFF  
 POS,HOLD,OFF  
 POS,LOCK,OFF  
 POS,COPY,OFF  
 POS,SCALE,0.0000  
 POS,RXDIFF,ON,ALL  
 POSRPT,ON  
 POSRPT,DUPL,ON  
 POSRPT,FORMAT,LONG  
 POSRPT,DIST,OFF  
 PRE,0  
 PRI,A,B,C  
 PTO,OFF  
 PTW,OFF  
 RECEIVERS,1  
 REMOTES,400  
 REPEATER,OFF  
 RFP,HIGH  
 ROLE,TRANSPOND,100,50,MB  
 RR,OFF  
 RTCM,-13  
 RXTH,-120  
 SCALE,VBAT,0.0048800,0.0000  
 SCALE,PA\_VF,0.0000221,0.0000  
 SCALE,PA\_VR,0.0000221,0.0000  
 SCALE,PATEMP,0.2250000,-58.00  
 SCALE,3.3V,0.0012207,0.0000  
 SCALE,1.8V,0.0012207,0.0000  
 SCALE,1.5VCFC,0.0012207,0.0000  
 SCALE,3.3DSP,0.0012207,0.0000  
 SCALE,1.6DSPC,0.0012207,0.0000  
 SCALE,1.2VFPGAC,0.0012207,0.0000  
 SCALE,ADC1,1.0000000,0.0000  
 SCALE,ADC2,1.0000000,0.0000  
 SCALE,ADC3,1.0000000,0.0000  
 SCALE,ADC4,1.0000000,0.0000  
 SCALE,ADC5,1.0000000,0.0000  
 SCALE,ADC6,1.0000000,0.0000  
 SDI,TRACE,OFF  
 SERIAL,3  
 SIG,DSP,-120  
 SIG,RELSPHI,10

SIG,RELSPLO,3  
SIG,AUTO  
SNP,TTL,120  
SNP,TTR,60  
SNP,NUP,1  
SNP,NDOWN,60,10  
SNP,RDOWN,2  
SNP,OTL,255  
SNP,CONNP,1  
SNP,ETEAP,2  
SNP,HTO,5  
SNP,TEXTL,255  
SNP,FLOODP,A  
SNP,INF,5  
SNP,RELAY,MASTER  
SNP,DATAP,Y  
SNP,MBHOP,4  
SOURCERELAY,OFF  
STATTIME,24  
SUBNET,OFF  
TIMEPROBE,FAST  
TIMESYNC,ON  
TIMEZONE,0,0  
TRACE,PORT:0  
TRACE,DIR,A:\LOGS  
TXLIMIT,200  
USB,ON

# APPENDIX C: EVENT PROGRAMMING

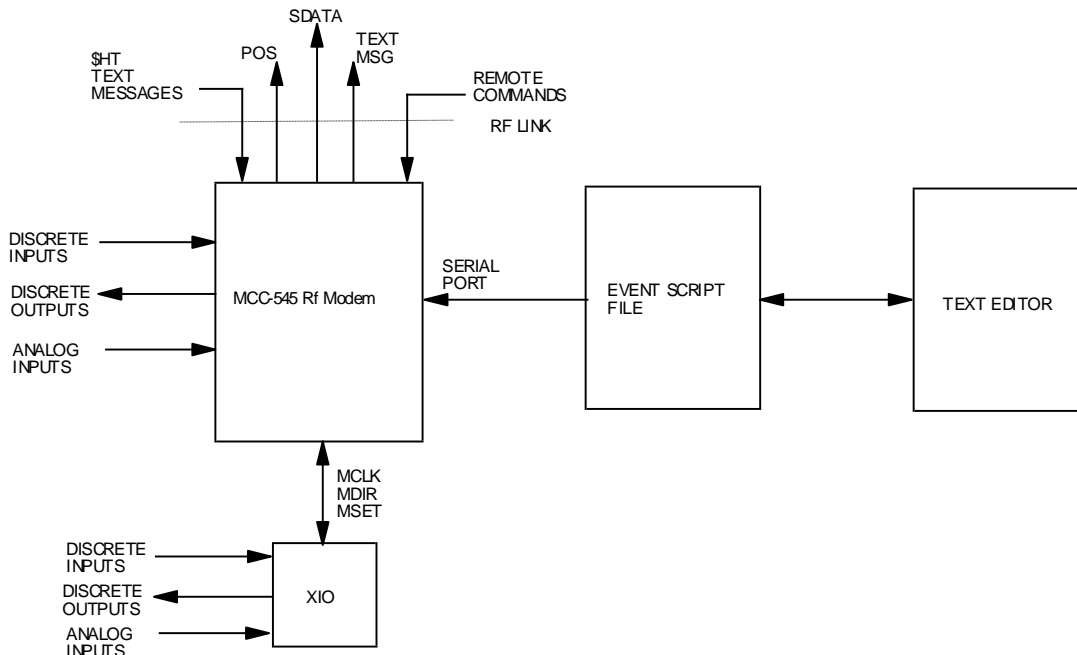
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## APPENDIX C: EVENT PROGRAMMING

The MRC-565 supports customer-programmed event logic. Discrete and analog inputs can be monitored by the event program to detect "*events*" which then perform a defined "*action*". Actions may include the controlling of discrete output signals, incrementing counters, setting timers, and transmission of canned messages and issuance of various reports. This means that customers are somewhat independent of factory reprogramming from MRC and that MRC-565 behavior can be readily modified in the field. It also means that operators now have limited power to make the MRC-565 react to various field-programmable conditions.

The operator sets up the event program when installing the MRC-565 or during maintenance and operation. Because the event program is implemented via operator commands, it can be entered not only at a local maintenance console, but also via the remote command capability. The event programs are stored within a non-volatile table in the MRC-565 battery-backed-up RAM. They are not lost due to external power failure. When the external power is restored, they will be enabled to respond to events again.

Programming is usually done by creating a "script file" of the required event commands, and loading these into the MRC-565 using XTERM or any other terminal emulator software. Several input/output lines are available directly from the processor card of the MRC-565 modems. In addition, an I/O expander card (XIO) can be optionally used which uses 3 lines to implement a high-speed serial link for accessing the signals of the expander card.





## Event Programming Overview

Event programs are composed of signal test and action commands stored in a non-volatile event table. The MRC-565A stores the event table in battery-backed-up-RAM. The MRC-565 and MRC-565C store the event table in FLASH memory.

The operator enters these event commands into the MRC-565. The MRC-565 scans the event table at power-up/reset, and then at every 1/16 second clock interval. It looks for the occurrence of defined events. When a defined event occurs, the MRC-565 invokes the corresponding action commands. The capability includes:

- Testing discrete input lines
- Setting or clearing a discrete output line
- Testing Analog input values
- Transmitting brief text messages
- Execute a local command of up to 40 characters
- Transmitting vehicle position reports
- Transmitting marker drop reports
- Transmitting vehicle collision reports
- Transmitting canned message reports.
- Defining sensor data (SDATA) groups
- Transmitting sensor data (SDATA) reports
- Setting or clearing the MDP Status Bits
- Setting or clearing and testing 5 timers
- Testing GPS status as a discrete input
- Testing Network status as a discrete input
- Setting or clearing and testing counters
- Setting or clearing and testing 2 high-speed counters
- Outputting pulses and square waves (pulse modulation)
- Reading and counting pulse inputs
- Max, Min, Average or other real-time signal computations

The position, marker drop, collision and canned message reports created conform to the FleetTrak standard. In addition other status bits can be set or cleared individually. Up to 16 data report groups can be defined for SDATA formatted data report generation.

The MRC-565 event monitor reads discrete and analog inputs and evaluates them with respect to event definitions in the event table. It can look for discrete input signals going persistently high or low, and for analog signals persistently exceeding or under running thresholds.

## Event definition

An "event" occurs when some input signal or timer changes its state. You can think of a state as being "on" or "off", "1" or "0", "true" or "false". When the state changes, an "action" can then be taken. Once the signal has changed state and the action performed, it will not take further action until the state changes again to prevent a continuous string of actions. For example, if a switch is turned "on", the lights come on and stay on. They don't continually go on, on, on... Once the switch is turned off, the lights can go off, and then they are ready to be turned on again, etc.

There are three classes of events: Reset, Immediate and Scanned. Scanned events subdivide into discrete I/O events and analog input events. These are defined in the following paragraphs.

### Reset Event

A reset event occurs only once when the MRC-565 powered up or reset, when the event monitor task is started for the first time, or is stopped - then restarted. It is a well-defined event that does not need to scan anything in order to determine whether or not a reset has occurred. It occurs once on each power up or monitor-start. There is also no corresponding end to this event. The logical end of this event would be power failure or shutdown, but either such event makes the MRC-565 unable to respond to anything. An action taken on a reset event command will remain as defined in the command until the MRC-565 is reset again or powered off, or until some other event changes the action. Stopping the event monitor will not clear the reset event definitions.

### Command Event

An immediate action can be triggered by entering a local event command from any port, or by remote command sent over the RF link. This type of action does not get stored in the event table and will not be re-issued on power-up or restart. In this way, the operator has the ability to manually override or control conditions in the field. The event state is considered to be "true" as soon as the command is entered or received. Once the action is completed, the event state is set to "false" again.

### Scanned Event

Scanned events are tested on a periodic basis by the monitor task. An input signal that would trigger a scanned event must be repeatedly tested to see if the signal persists at a trigger level before an event is started. A scanned event is started when a signal remains at (or above or below) the trigger level for a defined settling duration. When an event is detected by its input condition persisting at its high state for a settling duration, that event's associated action is triggered and the monitor task begins looking for the end of the event. The end of an event occurs when the event remains at a low state for a defined hold-off duration. After the hold-off duration with the input condition at its low state, the event is enabled to scan for the next event. For example, if an event is testing the battery voltage to be above 5.0 volts, the action will be triggered when the voltage is first detected to be at or above 5.0 volts for the entire settling period. When the voltage goes below 5.0 volts for the hold-off period, it will re-arm the event to

trigger the next time the voltage goes to or above 5.0 volts. The event action is not triggered when the voltage crosses the 5.0 level in the downward direction, only the upward direction. If one wants to detect both voltage crossings, there should be two events defined, one to detect the positive change (ADCHI), and one to detect the negative change (ADCLOW).

The settling and hold-off durations are programmable for each scanned event. They are specified in clock-tick counts where each tick is 62.5 milliseconds, or 1/16 second. Because these durations are programmable, scanned event hysteresis is fully controllable. Given the 62.5 millisecond sampling rate, events are limited to those that persist longer than 62.5 milliseconds but shorter than about an hour duration. Similarly, hold-off times between events must also persist longer than 62.5 milliseconds. Attempting to program events that are briefer than 62.5 milliseconds will prove unreliable. It is important to remember that a scanned event must change slow enough that the event monitor can sample the input line reliably.

The external I/O expander (XIO) has its own processor to scan its event definition table. Its internal "clock-tick" will be set to one millisecond per increment. The MRC-565 will configure the XIO when event commands are processed from the script file. The XIO will monitor its own events and send changes to the MRC-565 using a serial interface.

### **Discrete Event**

A discrete event is determined by whether or not a discrete input signal remains either high or low for the given settling duration. "high" or "low" is a part of the event definition set by the operator. The end of a discrete event occurs when the signal has persistently returned to its previous low or high state for the hold-off duration. For RS 232 signals, "high" is considered the ON state and "low" the OFF state. "high" is also known as SET; "low" as CLR.

The high/low convention follows the voltage level of the input signal. For TTL signals, "high" is a +5 volt level, and "low" is zero volts. For the RS-232 modem-control signals, "high" is +10 volts and "low" is -10 volts. For the GPS input, a "high" is when the GPS is at "V1" or "V2" status, and "low" is when there is no GPS characters being received at the RS-232 port or when the GPS is at the "V0" status. The NET input is "high" when the RF modem is online to a Base or Repeater that is connected to a host system. The NET "low" input indicates the RF modem is offline to a Base or Repeater.

### **Analog Event**

An analog event is determined by whether or not an analog input signal remains above or below a threshold for the given settling duration. "Above" or "below" and the threshold level are also given in the event definition. The end of an analog event occurs when the signal has persistently returned to the non-event side of the threshold for the hold-off duration.

## Action Definition

An "action" can be assigned to each event defined in the event table. When the event condition is detected, the action is initiated. Available actions are defined in the following sections. Multiple actions are supported by defining multiple events that test the same input, but take different action, or multiple actions can be defined using a special "continue" event. The "continue" event does not test the input condition again, but will trigger the action when the event it is connected to detects the event.

Any action can be forced on a timed basis by several methods. One method is to use the MRC-565 scheduler (SCHED command) to trigger the desired immediate action. For example, the UPDT action can be specified by the insertion of the `EVENT, UPDT, group-number` command into the MRC-565 scheduler to produce reports on a timed basis. See the SCHED command for this capability. Another example would be to pulse an output line by placing two commands in the scheduled event list that would first SET then CLR the signal. The duration of the pulse would be controlled by the offset value in the SCHED command. Yet another method is to use an event timer (counter) to facilitate scheduling of actions. Special timer registers are provided for this purpose, and will automatically count down from a non-zero value to zero at a rate of 1/16 seconds per count. An event command can monitor the timer register, and when it reaches zero, the action can be taken, and the timer reset to the next desired time count.

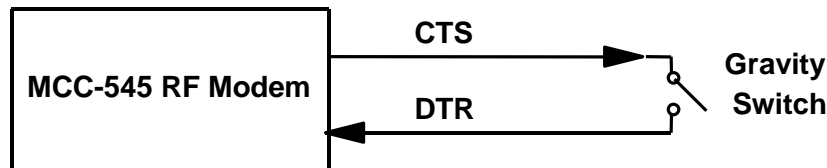
## Programming in Real-Time

Events are programmed via operator commands, one event per command line. It is a multi-step process. Because of this, each event being entered will be a fragment until all event definitions are complete. If the event monitor is allowed to execute a fragment of an event, strange and possibly adverse actions will occur. Therefore, the operator should stop the event monitor when adding events and actions to the event table. The event monitor task can be stopped and started by operator command. The best way to do this is to use a script file containing the stop command, a command to delete all prior definitions, the desired event definitions, and a start command.

Some examples are given below, following these, a detailed description of each event command and action is given.

**Example 1: A Scanned Event - Vehicle Tip-Over Detection**

Suppose the MRC-565 is wired to detect a vehicle tip-over using the CTS and DTR signals and a gravity switch that closes if it does not remain mostly upright. The CTS output is used to enable tip-over detection. The DTR input is the signal on which tip-over event is detected. Normally open, the switch prevents DTR from receiving the CTS signal. If CTS is enabled and the vehicle tips over such that the switch closes, the CTS signal is presented to DTR.



**CTS is set to 5V on power-up, DTR is low if switch is open**

**DTR will go high when the switch is closed**

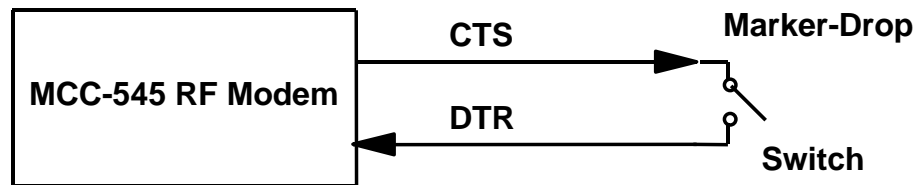
To make the tip-over detection mechanism function, the CTS signal must be enabled so that it can be detected at DTR should the switch close. A good time to enable CTS – set CTS to high – may be when the MRC-565 is powered up. The command `EVENT, RESET, SET, CTS` will do this. The event is `RESET`. The action is `SET, CTS`. The "ignition" bit should also be set in the status word. The bits of the status register are numbered from low order to high order, `BIT0` through `BIT15`. The `COLLISION` bit is the same as `BIT0`, and the action "COLLISION" is used instead of "SET,BIT0" for clarity.

The command `EVENT, DIOHI, DTR, 16, 160, COLLISION` defines an event that creates a vehicle collision report if the DTR signal is high for 1 second (16 sixteenths of a second). Collision is defined as the vehicle being tipped over. The event will clear and be ready for another event if the signal is low for 10 seconds (160 sixteenths of a second). "DIOHI" means "discrete I/O high" and "DTR" specifies the DTR discrete input. The parameters "DIOHI, DTR, 16, 160" define the event. The parameter "COLLISION" defines the action. The User will create the event table with the following commands:

```
EVENT, STOP
EVENT, DEL, ALL
EVENT, RESET, SET, CTS
EVENT, RESET, SET, BIT2
EVENT, DIOHI, DTR, 16, 160, COLLISION
EVENT, START
SAVE
```

**Example 2: A Scanned Event - Marker-Drop**

Suppose the MRC-565 is wired to detect a marker-drop pushbutton using the CTS and DTR signals wired to a pushbutton switch mounted somewhere in a vehicle or aircraft. The CTS output is used to enable switch detection. The DTR input is the input signal on which marker-drop is detected. Normally open, the switch prevents DTR from receiving the CTS signal. If CTS is enabled and the marker-drop button pressed such that the switch closes, the CTS signal is presented to DTR.



**CTS is set on reset in order to have a signal to detect on DTR**

**DTR is scanned every 1/16 second for the high condition**

To make the marker-drop mechanism function, the CTS signal must be enabled so that it can be detected at DTR should the switch close. A good time to enable CTS – set CTS to high – may be when the MRC-565 is powered up. The command `EVENT,RESET,SET,CTS` will do this. The event is `RESET`. The action is `SET,CTS`. The "ignition" bit should also be set in the status word, the command `EVENT,RESET,SET,BIT2` will set the ignition bit. The bits of the status register are numbered from low order to high order, `BIT0` through `BIT15`. The `MARK` bit is the same as `BIT3`, and the action "`MARK`" is used instead of "`SET,BIT3`" for clarity.

The command `EVENT,DIOHI,DTR,16,160,MARK` defines an event that creates a vehicle collision report if the DTR signal is high for 1 second (16 sixteenths of a second). The event will clear and be ready for another event if the signal is low for 10 seconds (160 sixteenths of a second). "`DIOHI`" means "discrete I/O high" and "`DTR`" specifies the DTR discrete input. The parameters "`DIOHI,DTR,16,160`" define the event. The parameter "`MARK`" defines the action.

The User will create the event table with the following commands:

```
EVENT, STOP
EVENT, DEL, ALL
EVENT, RESET, SET, CTS
EVENT, RESET, SET, BIT
2
EVENT, DIOHI, DTR, 16,
160, MARK
EVENT, START
SAVE
```

**Event Programming Command Summary**

There can be from 1 to 400 events defined in the event table including reset and scanned events. The following list shows all the command formats. Commands tagged "Yes" in the "Event" column each consume one entry in the event table. Some of the commands, tagged with "No", are used to free up event table entries or control the operation of the event monitor.

There is also a group table, and a text table. The group table an array of 16 groups by 16 sensors. Each entry in the group table consists of a sensor type – discrete or analog – and a discrete bit identification or analog channel number. Commands tagged "Yes" in the "Group" column each consume one entry in the group table. Some of the commands with "Yes" are used to free up group table entries. The text table is used to store up to 40 text messages or operator commands of up to 40 characters each.

There are 8 accumulators, 8 timers and 8 counters that can be used to facilitate the creation of complex logic.

Command	Table Entry?	
	Event	Group
EVENT	No	No
EVENT, DEL, <i>event number</i>	No	No
EVENT, DEL, ALL	No	No
EVENT, START	No	No
EVENT, STOP	No	No
EVENT, RESET, <i>action</i>	Yes	No
EVENT, DIOHI, <i>bit-name, settle, holdoff, action</i>	Yes	No
EVENT, DIOLOW, <i>bit-name, settle, holdoff, action</i>	Yes	No
EVENT, ADCHI, <i>chan-name, hi-level, settle, holdoff, action</i>	Yes	No
EVENT, ADCLOW, <i>chan-name, low-level, settle, holdoff, action</i>	Yes	No
EVENT, IFGT, <i>bit-name, bit-name, action</i>	Yes	No
EVENT, IFLT, <i>bit-name, bit-name, action</i>	Yes	No
EVENT, IFEQ, <i>bit-name, bit-name, action</i>	Yes	No
EVENT, CONT, <i>action</i>	Yes	No
EVENT, DO, <i>action</i>	Yes	No

EVENT, DISPLAY, <i>item-number</i>	Yes	No
EVENT, TEXT	No	No
EVENT, TEXT, <i>item-number</i> , <i>message text</i>	Yes	Yes
EVENT, TEXT, DEL, ALL	No	No
EVENT, TEXT, DEL, <i>item-number</i>	No	No
EVENT, GROUP	No	No
EVENT, GROUP, <i>group-number</i> , <i>bit-name</i> or <i>chan-name</i> , ...	No	Yes
EVENT, GROUP, DEL, ALL	No	Yes
EVENT, GROUP, CLEAR, <i>group-number</i>	No	Yes
EVENT, UPDT, <i>group-number</i>	No	No
EVENT, STATUS, { <i>bit-name</i> , <i>chan-name</i> }	No	No
EVENT, <i>action</i>	No	No
SCALE, <i>chan-name</i> , <i>slope</i> , <i>offset</i>	No	No

## Event Programming Command Details

### Commands

#### EVENT

Displays the current event and group table when no additional parameters are attached. All the event commands begin with "event," followed by parameters.

#### **EVENT, DEL, ALL**

Delete all events in the event table. Event table commands should be edited in script files and output to the MRC-565 using XTERM in order to reload the event table. This command does not delete the text messages or group definitions.

#### **EVENT, DEL, number**

Delete only the numbered event from the event table. The events will be renumbered when one is deleted. Event table commands should be edited in script files and output to the MRC-565 using XTERM in order to reload the event table.

#### **EVENT, START**

Start the event scanner. Scanned events will not be detected unless scanning is started. This command causes the event scanner to review the event table every 62.5 milliseconds for the occurrence of scanned events and the end of scanned events. This command also performs RESET events. On MRC-565 reset, the event scanner is started.

#### **EVENT, STOP**

Stop the event scanner. Scanned events will not be detected while scanning is stopped. This command should be issued prior to clearing the event table (EVENT, DEL, ALL) and reprogramming it with events. This command does not affect the detection of the reset event. On



MRC-565 reset, the event scanner is started again if the SAVE command was not issued while in the EVENT,STOP state.

**EVENT, action**

A direct command for immediate action can be issued. This event command will not be added to the event table, but will cause the action to occur when the command is entered. This can be used to take action using remote commands, and also can be placed in the MRC-565 schedule list for periodic event application.

**EVENT, STATUS, {bit-name, or chan-name}**

This form of the command lets the operator display an immediate value for any discrete input bit or any ADC channel. For example: to display the status on the DTR input line,

**EVENT,STATUS,DTR**<cr>. To display forward power, enter **EVENT,STATUS,FPWR**<cr>.

**EVENT, RESET, action**

Define an action to be taken at power-up/reset. This is useful for setting control outputs at a known state or sending a message to a host system that the MRC-565 has been reset. These RESET actions will also occur if the event monitor is stopped, then restarted. This allows entering new RESET events into an existing table.

**EVENT, DIOHI, bit-name, settle, holdoff, action**

Define an event that looks for a discrete input line to go to a high level.

Parameter	Description
DIOHI	Scan discrete input signal for high condition.
bit-name	Name of discrete input signal to be scanned for high level. (single or multiple inputs)
settle	Number of clock ticks for the input signal to settle at the high level before declaring an event
holdoff	Number of clock ticks for the analog input signal to settle at the low level to be armed for detecting the next event.
action	MRC-565 action to be taken when event is declared. See actions below.

Logical combining of multiple discrete inputs is allowed. This is done by expanding the bit-name parameter of the command into a list on inputs separated by logic operator characters. For example, to test both the RTS and DTR inputs in one event, use the string ",DTR & RTS," in the bit-name parameter. Up to 5 inputs can be used in a single event line. Any of the inputs can be "inverted" before the combination. For example, if the DTR input must be high and the RTS input low to trigger an event, use the string ",DTR & !RTS," in the bit-name parameter. The inputs can be combined in any order. The evaluation is done from left to right. There is no use of "(" and ")" to form more complex ordering. The "0" and "1" values are used for "low" and

"high". If the result of the combination of signals is "1", then the DIOHI condition is satisfied. If the result of the combination is "0", then the DIOLOW condition is satisfied. Both the DIOHI and DIOLOW event types can use the logical signal support.

Table of Logical Operators:

Operator	Definition
&	AND
	OR
!	NOT Logical signal inversion

**EVENT, DIOLOW, bit-name, settle, holdoff, action**

Define an event that looks for a discrete input line to go to a low level.

Parameter	Description
DIOLOW	Scan discrete input signal for low condition.
bit-name	Name of discrete input signal to be scanned for low level. (single or multiple inputs)
settle	Number of clock ticks for the input signal to settle at the low level before declaring an event.
holdoff	Number of clock ticks for the analog input signal to settle at the high level to be armed for detecting the next event.
action	MRC-565 action to be taken when event is declared. See actions below.

**EVENT, IFGT, bit-name1, bit-name2, action**

Test whether a timer, counter or accumulator is greater than another timer, counter or accumulator.

Parameter	Description
IFGT	If first parameter is greater than second parameter.
bit-name1	Name of a timer, counter or accumulator to test.
bit-name2	Name of a timer, counter or accumulator to test bit-name1 against.
action	MRC-565 action to be taken when event is declared. See actions below.

**EVENT, IFLT, bit-name1, bit-name2, action**

Test whether a timer, counter or accumulator is less than another timer, counter or accumulator.

Parameter	Description
IFGT	If first parameter is less than second parameter.
bit-name1	Name of a timer, counter or accumulator to test.
bit-name2	Name of a timer, counter or accumulator to test bit-name1 against.
action	MRC-565 action to be taken when event is declared. See actions below.

**EVENT, IFEQ, bit-name1, bit-name2, action**

Test whether a timer, counter or accumulator is equal to another timer, counter or accumulator.

Parameter	Description
IFEQ	If first parameter is equal to second parameter.
bit-name1	Name of a timer, counter or accumulator to test.
bit-name2	Name of a timer, counter or accumulator to test bit-name1 against.
action	MRC-565 action to be taken when event is declared. See actions below.

#### **EVENT, CONT, action**

The CONT (Continue) event is used to define multiple actions to an event. An event definition command can be followed by any number of CONT commands and are considered to be an extension of the previous event command. For example:

```
EVENT, DIOHI, DTR, 1, 1, SET, BIT0 ; Defines an event with one action
EVENT, CONT, TXT, 1 ; Add another action
EVENT, CONT, UPDT, 1 ; Add another action
EVENT, CONT, CLR, T1 ; Add another action
EVENT, DIOLOW, DTR, 1, 1, CLR, BIT0 ; End previous event definition, Start next one
```

#### **EVENT, DO, action**

The DO event is provided for cases where an unconditional action is required. This type of event is not connected to other event lines as the CONT is. It is independent and will be initiated every time the event monitor executes the script item. For example: `EVENT, DO, INC, C1`

#### **EVENT, ADCHI, chan-name, hi-level, settle, holdoff, action**

Define an event that looks for an analog input signal to go at or above a high level.

Parameter	Description
ADCHI	Scan A-to-D converter channel (analog input signal) for high condition.
Chan-name	Name of analog input signal to be scanned for high condition. (single input only)
hi-level	Signal level for the event to trigger at or above which the analog input signal must persist in order for an event to be declared. Scaled in Engineering Units.
settle	Number of clock ticks for the input signal to settle at or above the trigger level before declaring an event.
holdoff	Number of clock ticks for the input signal to settle below the trigger level to be armed for detecting the next event.
action	MRC-565 action to be taken when event is declared. See actions below

#### **EVENT, ADCLOW, chan-name, low-level, settle, holdoff, action**

Define an event that looks for an analog input signal to go at or below a low level.

Parameter	Description
ADCLow	Scan A-to-D converter channel (analog input signal) for low condition.
Chan-name	Name of analog input signal to be scanned for low condition. . (single input only)
low-level	Signal level for the event to trigger at or below which the analog input signal must persist in order for an event to be declared. Scaled in Engineering Units.
settle	Number of clock ticks for the input signal to settle at or below the trigger level before declaring an event.
holdoff	Number of clock ticks for the input signal to settle above the trigger level to be armed for detecting the next event.
action	MRC-565 action to be taken when event is declared. See actions below.

### **EVENT , TEXT , item-number, message or command text**

Add a new text string into the text table. This command will replace an existing item if one already exists with the same item number.

Parameter	Description
TEXT	Define a Text string command.
item-number	Item number to be created or replaced by this command. Valid range: 1 through 40.
message text	Body of the text. Can be up to 40 characters, and will be converted to upper case. The text is used by the TXT or CMD action to send a text message or issue a local command.

### **EVENT, TEXT**

Displays the current text table.

### **EVENT, TEXT, DEL, ALL**

Deletes all Previously defined text items.

### **EVENT, TEXT, DEL, item-number**

Deletes a specific item from the text table. This command makes the given item be a null message. The other text string items in the table are not affected.

### **EVENT, GROUP**

Displays the group table. There can be as many as 16 groups defined, where each group consists of a selected set of analog inputs or discrete inputs. The "event, group" set of commands allows the groups to be defined, displayed, and transmitted as a sensor data report.

The Group Table layout is like a two dimensional array where each row is a different group, and each column is a different sensor. In this case a sensor can be either an analog or discrete input. **Type** indicates discrete or analog. For discrete, **Id** is the bit number. For analog, **Id** is the channel number.

		Sensor Number				
		1	2	3	• • •	16
Group Number	1	Type/Id	Type/Id	Type/Id		Type/Id
	2	Type/Id	Type/Id	Type/Id		Type/Id
	3	Type/Id	Type/Id	Type/Id		Type/Id
	•					
	•					
	•					
16	Type/Id	Type/Id	Type/Id		Type/Id	

**EVENT , GROUP , group-number, bit-name or chan-name, ...**

Define an event sensor data (SDATA) report group.

Parameter	Description
GROUP	Group control event command.
group-number	Group number to be set by this command. Valid range: 1 through 16.
bit-name or chan-name	List of up to 16 discrete and/or analog input signal names to be included in the group. The values of these signals form the contents of a sensor data (SDATA) report. They are reported in the order specified in this command. Append a “/F” to any name for floating point scaling. Append “(x.xx)” for decimal scaling as: ADC1/F(0.1)

Example: EVENT, GROUP, 1, FPWR/F, ADC1, ADC2/F(1.123)

**EVENT, GROUP, DEL, ALL**

Delete all group definitions. Clears the group table.

**EVENT, GROUP, DEL, group-number**

Delete a specific group definition from the group table. This does NOT cause the other defined groups to be renumbered.

Parameter	Description
GROUP	Group control event command.
DEL	Delete group table sub-command.
group-number	Group number to be deleted by this command. Valid range: 1 through 16.

**EVENT,UPDT, group-number**

Produce an immediate SDATA group report when the command is entered.

Parameter	Description
UPDT	Update sub-command; i.e., issue a group sensor data (SDATA) report.
group-number	Group number to be reported in an SDATA report. Valid range: 1 through 16.

This command can be included in the MRC-565 schedule to produce reports on a periodic or prescribed time of day. For example, "**SCHED,I,10:0,EVENT,UPDT,3**" will schedule the group 3 sensor data report every 10 minutes.

**SCALE, chan-name, slope {, offset}**

Enter engineering units scale factor and offset for an analog channel. This adds the optional offset parameter to the original MRC-565 SCALE command. Analog event detection is based on scaled values, not raw counts. The scaled value is computed as:

$$\text{scaled value} = (\text{analog channel raw count} * \text{slope}) + \text{offset}$$

Parameter	Description
chan-name	Name of analog input channel to be scaled by the factors provided in this command.
slope	Multiplier scaling factor. The analog input channel raw count is multiplied by this value. Valid: any decimal floating point number that can be represented in Motorola 68000 32-bit floating point format. However, there is a further restriction on the value of slope. See below.
offset	Bias scaling factor. This value is added to the product of the channel raw count and the multiplier scaling factor. Optional parameter. Assumes zero offset when not given. Valid: any decimal floating point number that can be represented in Motorola 68000 32-bit floating point format. However, there is a further restriction on the value of slope. See below.

Slope and offset values must be chosen such that the resultant scaled value is in the range - 8192.0 through -0.001, 0.000 and +0.001 through +8191.0. Only four digits of the scaled value are significant.

**Action Definitions**

The following table shows the possible types of action that can be taken when an event occurs.

<b>Action Value</b>	<b>Action Parameters</b>	<b>Description</b>
<b>TXT</b> , <i>nn</i>	text table item number	Transmit a text message to the default destinations. NN can range from 1 to 40.
<b>CMD</b> , <i>nn</i>	text table item number	Execute a local command. NN can range from 1 to 40.
<b>CAN</b> , <i>nn</i>	Canned message number	The canned message number is transmitted to 1 to 4 default destination IDs. Valid range: 0 to 255.
<b>POS</b>		A position report with current GPS coordinates is transmitted to 1 to 4 default destination IDs.
<b>MARK</b>		A marker report with current GPS coordinates is transmitted to 1 to 4 default destination IDs. The marker bit is set in one report, but does not remain set.
<b>COLLISION</b>		A vehicle collision report is transmitted to 1 to 4 default destination IDs. The collision bit is set in one report, but does not remain set.
<b>SET</b> , <i>ccc, ddd</i>	ccc=Bit, Timer, Counter, Accumulator Name ddd=optional decimal value for Timer, Counter or Accumulator	If ccc is a named discrete output or status bit, it is set = 1 and ddd is not used. If ccc is a Timer, Counter or Accumulator, then ddd is a decimal value to put into ccc. If ccc is a status bit, a POSS report will be transmitted with the updated status bits. The bit remains set.
<b>SET/N</b> , <i>ccc</i> <b>SET/T</b> , <i>ccc</i>	ccc = status bit name ccc = status bit name	Sets the status bit and does NOT transmit POSS "Trigger" a POSS report after setting the status bit, but clear the bit after the transmission so it is a one-time event and does not persist.
<b>CLR</b> , <i>ccc</i>	ccc=Bit, Timer, Counter, Accumulator Name	The named discrete output, status bit, Timer, Counter or Accumulator is cleared to 0. If ccc is a status bit, a POSS report will be transmitted with the updated status bits. The bit remains cleared.
<b>CLR/N</b> , <i>ccc</i> <b>PULSE</b> , <i>bit-name, ddd, iii, nnn</i>	ccc = status bit name bit-name is any discrete output signal	Clears the status bit and does NOT transmit POSS Produce a pulse or series of pulses on the output line where: ddd is the pulse duration in clock ticks, iii is the interval between pulses in clock ticks and nnn is the number of pulses to output.
<b>ADCIN</b> , <i>ccc, aaa, mult</i>	ccc=any ADC channel name aaa=accumulator name A1 – A24 mult=decimal scaling multiplier	Read the ADC channel value and store in it the given accumulator. The value is scaled, multiplied by the optional multiplier, then converted from floating point to a long 32-bit integer. The value of 10.123 with a multiplier of 10 will be stored as 103.
<b>UPDT</b> , <i>group-number</i> <b>NC</b> , <i>ccc</i>	SDATA report group number +1	The SDATA report specified by the group number is transmitted to 1 to 4 default destination ids. Increment a counter by 1. Where ccc must be a valid counter (C1-C8)
<b>DEC</b> , <i>ccc</i>	-1	Decrement a counter by 1. Where ccc must be a valid counter (C1-C8)

<b>ADD</b> , ccc, ddd	Add the decimal value of ddd to ccc. Where ccc must be a valid accumulator (A1-A24) . The result is stored in ccc.
<b>SUB</b> , ccc, ddd	Subtract the decimal value of ddd from ccc. Where ccc must be a valid accumulator (A1-A24) . The result is stored in ccc.
<b>MUL</b> , ccc, ddd	Multiply ccc by the decimal value of ddd and place the result in ccc. Where ccc must be a valid accumulator (A1-A24).
<b>DIV</b> , ccc, ddd	Divide ccc by the decimal value of ddd and place the result in ccc. Where ccc accumulator (A1-A24).
<b>MOV</b> , ddd, sss	Move the source sss into ddd where sss and ddd are valid Timers (T1-T8) , Counters (C1-C8) or Accumulators (A1-A24)
<b>ADDA</b> , ccc, aaa	Add the accumulator value of aaa to ccc. Where aaa and ccc must be a valid accumulator (A1-A24) . The result is stored in ccc.
<b>SUBA</b> , ccc, aaa	Subtract the accumulator value of aaa from ccc. Where aaa and ccc must be a valid accumulator (A1-A24) . The result is stored in ccc.
<b>MULA</b> , ccc, aaa	Multiply ccc by the accumulator value of aaa and place the result in ccc. Where aaa and ccc must be a valid accumulator (A1-A24).
<b>DIVA</b> , ccc, aaa	Divide ccc by the accumulator value of aaa and place the result in ccc. Where aaa and ccc accumulator (A1-A24).

The default destination IDs for messages created by the actions above are set via the DESTINATION, *d1 {, d2 {, d3 {, d4}}*} command. When a single ID of "0" is given in a Meteor Burst Network that uses the MRC-520B for a Master Station, the messages are sent to the network host system for routing via the source routing system. In a Line-of-Sight network, using MRC-565's as Base and/or Repeater Stations, then a single ID of "1" is used for routing to the Host via any Base or Repeater.

## Common Command Parameters

### Settle

*settle* is the number of clock ticks required "at or above" the event level to trigger an event. Valid range: 1 - 65535. This corresponds to a range of 62.5 milliseconds to 1 hour, 8 minutes and 16 seconds. For discrete events, the event level is "high" or "1". For analog events, the level is given in engineering units.

### Holdoff

*holdoff* is the number of clock ticks required "below" the event level to allow another event. Valid range: 1 - 65535. This corresponds to a range of 62.5 milliseconds to 1 hour, 8 minutes and 16 seconds.



**Bit-name**

<b>Bit Name</b>	<b>I/O; Voltage Range</b>	<b>Definition</b>	<b>Description</b>
<b>BIT0- BIT15</b>	Status Register Bits	0 or 1	The bit names BIT0, BIT1, ...through BIT15 correspond to the bits of the 16-bit status register. BIT0 is the low order bit, BIT15 is the high order bit.
<b>DTR</b>	Input; TTL 0V to 5V	Data Terminal Ready	RS 232 serial port signal indicating the data terminal connected to the serial port is ready and able to receive data from the MRC-565 (dataset) on Rx Data.
<b>RTS</b>	Input; RS 232 $\pm$ 10V	Request to Send	RS 232 serial port signal indicating the data terminal connected to the serial port wants to transmit data to the MRC-565 (dataset) on Tx Data.
<b>CTS</b>	Output; TTL 0V to 5V	Clear to Send	RS 232 serial port signal indicating the MRC-565 (dataset) is ready and able to receive data from the data terminal connected to the serial port on Tx Data.
<b>RING</b>	Output; RS 232 $\pm$ 10V	Ring Detected	RS 232 serial port signal indicating the MRC-565 (dataset) is wants the attention of the data terminal connected to the serial port.
<b>MCLK MDIR MSET</b>	Output; TTL 0V to 5V Output; TTL 0V to 5V Input; TTL 0V to 5V	Clock Data In Data Out	These three signals can be used as individual inputs and outputs as noted. In addition they can be used to communicate with the external I/O expander using a clocked serial high speed data stream.
<b>IN1 , IN2 IN3 , IN4 RO1 , RO2 GPS</b>	Optically Isolated Inputs 0-5 Volts Relay Contacts GPS status	0 or 1 NO,NC 0 or 1	Typically requires an input greater than 1 volt to trigger an input transition from 0 to 1. Provides NO,COM,NC contacts Current GPS receiver status and RS-232 port condition. 0=V0 or RS-232 disconnected. 1=V1 or V2 and RS-232 connected.
<b>NET T1 - T8</b>	Network Status 32-bit Timers can be used both as an Input and as an Output. Timers range from 0 to 16,777,216 counts. (12 days, 2 hrs, 18 min, 58.5 seconds)	0 or 1 0 or n	Network online/offline status. 0=offline , 1=online Timer registers. When these are set to a non-zero value, they will count down one count for each 1/16 second (62.5 milliseconds). Use action = SET, T1, nnnn to start counting. These all are set=0 on reset. Power fail/restart will retain the count at power fail.
<b>C1 - C8</b>	32-bit Counters can be used both as an input and as an output. Counters can range from 0 to 16,777,216 counts.	0 or n	Counter registers. These can be set to a value, cleared to zero, incremented or decremented. A 0 decrements to 16,777,216. A 16,777,216 increments to 0.
<b>A1-A24</b>	32-bit Accumulators can be used both as an input and as an output. Value can range from 0 to +/-16,777,216	0 or n	General purpose accumulators. These are used for computational or temporary storage of numerical values.

Each of the bit-names in the above table can be used in *Event* and *Action* definitions. The DIOHI/DIOLOW events can use DTR, RTS, IN1-4, GPS, NET, T1-T8, C1-C8, A1-A24 as inputs. The

Action parameter can use BIT0-BIT15, CTS, RING, MCLK, MDIR, MSET, RO1-R02, T1-T8, C1-C8, A1-A24 as outputs.

Examples:

**EVENT,DIOHI,IN1,16,16,SET,RO1** Waits for input line 1 to go high for 1 second, then sets RO1 to NC.

**EVENT,DIOLOW,DTR,16,16,SET,T1,160** Waits for DTR to go high for 1 second, then starts timer-1 at 160 counts (10 seconds).

**EVENT,DIOLOW,T1,1,1,TXT,1** Waits for timer-1 to go to zero, then sends a text message indicating that DTR timed-out.

**ADC Channel Names**

Channel Name	Definition	Description
<b>FPWR</b>	Forward RF power	RF power going out of the MRC-565 transmitter.
<b>RPWR</b>	Reverse RF power	RF power being reflected back to the MRC-565 transmitter.
<b>LBAT</b>	Battery level	Voltage level of the MRC-565 battery.
<b>DETRF</b>	Detected RF	Current MRC-565 receiver detected RF level.
<b>TEMP</b>	Internal temperature	Internal temperature of the MRC-565 enclosure.
<b>TXC</b>	Transmit Count	Total number of transmissions
<b>ACK</b>	Acknowledge Count	Total number of acknowledgements
<b>RXC</b>	Received Segments	Total number of received text message segments, position reports and data reports
<b>PROBE</b>	Idle Probe Count	Total number of Idle probes and poll frames received
<b>REMOTE</b>	Number of Remotes	Number of remotes connected to this unit.
<b>ADC1</b>	Analog Input	Available MRC-565/C 10-bit A-to-D channel.
<b>ADC2</b>	Analog Input	Available MRC-565/C 10-bit A-to-D channel.
<b>ADC3</b>	Analog Input	Available MRC-565/C 10-bit A-to-D channel.
<b>ADC4</b>	Analog Input	Available MRC-565C/ 10-bit A-to-D channel.
<b>ADC5</b>	Analog Input	Available MRC-565/C 10-bit A-to-D channel.
<b>ADC6</b>	Analog Input	Available MRC-565/C 10-bit A-to-D channel.

**Event Programming Examples**

**Example 1: Vehicle Collision Detection**

From the example above, the following is the script for initializing the MRC-565 for the detection of vehicle tip-over.

```

EVENT, STOP
EVENT, DEL, ALL
EVENT, RESET, SET, CTS
EVENT, DIOHI, DTR, 16, 160, COLLISION
.
.      other MRC-565 initialization commands
    
```

```
EVENT, START
```

### Example 2: MRC-565 Reset Notification

Suppose a system that requires notification if the MRC-565 resets. The following is the script for initializing the MRC-565 for the detection and reporting of MRC-565 reset using a text message.

```
EVENT, STOP
EVENT, DEL, ALL
EVENT, TEXT, 1, Dead River RF Modem Reset
EVENT, RESET, TXT, 1
.
.      other MRC-565 initialization commands
.
EVENT, START
```

The following is the script for initializing the MRC-565 for the detection and reporting of MRC-565 reset using a canned message number 1.

```
EVENT, STOP
EVENT, DEL, ALL
EVENT, RESET, CAN, 001
.
.      other MRC-565 initialization commands
.
EVENT, START
```

### Example 3: MRC-565 High Temperature Notification

Suppose a system that requires notification of the MRC-565 enclosure becoming excessively warm. The following is the script for initializing the MRC-565 for the detection and notification of high temperature using canned message number 2. This example assumes the temperature sensor and A/D converter are calibrated to produce a raw count range of 0 to 1023 that corresponds to a Celsius temperature range of -64 degrees to +192 degrees. The `SCALE` command provides the engineering units conversion factors for this. The event occurs when the temperature A/D channel is at 50 degrees C or above for one minute or more (960 ticks). The event ends when the temperature drops below 50 degrees C for 10 minutes (9600 ticks).

```
EVENT, STOP
```

```

EVENT, DEL, ALL
SCALE, TEMP, 0.25, -64.0
EVENT, ADCHI, TEMP, 50.0, 960, 9600, CAN, 002
.
.      other MRC-565 initialization commands
.
EVENT, START

```

#### Example 4: MRC-565 Low Temperature Notification

Suppose a system that requires notification of the MRC-565 enclosure becoming excessively cold. The following is the script for initializing the MRC-565 for the detection and notification of low temperature using canned message number 3. This example the same temperature scaling as the previous example. The event occurs when the temperature A/D channel is at -30 degrees C or below for one minute or more (960 ticks). The event ends when the temperature goes above -30 degrees C for 10 minutes (9600 ticks).

```

EVENT, STOP
EVENT, DEL, ALL
SCALE, TEMP, 0.25, -64.0
EVENT, ADCLOW, TEMP, -30.0, 960, 9600, CAN, 003
.
.      other MRC-565 initialization commands
.
EVENT, START

```

#### Example 5: MRC-565 Temperature Control

Suppose a system that requires thermostatic-like control of the MRC-565 enclosure when it becomes excessively warm or cold. The following is the script for initializing the MRC-565 for the detection and correction of temperature out-of-bounds conditions. This example uses the same temperature scaling as the previous two examples. The same temperature thresholds are used. Instead of sending canned messages, it uses relay closures to turn a heat pump on and off as needed to heat and cool the equipment room as needed. Relay closure RO5 is used to turn the heat pump on and off in cooling mode. Relay closure RO6 is used to turn the heat pump on and off in heating mode. RTS is used to detect heat pump failure. If the heat pump fails indicated by RTS going low for 5 seconds, canned message 4 is transmitted.

```

EVENT, STOP
EVENT, DEL, ALL
SCALE, TEMP, 0.25, -64.0
EVENT, ADCHI, TEMP, 26.0, 960, 960, SET, RO5
EVENT, ADCLOW, TEMP, 25.0, 960, 960, CLR, RO5
EVENT, ADCLOW, TEMP, 5.0, 960, 960, SET, RO6
EVENT, DIOHI, TEMP, 10.0, 960, 960, CLR, RO6
EVENT, DIOLOW, RTS, CAN, 80, 960, CAN, 004
.
.       other MRC-565 initialization commands
.
EVENT, START

```

### Example 6: Marker Drop Button

The following is the script for initializing the MRC-565 for the detection of a vehicle operator pressing a "drop marker" button wired into the RTS signal to go high when the button is depressed. A MARK message is transmitted if the operator depresses the button for at least a quarter of a second (4). The operator must release the button for three seconds (48) before another button press will be detected.

```

EVENT, STOP
EVENT, DEL, ALL
EVENT, DIOHI, RTS, 4, 48, MARK
.
.       other MRC-565 initialization commands
.
EVENT, START

```

### Example 7: Max/Min/Averaging A/D channel values

Calculations can be performed on ADC channel values to compute averages, maximums, minimums, etc. This is accomplished using the ADCIN action to read a value into an accumulator, then doing math operations as desired. The following example shows a way to average the forward power value. Many other calculations are possible. Every 5 seconds the FPWR channel is read into accumulator 9. This value is then added to accumulator 10 to sum the readings. Every minute the sum is divided by the number of samples to compute the average. Notice that the ADCIN command uses a multiplier of 10 when inputting the value into accumulator 9. Since the accumulator is an integer, this multiplier lets one decimal fraction digit be included in the sum. The value of 100.6 Watts would be read in as 1006, multiplied by 10 to

<u>;EVENT</u>	<u>ACTION</u>	<u>COMMENTS</u>
event, stop		;stop event monitor
event, del, all		;delete prev table
;		
event, reset,	clr, a9	;clear current reading
event, reset,	clr, a10	;clear total
event, reset,	clr, a11	;clear max
event, reset,	set, a12, 9999	;init min to a big value
event, reset,	clr, c1	;clear sample counter
event, reset,	set, c2, 12	;set number of samples
;		
event, diolow, t1, 1, 1, set,	t1, 80	;if t1 is zero, set t1 to 80 (5 secs)
event, cont,	adcin, fpwr, a9, 10	;also read fwdpwr into reg A9
event, cont,	adda, a10, a9	; add A9 to total A10
event, cont,	inc, c1	; increment sample counter
;		
event, ifgt, a9, a11,	mov, a11, a9	;get new max value
;		
event, iflt, a9, a12,	mov, a12, a9	;get new minimum value
;		
event, ifeq, c1, c2,	diva, a10, c2	;if C1 == C2 compute average
event, cont,	updt, 1	;then trigger group 1 SDATA report
event, cont,	clr, a10	; clear the total
event, cont,	clr, c1	; clear the sample counter
event, cont,	clr, a11	; clear the max value
event, cont,	set, a12, 9999	; init min to big value
;		
;Define the SDATA group contents		
;	Max Min Average	
event, group, 1,	a11/f(.1), a12/f(.1), a10/f(.1)	

get 1006. Later, when the sum is put into the SDATA report, the FPWR/F(0.1) group/sensor definition converts the average value back to floating point and scales the value back to Watts with one decimal fraction digit.

### MRC-565 I/O Signals

The discrete I/O lines provide digital inputs that can be read (sensed) by the event software. MRC-565 has 3 discrete input lines, 4 discrete output lines and 4 internal analog inputs. One input senses a 0 to 5 Volt CPU input pin and the other senses a modem control RS 232 ±10V input line (RTS). The MRC-565 has 7 discrete input lines, 6 discrete output lines, 5 internal analog inputs and 6 external analog inputs.

**Discrete Inputs and Outputs**

Connector Name	Pin Number	External Signal Name	Direction or Function	Internal Signal Name	MRC -565A	MRC -565
J8	36	DTR	Input	TP3 +/- 10V	Yes	Yes
J8	32	RTS	Input	DSR +/- 10V	Yes	Yes
J8	31	CTS	Output	TP4 +/- 10V	Yes	Yes
J8	34	RING	Output	AVEC +/- 10V	Yes	Yes

Connector Name	Pin Number	External Signal Name	Direction or Function	Internal Signal Name	MRC -565A	MRC -565
J8	12	MCLK	Output	TP2 0-5V	Yes	Yes
J8	28	MDIR	Output	TP1 0-5V	Yes	Yes
J8	13	MSET	Input	TP0 0-5V	Yes	Yes

Connector Name	Pin Number	External Signal Name	Direction or Function	Internal Signal Name	MRC -565A	MRC -565
J8	19,20	IN1	OptIsoInput	TP5 0-5V	No	Yes
J8	18,3	IN2	OptIsoInput	TP6 0-5V	No	Yes
J8	1,2	IN3	OptIsoInput	TP7 0-5V	No	Yes
J8	16,17	IN4	OptIsoInput	TP10 0-5V	No	Yes
J8 (no,com,nc)	15,14,29	RO1	RelayOutput	TP11 0-5V	No	Yes
J8 (no,com,nc)	11,26,9	RO2	RelayOutput	TP12 0-5V	No	Yes

**Analog Input Channels**

The Analog input channels are read using a 12-bit A/D converter. Each of these has a corresponding scaling factor and offset that is set using the SCALE command. The MRC-565A has only the first four internal channels.

Connector Name	Pin Number	Signal Name	Direction or Function	Internal Signal	MRC -565A	MRC -565
		FPWR	Tx Fwd Pwr	AN0	Yes	Yes
		RPWR	Rev Pwr	AN1	Yes	Yes
		DETRF	SP	AN2	Yes	Yes
		LBAT	Loaded Battery	AN3	Yes	Yes
		TEMP	Internal Temp	AN4	No	Yes
J8	38	ADC1	Input	AN5	No	Yes
J8	39	ADC2	Input	AN6	No	Yes
J8	40	ADC3	Input	AN7	No	Yes
J8	37	ADC4	Input	AN8	No	Yes
J8	42	ADC5	Input	AN9	No	Yes
J8	41	ADC6	Input	AN10	No	Yes

**External Input/Outputs (XIO)**

When the XIO controller is attached to the MRC-565 or the MRC-565C, then 8 additional discrete inputs, 10 discrete outputs, 2 counters and 6 analog inputs are available. The controller uses three I/O lines, MCLK, MDIR and MSET, for a high speed synchronous port, and can input and output packets for communicating with the XIO controller.

<b>External Signal Name</b>	<b>Direction or Function</b>	<b>Internal Signal Name</b>
<b>XIN1</b>	Discrete Input	Port C, bit 2
<b>XIN2</b>	Discrete Input	Port C, bit 1
<b>XIN3</b>	Discrete Input	Port B, bit 7
<b>XIN4</b>	Discrete Input	Port B, bit 6
<b>XIN5</b>	Discrete Input	Port B, bit 5
<b>XIN6</b>	Discrete Input	Port B, bit 4
<b>XIN7</b>	Discrete Input	Port B, bit 3
<b>XIN8</b>	Discrete Input	Port A, bit 4
<b>XIC1</b>	High Speed Input Counter	---
<b>XIC2</b>	High Speed Input Counter	---
<b>XOUT1</b>	Discrete Output	Port D, bit 7
<b>XOUT2</b>	Discrete Output	Port D, bit 6
<b>XOUT3</b>	Discrete Output	Port D, bit 5
<b>XOUT4</b>	Discrete Output	Port D, bit 4
<b>XOUT5</b>	Discrete Output	Port D, bit 3
<b>XOUT6</b>	Discrete Output	Port D, bit 2
<b>XOUT7</b>	Discrete Output	Port D, bit 1
<b>XOUT8</b>	Discrete Output	Port D, bit 0
<b>XOUT9</b>	Discrete Output	Port C, bit 7
<b>XOUT10</b>	Discrete Output	Port C, bit 8
<b>XADC1</b>	10-Bit Analog Input	Port A, bit 0
<b>XADC2</b>	10-Bit Analog Input	Port A, bit 1
<b>XADC3</b>	10-Bit Analog Input	Port A, bit 5
<b>XADC4</b>	10-Bit Analog Input	Port E, bit 0
<b>XADC5</b>	10-Bit Analog Input	Port E, bit 1
<b>XADC6</b>	10-Bit Analog Input	Port E, bit 2



# **APPENDIX D: INSTALLATION DETAILS**

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## APPENDIX D: INSTALLATION DETAILS

Site selection and general installation guidelines are provided in this section, including instructions for cabling, antenna and power source connections. Power up procedures, initialization and functional test procedures are described that should be performed prior to placing the MRC-565 on-line within the network.

### Site Selection

There are 5 important factors to consider in selecting an optimum site:

1. External noise/interference
2. DC power source
3. Horizon angle
4. Antenna type
5. Antenna height

### External Noise/Interference

Noise and signal interference can reduce the performance of the MRC-565. The most common sources of noise and interference are as follows:

- Cosmic Noise
- Power Line Noise
- Auto Ignition Noise
- Computer-Generated Interference
- External Signal Interference

### Cosmic Noise

Cosmic noise is the limiting noise factor in a meteor burst system. This noise is generated by star systems in the galaxy and is frequency dependent. The noise is approximately 15 dB above thermal at 40 MHz and 13 dB above thermal at 50 MHz. This noise is diurnal in nature. It is the highest when the antennas are pointed directly at the center of the galaxy and lowest when they are pointed at right angles to it. Daily variations of 3 to 4 dB can be expected. An optimal meteor burst site is one that is limited only by cosmic noise.

### Power Line Noise

One of the main sources of manmade noise are high voltage power lines. Noise on these lines is generated by high voltage breakdown occurring on power line hardware such as transformers and insulators. This noise can be seen with an oscilloscope at the Receiver IF test point as a series of spikes that occur every 8 ms (1/60 Hz) or every 10 ms (1/50 Hz). The level of the spikes will be much higher than the normal background noise floor. The number of spikes can vary, depending upon the level of interference, from one or two every 8-10 ms to several dozen every 8-10 ms. The impulse noise blanker in the MRC-565 will remove a large amount of this noise.

However, as the number of spikes increase, the effectiveness of the blanker is reduced. When setting up a site always look at the IF test point with a scope to determine the level of the power line noise interference. It is mandatory that power line noise be avoided for an optimum site. Try to place the receiver antenna well away from power lines.

**NOTE.**

**Power companies are required to properly maintain their power lines to reduce noise. Call the local utility in case of severe noise.**

### **Automobile Ignition Noise**

Automobile ignition noise is generated by all gasoline engines and is a result of the high voltage required to fire the spark plugs. Auto ignition noise is similar to power line noise with the exception that it does not have the 8-10 ms period which is associated with power line noise.

### **Computer-Generated Interference**

All computers and printers contain high-speed circuits that generate spurious signals throughout the 37-50 MHz band. Interference will result if any of these signals couple into the antenna at the MRC-565 receive frequency. To minimize this type of interference, try to keep the antenna away from computers by at least 100 feet. The noise blanker will not suppress computer-generated interference.

### **Signal Interference**

This type of interference will occur whenever another transmitter is producing harmonics at the receiver center frequency of the MRC-565. Antenna nulling and spatial separation can be used to reduce this type of interference.

**NOTE**

**With XTERMW installed (see Section 3.3), the STAT command can be used to determine the site antenna noise levels. Ideally, the background noise levels should be less than -115 dBm.**

### **DC Power Source**

The MRC-565 requires a 12 (11.0-16.0) VDC power source. The average standby current at an input voltage of 13.0 VDC is about 150 ma in a full operating mode (w/o GPS) without any low power modes (LPM) enabled. When the unit transmits it requires about 25 amps for 100 msec. An automobile battery provides an excellent power source. When operating from a battery with Solar Panel Charger low power modes can be used to reduce current drain in receive mode.

If there is no AC power available a solar panel can be used to charge the battery. The size of the solar panel is determined by the solar radiation available at the location of the site. In most locations in the USA, a 40 watt solar panel will suffice. At higher elevations, where winter

temperatures are below freezing, a larger panel will have to be used. Consult MRC or contact the solar panel manufacturer to perform this calculation for you and make a recommendation.

The power cable between the battery and the MRC-565 should be kept shorter than 10 feet and rated at #14 AWG or lower. (See Section 3.2.2.1 for more details.)

**CAUTION**

**The MRC-565 does not have an internal fuse and consideration should be given to installing an external fuse between the battery and 565.**

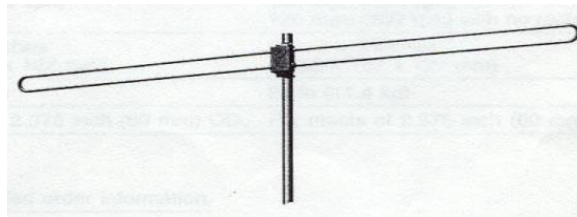
### Horizon Angle

To obtain maximum performance in an MBC network the station must be installed on level flat ground to provide a good ground plane. Lack of a good ground plane can reduce link performance by a factor of two. Furthermore, the terrain in front of the antenna must be free of buildings, bridges and other obstructions for a distance at least 30 times the height of the antenna. Trees and other shrubbery do not present a problem if they are kept at least 20 feet (6 meters) from any of the antenna elements.

The antenna for MBC operation generally does not require a tilt angle and can be mounted parallel to the ground. In the case of very short ranges (200-300 miles) and obstructions exceeding 5° from horizontal a tilt angle may be advantageous. Please consult MRC's sales department for specific recommendations.

### Antenna Selection

Horizontal polarization is normally used in a meteor burst network. The simplest antenna to use is a dipole, however, a Yagi antenna will provide an improvement in performance by a factor from 2 to 4, depending on the number of elements used.



**DIPOLE ANTENNA**



**3-ELEMENT YAGI ANTENNA**

The information bandwidth of the system is less than 20 KHz, therefore, a very narrow bandwidth antenna may be used when operating on a single frequency. In a two-frequency network the bandwidth of the antenna must be wide enough to accommodate both frequencies. The antenna must provide a 50Ω load. In the U.S. USDA SNOTEL Network, two frequencies are used:

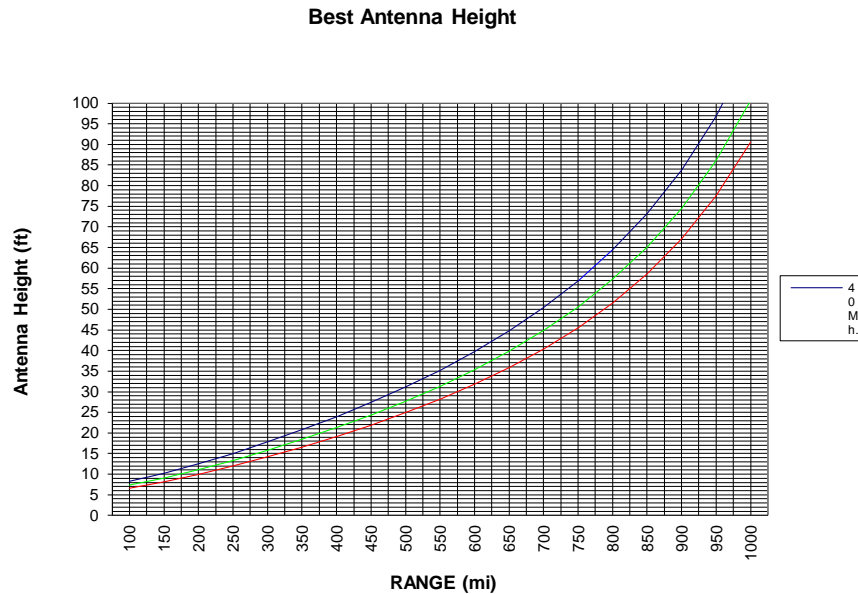
TX = 41.61 MHz and RX = 40.67 MHz. The Bandwidth of the antenna used is 1 MHz.

Always consult with MRC’s engineering department for assistance when any questions arise with respect to antenna selection.

Assembly instructions are included with each antenna. Please refer to these for proper assembly for all antenna elements.

**Antenna Height**

The height of the antenna for MBC operation should be optimized as a function of the distance between the remote station and the master station. A plot of optimum antenna height versus range is shown below.



**REMOTE STATION ANTENNA HEIGHT FOR METEOR BURST**

The antenna cable length must be kept as short as possible to minimize line losses. Try to maintain a line loss between the antenna and the MRC-565 to less than 2 dB.

A table of cable loss (at 50 MHz) for various types of co-ax cables is given below for reference.

CABLE TYPE	Loss/100 feet (dB)	Diameter (Inches)	Weight/100 feet (lbs.)
RG 223, RG 58	3.0	.211	3.4
RG 214, RG 8	1.8	.425	12.6
RG 17	1.2	.870	20.1
LDF4A-50 ½ inch heliax	.48	.500	15.0
LDF5A-50 7/8 inch heliax	.26	.875	33.0

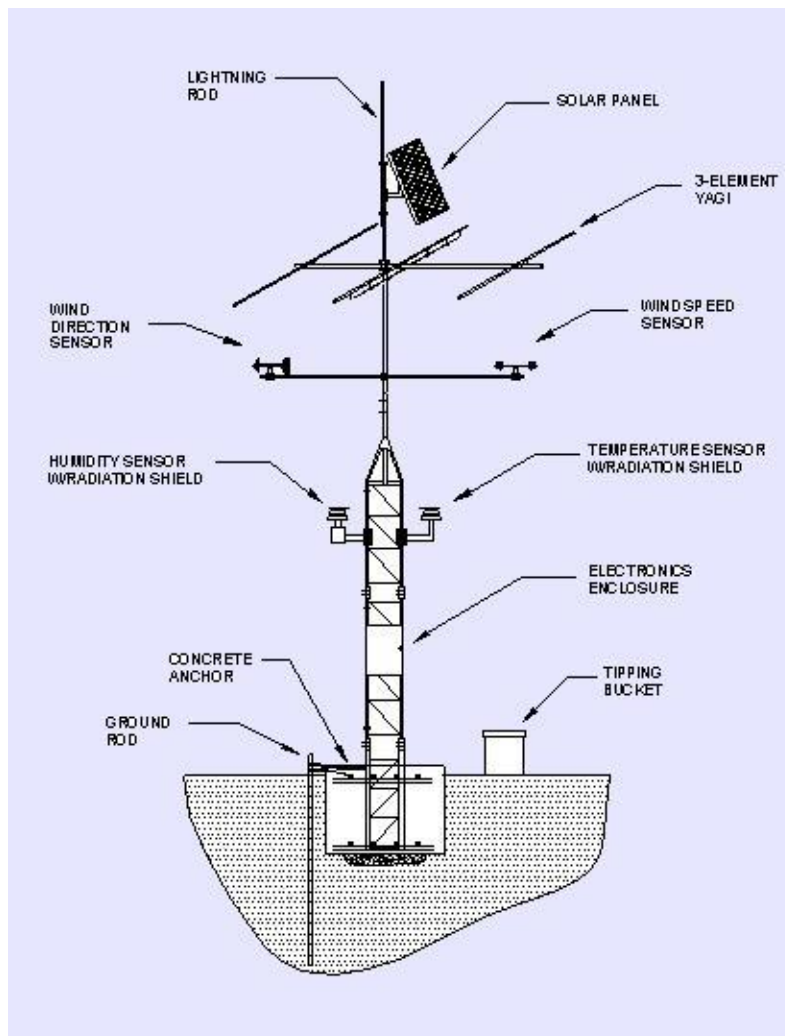
### **Human Exposure To Radio Frequency Electromagnetic Fields**

For fixed applications, antenna gains and mounting techniques can vary depending on the application. A Yagi antenna, not exceeding 10 dBi, must be mounted a minimum of .90 meters from humans. Lower gain antennas (5.2 dBi), such as side mount dipoles must be mounted no closer than .52 meters. This separation will provide RF shielding between the antenna and humans, reducing the RF exposure to levels below that specified in FCC OET Bulletin 65.

Always disable the transmitter when working on the antenna and/or co-ax cable.

## Equipment Installation

The MRC-565 operates over a temperature range from  $-30^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  and is housed in a aluminum case. A NEMA waterproof enclosure is recommended for outdoor installations. To ensure proper operation, shielded cable is recommended for all connectors. Also, use adequate strain relief on all cables and a weatherproof seal at the entry point of the enclosure. A typical remote station installation is shown below.



**Figure 12. Typical Remote Station with 3-Element YAGI Antenna**

APPENDIX D: INSTALLATION DETAILS

In general, the following components are required for a typical remote station installation (sensors are not specified since they will vary from site to site).

ITEM	DESCRIPTION	QTY	PART NUMBER
1	Packet Data Radio	1	MRC-56500300
2	Data Logger (optional)	1	CR10X/CR1000 or equivalent
3	Antenna (choose one of the following): Folded Dipole or 3-Element Yagi	1	MBD or MBY-3
4	40-60 Watt Solar Panel (with 20 ft., 12 AWG Cable)	1	
5	Mounting Bracket for Solar Panel	1	
6	Solar Panel Regulator, 6A	1	
7	Shielded Cable for Solar Panel	20 ft.	
8	12V, 100 A-H, Rechargeable, Sealed Battery	1	
9	6' Power Cable	1	
10	Lightning Surge Protector (Coax)	1	
11	Aluminum NEMA Enclosure	1	
12	Mounting Plate for NEMA Enclosure	1	
13	50' RG-214N Coax Cable	1	
14	Conduit Assembly	Lot	
15	Hose Clamps	Lot	
16	Ground Rod Assembly	1	
17	Tower Assembly	1	
18	Entry Connectors for NEMA Enclosure	Lot	
19	Padlock	1	
20	Lightning Rod	1	



# APPENDIX E: INTEROPERABILITY

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**APPENDIX E: INTEROPERABILITY WITH OTHER MRC PRODUCTS**

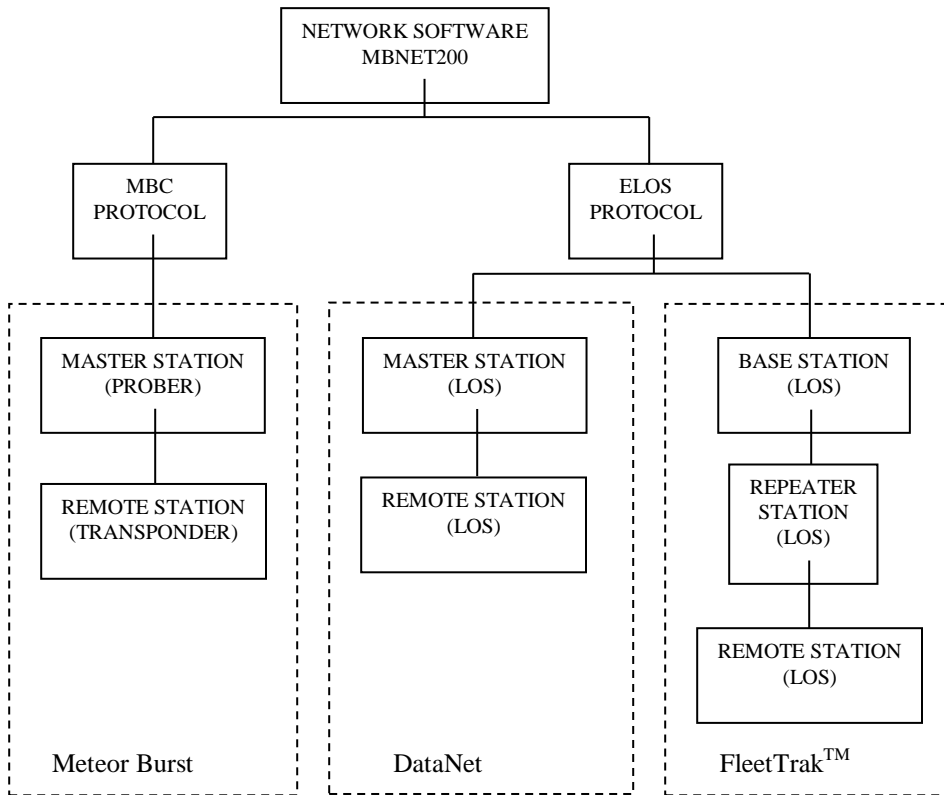
MBNET200 is the network software and operating system that is embedded within the MRC-565. This network software module is also embedded in MRC’s other products and provides interoperability among MRC’s three primary networks: Meteor Burst, DataNet and FleetTrak™.

MODEL NO.	DESCRIPTION	MODULATION
MRC-525	Meteor Burst Master Station	BPSK
MRC-565	Packet Data Radio	BPSK
MRC-565	Packet Data Radio	GMSK

There are two network protocols that are embedded within MBNET200:

- Meteor Burst Communications Protocol (MBC)
- Extended-Line-of-Sight Protocol (ELOS)

MRC configures these products and protocols into three distinct networks as shown in the figure below.



**Figure 13. MRC Networks**

The three primary products are used within the three networks as follows:

	MRC-525	MRC-565
<b>Meteor Burst</b>		
Master	X	
Remote		X
<b>DataNet</b>		
Master		X
Remote		X
<b>FleetTrak™</b>		
Base		X
Repeater		X
Remote		X

The MRC-565 Packet Data Radio is configurable into six different operating modes. Each mode is a function of its specific role within one of the three networks.

MODE	NETWORK	PROTOCOL	FUNCTION
Transponder	Meteor Burst	MBC	As a remote station in a meteor burst network
Master	DataNet	ELOS (CSMA)	Direct communications with other master stations in networks that have no landlines or a central Host. It also communicates with remote stations but not repeaters.
Base	FleetTrak™	ELOS (CSMA & TDMA)	It is connected by landline to a central Host. It communicates with both remotes and repeaters.
Repeater	FleetTrak™	ELOS (CSMA & TDMA)	As a repeater it communicates with base stations, other repeaters and remote stations.
Remote	FleetTrak™	ELOS (CSMA & TDMA)	As a remote it communicates with base stations, repeaters and other remote stations.
Remote	DataNet	ELOS (CSMA)	As a remote it communicates with Master Stations and other remote stations.

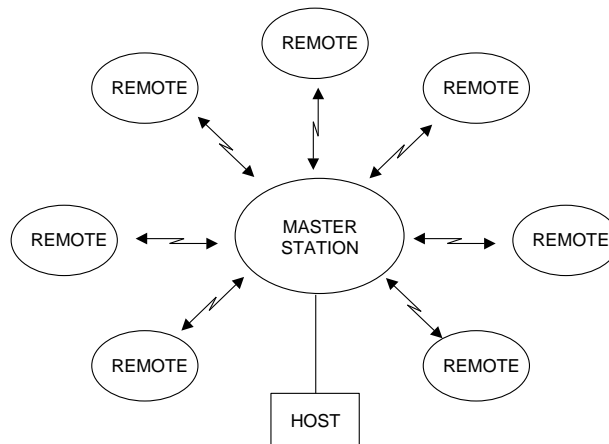
The MRC-565 operating with BPSK modulation has a 6 dB improvement in sensitivity over the MRC-565 operating with GMSK modulation, however, its data rate is limited to 4.0 kbps. The MRC-565 operating in GMSK has a maximum data rate of 9.6 kbps. Therefore, the choice between using the MRC-565 or the MRC-565C is a trade-off between performance and data rates.

For reference, each of the three networks are briefly described below.

### Meteor Burst

Meteor Burst is a meteor burst communication system (MBCS) that uses the MBC protocol. An MBCS system operates seamlessly between ground and meteor burst for the transmission of digital data. Groundwave will generally cover distances up to about 100 miles and meteor burst seamlessly extends this coverage to 1,000 miles. Groundwave provides instantaneous communications while meteor burst reflects signals off the ionized trails created by micrometeors entering the atmosphere at a height of 60 miles above the earth's surface. These trails, called bursts, are random but predictable in number and last from a few milliseconds to several seconds. During this brief period of time, information is exchanged between a master station and a remote station. MBCS is a natural time division multiplexed (TDMA) system, therefore thousands of remote stations can operate into one master station on a single frequency.

In its simplest form, a Meteor Burst network consists of one master station operating in a star configuration to all remote stations located within its RF communication range of 1,000 miles.

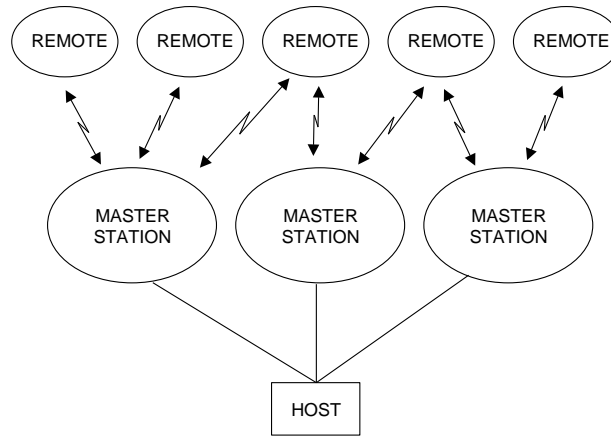


The master station is an MRC-520B and the remote stations are all MRC-565s. The master station is normally connected to a host computer in a Data Center or a customer's office. The network operates on either a single frequency for half-duplex or two frequencies for full-duplex.

The master station operates in the "probing" mode and the remote stations operate in the "transponder" mode. That is, when a remote station hears a probe signal from the master station it responds by transmitting the data stored in its buffer. The remote stations are programmed to respond at specific time intervals (e.g., hourly) and also based on events that may have occurred

at the remote station site. Programming may be done on-site or from any off-site location using a web browser.

Multiple master stations are interconnected into a clustered star configuration as shown below.



The remote stations transmit their data to whichever master station probe is received. Multiple master stations will significantly improve the performance of the network because of the additional RF links available to each remote station.

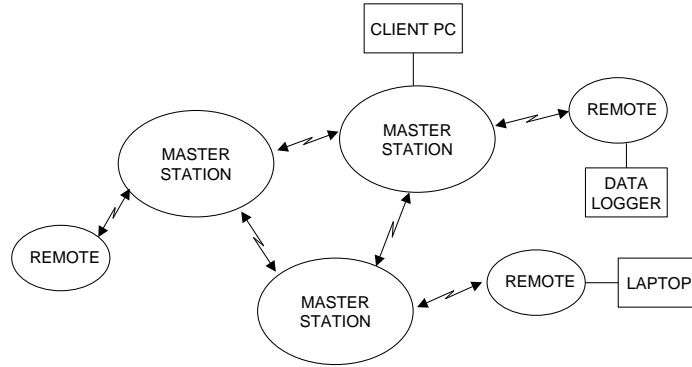
For a complete description of Meteor Burst networks, refer to MRC's web site or the documents referenced in Section 1.2.

The specific O&M manuals for the products used in a Meteor Burst network are:

MAN-OM-525 Meteor Burst Master Station  
 MAN-OM-MRC-565 Meteor Burst Remote Station

## DataNet

DataNet is an autonomous packet switched network that uses the ELOS protocol and does not require the use of landlines or a central Host. A typical network configuration is shown below.



DataNet is an ELOS system that uses the same robust protocols developed for meteor burst, however, it operates line of sight only and relies on groundwave diffraction, atmospheric diffraction and tropospheric propagation. These various modes of operation, along with robust protocols and low band VHF, provide communication ranges from 50 to 100 miles. DataNet is basically a cellular network with either an MRC-565 or MRC-565C operating as the master station for each cell. DataNet operates as either a single cell or can be expanded to include hundreds of cells. Adaptive network connectivity, two-way messaging and data acquisition are features embedded within the network.

All network data is routed between master stations and their respective remote stations. No repeaters are used. Access to the network is made at any node by connecting an operator terminal (e.g., a laptop or PC) to one of the RS-232 ports that are available at each of the master station and remote station locations. If desired, a Host may be interfaced to any one of the master stations using a landline.

The remote stations are normally at fixed locations and can interface to a variety of peripheral devices.

The connectivity between specific master stations and remotes are normally defined at the time the network is designed and deployed. If one master station goes down, the remote stations assigned to it automatically choose their own connectivity with a new master station based on their proximity to the master station, signal strength and other link parameters. Connectivity tables are automatically updated and exchanged among all master stations whenever a remote station attaches itself to a new master station.

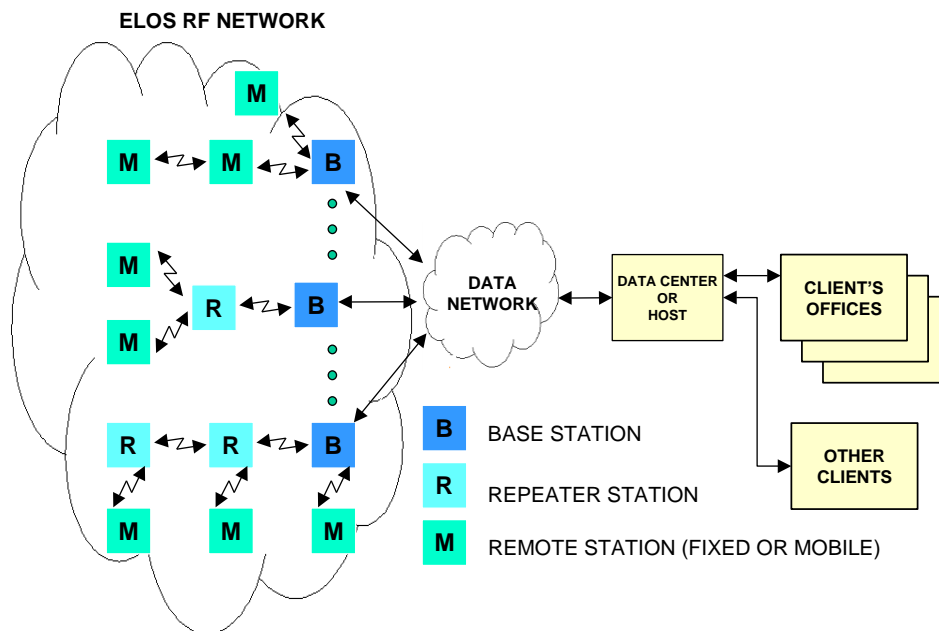
The network operates on a single frequency. The ELOS protocol uses CSMA for communication between all network nodes.

## FleetTrak™

The FleetTrak™ network is used for applications that require the position of mobile resources to be reported in real-time and at varying update rates. A typical FleetTrak™ network is shown below. One or more Data Centers are normally used for the central collection and distribution of data to a customer's office. The network can be as small as one base station or may be comprised of thousands of base stations, repeaters and remote stations. The networks are used for position reporting in mobile applications (AVL), fixed site data collection (SCADA) and messaging. Either an MRC-565 or MRC-565C may be used in a FleetTrak™ network.

The FleetTrak™ network operates line-of-sight using groundwave. The range of communication by groundwave is primarily determined by diffraction around the curvature of the earth, atmospheric diffraction and tropospheric propagation. These ranges are successfully extended by MRC from 50-100 miles through the use of robust protocols, sensitive receivers and short packetized messages.

The FleetTrak™ network uses the ELOS protocol and combines CSMA (carrier sense multiple access) and TDMA (time division multiple access) for achieving a channel utilization greater than 90%.



When a remote station (mobile) desires to establish connectivity with the network it sends a “poll request”, which specifies data type and desired update interval, to the nearest base station using the CSMA mode. The base station acknowledges this request and adds the mobile to its TDMA polling database. The mobile then sends its data in the TDMA mode when polled by the base station.

Since one base station may be in contact with hundreds of mobiles at any one time, it organizes the responses from up to 10 mobiles on a single transmission burst (TDMA). The ten mobiles

will then report in sequence, in accordance with their assigned transmit slots. The base station acknowledges the data received from each of the ten mobiles and then polls ten more mobiles on the next burst transmission.

Using the above techniques, there is no contention and all reports are delivered at a 90% channel utilization rate. With these efficiencies, sufficient channel time is still available for two-way messaging and various other non-periodic data transfers using the CSMA mode.

The MRC-565C is the only VHF transceiver used in the network. It can be dynamically configured to operate in three distinct modes: as a remote (mobile), as a base station or as a repeater station. As a base station, it also maintains RF communications with all mobiles operating within its own cell network, routing all data to a Host through a data network connected to one of its RS-232 ports.

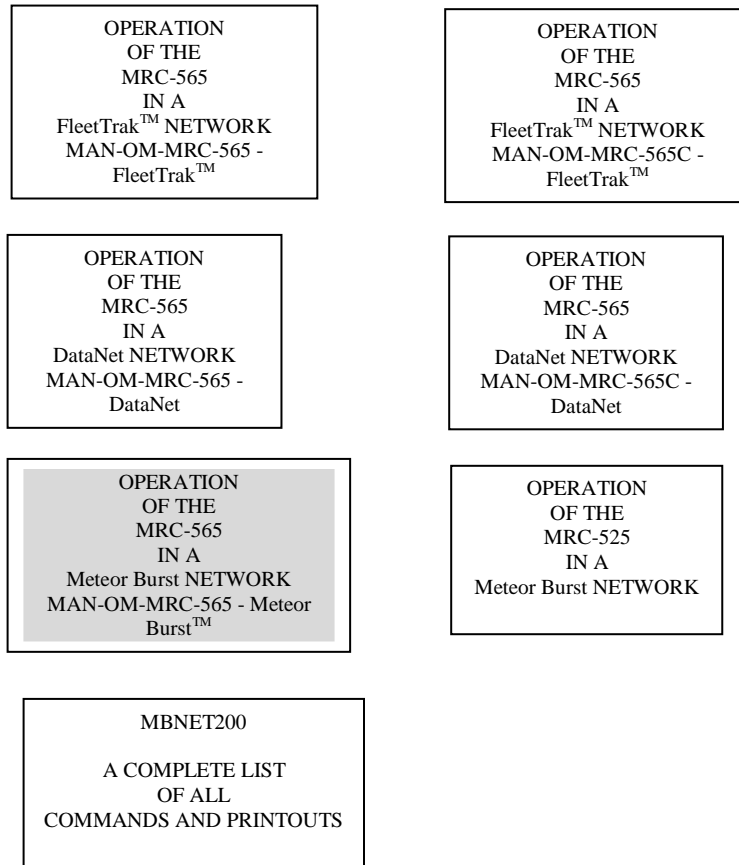
When a direct connection to a central Host is not available at a particular base station site, the MRC-565C is configured to operate as a repeater station. As a repeater station, it routes all data to the nearest base station for subsequent delivery to the Host. Multiple repeater links may be chained together for expansion of the network.

As a mobile, the MRC-565C is free to roam throughout the network, automatically linking with the nearest base station or repeater. When mobiles are out of range of a repeater or base station, but within range of other mobiles, they will automatically select another mobile as their repeater into the network. The only mobiles that may be selected are ones that have connectivity with a repeater or base station.



**Related Documents**

The documents that describe each product’s operating role within each of the three networks is shown below.



**Figure 14. Network Document Tree**